Technical Bulletin

# 1S20

## Arc Fault Monitor Relay

## Features

- Compact, economic design
- Simple panel mounting for retrofit applications
- Two or three arc sensor inputs
- Two high speed tripping duty arc sense output contacts
- Push button reset
- Continuous arc sensor supervision
- Integrated self supervision
- Fail alarm contact
- 20-60 & 36-150V DC auxiliary versions

## Introduction

Medium voltage switchgear is a key element in the power supply chain. Existing protection systems operate effectively under most circumstances, but they are too slow to handle arcing short circuits.

Arcing faults can occur as a result of insulation breakdown due to equipment age & / or poor maintenance.

The degree of damage caused by arcing depends principally on the duration of the arc. If an arc lasts only 100ms, the switchgear needs to be checked & the insulation resistance measured before power can be re-established. With a 200ms arc, the power supply will be interrupted; the switchgear must be checked; power is re-established only after minor repairs. In the event of a 500ms arc the supply is interrupted, metal parts of the switchgear are destroyed & poisonous gases are emitted. A 1s arc destroys most of the switchgear & may cause a fire, injury to personnel & damage to property.

The over-current caused by an arc is, due to its resistance, lower than the over-current caused by a “metallic” short circuit. The over-current caused by the arc may also be lower than the protection start current when energising circuits or starting large motors. The consequence of these conditions is that a protection system based solely on over-current detection cannot effectively discriminate between normal system currents & an arc fault condition:

- For moderate arc fault currents the trip time of the over-current IDMT stage will be too slow;
- For very low arc fault currents the instantaneous trip stage of a standard over-current relay cannot be set low enough.


1S30 Sensors - front & back

1S20 depicted in panel mount case configuration

## ARC Fault Protection

Made in Australia

Arc fault protection is a relatively new technique employed for the fast clearance of arcing faults on BUS bars & within metal clad switchgear & associated cable boxes. The arc is detected using an optical sensor & the signal input to a protection device which also monitors the load current on the system. A trip signal can be achieved in less than 10ms using arc detection only or within 15ms when using overcurrent check. This is considerably faster than a traditional IDMT overcurrent relay & provides additional protection from the onset of arcing faults with relatively low fault currents.

Arguably the greatest risk of arc fault damage exists at the CB cable termination & in the CB chamber itself due to the slow clearance times of the IDMT feeder protection. The CB cable termination is particularly at risk to ingress of moisture & rodent damage.

The problem of arc faults is most prevalent in older metal clad switchgear which already has operational protection systems. The 1S20 Arc Fault Monitor has therefore been designed for the following applications:

**EXISTING SWITCHGEAR**
Where a requirement exists to retrofit arc fault protection to metal clad switchgear utilizing the existing overcurrent protection relay;

**NEW SWITCHGEAR**
Where a requirement exists to install arc fault protection to new switchgear for integration with the customer preferred overcurrent feeder protection relay.

# Switchgear Applications

**SWITCHGEAR ARC PROTECTION**

Risk of arc fault damage exists at the CB cable termination & in the CB chamber itself. The CB cable termination is particularly at risk to ingress of moisture & rodent damage.

One, two or three arc sensors may be connected to the 1S20 Arc Fault Monitors as depicted in the single line application diagrams at right.

Figures 1 & 2 show the trip signals being used to trip the feeder circuit breaker in the event of an arc fault occurring at any sensor provided the overcurrent relay starter contact is picked up. In these applications the overcurrent check stage is optional as the consequence of a single feeder outage is less than the loss of an entire BUS.

Figure 3 shows an application where a single 1S20 is applied for the protection of the Cable box, CT chamber & CB chamber using three sensors. In this configuration one arc trip output is used to trip the feeder circuit breaker in the event of an arc fault in the cable box / CT chamber. The second trip output is set for independent operation to trip the BUS breaker (BUS overcurrent check not shown), in the event of an arc fault in the CB chamber.

**EXISTING SWITCHGEAR APPLICATIONS**

The existing overcurrent relay protecting the feeder will normally provide an independent output contact associated with the start current setting of the relay. That is an output contact that will close when a phase or earth fault current is detected above the threshold which starts the internal relay timers. This starter element should be set for instantaneous operation so that it will pick up in the order of 15ms.

An Arc Fault Monitor relay 1S20 is installed on the switchgear panel adjacent to the protection relay. The 1S20 is specifically designed for simple retrofit to existing panels & requires only a single 31mm mounting hole to be drilled. The 1S20 fits through this hole, the designation label supplied with the unit positioned & the retention shroud fitted. Refer Figure 8.

1S30 optical arc sensors are fitted in the cable termination box & CT chamber as depicted in figure 2.

The overcurrent relay starter contact may optionally be wired in series with the arc fault detection trip output contact as depicted in figure 7. The resulting “AND” function trip output is wired to trip the breaker in ~15ms in the event that an arc fault is detected while the overcurrent start element is picked up.

