For safe measurement and control in hazardous areas

MTL700 SERIES

Shunt-diode safety barriers



Selected items within this Series are available in the UK through MTL's new express service

- **1 or 2 channels in same slim package**
- **Electronic protection prevents blown fuses**
- **All models short-circuit proof**
- **Stay-put tagging & cable-screen earthing**
- **Certified to worldwide standards**

MTL700 Series shunt-diode safety barriers are 1- or 2-channel devices which pass an electrical signal in either direction without shunting it, but limit the transfer of energy to a level that cannot ignite explosive atmospheres. Connected in series with the signal transmission lines on a process plant, they protect hazardous-area wiring and equipment against faults occurring in the safe area, and enable a wide range of measurement and control operations to be carried out simply and inexpensively by intrinsically safe techniques. Conventional wiring and, frequently, standard transducers can be employed in the hazardous area, and can be worked on for maintenance or calibration purposes without further precautions. Safe-area equipment needs no certification and can be modified or extended as required.

Applications include the protection of installations containing 'simple' uncertified devices such as thermocouples, switches, and resistive sensors, or separately certified 'energy storing' or 'voltage producing' apparatus, for example ac sensors, transmitters, and current-to-pneumatic (I/P) converters. All 'simple' devices can be used in areas of continuous hazard: 'energy-storing apparatus' is certified for use in a particular 'zone' or 'division'. MTL700 Series barriers give protection in all normally occurring explosive atmospheres, including all mixtures with air of flammable gases, vapours, dusts, fibres and flyings.

Essential features of the MTL700 Series are the self checking 'as-you-mount-it' earthing via two studs directly to nickel-plated brass or copper busbar. The earth connection is on top of the unit, allowing easy inspection, installation and removal. The shape of the barrier has been designed for easy wiring, while the common (14.5 mm) space requirement of both 1- and 2-channel units simplifies planning or alteration of installations of all sizes. The terminals of the barrier are angled for easy access and accept field wiring directly, making a second set of terminals unnecessary. The busbar is insulated for separate earthing, to eliminate the danger of invasion by fault currents.

The range was tailored to meet most users' needs without offering a confusing mass of options. Following the philosophy that users are busy people deserving clear solutions, we have highlighted throughout the literature the 7 'key' application-oriented barriers that meet the majority of process control requirements. These key barriers are stocked worldwide and are available from MTL distributors on immediate delivery, enabling users to reduce their inventory and making the choice and use of barriers even easier.

Overvolt protection in four models permits their use with unregulated power supplies.

For higher-power applications, a range of MTL700P barriers takes advantage of changes in interpretation of the standards. See page 2-14 for details.

References. The following documents are available for further information on MTL700 Series barriers:

AN9007 *A user's guide to shunt-diode safety barriers*
INM700 *The MTL700 and 700P Series instruction manual*
Technical papers *TP1064, TP1082, TP1083, TP1106*

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SPECIFICATIONS

'Key' barriers shown in blue

For notes 1 to 7 see 'Terminology' (page2-7)

Model No.	Safety description [1]			Polarities available [2]			Application	Basic circuit	Max. end-to-end resistance [3]	Vwkg at 10(1)µA [4]	Vmax [5]	Fuse rating [6]
				Hazardous				Safe				
MTL	V	Ω	mA	+	–	ac			Ω	V	V	mA
702	25	200	125	√			Transmitters	See 'HOW THEY WORK' (page 2-7) and 'OVERVOLT-PROTECTED BARRIERS' (page 2-5)	–	–	35	**See 'How they work' 50**
706	**28**	**300**	**93**	√			**Transmitters**		**–**	**–**	**35**	
†707	**28**	**300**	**93**	√			**Switches**		**–**	**–**	**35**	
	28	**diode**	**–**						**–**	**–**	**–**	
708	**28**	**300**	**93**	√			**Solenoids, alarms, LEDs**		**–**	**–**	**35**	
†710	10	50	200	√	√	√	6V dc & 4V ac systems	3 1 * 4 2	85	6.0	6.9 [c]	50
†715	15	100	150	√	√		12V systems		155	12.0	13.0	100
†722	22	150	147	√	√		18V dc systems		185	19.0	20.2	50
†728	**28**	**300**	**93**	√			**Controller outputs, solenoids**		**340**	**25.5**	**26.6**	**50**
728	28	300	93		√	√	Transmitters		340	25.5 [b]	26.6 [d]	50
751	1	10	100			√	Active dc & ac sensors (low impedance receivers)	3 1 ac 4 2	20	0.3	2.0	250
	1	10	100						20	0.3	2.0	250
755	**3**	**10**	**300**			√	**Resistance temperature detectors**		**18.0 [a]**	**(0.6)**	**3.6**	**250**
	3	**10**	**300**						**18.0 [a]**	**(0.6)**	**3.6**	**250**
758	7.5	10	750	√	√		Gas detectors	3 (26V:796) 1 * 4 (20V:796) 2	18	6.0	7.0	200
	7.5	10	750						18	6.0	7.0	200
†761	9	90	100			√			145	6.0	7.5	100
	9	90	100						145	6.0	7.5	100
764	12	1k	12	√	√	√	Strain-gauge bridges		1075	10.0	10.7 [e]	50
	12	1k	12						1075	10.0	10.7 [e]	50
†766	12	150	80			√			185	10.0	11.2	50
	12	150	80						185	10.0	11.2	50
767	15	100	150	√	√		12V dc systems		155	12.0	13.0	100
	15	100	150						155	12.0	13.0	100
768	22	150	147	√	√		18V dc systems	(768 & 779 require channels separate in IIC)	185	19.0	20.2	50
	22	150	147						185	19.0	20.2	50
779	28	300	93	√	√		Controller outputs		340	25.5	26.6	50
	28	300	93						340	25.5	26.6	50
796	26	300	87	√	√		Vibration probes (MTL796 negative)		340	23.5	24.6	50
	20	390	51						435	17.5	18.7	50
760	**10**	**50**	**200**			√	**Active dc & ac sensors Thermocouples**	3 1 ac 4 Star connected (Note 7) 2	**85**	**6.0**	**7.4**	**50**
	10	**50**	**200**						**85**	**6.0**	**7.4**	**50**
765	15	100	150			√			135	12.0	13.2	50
	15	100	150						135	12.0	13.2	50
772	22	300	73			√	2-wire dc & ac systems		340	18.0	19.7	50
	22	300	73						340	18.0	19.7	50
778	28	600	47			√			665	24.0	25.7	50
	28	600	47						665	24.0	25.7	50
786	28	diode	–	√	√		Signal returns	3 1 4 2	2.2V+30Ω	25.5	26.6	50
	28	diode	–						2.2V+30Ω	25.5	26.6	50
787	28	300	93	√	√		Controller outputs, switches	3 1 787S 4 2	340	25.5	26.6	50
	28	diode	–						2.2V+30Ω	25.5	26.6	50
†787S	**28**	**300**	**93**	√			**Transmitters**		**340**	**25.5**	**26.6**	**50**
	28	**diode**	**–**				**Controller outputs, switches**		**0.9V+20Ω**	**25.5**	**26.6**	**50**
788	28	300	93	√	√		Transmitters	3 (28V) 1 250Ω 4 (10V) 2	340	25.5	26.6	50
	10	50	200						85	6.0	6.9	50
									340	25.5	26.6	50
788R	28	300	93	√	√				85	6.0	6.9	50
	10	50	200									
791	11	51	216	√			31.25kbit/s Fieldbus installations	3 1 Internal terminator 4 2	62.6	10V (at 50µA)	10.5	100
	11	51	216		√				62.6	–10V (at 50µA)	–10.5	100
799	Dummy barrier for securing cables for future installations – takes hazardous-area circuits to earth							3 1 Terminal 1 & 2 open circuit 4 2				

