

Overview

The FG-R05-3A sensor is a high-sensitivity AC and DC leakage current sensor with individual open drain alarms and an analog output for leakage current indication. In addition, its integrated test coil can be initiated by a test input to perform a functional alarm test.

Applications

Typical applications include residual current sensor for In-Cable Control and Protection Devices (IC-CPD) or Wallbox.

Benefits

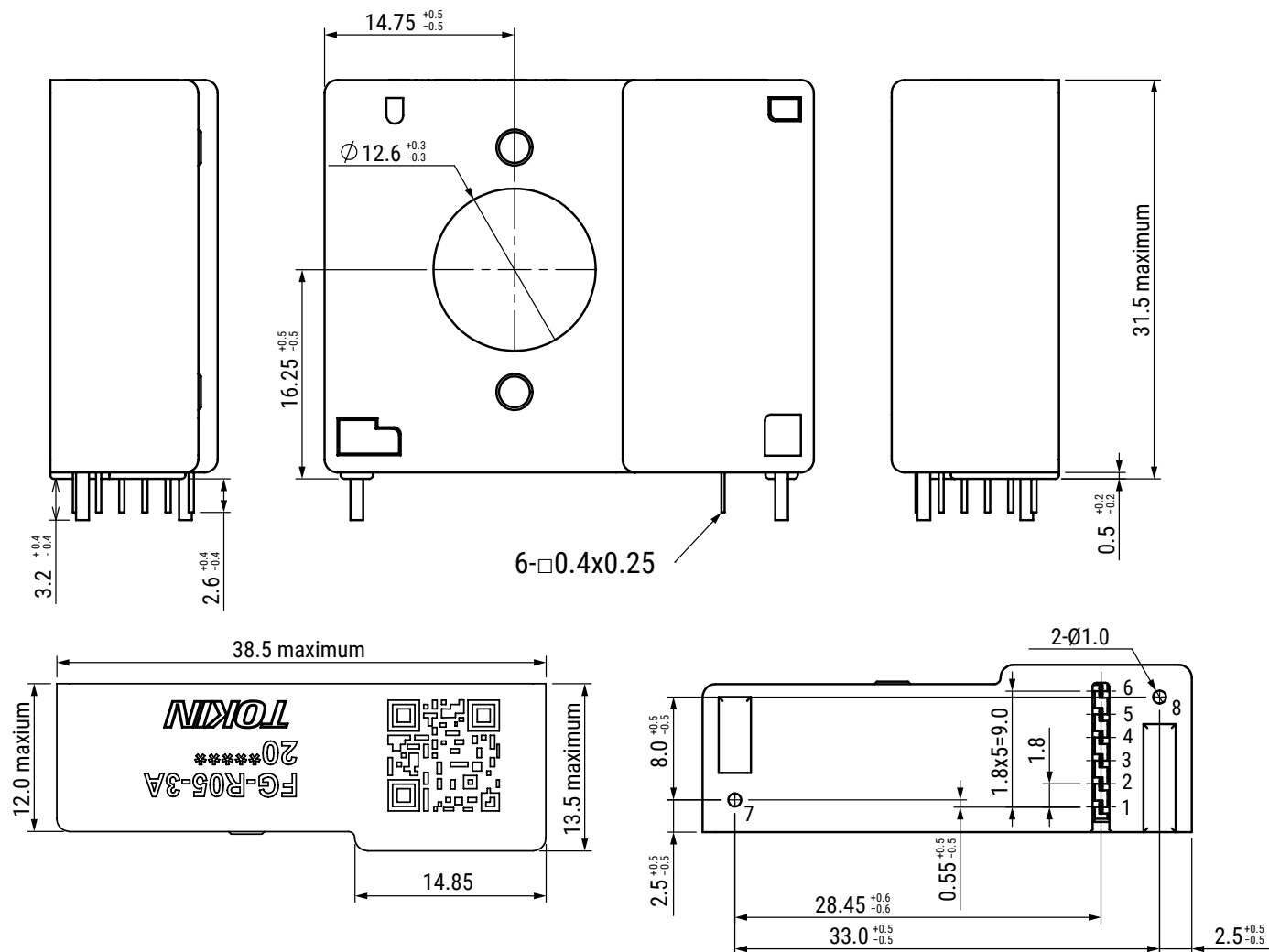
- Open-loop, fluxgate-based current sensor
- PCB mounting
- Digital output of fault detection
- Conforms to IEC 62752:2016/A1:2018
- Conforms to UL 2231-2
- RoHS compliant