The second arc trip & fail alarm contacts may be employed for interface to a SCADA system for fault reporting.

**NEW SWITCHGEAR APPLICATIONS**

For new switchgear installations a modern numeric feeder protection relay is likely to be employed which will have numerous programming & configuration options.

The basic concept is the same as for the existing switchgear application described above except that the additional features & flexibility of modern feeder protection relay allows improved system integration.

This may be achieved by using the second arc trip output contact to interface to a programmable status input on the feeder protection relay. Depending on the model of protection relay being used this input may be programmed to provide an alarm message on the HMI, time stamped event record available via its communications link.

Where this level of system integration is employed the 1S20 does not need to be mounted on the front panel as the alarm indications are available on the feeder relay. Remote reset of the 1S20 LED is achieved by momentary interruption of the power supply using a SCADA controlled series contact. The DIN rail mounting option is a convenient alternative in this situation.

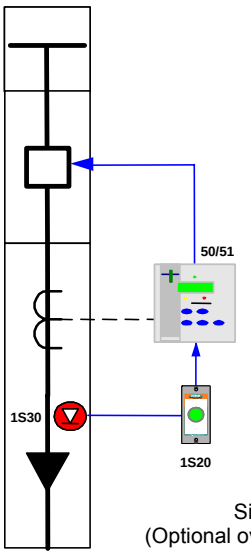



Figure 1:
Single arc sensor - Cable box only
(Optional overcurrent check stage depicted)

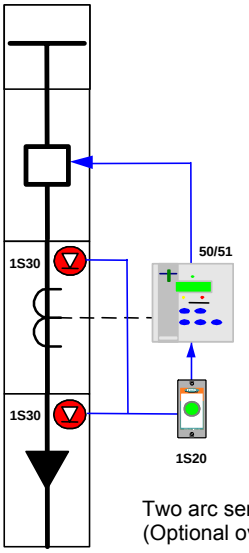



Figure 2:
Two arc sensors - Cable box & CT chamber
(Optional overcurrent check stage depicted)

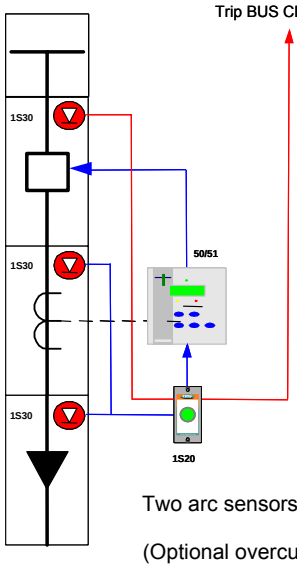



Figure 3:
Two arc sensors - Cable box & CT chamber
Independent trip to CB
(Optional overcurrent check stage depicted)

One arc sensor - CB chamber
Independent trip to BUS breaker
(BUS overcurrent check stage not shown)

**COMBINED BUS BAR & SWITCHGEAR ARC PROTECTION**
Figure 4 shows an application where a single 1S20 is applied for the protection of the Cable box & CT chamber plus the CB chamber & BUS chamber using three sensors.

In this configuration one arc trip output is used to trip the feeder circuit breaker in the event of an arc fault in the cable box / CT chamber. The second trip output is set for independent operation to trip the BUS breaker (BUS overcurrent check stage not shown), in the event of an arc fault in the CB chamber or BUS chamber.

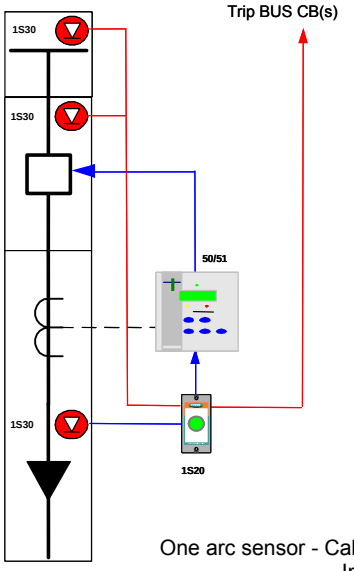



Figure 4:
One arc sensor - Cable box / CT chamber
Independent trip to CB

Two arc sensors - CB chamber & BUS chamber
Independent trip to BUS breaker
(BUS overcurrent check stage not shown)


Figure 5:
1S20 shown mounted in through hole panel configuration

**BUS BAR ARC PROTECTION**
Figure 6 depicts how the 1S20 may also be applied for the protection of bus bars. The number of sensors in the bus chamber is dictated by the switchgear design and the length of switchboard.

In most indoor metal clad switchgear the bus bar chamber is a continuous chamber between panels only broken into segregated sections at a bus section breaker & as such the strategic placement of one or two arc sensors in each bus bar chamber run is normally adequate.