a: Tolerance ±0.15Ω at 20°C, channels track within 0.15Ω from –20 to +60°C.
b: ac version 24.5V.
c: ac version 7.4V.
d: ac version 26.1V.
e: ac version 11.2V.
†: For higher-power versions of these barriers, see page 2-15.
*Diagrams show positive versions. All diodes reversed on negative versions. Additional diodes fitted on ac versions.
Patents for MTL787S: UK Patent No. 2210522, USA Patent No. 4860151

OVERVOLT-PROTECTED BARRIERS

MTL702+* for 2-wire 4/20mA transmitters

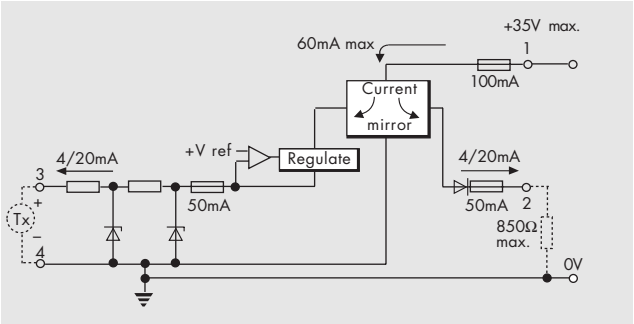
The MTL702+ is a 1-channel shunt-diode safety barrier, with built-in electronic overvolt protection, for energising a 2-wire 4/20mA transmitter in a hazardous area. It is powered from a positive supply of 20–35V dc and delivers a 4/20mA signal into an earthed load in the safe area. It is proof against short circuits in the field and in the safe area, and is highly accurate. Like all barriers, the MTL702+ will pass incoming communication signals of any frequency from a 'smart' transmitter, but inherently it cannot pass any such signals in the outgoing direction.

Since the MTL702+ has no return channel for energising the load, the entire output of the single '25V' channel is available to power the transmitter, providing high output capability. This channel is positively polarised, and the safe-area signal is derived from the current that flows through it by means of a built-in 'current-mirror' amplifier, with unity current gain, which repeats the current in a separate circuit in the safe area.

To prevent any leakage through the Zener diodes and maximise the output voltage available at 20mA, the voltage applied to the barrier section is held constant at a suitable reference value by a comparator amplifier and regulator. A separate circuit limits the current to protect the fuse in the event of a short circuit in the hazardous area.

With a 22V supply, the MTL702+ will deliver 14V at 20mA for the transmitter and lines and a quite exceptional 17V for the load, both voltages being increased by 2V if the supply is at least 24V. The maximum consumption in normal operation is 60mA.

BASIC CIRCUIT



ADDITIONAL SPECIFICATION (MTL702+)

Supply voltage
20 to 35V dc, positive w.r.t. earth
Voltage available for transmitter and lines (at 20mA)
(V_{supply} – 8V), limited at 16V
Voltage available for load (at 20mA)
V_{supply} – 5V
Load resistance
850Ω maximum
Output impedance to load
>1MΩ
Calibrated accuracy (at 20°C with 250Ω load)
0.05% of maximum output, including non-linearity and hysteresis
Zero temperature drift
<0.005% of maximum output per °C
Span temperature drift
<0.005% of maximum output per °C
Supply current
8 to 40mA + 10mA max. at 20V
8 to 40mA + 20mA max. at 35V
* Not CE marked.

OVERVOLT–PROTECTED BARRIERS

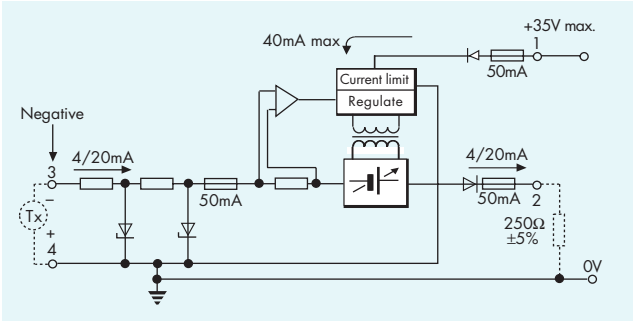
Four models in the Series (MTL702+, 706+, 707+ and 708+) have built-in overvolt protection, allowing their use with unregulated power supplies. In many applications, eg, sensor inputs or controller outputs, there is insufficient power available to blow the barrier fuse and this additional protection is not necessary. But, where the barrier is connected to a power supply, eg, for energising transmitters, switches, solenoids or local alarms, overvolt protection allows the barriers to be used with unregulated supplies up to 35V dc and also gives protection against faulty wiring during commissioning.

MTL706+ for 'smart' 2-wire 4/20mA transmitters

UK Patent No. 2205699
European Patent (Germany, France, Italy) No. EP 0 294 139 B1
USA Patent No. 4967302

The MTL706+ is a 1-channel shunt-diode safety barrier, with built-in electronic overvolt protection, for energising a 2-wire 4/20mA transmitter in a hazardous area. It is powered from a positive supply of 20–35V dc and delivers a 4/20mA signal into an earthed load in the safe area. It is proof against short circuits in the field and in the safe area and is extremely accurate. The MTL706+ will pass incoming communication signals up to 10kHz from a 'smart' transmitter, while in the outgoing direction it will pass signals of any frequency likely to be encountered.
Since the MTL706+ has no return channel for energising the load, the entire output of the single '28V' channel is available to power the transmitter, providing high output capability. This channel is negatively polarised, and the safe-area signal is in fact the very current that returns through it from the hazardous area, the novel circuit being energised by a built-in floating dc supply derived from the external dc source of power.
To prevent any leakage through the Zener diodes and maximise the output voltage available at 20mA, the floating supply is given a rising voltage/current characteristic. This is achieved by monitoring the 4/20mA current, an arrangement which allows all-frequency communication in both directions. A separate circuit limits the current to protect the fuse in the event of a short circuit in the hazardous area.
With a 22V supply, the barrier will deliver 15V minimum at 20mA for the transmitter and lines and consumes less than 40mA in normal operation.
Note: the MTL706+ supersedes the MTL705+, which was similar in basic performance but did not pass outgoing communication signals below about 1kHz.