Ordering Information

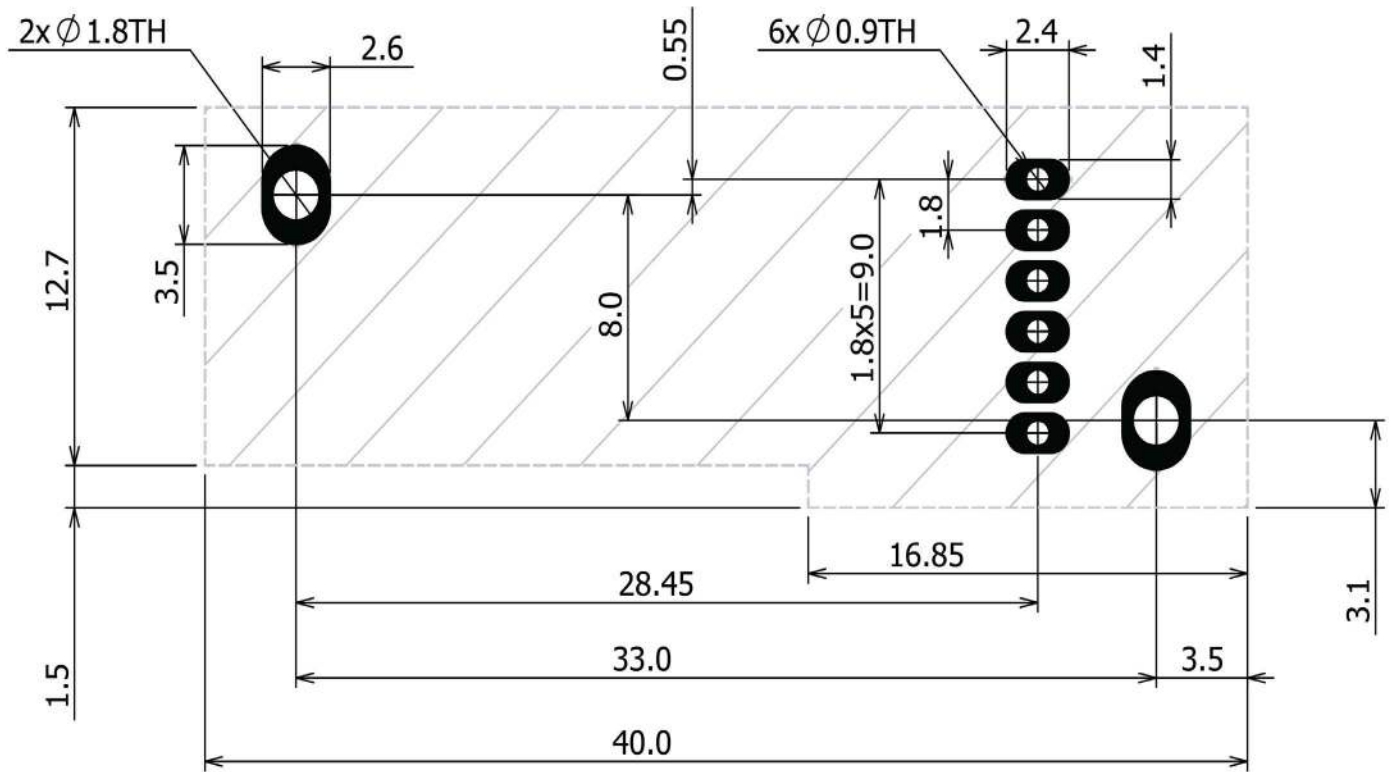
| FG- | R05- | 3A |
|--------|----------------|---|
| Series | Shape | Current Detection Standards |
| FG | R05 = Vertical | 3A = IEC 62752:2016/A1:2018 and UL 2231-2 |