Some indoor metal clad switchgear may segregate the bus chamber of each panel from the next via insulated bus chamber side barriers per panel, if this is the case then each bus chamber per panel would need to be monitored by at least one arc sensor.

In large enclosures the arc sensors should be placed at approximately 5m intervals.

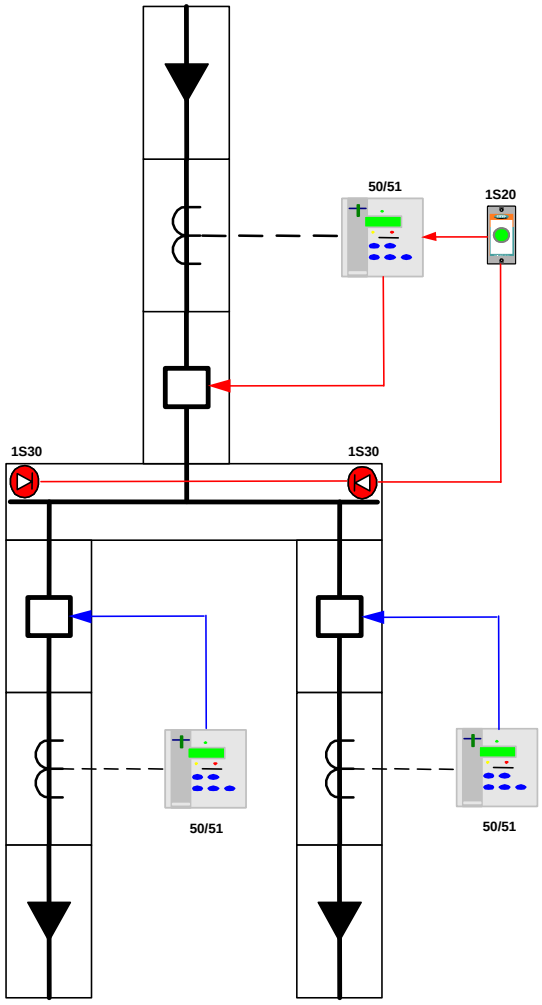
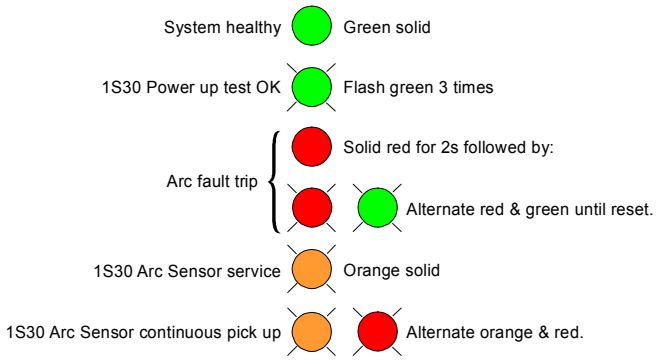



Figure 6:
One, two or three arc sensors located in the BUS chamber

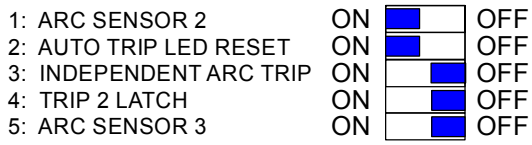
## OPERATION INDICATOR

A single tri colour LED is integrated into the front panel reset push button to provide the following status indications:




## CONFIGURATION SWITCH

The configuration switches are accessible to the user by first unplugging the electronic module from the terminal base.




## CONFIGURATION SWITCH SETTINGS

The internal wiring label identifies the position of the following switch functions:

Switch 1: Arc sensor 2 ON or OFF
Must be set to OFF if arc sensor 2 is not fitted.

Switch 2: Automatic self reset ON or OFF
If set to ON the flashing red/green arc fault alarm LED will auto reset (Extinguish) after 4 hours.

Switch 3: Independent arc trip output contacts
Set to ON for Arc sensor 1 to operate trip output 1 & Arc sensor 2 to operate trip output 2.

Set to OFF for Arc Sensor 1 or 2 to operate both trip outputs.

Switch 4: Arc fault trip output 2 latch function.
Set to ON for four (4) hour latching function
Set to OFF for self reset (S/R) as per trip contact 1.

Switch 5: Optional arc sensor 3 ON or OFF
Must be set to OFF if arc sensor 3 is not fitted.

## ARC SENSOR CIRCUIT SUPERVISION

The 1S30 Arc Sensor is the heart of the system & supervision of circuit continuity is critical for correct operation. To monitor the integrity of the wiring between the 1S30 arc sensor & 1S20 Arc Monitor, a continuous 2mA supervision current flows between the units. The 1S20 alarm contact will drop out after a 1s time delay if it fails to detect this current.