BASIC CIRCUIT



ADDITIONAL SPECIFICATION (MTL706+)

Supply voltage
20 to 35V dc, positive w.r.t. earth
Output current
4 to 20mA
Voltage available for transmitter and lines
15V minimum at 20mA with 22V supply
15.5V typical at 20mA with 24V supply
Note: voltages are negative w.r.t. earth
Load resistance
250Ω ±5% (can be greater if reduced transmitter voltage is acceptable)
Accuracy
±2µA under all conditions
Supply current
35mA typical at 20mA with 24V supply
40mA maximum at 20mA with 35V supply

OVERVOLT-PROTECTED BARRIERS
(continued)

MTL707+ for switch inputs

UK Patent Nos. 2245439, 2210521
European Patent No. EP 0 310 280 B1

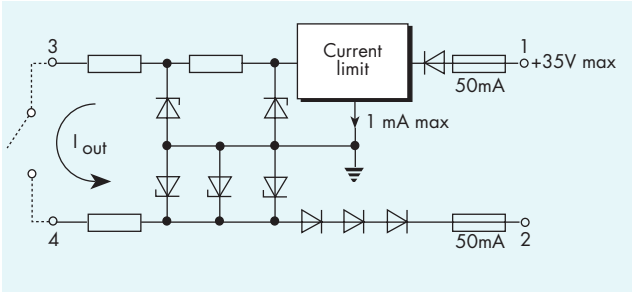
The MTL707+ is a 2-channel shunt-diode safety barrier similar to the MTL787+ but with built-in electronic overvolt protection. It is intended primarily for safeguarding a hazardous-area switch controlling a relay, opto-coupler or other safe-area load from an unregulated dc supply in the safe area.

The outgoing channel accepts supply voltages up to +35V and is protected against reverse voltages: the return channel is unaffected by voltages up to +250V.

In normal operation the protection circuit introduces only a small voltage drop and shunts less than 1mA to earth, so its overall effect is minimal. If the supply voltage exceeds about 27V, however, causing the Zener diodes to conduct – or if the safe-area load has a very low resistance – the supply current is limited automatically to 50mA, protecting the fuse and power supply and enabling the loop to continue working.

For a higher-power version of this barrier, see page 2-15.

BASIC CIRCUIT



ADDITIONAL SPECIFICATION (MTL707+)

Supply voltage (V_s)
10 to 35V dc, positive w.r.t. earth
Output current (I_{out})
Up to 35mA available
Maximum voltage drop (at 20°C, current not limited)
I_{out} x 370Ω + 1.5V, terminal 1 to 3
I_{out} x 50Ω + 2.1V, terminal 4 to 2
Supply current
I_{out} + 1mA max, Vs <26V
Limited at 50mA, Vs >28V or low load resistance

MTL708+ for switched outputs

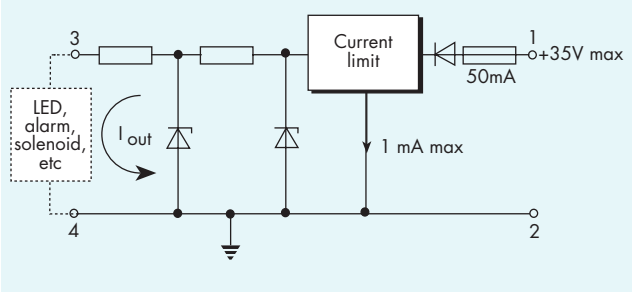
UK Patent No. 2210521
European Patent No. EP 0 310 280 B1

The MTL708+ is a 1-channel shunt-diode safety barrier similar to the MTL728+ but with built-in electronic overvolt protection. It is intended primarily for safeguarding solenoids, alarms, light-emitting diodes or other hazardous-area loads controlled by a safe-area switch from an unregulated dc supply in the safe area.

The barrier accepts supply voltages up to +35V and is protected against reverse voltages.

In normal operation the protection circuit introduces only a small voltage drop and shunts less than 1mA to earth, so its overall effect is minimal. If the supply voltage exceeds about 27V, however, causing the Zener diodes to conduct – or if the hazardous-area load has a very low resistance – the supply current is limited automatically to 50mA, protecting the fuse and power supply and enabling the loop to continue working.

BASIC CIRCUIT



ADDITIONAL SPECIFICATION (MTL708+)

Supply voltage (V_s)
10 to 35V dc, positive w.r.t. earth
Output current (I_{out})
Up to 35mA available
Maximum voltage drop (at 20°C, current not limited)
I_{out} x 370Ω + 1.5V, terminal 1 to 3
Supply current
I_{out} + 1mA max, Vs <26V
Limited at 50mA, Vs >28V or low load resistance

HOW THEY WORK

All MTL700 Series barriers are based on the same simple principle. Each channel contains two stages of pulse-tested Zener or forward-connected diodes and an 'infallible' terminating resistor. In the event of an electrical fault in the safe area, the diodes limit the voltage that can reach the hazardous area and the resistor limits the current. A fuse protects the diodes, and the two stages of voltage limitation ensure continued safety if either stage should fail. No active output-current limiting circuits are employed. All models are certified 'ia' for all zones and 'IIC' for all explosive atmospheres.

TERMINOLOGY

1. Safety description
The safety description of a barrier, eg '10V 50Ω 200mA', refers to the maximum voltage of the terminating Zener or forward diode while the fuse is blowing, the minimum value of the terminating resistor, and the corresponding maximum short-circuit current. It is an indication of the fault energy that can be developed in the hazardous area, and not of the working voltage or end-to-end resistance.

2. Polarity
Barriers may be polarised + or –, or non-polarised ('ac'). Polarised barriers accept and/or deliver safe-area voltages of the specified polarity only. Non-polarised barriers support voltages of either polarity applied at either end. An exception to this is the MTL791 Fieldbus barrier which has one positive and one negative channel.

3. End-to-end resistance
The resistance between the two ends of a barrier channel at 20°C, ie of the resistors and the fuse. If diodes or transistors are present, their voltage drop (transistors ON) is quoted in addition.

4. Working voltage (Vwkg)
The greatest steady voltage, of appropriate polarity, that can be applied between the safe-area terminal of a 'basic' barrier channel and earth at 20°C for the specified leakage current, with the hazardous-area terminal open circuit.

5. Maximum voltage (Vmax)
The greatest steady voltage, of appropriate polarity, that can be applied continuously between the safe-area terminal of any barrier channel and earth at 20°C without blowing the fuse. For 'basic' barriers, it is specified with the hazardous-area terminal open circuit; if current is drawn in the hazardous area, the maximum voltage for these barriers is reduced. The 'ac' channels of 'basic' barriers and most channels of overvolt-protected barriers withstand voltages of the opposite polarity also – see circuit diagrams.

6. Fuse rating
The greatest current that can be passed continuously (for 1000 hours at 35°C) through the fuse.

7. Star connection
In star-connected barriers, the two channels are interlocked such that the voltage between them cannot exceed the working voltage, Vwkg: this allows for higher cable capacitance or inductance.