Dimensions in mm



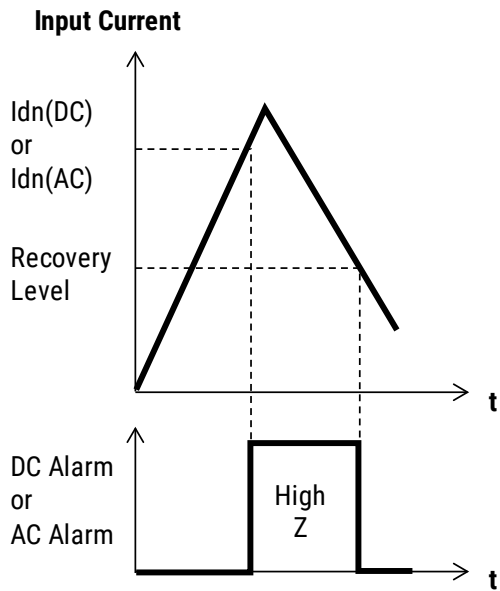
| Pin Number | Symbol | Pin Type | Functions |
|------------|--------------------------|---------------|---|
| 1 | VDD | Power | Power supply, 5 V |
| 2 | GND | Power | Ground |
| 3 | AOUT | Analog output | Analog output. This is for monitoring purposes, and is not safety function! Offset voltage is 2.25 V (typical). Sensitivity is 40 V/A (typical). |
| 4 | DC Alarm (Open-Drain) | Open drain | Active high if DC current is in the range of 3 to 6 mA. |
| 5 | AC Alarm (Open-Drain) | Open drain | Active high if AC current is in the range of 15 to 20 mA. IEC62752:2016 and UL 2231 (CCID20) |
| 6 | TEST | Input | Test input. Internal pull-down with 100 k Ω . Test sequence starts when input positive pulse input (>120 usec). |

PCB Footprint - Top View



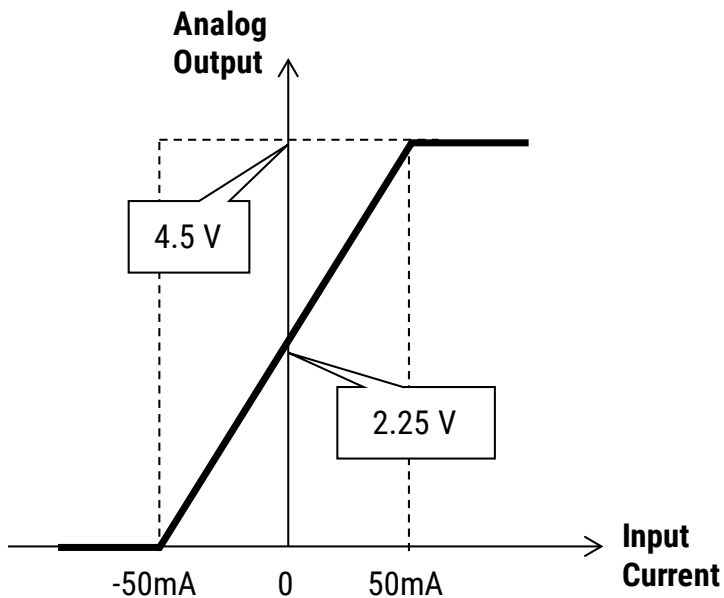
Output Characteristics

Switching Operation



When the residual current exceeds the threshold level ($I_{dn}(DC)$ or $I_{dn}(AC)$), PIN 4 (DC Alarm) or PIN 5 (AC Alarm) will change from low level to high impedance. Each output goes back from high impedance to low level when residual current falls below recovery level.

PIN 3 Analog Output – DC Characteristics



Output Characteristics cont.

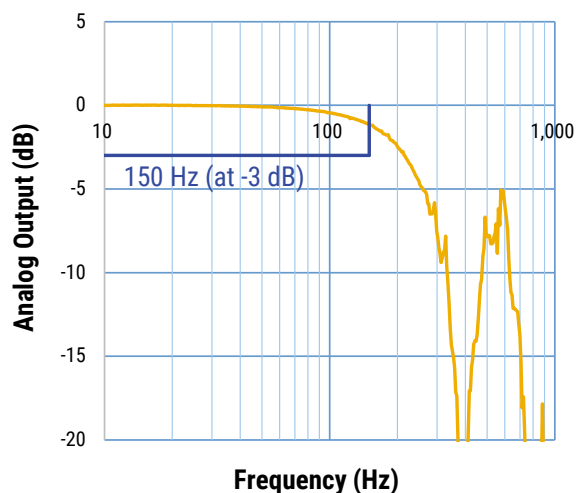
Output State

| DC Alarm | AC Alarm | State |
|----------------|----------------|--|
| GND | GND | Normal Condition |
| High Impedance | GND | DC Detection Current > 6 mA |
| GND | High Impedance | AC Detection Current > 20 mA |
| High Impedance | High Impedance | DC Detection Current > 6 mA and AC Detection Current > 20 mA |

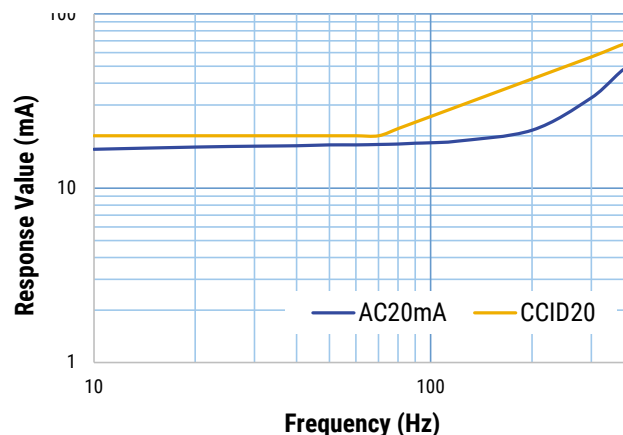
Temperature of primary wire should not exceed 105°C.

