

ECM3 EARTH CONTINUITY RELAY

Electrical Protection for Hard Rock Mines

Application

The ECM3 has been designed to provide earth continuity protection for cables containing pilot cores. In practical applications, environmental factors often prevent an earth continuity protection system from complying with both requirements of AS/NZS 2081 and AS/NZS 4871. Affecting factors can include coupled noise onto the pilot of the cable, variation in the resistance of the pilot cable due to temperature, and the overall length of the cable. The introduction of the dynamic trip response characteristic allows an electrical protection system incorporating an ECM3 to maintain a much lower touch voltage under earth fault conditions without any degradation of reliability or the introduction of nuisance tripping.

Ampcontrol has developed the ECM3 - EC protection relay, which is designed with AS/NZS 2081 (2011) and AS/NZS 4871.1 (2012) in mind, to achieve superior touch potential compliance and noise immunity of an EC protected system than any current generation EC relay.



Features

- Earth continuity protection
- Resistive termination unit for greater noise tolerance
- Resistance dependent trip characteristic
- Robust pilot noise rejection
- Selectable trip resistance from 15Ω to 90Ω in 5Ω steps
- DIN rail mounted
- External reset
- AC or DC supply operation
- LED status indicators

Description

Earth continuity protection is provided using pilot earth loop or earth continuity monitoring. The ECM3 relay monitors a low voltage DC signal applied between the pilot and earth of the cable and, by measuring this signal, determines the resistance of the Pilot-Earth loop.

Unlike its predecessor, the ECM2, the ECM3's earth continuity trip point can be reduced, restricting the earth resistance and maintaining touch potential compliance. The pilot resistance trip point is adjustable in steps of 5Ω from 15Ω to 90Ω. Setting the trip threshold closer to the pilot resistance ensures that the maximum touch voltage is kept within an acceptable range. The maximum loop resistance setting is 90Ω.

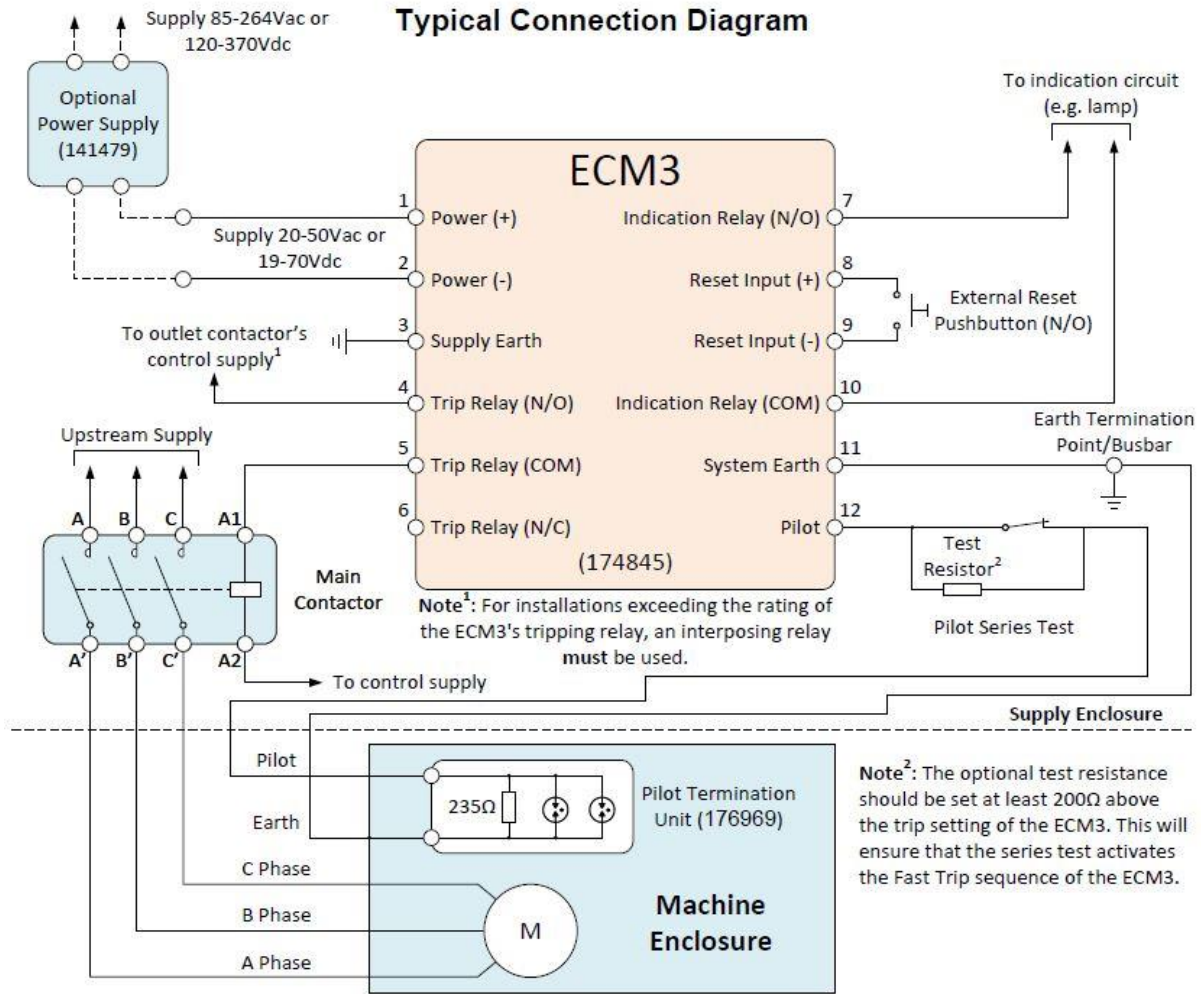
The ECM3 implements earth continuity protection using a resistance dependent trip characteristic, whereby the speed of trip actuation is related to the magnitude of the fault. In this manner, a very high impedance fault in the earth return path (e.g. cable open circuit) will result in a very fast trip, and a fault where the earth return path gradually increases over the trip setting will result in a slower trip actuation. The substantial advantage of this method is that sources of pilot noise, such as cable slip rings and non-symmetrical cables, have a significantly reduced impact on the ECM3. This dynamic trip time response distinguishes the ECM3 from other current generation EC relays by providing far superior noise immunity.