8. Maximum safe-area voltage (U_m)
The maximum permissible safe-area voltage (U_m) for MTL700 Series barriers is 250V ac/dc.

GENERAL SPECIFICATION

Ambient temperature and humidity limits
–20 to +60°C continuous working
–40 to +80°C storage
5–95% RH

Leakage current
For 'basic' barriers with a working voltage of 5V or more, the leakage current decreases by at least one decade per volt reduction in applied voltage below the working voltage, over two decades. For the MTL755 it decreases by at least one decade for a 0.4V reduction in applied voltage.

Terminations
Terminals accommodate conductors up to 4mm² (12AWG)
Hazardous-area terminals are identified by blue labels.

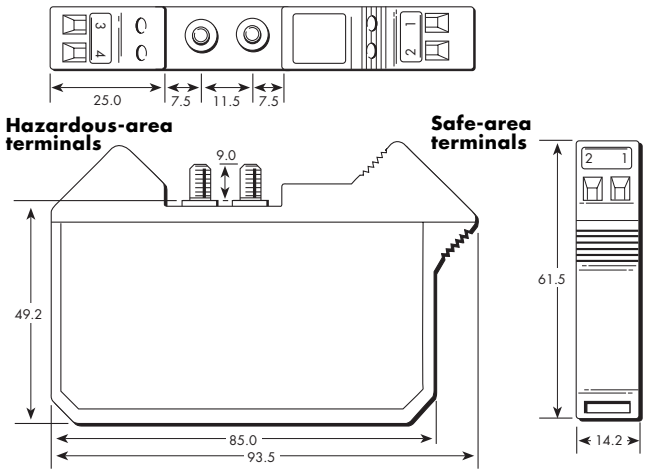
Colour coding of barrier top
Grey: non-polarised
Red: positive polarity
Black: negative polarity
Black (red label for safe-area terminals): positive supply, negative to transmitter (MTL706)
White: dummy barrier, MTL799

Weight
125g approx

Mounting and earthing
By two integral M4 x 9 tin-lead plated steel fixing studs and stainless steel self-locking nuts (provided).

EMC compliance
EN 50 081-2/EN 50 082-2, generic emission/immunity standards. These refer to appropriate IEC/CISPR standards.

DIMENSIONS (mm)



KEY BARRIERS SUMMARISED

TYPE	APPLICATION	KEY BARRIER	
Analogue input (low-level)	Resistance temperature detectors Thermocouples, ac sensors	**755ac** **760ac**	
Analogue output	Controller outputs, one line earthed Controller outputs, neither line earthed	**728+** **787S+**	
		dc power supply	
		26.0V	20–35V
Analogue input (high-level)	Transmitters, 2-wire, 4/20mA	**787S+**	**706+**
Digital (on/off) input	Switches	**787S+**	**707+**
Digital (on/off) output	Solenoids, alarms, LEDs	**728+**	**708+**

Patents for MTL706+, 707+, 708+, 787S+

Telematic Ltd offers compatible surge protection devices of identical mechanical construction to the MTL700 Series.

Ask for the MTL370 Series data sheet!

CHOOSING A BARRIER – FOR SENSORS

Choosing the right barrier is now even easier – just scan these four pages to find the answer. The majority of requirements are met by seven 'key' barriers, which are held in stock by MTL distributors all over the world and usually provide the most economical solutions. For quick identification we have picked them out in blue. Where alternatives exist, use a key barrier if possible. If you do not find what you require, please consult Application Note AN9007, available from MTL, or contact our experts at Luton.

Note: voltage figures shown on busbar are safety description values.

Hazardous area | **Safe area**

ANALOGUE INPUTS, LOW LEVEL

Thermocouples

The preferred barrier for thermocouples is the MTL760ac, whose 2-channel non-polarised design retains the 'earth-free' nature of the signal. Provided that the receiver's input circuit floats, the combination rejects common-mode ac and dc interference up to at least 6V and is unaffected by earth faults on the primary element. Even if the receiver's circuit is tied to its '0V' rail, the use of a 2-channel barrier takes the worry out of earthing. To eliminate errors due to thermal emfs, the compensating cable should be continued from the barrier to the receiver. For moving coil or other low resistance receivers, use the MTL751 (40Ω) or the MTL755ac (36Ω) if the resistance of the MTL760 (170Ω) is unacceptable.

USA regulations permit the thermocouple to be earthed on the assumption that the barrier will not conduct, but Europe and other 'IEC countries' assume that it may do so. In these countries either the thermocouple and its cables must be insulated to withstand 500V, Fig. 1; or the earth loop must be broken by an isolating transmitter, Fig. 2, or by one of the isolating interface devices in the MTL2000, 3000, 4000 or 5000 Series.

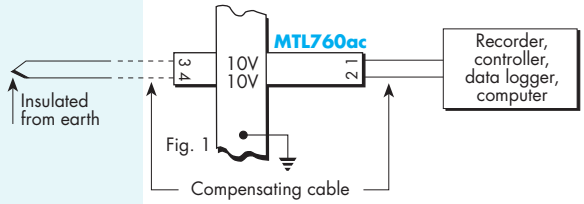


Fig. 1

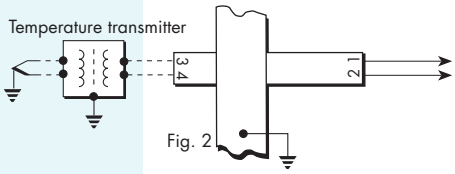


Fig. 2

Photocells, ac sensors, flowmeters

Similar arguments apply, and the MTL760ac is recommended, Fig. 3. Any other 2-channel non-polarised barrier that will handle the voltage would be suitable. All MTL barriers of this type transmit signals up to a few kHz. At higher frequencies the self capacitance of the Zener diodes – around 1000pF – may attenuate the signal. No certification is required for sensors generating less than 1.2V, 0.1A, 20μJ and 25mW. In practice this includes all photocells, but some ac sensors may have significant inductance and require to be designed and certified for use in hazardous areas.

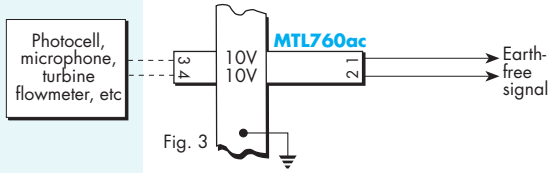


Fig. 3

Resistance temperature detectors

For 3-wire circuits with a floating bridge, the most economical solution is provided by the MTL755ac 2-channel barrier, Fig. 4. The two leads from the bridge arms are protected by the barrier, while the third (supply) lead is earthed at the busbar. The MTL755ac has a low end-to-end resistance of only 18.0Ω per channel to minimise span changes, and its channels track within 0.15Ω (from –20 to +60°C) to minimise zero shift with temperature. Close tolerancing of each channel to ±0.15Ω at 20°C facilitates barrier substitution.