The rise time of the supply voltage is 50 μ s to 100 ms.

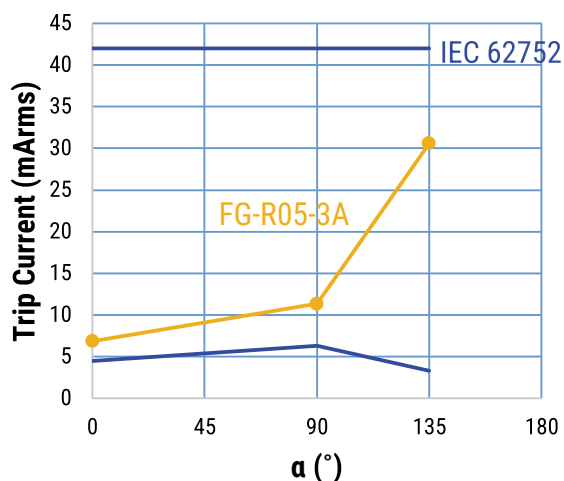
Frequency Characteristics of Analog Output



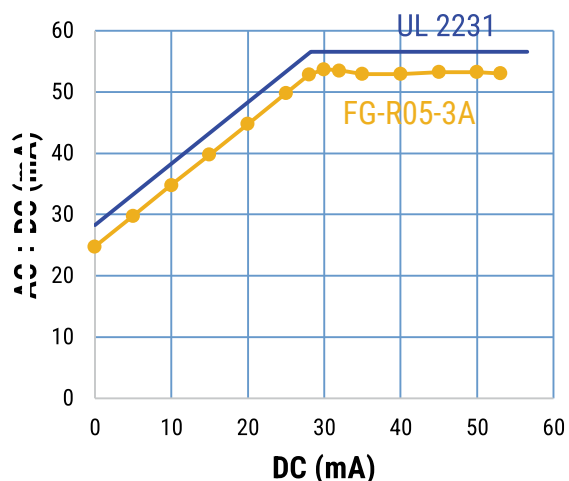
Frequency Characteristics of Response Value



Trip Current of Pulsating DC at Phase 0°, 90°, 180°



Trip Current of AC + DC



Above data are not guaranteed values, for reference only.

Environmental Compliance

FG sensors are RoHS compliant.



Specifications

| Item | Performance Characteristics |
|---|-----------------------------------|
| Primary Rated Voltage | 250 V |
| Primary Nominal Current | 80/40 A Maximum (1 phase/3 phase) |
| Supply Voltage Range | 4.75 – 5.25 V (5 V typical) |
| Maximum Input Voltage of Digital Output | Supply Voltage + 0.3 V |
| Input Voltage Range of TEST (LOW) | 0.0 – 0.6 V |
| Input Voltage Range of TEST (HIGH) | 2.5 V - Supply Voltage |
| Maximum Sink Current of Digital Output | 10 mA |
| Current Consumption | 13 mA (at measurement 0 mA) |
| Operating Temperature Range | -40°C to +105°C |
| Storage Temperature Range | -40°C to +105°C |

Tests

ESD Test

DC Detection Current within specifications as per Table 1 – Ratings & Part Number Reference after ESD test.

| Parameter | Result |
|--|--------|
| Electrostatic Discharge Voltage Human-Body Model (HBM) R = 1,500 Ω, C = 100 pF, U = ±2,000 V | Passed |
| Electrostatic Discharge Voltage Charged-Device Model (CDM) U = ±800 V | Passed |

Tests cont.