The relay is housed in a DIN rail mount enclosure. The user interface consists of three indication lamps (R/Y/G LED's) and a selector switch for the setting of the series pilot resistance.

The ECM3 relay performs the following functions:

1. Ensures earth return path exist and is below the resistance set point selected to maintain touch potential limitations.
2. Provides an interlock relay to interface in the start sequence of the cables control circuit ensuring pilot circuit healthy prior to start.
3. Provides one set of voltage free contacts for indication.

Typical Connection Diagram



Connection Explanation

Reference	Terminal Name	Connection Information
Terminals 1 & 2	Power	The ECM3 requires a regulated supply of 20-50Vac or 19-70Vdc. For power consumption, see specifications. An optional external power supply is available to extend the incoming voltage range to 85-264Vac or 120-370Vdc.
Terminal 3	Supply Earth	Optional earth connection for the ECM's power supply.
Terminals 4, 5 & 6	Trip Relay	The ECM3's tripping relay is a changeover relay with both a normally open and normally closed contact available.
Terminals 7 & 10	Indication Relay	The Indication Relay is intended to be wired into an indication circuit, such as a lamp or PLC input.
Terminals 8 & 9	Reset Input	To reset an earth continuity trip on the ECM3, terminals 8 and 9 must be shorted together. This is generally implemented using an external normally open pushbutton.
Terminal 11	System Earth	Earth connection for the ECM3's loop measurement circuit. Must be the same earth reference as the earth circuit used at the load/termination point.
Terminal 12	Pilot	Pilot connection.
Pilot Series Test	N/A	The pilot series test connects a test resistance in series with the pilot line, testing that the ECM3 trips the contactor. The pilot series test can be an Open Circuit test (to test functionality of a cable disconnection or break). Alternatively, the test button can add a resistance into the pilot circuit to test the high impedance tripping characteristic. The power rating of this resistor should exceed 1W and be suitably rated for the potentially induced voltages that may be exhibited on the pilot.
Pilot Termination Unit	N/A	The Pilot Termination Unit contains the ECM3's 235Ω terminating resistor, as well as two 90V gas arrestors.

Advantages of the Variable Trip Threshold & Dynamic Trip Time Response

The ECM3 allows the user to adjust the trip point between 15Ω - 90Ω with 5Ω increments. The trip threshold should ideally be set as per the earth protection study recommendations such that touch potentials under fault conditions remain within the limits. Typically, this can be calculated to be 5Ω to 10Ω above the healthy earth return path's impedance. The ability to reduce the earth continuity trip point means that the maximum possible touch voltage is significantly reduced.

In conventional earth continuity protection relays, setting the trip threshold this close to the healthy value would result in excessive nuisance trips due to electrical noise coupling with the pilot conductor. As a result, conventional systems increase the trip level, which can result in higher touch potentials during fault conditions.