## ARC SENSOR FUNCTION

The 1S30 is an optical sensor that responds to the flash of light emitted during the incidence of an arcing fault. Onset of the light flash & detection by the 1S30 occurs in a few ms.

When an arc is detected, the resistance presented by the 1S30 drops to a level where the current flow increases to approximately 20mA. This increased current flow is instantaneously detected by the 1S20 & its trip output contacts closed. Refer to the 1S30 Technical Bulletin for further details.

## ARC FAULT TRIPPING USING CURRENT CHECK

Fast operation of a tripping scheme usually results in reduced system security. The arc detection method can however, combine the 1S20 optical detection technique with a traditional overcurrent method to maximize system security particularly for BUS bar protection schemes. Both conditions must coexist for the trip condition to be met as depicted in figure 7.

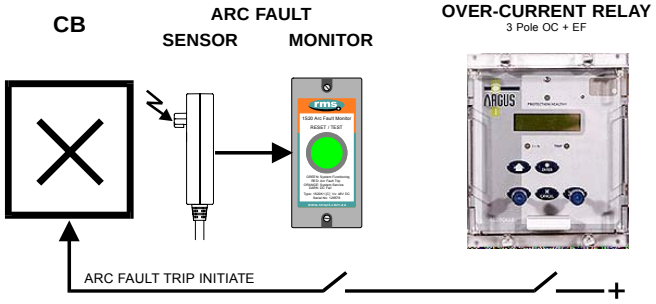



Figure 7:
Key components required to implement an Arc Fault Protection scheme with an overcurrent check stage to enhance system security

The application examples in figures 1 to 5 utilize this concept for enhanced system security in that both the 1S20 AND the OC 50 starter contact must be picked up for a CB trip signal to be initiated. As the arc fault trip contact picks up considerably faster than the overcurrent relay starter element, the CB trip time will be dictated by the overcurrent relay performance.

## LOW CURRENT ARCING FAULTS

Arcing faults can occur at low current levels & it is possible for the over-current starter element to be set above this level. To avoid this problem & obtain very fast clearance (<10ms), of an arc fault, the 1S20 arc fault trip contact may be wired directly to the breaker operate coil. It should be noted that this method may lead to reduced system security.

## ARC DETECTION RESET TIME (Effect of multiple arc trips)

A delay of 2s is required to reset the 1S20 after an initial arc sensor trip. Subsequent arc detection will cause the trip output contacts to re-operate & reset the time delays described under *Configuration Switch Settings*.

## INDEPENDENT TRIP OUTPUT CONTACTS

The 1S20 may be set using configuration switch 3 for both trip output contacts to pick up when an arc is detected by any sensor input. Alternatively arc sensor 1 can be linked to trip contact 1 & arc sensor 2 (& 3 if fitted), to trip contact 2. This function may be applied where an arc fault detected in the cable box is directed to trip the feeder circuit breaker while an arc fault in the BUS chamber is to be directed to trip the BUS.

## ARC SENSOR CONTINUOSLY PICKED UP

High ambient light levels may cause a 1S30 to be continuously picked up. This condition could occur for example if the CB cable box cover was left open in very high ambient light level conditions. A non arc fault over-current pick up would then result in an arc fault trip operation.

To avoid possible mal operation due to this condition, the 1S20 is designed to automatically disable the arc fault tripping function if the 1S30 sensor is picked up for >10s. The 1S20 alarm contact will be set & the front LED flash alternate orange & red until the ambient light level problem is corrected. The 1S20 will then perform an arc sensor test function & automatically reset.

# Mounting

Panel mounting is achieved using a 31mm diameter hole in the panel adjacent to the protection relay.

Rear of cubicle surface or DIN rail mounting is also possible by fitting the optional H01180001B DIN rail clip.