EMC Test

DC Alarm and AC Alarm do not malfunction during noise stimulation.

| Parameter | Conditions | Result |
|--|---|--------|
| IEC 61000-4-3 Radiated, radio-frequency, electromagnetic field immunity | 20 V/m, 80 MHz – 1 GHz 80% AM 1 kHz | Passed |
| ISO 11452-2 (ALSE) Electrical disturbances from narrowband radiated electromagnetic energy | 50 V/m 200 MHz – 800 MHz 80% AM 1 kHz, 800 MHz – 2 GHz PM | Passed |
| ISO 11452-4 (BCI) Electrical disturbances from narrowband radiated electromagnetic energy | 100 mA 20 MHz – 200 MHz 80% AM 1 kHz | Passed |

Dielectric Strength

| Parameter | Conditions | Values |
|--------------------------|--|------------------------|
| $U_{W, \text{prim-sec}}$ | Impulse (1.2 $\mu\text{s}/50 \mu\text{s}$), PIN 1-6 vs insulated primary wire, 5 pulse -> polarity +, 5 pulse -> polarity - | 5,500 V _{rms} |
| U_d | Test voltage, 60 seconds PIN 1-6 vs insulated primary wire | 1,500 V _{rms} |
| $U_{PD \times 1.5}$ | Partial discharge voltage, PIN 1-6 vs insulated primary wire * acc. to table 24 | 1,200 V _{rms} |
| $U_{PD \times 1.875}$ | Partial discharge voltage, PIN 1-6 vs insulated primary wire * acc. to table 24 | 1,500 V _{rms} |

* IEC 61800-5-1:2007

Table 1 – Ratings & Part Number Reference

| Part Number | Measurement Range (mA) | DC Detection Current ¹ (mA) | AC Detection Current ^{1,2} (mArms) | DC Alarm Response Time (ms) | AC Alarm Response Time (ms) |
|-------------|------------------------|--|--|--|--|
| FG-R05-3A | -50 - +50 | 4.5 typical 3 minimum 6 maximum | 17.5 typical 15 minimum 20 maximum (at 55 Hz) | 280 typical, 1,000 maximum (at measurement = 6 mA) 24 typical, 250 maximum (at measurement = 60 mA) 6 typical, 15 maximum (at measurement = 300 mA) | 60 typical, 250 maximum (at measurement = 30 mArms) 20 typical, 100 maximum (at measurement = 60 mArms) 8 typical, 20 maximum (at measurement = 150 mArms) 7 typical, 10 maximum (at measurement = 264 mArms) 7 typical, 10 maximum (at measurement > 5 Arms) |

¹ Recovery level = detection current/2.

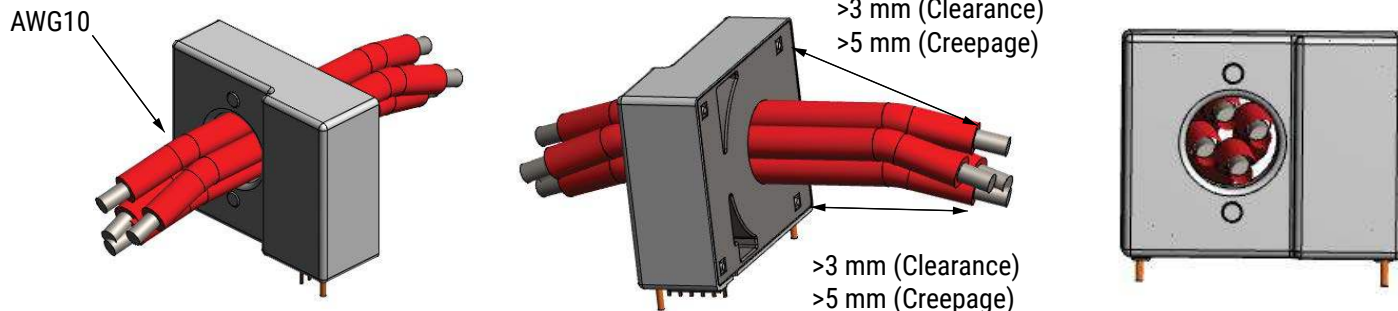
² Frequency characteristic of AC detection current = -1% typical, -2% minimum at 45 Hz/55 Hz and +1% typical, +2% maximum at 65 Hz/55 Hz.

| Part Number | PIN 3 AOUT Sensitivity (V/A) | PIN 3 AOUT Offset Voltage (V) | PIN 3 AOUT Frequency Range (Hz) | Hole Diameter (mm) | Weight (g) |
|-------------|------------------------------|-------------------------------|---------------------------------|--------------------|------------|
| FG-R05-3A | 40 typical | 2.25 typical | 150 maximum (at -3 dB) | ϕ 12.6 | 20 |

