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3-Phase Thyristor Fault Monitor

for use with AC thyristor stacks operating in single cycle burst fire and standard burst fire modes

Type TFM103-690V

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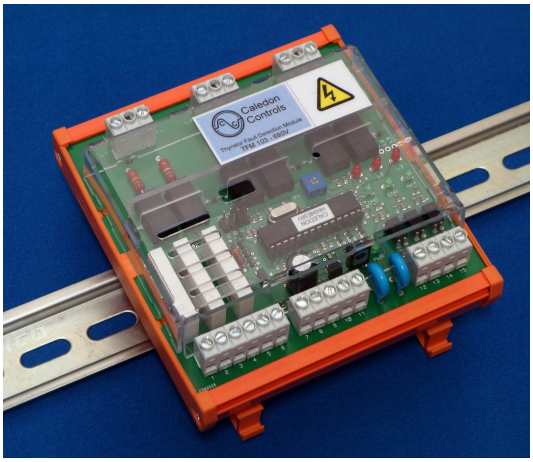

Features

- **Monitors for short or open circuit devices under load**
- **Suitable for single phase or 3 or 4-wire 3-phase loads**
- **May be used with 2-leg or 3-leg control of a 3-phase load.**
- **Suitable for monitoring on nominal 380V to 690V 3-phase supplies or 220V to 690V single phase supplies**
- **Latched or non-latched alarm outputs**
- **Volt free alarm contacts and LED indication**
- **Requires a 24V DC Power Supply**
- **For use with thyristor stacks or solid state relays controlled by a logic signal**

Brief Description

This module is intended for on-load monitoring of thyristors for open or short circuits. It can be used with single phase or 3-phase 2 or 3-leg thyristor stacks or solid state relays controlling AC loads operating in burst fire or single cycle burst fire modes and activated by a standard logic signal (not analogue input thyristor controllers). It detects an open or short circuit thyristor and signals an alarm condition via volt free relay contacts. It operates by comparing the voltage across the thyristors in normal operation with the logic command signal which determines whether the thyristors should be on or off.

The thyristor stack must be powered up and a load must be connected for the module to work correctly. 3-phase loads may be connected delta or 3-wire star or 4-wire star (3-leg control only).

Application and Wiring

A typical wiring diagram for use in a 3-phase 3-leg system is shown in Figure 1.

Connections must be made to the line and load side of the thyristor pairs in each controlled leg. For single phase operation the L1 / T1 terminals must be used and for 3-phase 2-leg operation the L1/T1 and L2 / T2 connections must be used. The required configuration must also be selected using jumpers 1A and 1B.

The logic ‘demand’ signal which controls the thyristor on / off switching must also be connected to a digital input on the module (terminals 12 and 13).

The following faults can be detected:-

1	Short circuit thyristor	Can be detected when the logic demand signal is low or switching.
2	Open circuit thyristor.	Can be detected when the logic demand signal is high or switching.

An open circuit is not detected when the logic signal is low, because in this case the thyristors are expected to be off or ‘open’ anyway. Similarly a short circuit is not detected when the logic signal is high because in this case the thyristors are expected to be on. The module operates by detecting a state of the thyristors which is opposite from that expected due to the state of the logic signal.

If no load is connected to the thyristors there will be no voltage across the thyristors when they are expected to be off, and therefore with the logic demand signal low a short circuit fault will be indicated.

If the thyristors are unpowered there will be no voltage across them, so again, with the logic demand signal low a short circuit fault will be indicated.

If the thyristor driver is faulty, for example causing half waving or causing the thyristors to remain permanently conducting, this will show as a thyristor fault.

The module is provided with a digital 'enable' input (terminals 12 and 14), so that it can be disabled when a false output would otherwise be obtained, for example when the thyristor 3-phase power is not present.

Three relay operated volt free contact outputs are provided for fault indication, one for each pair of thyristors in a 3-phase 3-leg system. Relays are energised and contacts are closed in the non-alarm condition and open in an alarm condition. The relays indicate a fault on the associated pair of thyristors but do not distinguish between a short circuit or open circuit, or which of the pair of thyristors is faulty. The type of fault is indicated by repeated coded flashing of the red LEDs (one for each thyristor pair). In the event of a short circuit device it is not possible to determine which of a pair of back to back devices is short circuit without removing it from circuit. There are therefore 3 fault indications possible for each pair of thyristors:-

Type of fault	LED Indication
Open circuit thyristor with cathode connected to load	Single flash followed by pause
Open circuit thyristor with cathode connected to line	Two flashes followed by pause
Short circuit thyristor	Three flashes followed by pause

The fault indication can be either latching or non-latching. Latching operation is initiated by removing jumper 1C. Latching operation is useful if it is wished to retain indication of the type of fault after 3-phase power has been removed from the thyristor stack. The fault indication remains latched even when the 'enable' signal is removed from the module. It can be reset by applying a momentary signal to the digital 'reset' input (terminals 12 and 15) or by removing 24V power from the module.

If the fault indication is non-latching then if the enable input is taken low (module disabled) the active relays will be energised (non-fault state) and the red LEDs will be extinguished.

If single phase operation is selected by jumper 1A then only the L1 relay (terminals 1 and 2) is active and the other two relays will remain permanently de-energised with open contacts. If 3-phase 2-leg operation is selected then the L3 relay (terminals 5 and 6) will remain permanently de-energised.

If the reset input is activated (even when the latching indication option is not selected) it will cause an indicated fault to be reset and the module will then make a new decision whether or not a fault exists.