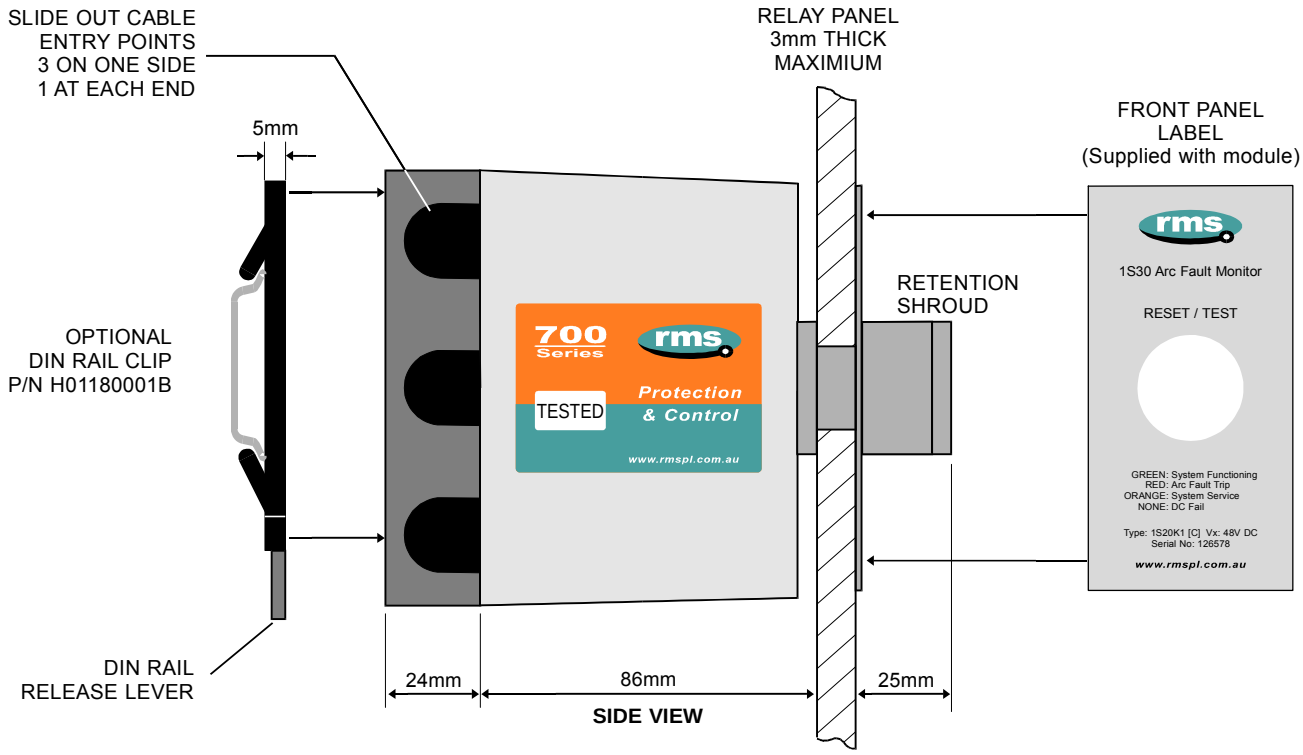



Figure 8: 1S20 Panel mounting arrangement depicted – Optional DIN rail mounting available