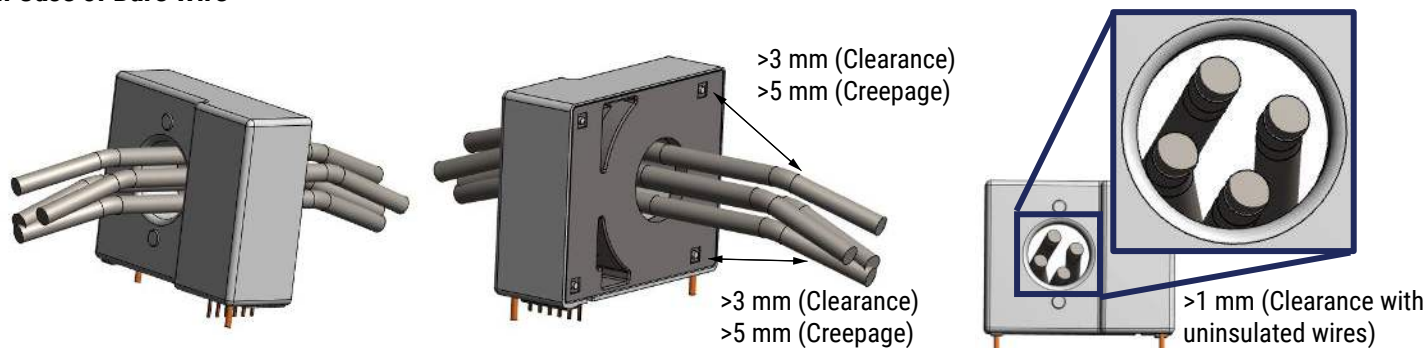
Recommended Wire Configurations

In Case of Insulated Wire

Three phase system < 480 V



In Case of Bare Wire



Reinforced insulation, insulation material group III, pollution degree 2, altitude < 5,000 m and overvoltage category II.
Please take enough creepage distance between each pin.

Soldering Process

FG-R05-3A

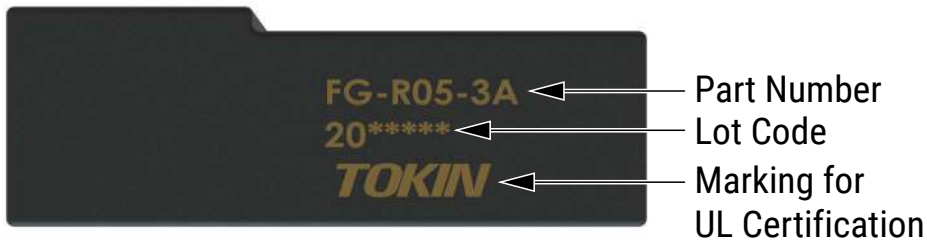
| | | |
|-----------------------|------------------------|-------------------|
| Wave Soldering | Preheating temperature | 100 – 140°C |
| | Preheating time | within 40 seconds |
| | Heating temperature | 260°C |
| | Heating time | within 10 seconds |

Packaging

| Type | Packaging Type | Pieces Per Box |
|------|----------------|----------------|
| FG | Tray | 300 |