The ECM3's dynamic trip time response overcomes this issue by utilising a fast trip response of 300msec, for high impedance faults such as an open circuit. The converse is also true for lower impedance faults by increasing the trip response between 300msec to 3sec depending on fault impedance.

Use on Cables with Asymmetrically Located Pilot

A cable is termed asymmetric if a single pilot core is not located in the centre of the three power cores. Asymmetry causes mains frequency voltage to be induced into the pilot core. The amount of induced voltage depends on cable length, cable parameters and load current. Practical tests have demonstrated that when the pilot core connected to an ECM3 is coupled with up to 150VAC of 50Hz noise, it is capable of monitoring the pilot resistance with an accuracy of 5%. The ECM3 relay is capable of monitoring earth continuity continuously and indefinitely when exposed to voltages up to 40VAC on the pilot core, with internal heating having no effect. If however the pilot is coupled with higher voltages, the relay's thermal overload trip begins to function. The thermal overload maintains an inverse time relationship with induced pilot noise magnitude. Such a trip will be indicated with all three indicating lamps (LED) flashing. The ECM3 requires time until the internal resistor has cooled sufficiently before the relay can be reset.

Persistent high AC voltages on the pilot circuit not only stress the relay thermally, but more importantly it is indicative of potentially hazardous step and touch voltages on the installation. When in operation, if the ECM3 repeatedly trips on thermal overload, it is important that steps are taken to reduce the AC voltage coupled into the pilot by either, shortening the cable, replacing the cable with a symmetric alternative or reducing the load.

Setting the Trip Threshold

Altering the trip threshold can be made with the ECM3 energised or not. Adjustment is achieved via the 16-position selector behind the clear front cover. To access the selector switch, carefully remove the clear plastic cover by levering it on the short side with a small blade screwdriver.

To set the trip threshold:

1. Begin with the ECM3 set to 90Ω. See setting table on ECM3 label for switch positions.
2. Install relay as per installation requirements. Power it up and confirm it shows the EC as healthy.
3. Using the 16-position selector, slowly lower the trip threshold until the ECM3's Red LED begins to flash whilst the Green LED remains on (the ECM3 is now indicating that the Pilot/Earth-Loop is above the resistance setting)
4. Before the Green LED turns off (EC trip), increase the trip threshold from this point by 10Ω (two (2) setting points).
5. The trip threshold is now set to 10Ω above the healthy pilot-earth impedance.
6. Carefully replace the clear cover by inserting it at an angle on one short side, then push on the other side until it locks in.

Output Relay and LED Operation

LED	State	Indication	Lamp Relay	Output Relay
Green	Flashing	Initial state the relay enters when the ECM3 is powered up (other LEDs are OFF).	De-Energised	De-Energised
	Steady On	With the external circuit showing the correct conditions and after a reset, the relay enters its normal operating mode with the green LED in a steady ON state.	Energised	Energised
	Off	ECM3 is in a tripped state.	De-Energised	De-Energised
Yellow	Flashing	Fault condition where the ECM3 has detected a SC between the pilot and earth.	De-Energised	De-Energised
Red	Fast Flashing	Fault condition where the ECM3 has detected that the series resistance of the pilot-earth loop has exceeded the "Fast Trip" threshold. The green LED will be off, indicating a tripped state.	De-Energised	De-Energised
Red	Slow Flashing	Slow flashing indicates that the pilot-earth loop series resistance has exceeded the "Slow Trip" threshold of the ECM3 and will initiate an EC trip within 3 seconds. Once a trip occurs, the green LED will turn off, indicating a tripped state.	De-Energised	De-Energised
All	Flashing	Thermal Overload. Investigate the cause and cycle power to the ECM3 relay to restore operation.	De-Energised	De-Energised
Red and Yellow	Flashing	Relay is faulty and needs to be returned to Ampcontrol for repair	De-Energised	De-Energised

The relay does not retain the trip state and indication when the power is removed. However, if a fault exists at power-up, the relay will indicate the fault and won't be able to be reset until the fault is removed.

Switching Inductive Loads

If the control voltage is AC and an inductive load is to be switched, such as a relay or contactor coil, an RC suppressor (e.g. PMR209 series from KEMET, 100nF 100Ω 250V) should be installed in parallel with the load. If a DC control voltage is used, then the inductive switched load should have a diode in parallel. RC suppressors and diodes reduce contact arcing, extending the life of the ECM3's relay contacts as well as reducing the chance for interference with the relays function.