To avoid 'false positives' the module samples the fault status every 48 milliseconds, and counts a number of cumulative fault results before an alarm is triggered. A negative fault result causes a positive count to be decremented by 1. The count is unaffected if, when the sample is taken, the fault cannot be assessed; for example, a short circuit fault when the logic demand signal is high. This means that fault detection may take longer on a system with slow burst fire operation. The number required to trigger an alarm determined by the position of potentiometer P1. With P1 fully anticlockwise the number is 10, and with it fully clockwise it is 100. Normally good results are obtained with the potentiometer fully anticlockwise.

Connections to Terminals

Connections are made to terminals which accept wires up to 1.5mm^2 cross section. The use of screened cable is not necessary for control signal wiring within a panel, but normal precautions should be taken to keep signal wiring away from power cables, and in particular to avoid running signal cables parallel to power cables. See also the notes on configuration jumper settings, and the typical wiring scheme.

Terminal Number	Function	Notes
Line Voltage Connections to Thyristors		
L1	Line connection, phase 1	The maximum current drawn by these inputs is 3mA. The connections might conveniently be made to the auxiliary cathodes on the thyristors. Unless the cables are fused at source to protect against short circuits they should be kept very short and segregated from all other wiring. A short circuit to earth of unfused wiring is potentially extremely hazardous and also likely to damage the thyristors.
T1	Load connection, phase 1	
L2	Line connection, phase 2	
T2	Load connection, phase 2	
L3	Line connection, phase 3	
T3	Load connection, phase 3	
Control Signal Terminals		
1	Alarm contact line 1 thyristors	Contacts are closed in the non-alarm state and open in alarm or on loss of the 24V supply to the module. Contacts are rated at 250V AC or 30V DC , 100mA. Inductive loads should be suppressed.
2		
3	Alarm contact line 2 thyristors	
4		
5	Alarm contact line 3 thyristors	
6		
7	+24V Supply	24V DC +/-20%. Supply current 60mA maximum.
8		
9	0V Supply	
10		
11	Functional Earth	Connect to metalwork immediately adjacent to the module
Digital Inputs		
12	Digital input common	These terminals are galvanically isolated from other terminals. Logic inputs may be activated by either a positive or negative voltage between 6V and 24V DC with respect to terminal 12. For activation by contact closure the 24V power supply which powers the module may be used to power the input via the contact. (connect terminal 12 to terminal 10 and terminal 8 to the required input via the contact). The logic demand signal which drives the thyristor triggers should be connected directly to terminals 13 and 12.
13	Logic demand signal	
14	Enable input	
15	Alarm reset input	

Configuration Jumper Selections

The 4 position jumper JMP1 should be configured for the desired functionality:-

Position	Linked	Unlinked
A	Single phase monitoring	3-phase monitoring
B (if A is unlinked)	3-phase 2-leg	3-phase 3-leg
C	Non-latching alarms	Latching alarms
D	No function	

Ordering Information

The part number for the standard instrument is TFM103-690V.

This is for an instrument suitable for monitoring single phase systems with supply voltages in the range 220V -20% to 690V +20% or 3-phase systems with supply voltages (line to line) in the range 380V -20% to 690V +20%

Instruments suitable for other voltages can be supplied to special order.

Specifications

Parameter	Value	Notes
Dimensions	115mm wide x 120 high x 60mm deep	Mounted on 35mm symmetrical DIN rail
Supply voltage	24V DC +/-20%.	
Supply current	Maximum 60mA.	Typically 35-40mA
Supply voltage to monitored thyristors	3-phase: 380V -20% to 690V + 20%	
	1-phase: 220V -20% to 690V +20%	
Current loading of monitoring circuits (per line)	Maximum 3mA RMS	
Isolation withstand - monitored thyristors to 24V circuits, 1 minute	5,550V RMS	These isolation specifications meet the requirements for reinforced insulation in an environment of pollution degree 2 and overvoltage category III (IEC 664) for voltages up to 600V RMS across the isolation barrier
Creepage distance on pcb across isolation barrier - monitored thyristors to 24V circuits	>11.5mm	
Alarm relay contact rating	250V AC, 30V DC, 100mA	Inductive loads must be suppressed
Isolation withstand between relay contacts and 24V circuits, 1 minute	2,300V RMS	
Creepage distance on pcb between alarm contacts and 24V circuits	3.3mm	
Isolation withstand between contacts on adjacent relays	2,200V RMS	
Digital input signals	>6V DC = on. Maximum voltage = 24V DC. Polarity may be positive or negative with respect to the common terminal.	Input current = 3mA @ 24V.
Ambient temperature	(operating) 0-55^{O}C	
	(storage) -25^{O}C to +70^{O}C	
Relative humidity	0-95% non-condensing	Pollution degree 2
Pollution (IEC 664)	Degree 2 (Only non conductive pollution is allowed. Temporary condensation may occur, but not normally while equipment is operating).	

Safety Standards Complies with European Low Voltage Directive and major international standards.

EMC Standards Complies with the European EMC Directive for operation in an industrial environment

The following European standards have been applied in whole or in part in the design of this instrument; EN61010-1:2010, EN61326-1:2006

Safety and Regulatory Considerations

The controller must be wired in accordance with electrical standards applicable in the country of installation.

Figure 1 Typical wiring schematic.

The fuses shown in the interconnections between the module and the thyristor cathodes are for short circuit protection of the wiring, and if fitted they should be mounted as close as possible to the thyristor cathodes. If these interconnecting wires are kept short and preferably segregated from all other wiring, the fuses may be omitted, providing that it is ascertained that this will comply with the required wiring regulations. (The gate and cathode connections to the triggers are, of course, similarly unprotected and kept as short as possible. Unprotected wires to the fault monitor should be considered in the same way).

The digital inputs to the module are low current devices and contacts controlling these inputs should be suitable for low current operation (In the drawing, an auxiliary contact on the contactor in the 3-phase supply to control the module 'enable', and a pushbutton to reset an alarm condition).