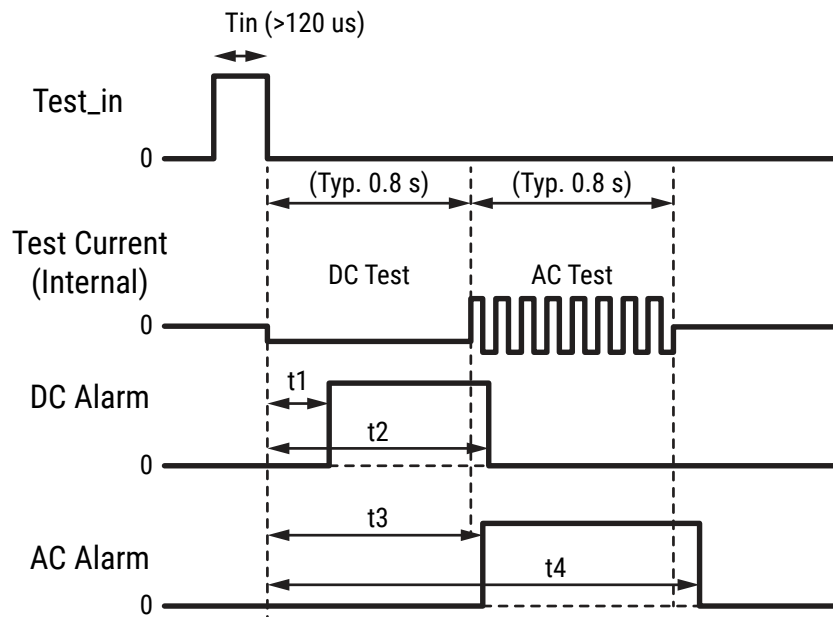
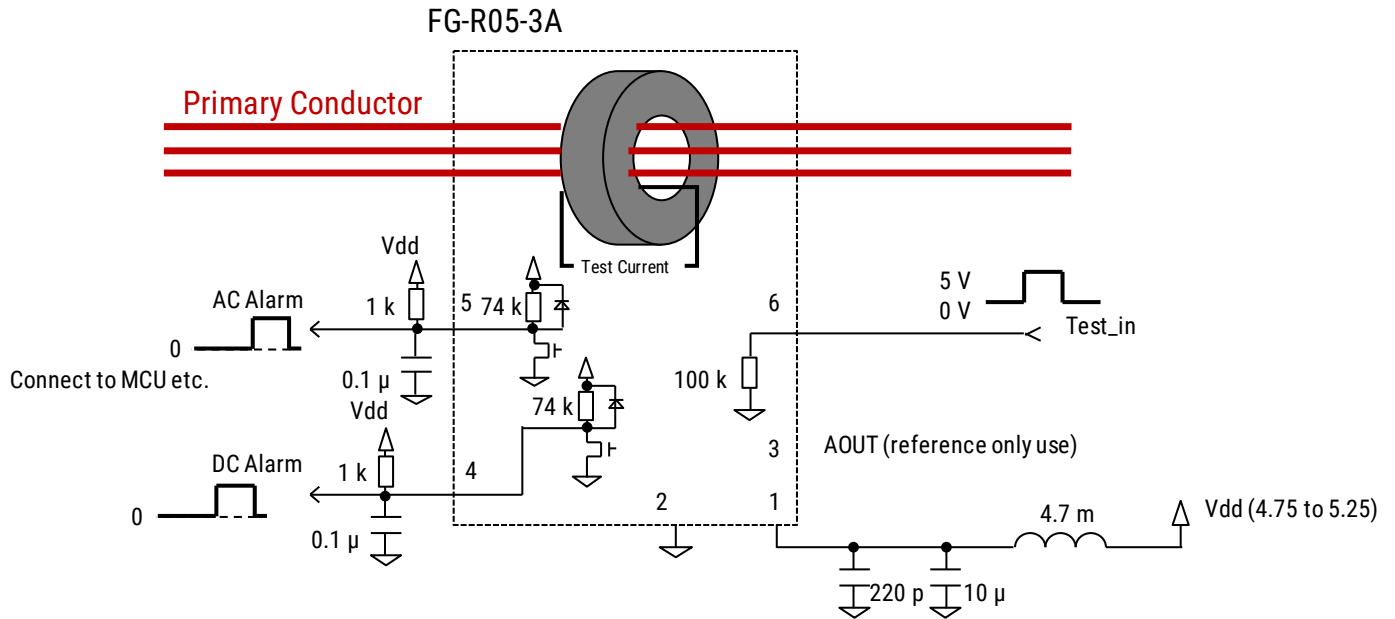
The product is packed in antistatic trays.