Optional Earth Connection for Power Supply

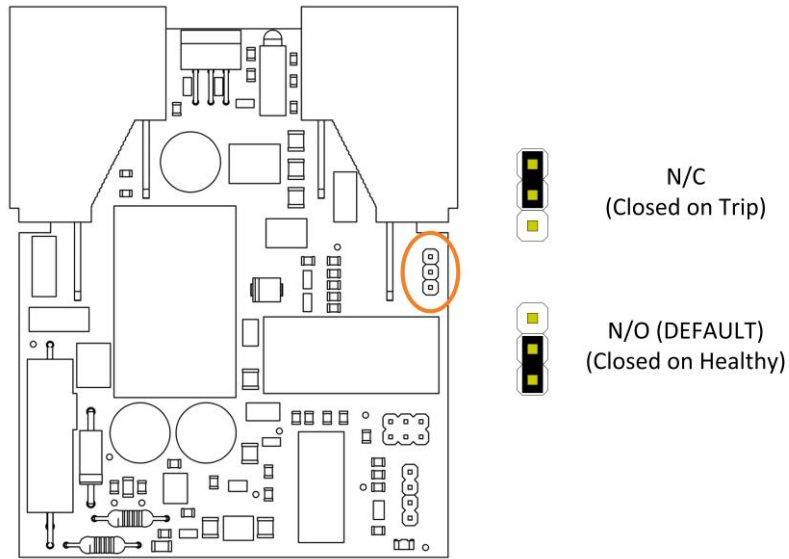
This connection may be used with a power supply that has significant common mode voltage transients (voltage transients between active and earth). The earth connection provides a path to shunt those energies to earth through an internal transient absorber (MOV) if they exceed a certain level. A regulated power supply should be used; excessive common mode transients may damage the ECM3.

Power Supply Input Protection

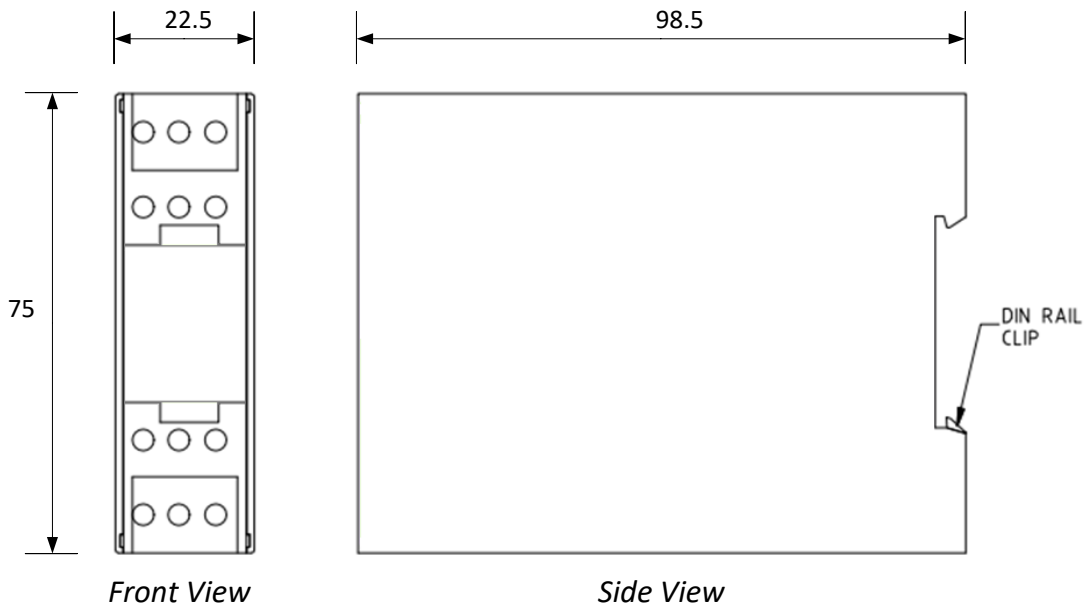
The power supply input is protected with a non-user replaceable thermal fuse that activates if excessive current flows into the relay. Excessive current could be caused by an internal fault or if the supply voltage exceeds the specified limits. The thermal fuse recovers after removal of the fault. If the fault persists, internal damage has occurred and the relay is required to be returned to Ampcontrol for repair.