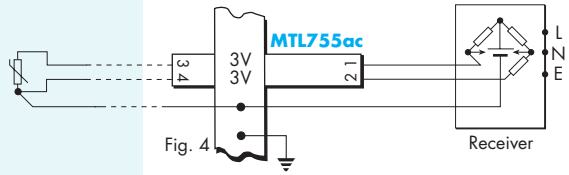


Fig. 4

If the bridge circuit is already earthed, a third barrier channel is needed; in practice this can be one half of another MTL755ac, Fig. 5. For extreme accuracy use three channels and an earth-free bridge, since the small errors due to barrier leakage tend to cancel.

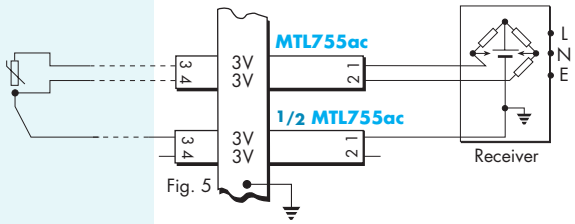


Fig. 5

4-wire constant-current circuits do not require matched barrier resistances, and can be protected more economically by two MTL761ac 2-channel barriers, Fig. 6. If the increase in loop resistance is too great, use two MTL755acs.

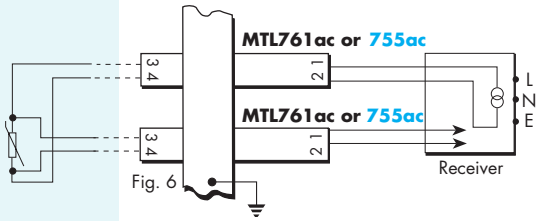


Fig. 6

CHOOSING A BARRIER – FOR SENSORS

Analogue inputs, low level (continued)

Slidewire displacement transducers

There are many solutions. Perhaps the simplest is that shown in Fig. 7, where an MTL760ac supplies power and brings back a unipolar signal. Other barriers that could be used include the MTL761ac, 765ac, 772ac, 778ac. Where polarity reversal or very high accuracy are required, use the techniques designed for strain-gauge bridges, below.

Strain-gauge bridges

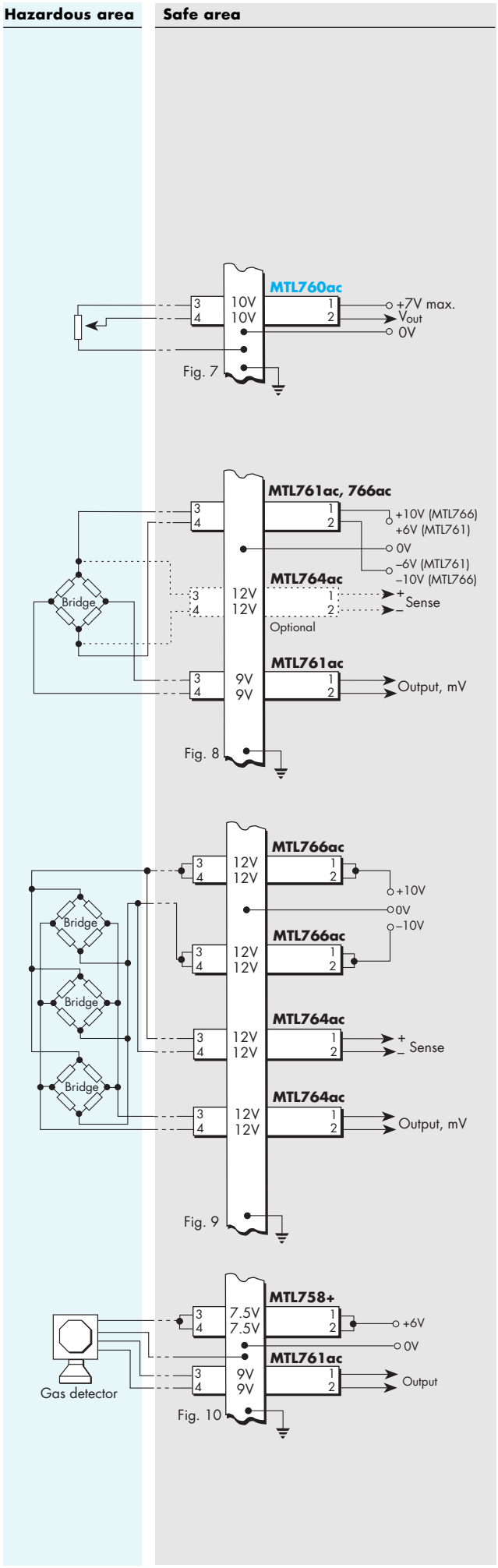
Fig. 8 shows an arrangement using two or three barriers, which is safe in IIC gases (system certificate no. Ex842125). With the MTL761ac, the circuit is powered from a 12V, 290Ω source; if the bridge resistance is 290Ω, then the bridge voltage is 6V. If the MTL766ac is used, the source is 20V, 370Ω, and provides a bridge voltage of 10V when the bridge resistance is 370Ω.

Quite frequently there is a demand to monitor three load cells, and a possible circuit is shown in Fig. 9 (system certificate no. Ex842128). The two channels of each MTL766ac barrier are connected in parallel to reduce the source resistance, and provide 8V across the three 350Ω bridges. However, the higher energy present means that the system is safe in IIA and IIB gases only.

For more power in IIC gases, see the MTL761Pac and MTL766Pac application on page 2-16.

Gas detectors, logic systems

Some devices require a high current at a low voltage, for example, 300mA at 2.3V for a typical gas detector. The low end-to-end resistance (18Ω) of the 2-channel MTL758+, and its working voltage of 6V, make this barrier ideal for energising gas detectors, 5V logic systems, certain displays and similar equipment. The two channels can be used separately or in parallel as required, and the system remains safe in IIC gases if an MTL761ac is added to bring back the measurement.



CHOOSING A BARRIER – FOR TRANSMITTERS AND SWITCHES

ANALOGUE INPUTS, HIGH LEVEL

2-wire 4/20mA transmitters

If several transmitters are to be operated from a common dc supply, and this can be closely regulated (at 26V max), the MTL787S+ now beats the previously recommended MTL788+ by nearly half a volt, providing up to 12.9V at 20mA for a transmitter and its lines, as well as the usual 5V for the load, Fig. 11. Its return channel is more tolerant of errors during installation and fault finding, and it is safe with cables of much higher inductance. If the load requirement can be reduced, the voltage available for the transmitter will be greater.

For a higher power barrier providing up to 14.6V at 20mA, refer to MTL787SP+ on page 2-16.

The voltage available for the transmitter and its lines can be increased by converting the return current into a 1–5V signal before it passes through an MTL788+ barrier. The MTL788R+ contains a 250Ω precision resistor for this purpose and makes 14.2V available, Fig. 12.