Marking



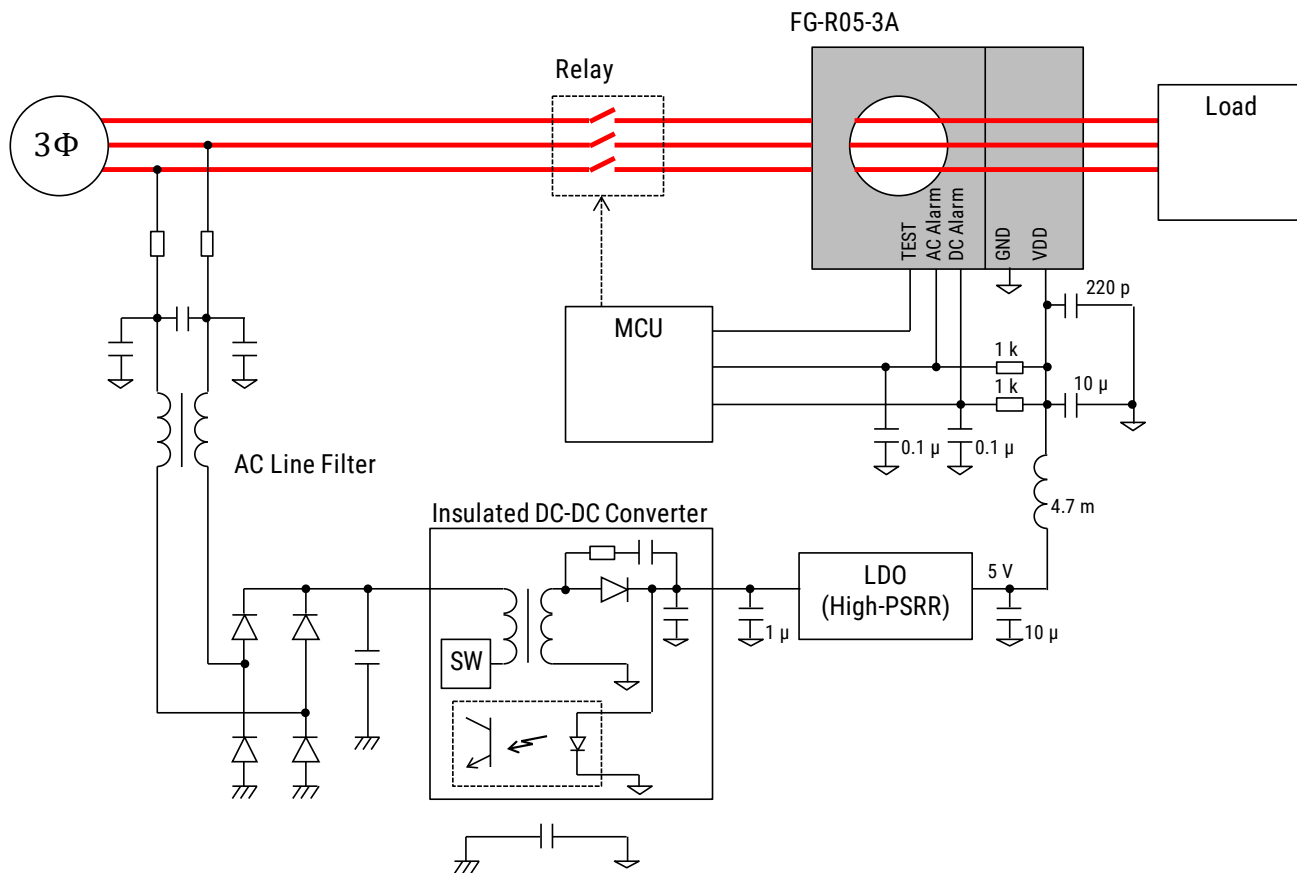
| Lot Code | |
|---|---|
| 1st and 2nd digit = Last two digits of Year | 19 = 2019 20 = 2020 21 = 2021 22 = 2022 |
| 3rd and 4th digit = Month of the Year | 01 = January 02 = February to 11 = November 12 = December |
| 5th and 6th digit = Day of the Month | 01 = 1st to 31 = 31st |
| 7th digit = Serial Number | 01, 02, etc. |

Self-Test Operation



| Parameter | Minimum | Maximum |
|-----------|---------|---------|
| t1 | 0.12 | 0.60 |
| t2 | 0.80 | 1.30 |
| t3 | 0.70 | 1.20 |
| t4 | 1.40 | 2.10 |

Recommended Circuit



Application Hints

- An X capacitor is effective in suppressing normal mode noise from the input.
- A Y capacitor and an AC line filter are effective in suppressing common mode noise from the input.
- It is recommended to use a High-PSRR LDO for the power input to the FG-R05-3A.
- Adding an LC filter to the Vdd improves noise immunity.
- Adding a capacitor of a few hundred pF or less to the Vdd improves high frequency noise immunity.
- Adding capacitors to the AC / DC Alarm jack and GND improve noise immunity.

Handling Precautions

Precautions for Product Storage

Current sensors should be stored in normal working environments. While the sensors are quite robust in other environments, exposure to high temperatures, high humidity, corrosive atmospheres, and long-term storage degrade solderability.

KEMET recommends that maximum storage temperature not exceed 85°C and atmospheres should be free of chlorine and sulfur-bearing compounds. Temperature fluctuations should be minimized to avoid condensation on the parts. Avoid storage near strong magnetic fields, as they can magnetize the product and cause its characteristics to change. Limit ambient magnetic fields to 50e or less.

For optimized solderability, the stock of current sensors should be used within 12 months of receipt.

Before Using Fluxgate-Based Residual Current Sensors

- Do NOT drop or apply any other mechanical stress, as such stresses may change performance characteristics.
- Do NOT exceed 260°C for 10 seconds when soldering. This is the maximum heat resistance grade of these sensors. Use a low-corrosion type flux when soldering.
- Do NOT allow strong static electricity near the sensor, as the circuit uses ICs. Static electricity can cause damage. Take static electricity precautions when handling.
- The case is Insulation Materials Group III. When designing the primary wire, be careful of clearance and creepage distance from the input/output terminal.

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