Changing the Operation of the Indication Relay Output

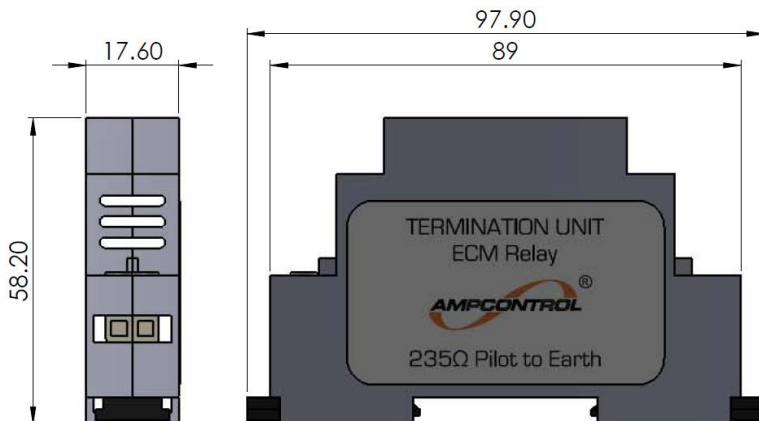
The ECM3's Indication Relay output is factory supplied as a normally open relay. If desired, this can be changed to a normally closed relay to suit the user's requirements. To change the function of the indication relay, remove the internals of the relay from the enclosure and install the jumper across the desired Pins as shown in the image below.



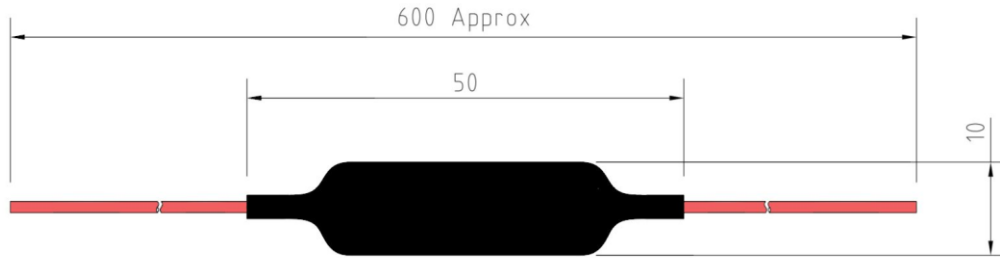
ECM3 Dimensional Diagram (174845)



ECM3 Termination Module with Suppression (176969)



ECM3 Termination Module with Suppression (Surface Mounted) (195131)



Specifications

General	
Regulated Supply Voltage	20-50VAC 50/60Hz, 19-70VDC 110/240VAC requires an additional external power supply – see ordering information
Power Consumption	2W
Tripping Relay Contacts (Terminals 4, 5, 6)	1 C/O 240VAC $\cos\phi = 1$ or 30VDC, 2A max, 100VA max.
Indication Relay Contacts (Terminals 7, 10)	1 N/O or 1 N/C 240VAC $\cos\phi = 1$ or 30VDC, 1A max, 100VA max.
Tolerable Pilot AC Voltage	up to 40Vrms continuous, 300Vrms maximum transient voltage
Ambient Temperature	0°C to 60°C
IP Rating	IP20
Earth Continuity Protection	
Key Trip Times (Slow Trip and Fast Trip)	Trip Setting ($15\Omega \dots 90\Omega$) < R_{SERIES} < 150Ω = 300ms...3s $R_{SERIES} > 150\Omega$ = 300ms
Pilot (Series) Resistance Trip Threshold	15Ω - 90Ω selectable in 5Ω increments (excludes external 235Ω terminating resistor)
Shunt Leakage Trip Value	1000Ω or lower, Trip reset threshold 1500Ω or greater. (excludes external 235Ω terminating resistor)
Dimensions	
ECM3	75 x 22.5 x 100mm
External Power Supply	90 x 22.5 x 100mm
Find Out More	
For more information on this product, contact Ampcontrol Customer Service on +61 1300 267 373 or customerservice@ampcontrolgroup.com or visit the Ampcontrol website: www.ampcontrolgroup.com	

Ordering Information

Part Number	Description
174845	ECM3 Earth Continuity Relay 20-50VAC 19-70VDC
141479	85-264VAC or 120-370VDC to 24VDC 1A External Power Supply
176969	ECM Termination Module with Suppression
195131* (See note below)	ECM Termination Module with Suppression (Surface Mounted)

NOTE



The surface mounted termination module was designed for shorter runs of cable or for installations exposed to lower noise levels. This is due to the power ratings of the internal component being less, roughly half that of the standard termination module.

DISCLAIMER

While every effort has been made to assure the accuracy of this document at the date of issue, Ampcontrol assumes no liability resulting from any omissions or errors in this document, and reserves the right to revise content at any time.