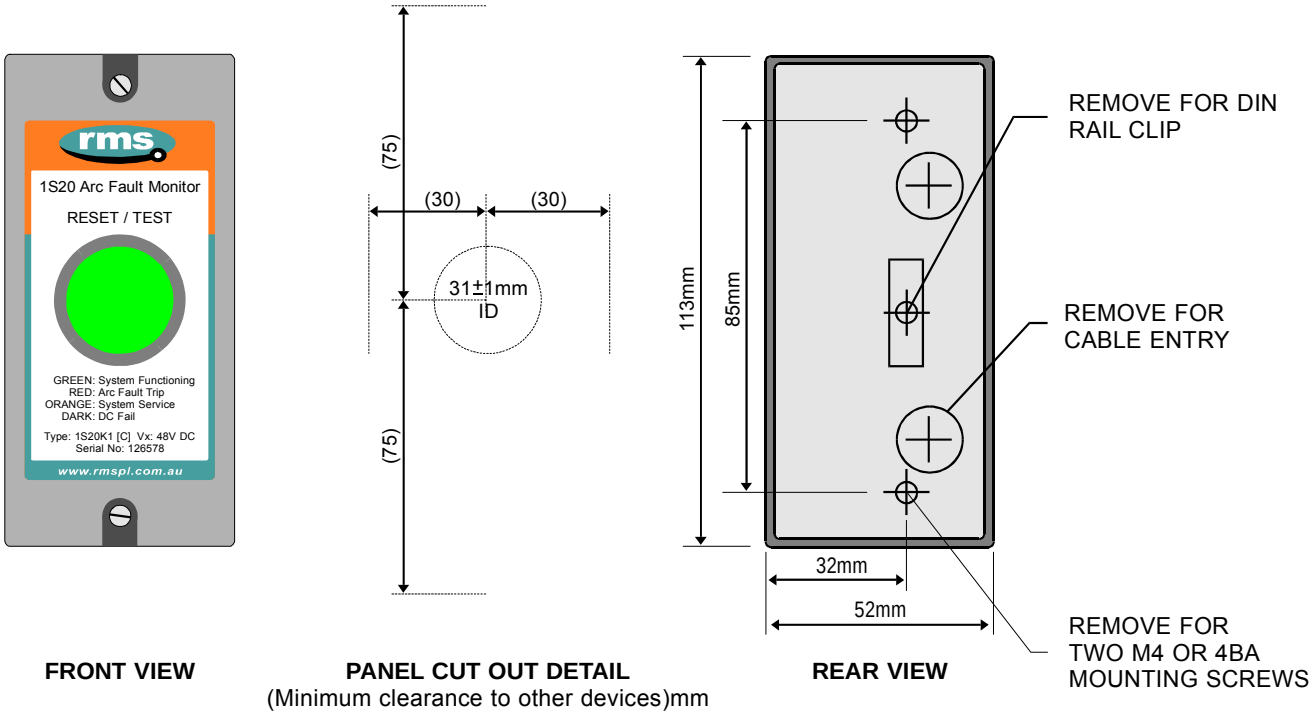


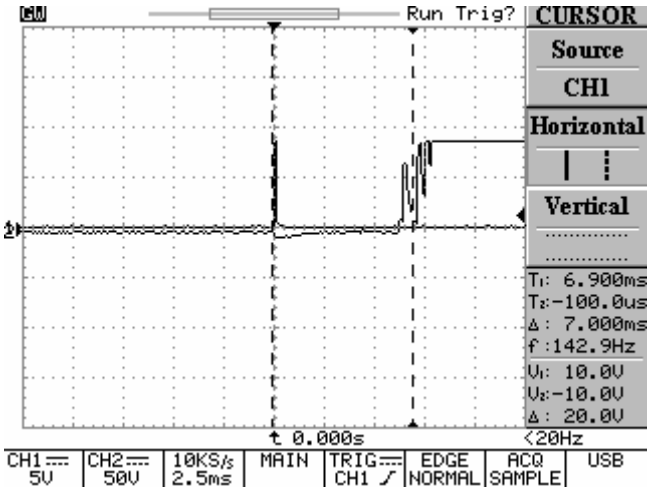

Figure 9: 1S20 Front view, panel cut out & rear view

# Technical Data

**AUXILIARY SUPPLY BURDEN** (At 110V DC)
Monitoring mode: Less than 4W
Arc fault detected: Less than 10W for 2s

**AUXILIARY SUPPLY**
20 - 60V DC
36 – 150V DC

**OPERATE TIME**
Arc fault trip contacts guaranteed to pick up in less than 10ms including bounce. Typical operate time is 7ms.




CRO trace showing nominal operation time of the trip contacts at 7ms. First contact touch at 6.25ms and fully closed by 7.25ms. Operation in <10ms is considered acceptable as current check relay operate time is ~15ms.

**ARC SENSOR INPUTS**
Two or three independent arc sensor inputs type 1S30 or similar.


Figure 10: 1S30 Arc Fault Sensor (Refer 1S30 Technical Bulletin)

**MINIMUM ARC DURATION**
The minimum arc "flash" duration required to guarantee operation of the output contacts is 1.25ms.

**TRIP CONTACT RESET TIME**
Once operated the trip output contacts reset as follows:
Trip contact 1: Self reset in 2s.
Trip contact 2: Reset as per configuration switch 4.

**MANUAL RESET**
Press front button or interrupt power supply to reset LED's.

**OUTPUT CONTACTS**
Arc fault trip contacts: 2 N/O
Fail alarm: 1 N/C for the power supply / CPU fail
Normally picked up & drops out to signal an alarm condition.

**OUTPUT CONTACT RATINGS** **IEC60255-0-2**

| | | |
|---|---|---|
| Carry continuously | 5A AC or DC | |
| Make & carry | 0.5s 20A AC or DC | |
| L/R ≤ 40ms & V ≤ 300V | 0.2s 30A AC or DC | |
| Break capacity I ≤ 5A & V ≤ 300V | AC resistive | 1,250VA |
| | AC inductive | 250VA @ PF ≤ 0.4 |
| | DC resistive | 75W |
| | DC inductive | 30W @ L/R ≤ 40ms<br>50W @ L/R ≤ 10ms |
| Minimum number of operations | | $10^6$ at maximum load |
| Minimum recommended load | | 0.5W limit 10mA / 5V |

**TRANSIENT OVERVOLTAGE** **IEC60255-5**
Between all terminals & earth 5kV 1.2/50us 0.5J
Between independent circuits without damage or flashover 5kV 1.2/50us 0.5J

**INSULATION COORDINATION** **IEC60255-5**
Between all terminals & earth 2.0kV RMS for 1 minute
Between independent circuits 2.0kV RMS for 1 minute
Across normally open contacts 1.0kV RMS for 1 minute

**AUXILIARY SUPPLY** **IEC60255-11**
Allowable breaks / dips in supply
Collapse to zero from nominal voltage ≤ 20ms

**HIGH FREQUENCY DISTURBANCE** **IEC60255-22-1 CLASS III**
2.5kV 1MHz common mode
1.0kV 1MHz differential mode No mal operation