If greater voltage capability is required for the transmitter or the load, or the supply is not closely regulated, then the MTL702+ is a proven good solution, Fig. 13. This overvolt-protected barrier delivers 14V at 20mA for the transmitter and lines from a 22–35V supply, plus a quite exceptional 17V for the load, both voltages being increased by 2V if the supply is at least 24V. It will pass incoming communication signals of any frequency from a 'smart' transmitter but inherently cannot pass signals in the outgoing direction. Accuracy is high and current consumption is less than 60mA.

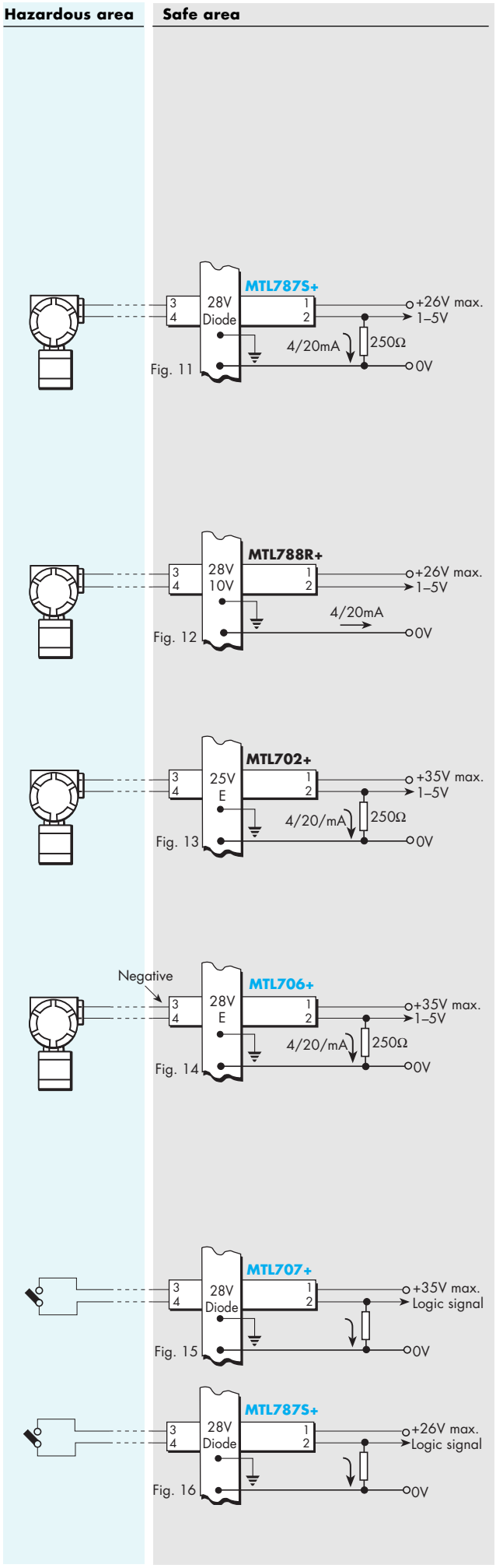
Where 2-way communication with 'smart' transmitters is required, there are two solutions. If the supply is closely regulated, choose the MTL787S+ (above). If it cannot be closely regulated, choose the MTL706+, Fig. 14. This overvolt-protected barrier – derived from the previously recommended MTL705+ – provides 15V at 20mA for the transmitter and lines from a 22–35V supply, plus 5V for the load. It is lower in cost than the MTL702+, is extremely accurate, has a standard safety description and consumes only 35mA. Note that the load resistor must be 250Ω ±5% and that terminal 3 is negative.

DIGITAL (ON/OFF) INPUTS

Switches

For switch-status transfer, Fig. 15, the MTL707+ is preferred for two reasons. First, the circuit fails safe if there is an earth fault on either line – ie the safe-area load de-energises. Second, the MTL707+ accepts up to 35V from poorly regulated power supplies without blowing its fuse: if the supply is well regulated, the MTL787S+ can be used, see Fig. 16.

In both cases, optimum power transfer with relays is achieved if the resistance of the load is made about equal to the combined resistance of the two channels. The relay coil should then be rated at about half the supply voltage.



CHOOSING A BARRIER – FOR CONTROL ELEMENTS

ANALOGUE OUTPUTS

Controller outputs – 4 to 20mA

In most cases the output current of a controller flows directly to its '0V' rail and the rail can be earthed at the busbar, Fig. 17. Occasionally the output circuit may be fully floating. In either event the 1-channel MTL728+ or half an MTL779+ provides the best solution. Overvolt protection is not required, since current limiting in the controller protects the fuse in the barrier. The voltage drop introduced by the barrier is 6.8V at 20mA.

If the output circuit of the controller is separated from the '0V' rail by the control transistor, Fig. 18, a 2-channel barrier is necessary. The MTL787S+ is recommended, since its return channel can handle up to 25.5V, allowing the control signal to be turned off completely. The voltage drop introduced by the barrier is 8.1V at 20mA.

The MTL787S+ is also suitable for controllers containing a resistor which enables the return current to be monitored for high-integrity operation, Fig. 19.

For higher-power I/P converters in IIC gases, refer to MTL728P+ or MTL787SP+ on page 2-17.

For IIB gases, refer to MTL729P+ on page 2-17 or 707P on page 2-16.

DIGITAL (ON/OFF) OUTPUTS

Solenoids, alarms, LEDs

Most solenoid valves, alarms, light-emitting diodes (LEDs) and other on/off hazardous-area loads are best driven via an MTL708+ 1-channel barrier, with built-in overvolt protection, Fig. 20. The circuit fails safe with an earth fault on the live line and is unaffected by an earth fault on the earth return, while the barrier will accept up to 35V without blowing its fuse. If the supply is well regulated, an MTL728+ or half an MTL779+ can be used.

For more power in IIC gases, refer to MTL728P+ on page 2-17.

Should greater power be required for heavy-duty solenoids in IIB or IIA gases only ('IEC countries'; C & D in USA and Canada), use the two channels of the MTL779+ connected in parallel or consider the MTL3022 or MTL5022.