**ELECTROSTATIC DISCHARGE** **IEC60255-22-2 CLASS III**
6kV contact discharge No mal operation

**RADIO FREQUENCY INTERFERENCE** **IEC60255-22-3**
10V/m, 80 TO 1,000MHz No mal operation

**FAST TRANSIENT** **IEC60255-22-4**
4kV, 5/50ns, 2.5KHz repetitive No mal operation

**CONDUCTED RFI** **IEC60255-22-6**
10V, 0.15 to 80MHz No mal operation

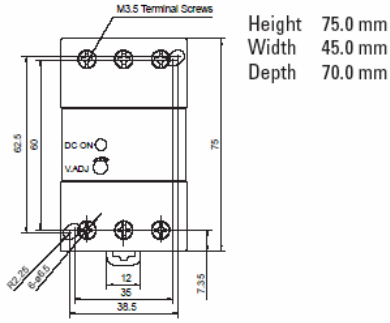
**TEMPERATURE RANGE**
Operating: -5 to +55°C
Storage: -25 to +75°C

**HUMIDITY** **IEC68-2-1/2**
40 °C & 95% RH non condensing

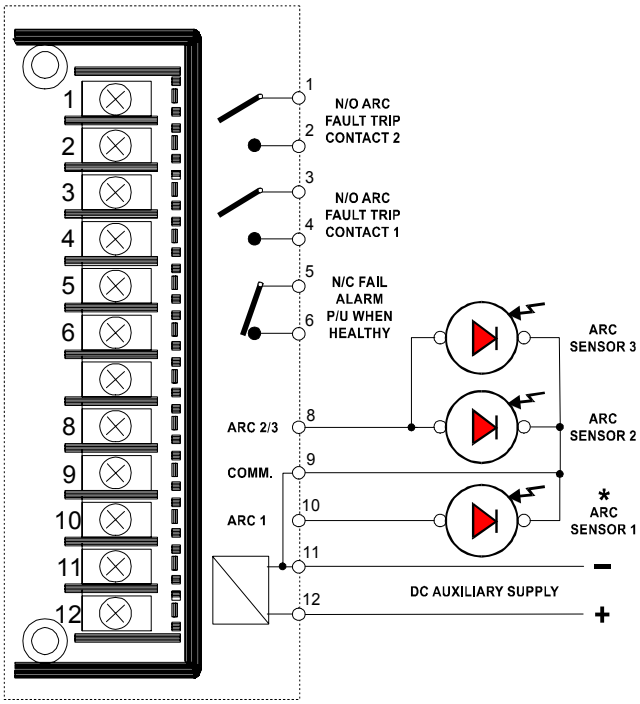
**CASE**
ZA12 flush or DIN rail mount type
12 M4 screw terminals
Plug in module to facilitate easy wiring & fast changeover

**AC AUXILIARY SUPPLIES (PS5R-A24 MODULE)**
The Idec PS5R DIN rail mount power supply is suitable for providing the 24V DC auxiliary supplied required for operating the 1S20 Arc Fault Monitor from an AC auxiliary.

Vx input: 85 to 264V AC
Power output: 7.5W continuous




Height 75.0 mm
Width 45.0 mm
Depth 70.0 mm




**1S20 SOCKET TERMINAL LAYOUT**
Viewed the from front when un-plugged from the main housing
(Note: * Always wire Arc Sensor 1. Arc sensor 2 & 3 optional)