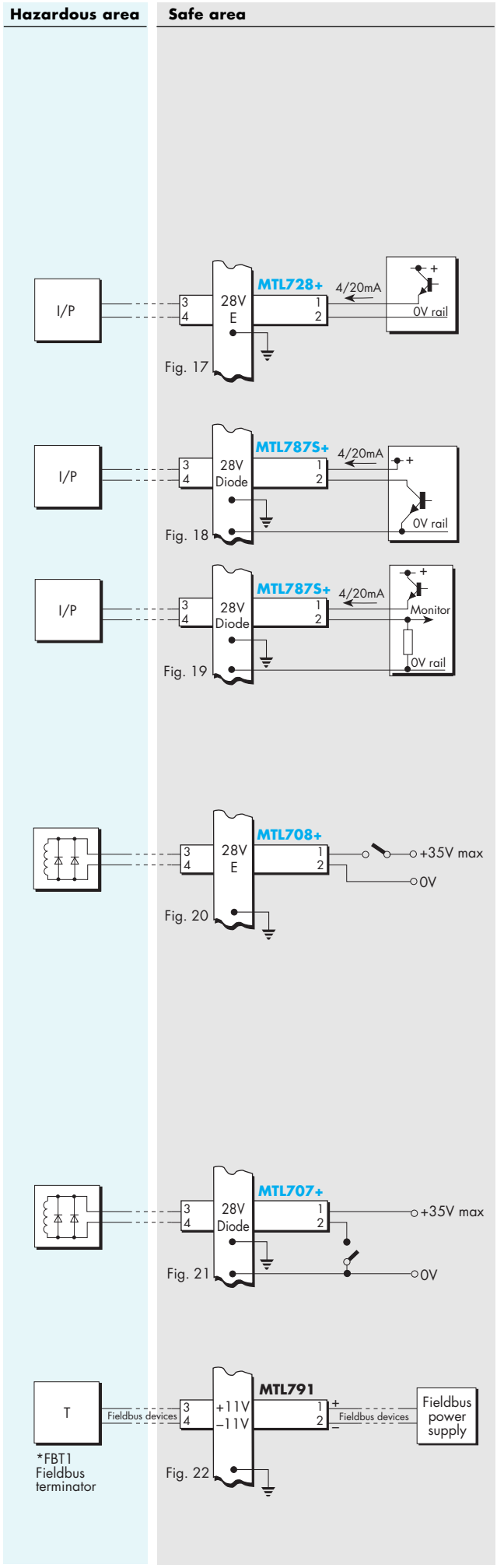
Alternatively, consider the higher-power MTL729P+ on page 2-17.

If the control switch is on earth, then a 2-channel barrier has to be used, Fig. 21, but be aware that an earth fault on the return line will energise the solenoid, whereas one on the live line does the opposite. If the supply is poorly regulated use the MTL707+ *(or MTL707P+)*. If it is well regulated use the MTL787S+ *(or MTL787SP+)*. Alternatively, for operational safety, use an MTL2000, 3000, 4000 or 5000 Series isolating interface unit.

Fieldbus applications

The MTL791 (Fig. 22) is a 2-channel barrier designed specifically for 31.25kbit/s Fieldbus applications. Used with a suitable floating Fieldbus power supply of up to 20V (such as that provided by the MTL5995 unit) it extends the range of Fieldbus applications into hazardous areas. It is provided with an internal integral safe-area terminator*.

** 'Terminators' are used to terminate a Fieldbus – see section 7 for details of the FBT1 DIN-rail mounting terminator.*



How to use it – Cable parameters and permitted combinations

Barrier model number MTL	Number of single channels interconnected within hazardous area	Earth [1] return used?	Maximum permissible cable parameters					Matched [3] power W (BASEEFA)
			BASEEFA (group IIC) [2]			FM (groups A&B)		
			Capacitance µF	Inductance mH	or L/R ratio µH/Ω	Capacitance µF	Inductance mH	
702+	1	Yes	0.17	2.2	46	0.17	2.2	0.78
706+	1	Yes	0.13	4.2	55	0.12	4.0	0.65
707+	Both	Yes	0.13	4.2	55	0.12	4.0	0.65
708+	1	Yes	0.13	4.2	55	0.12	4.0	0.65
710	1	Yes	3.0	0.95	72	3.0	1.0	0.50
715	1	Yes	0.75	1.65	65	0.7	1.4	0.56
722	1	Yes	0.26	1.75	46	0.2	1.4	0.81
728	1	Yes	0.13	4.2	55	0.12	4.0	0.65
751ac	1	Yes	1000	3.6	1450	1000	4.5	0.025
	2	Yes	1000	0.95	540	1000	1.2	0.05
		No	1000	3.6	725	1000	4.5	0.05
755ac	1	Yes	1000	0.46	165	1000	0.4	0.23
	2	Yes	1000	0.125	69	150	0.1	0.45
		No	40	0.46	70	150	0.1	0.45
	3	No	40	0.125	48	–	–	0.68
	4	Yes	40	0.035	31.25	–	–	0.92
		No	40	0.06	42	–	–	0.92
758	1	Yes	10	0.070	27	6.0	0.05	1.41
	2	Yes	10	0.013	10.5	6.0	0.02	2.82
760ac	1	Yes	3.0	0.95	72	3.0	0.9	0.50
	2	Yes	3.0	0.27	28	3.0	0.2	1.00
761ac	1	Yes	5.0	3.6	161	3.1	3.5	0.23
	2	Yes	5.0	0.95	60	0.4	1.0	0.45
		No	0.42	3.6	80	0.4	1.0	0.45
	4	Yes	0.42	0.20	26.39	–	–	0.90
		No	0.42	0.37	37.78	–	–	0.90
	6	Yes	0.42	0.085	14.39	–	–	1.35
		No	0.42	0.13	18.67	–	–	1.35
764±	1	Yes	1.6	230	900	1.5	200	0.04
	2	Yes	1.0	60	345	1.0	60	0.08
764ac	1	Yes	1.6	230	900	1.5	200	0.04
	2	Yes	1.6	60	345	0.18	60	0.08
		No	0.2	230	450	0.18	60	0.08
765ac	1	Yes	0.75	1.65	65	0.7	1.3	0.56
	2	Yes	0.75	0.32	24.75	0.7	1.4	1.13
766ac	1	Yes	1.4	5.8	150	1.5	5.6	0.24
	2	Yes	1.4	1.5	58	0.18	1.5	0.48
		No	0.2	5.8	75	0.18	1.5	0.48
767	1	Yes	0.75	1.65	65	0.7	1.7	0.56
	2	Yes	0.50	0.32	24.75	0.5	0.4	1.12
768	1	Yes	0.26	1.75	46	0.2	1.7	0.81
772ac	1	Yes	0.18	6.8	86.6	0.2	6.0	0.41
	2	Yes	0.18	1.75	34	0.2	1.8	0.81
778ac	1	Yes	0.13	16	106	0.12	14	0.33
	2	Yes	0.13	4.2	41	0.12	4.2	0.66
779	1	Yes	0.13	4.2	55	0.12	4.0	0.65
786	1 or 2	Yes	0.13	–	–	0.11	500	–
787 & 787S	Both	Yes	0.13	4.2	55	0.11	4.0	0.65
788 & 788R	Both	Yes	0.13	0.37	24	0.11	0.5	1.15
791	Both	No	0.27	0.35	31	0.24	0.31*	1.18
796	Both	Yes	0.16	1.9	34.5	0.13	2.0	0.82