# Ordering Information

Generate the required ordering code as follows: e.g. 1S20 CAA

**1S20** [1] [2] [3] **Arc Fault Monitor Relay**

**1 AUXILIARY SUPPLY RANGE**

A 20 - 60V DC
C 36 - 150V DC

**2 MOUNTING**

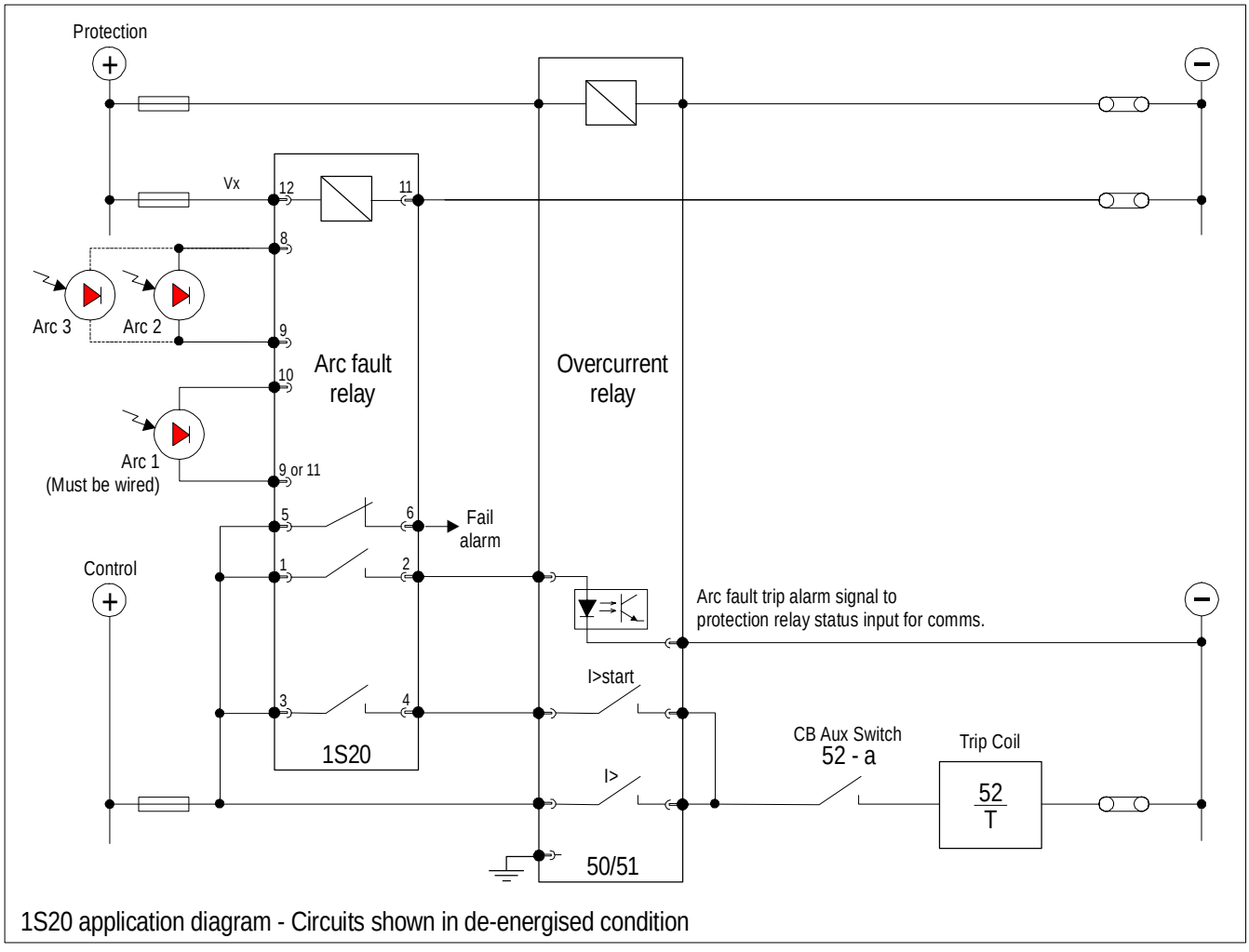
A Panel mount
B DIN rail mount

**3 SENSORS**

A Two arc sensor inputs (Default)
B Three arc sensor inputs

**PS5R POWER SUPPLY MODULE**
Use the PS5R-A24 DIN rail mount module to power a single 1S20 from an 85-164V AC auxiliary source.

**1S30 ARC FAULT SENSOR**
Refer to the 1S30 Technical Bulletin for ordering information on the Arc Sensor.




1S20 application diagram - Circuits shown in de-energised condition

## Australian Content

Unless otherwise stated the product(s) quoted are manufactured by RMS at our production facility in Melbourne Australia. Approximately 60% of our sales volume is derived from equipment manufactured in house with a local content close to 90%. Imported components such as semi-conductors are sourced from local suppliers & preference is given for reasonable stock holding to support our build requirements.

## Quality Assurance

RMS holds NCSI (NATA Certification Services International), registration number 6869 for the certification of a quality assurance system to AS/NZS ISO9001-2000. Quality plans for all products involve 100% inspection and testing carried out before despatch. Further details on specific test plans, quality policy & procedures may be found in section A4 of the RMS product catalogue.

## Product Packaging

Protection relays are supplied in secure individual packing cardboard boxes with moulded styrene inserts suitable for recycling. Each product & packing box is labeled with the product part number, customer name & order details.

## Design References

The products & components produced by RMS are based on many years of field experience since Relays Pty Ltd was formed in 1955. A large population of equipment is in service throughout Australia, New Zealand, South Africa & South East Asia attesting to this fact. Specific product & customer reference sites may be provided on application.

## Product Warranty

All utility grade protection & auxiliary relay products, unless otherwise stated, are warranted for a period of 24 months from shipment for materials & labour on a return to factory basis. Repair of products damaged through poor application or circumstances outside the product ratings will be carried out at the customer's expense.

## Standard Conditions of Sale

Unless otherwise agreed RMS Standard Terms & Conditions (QF 907) shall apply to all sales. These are available on request or from our web site.


**Relay Monitoring Systems Pty Ltd**

6 Anzed Court, Mulgrave, Victoria 3170, AUSTRALIA

Tel: 61 3 9561 0266 Fax: 61 3 9561 0277 Email: rms@rmspl.com.au Web: www.rmspl.com.au