* L/R = 31µH/Ω

System combination	BASEEFA system Cert. No.	Earth [1] return used?	BASEEFA Maximum permissible cable [2] parameters for group IIC (hydrogen)			Matched [3] power W (BASEEFA)
			Capacitance µF	Inductance mH	or L/R ratio µH/Ω	
2 x 761ac channels 2 x 764ac channels 2 x 766ac channels	Ex842125	Yes	0.2	0.24	11.6	1.01
4 x 761ac channels 2 x 764ac channels	Ex842125	Yes	0.2	0.2	12.7	0.98
2 x 764ac channels 4 x 766ac channels	Ex842128	Yes	0.2	0.28	11	1.04
758 + 761ac	Ex872392	Yes	0.42	0.013	10.5	3.27
			BASEEFA Maximum permissible cable parameters for group IIB (not safe for group IIC)			
4 x 764ac channels 4 x 766ac channels	Ex842128	Yes	0.6	1.1	32.6	1.12
2 x 768 channels	Ex842114	Yes	0.78	1.8	70	1.62
2 x 768 channels Any number of 786 channels	Ex842114	Yes	0.39	1.8	46.6	1.62
2 x 779 channels	Ex842114	Yes	0.39	4.3	83	1.3
2 x 779 channels Any number of 786 channels	Ex842114	Yes	0.39	4.3	55.6	1.3

The tables give the maximum permitted cable parameters for hazardous-area circuits in groups IIC and IIB. Note that values for both the hazardous-area cabling *and load* are included in the above parameters. However, the tables are by no means exhaustive and for full details of other safe combinations, consult either BASEEFA system certificate Ex832469 or MTL. The MTL702 is covered by BASEEFA system certificate Ex842308, and the MTL706 by Ex872513.

A 1986 revision of CENELEC standard EN 50 020 removed the requirement for an additional safety factor for unprotected contacts in Zone 0, so the parameters shown will apply equally to switched and non-switched circuits. In practice cable parameters rarely present a problem, as all cables normally used for instrument interconnection have L/R ratios below 25µH/Ω and capacitance below 200pF per metre.

Note 1 If values are not quoted for when an earth return is not used, those *for* an earth return ('Yes' in the table) can be used.

Note 2 For most practical purposes, the values of the parameters for groups IIB and IIA are respectively three and eight times the values for group IIC. Values for IIA are 2.6 times those for IIB.

Note 3 The maximum power that can be drawn from the barrier combination under fault conditions. Used for assessing the temperature classification of 'simple' hazardous-area apparatus.

For FM permitted combinations, refer to MTL document SCI-88.

APPROVALS

COUNTRY (AUTHORITY)	STANDARD	CERTIFICATE/FILE No.				APPROVED FOR
		MTL710 to 796 except MTL791 (see notes)	MTL702+	MTL706+	MTL707+/708+/ 787S+	
Argentina	IAP CA 4.01 1989	INTICITEI 92A001	INTICITEI 92A001	INTICITEI 92A001	INTICITEI 92A001	[Ex ia] IIC
Australia (QMD)	CMA 1925-1981	QMD 85 6001 XSU*	QMD 85 6124 XU			Mining
Australia (NSW M)	CMRA 67/1982	MDA Ex. ia 1321	MDA Ex. ia 1411	MDA Ex. ia 1321	MDA Ex. ia 1321	Coal and shale mines
Australia (SA)	AS2380.7-1987	Ex 562	Ex 692	Ex 562X	Ex 562X	(Ex ia) IIC
Brazil	NBR 8447/84	CE.Ex-221/92[a]		CE.Ex-220/92	CE.Ex-221/92	BR-Ex ia/ib IIC
Canada (CSA)	C 22.2, No 157	LR36637-14	LR36637-16	LR36637-26	LR36637-20	Class I, II, III, Div. 1, A-G
China (NEPSI)	GB3836.1-83	GYJ96298	GYJ96298	GYJ96298	GYJ96298	(ia) IIC T6
	GB3836.4-83	GYJ96298	GYJ96298	GYJ96298	GYJ96298	
Czechoslovakia (FTZU)	CSN 33 0380	J02033	J02033	J02033	J02033	[Ex ib IIC]
Denmark (DEMKO)	EN 50 020	R75916*				[EEx ia] IIC
Hungary (BKI)	MSZ 4814/7-77	87B2-018	87B2-018	87B2-018	87B2-018	[Ex ib] IIC
Japan (TIIS)	1979 Rec. Pract.	C10619 to C10636†	39286			Groups 2 and 3a, G5
Korea (KRS)		LND03065-EL001	LND03065-EL001	LND03065-EL001	LND03065-EL001	[EEx ia] IIC Tamb = 60°C
Poland (KDB)	PN-84/E-08107	KDB Nr.91.009W†	KDB Nr. 91.010W	KDB Nr 91.011W	KDB Nr.91.012W	[Ex ia] IIC
Romania (ISM)	STAS 6877/4-87	ISM Nr. 90.2820	ISM Nr. 90.2821	ISM Nr. 90.2822	ISM Nr. 90.2820	[Ex ia] IIC
Switzerland (SEV)	EN 50 020	ASEV 84.14332X	ASEV 84.14332X	ASEV 84.14332X	ASEV 84.14332X	[EEx ia] IIC
UK (BASEEFA)	EN 50 020	Ex832452[b]	Ex84B2307	Ex87B2428	Ex832452	[EEx ia] IIC
UK (BASEEFA) (Systems)	EN 50 039	Ex832469	Ex842308	Ex872513	Ex832469	[EEx ia] IIC
UK (BASEEFA)	BS 4683:Pt 3	Ex83453	Ex83453		Ex83453	Ex N II T6 in MT20N
UK (BASEEFA, Indianvn)	EN 50 020	Ex89C2346		Ex89C2347	Ex89C2346	[EEx ia] IIC
UK (HSE (M))	EN 50 020	HSE (M) 8570006			HSE (M) 8570006	[EEx ia] I – coal mining
UK (Lloyds Reg)	Type Approved	86/00102	86/00102	86/00102	86/00102	All vessels registered
USA (FM)	3610 Entity	J.I. 1H8A1.AX, J.I. 2P0A4.AX[c]	J.I. 1K4A1.AX	J.I.0R6A1.AX	J.I. 2P0A4.AX	Class I, II, III, Div. 1, A-G
USA (MSHA)	Classified	1320-11-17,20-31,40-44*	132010			Mining systems
USA (UL)	UL 913	E120058	E120058	E120058	E120058	Class I, II, III, Div. 1, A-G
USSR (VNIIVE)	GOST 22782.5-78 EN 50 020 & IEC 79-11	N 144	N 144	N 144	N 144	Ex ia/ib IIC

**MTL758 certification in hand*
†including MTL787S
Note: UK BASEEFA is to CENELEC standards

a: MTL758 CE.Ex222/92, approved for BR-Ex ib IIC
b: MTL791 Ex94C2172
c: MTL791 J.I.4X0A4.AX, approved additionally for non-incendive Class 1, Div 2, ABCD

MOUNTING ACCESSORIES, MOUNTING KITS AND ENCLOSURES

See MTL700 and MTL700P enclosures, MTL700 and MTL700P accessories.

HOW TO ORDER:

See MTL700 series ordering information.