Fluxgate-Based Residual Current Sensor, FG-R14 Series

Overview

The FG-R14 series 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. By updating the ASIC from the conventional product, it is fully compliant with IEC62955.

Applications

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

Benefits

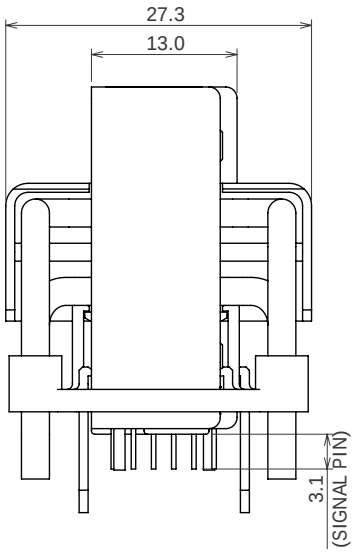
- Open-loop, fluxgate-based current sensor
- PCB mounting
- Digital output of fault detection
- Conforms to IEC 62752:2016/A1:2018 (FG-R14-6A and FG-R14-6B)
- Fully compliant to IEC 62955:2018[1] (FG-R14-6A and FG-R14-6B), can be used for RCD-MD
- RoHS compliant
- 3,000 A surge current capability
- Composed of AEC-Q certified parts
- Compliant with ASIL_B for Safety Element out of Context(SEooC)

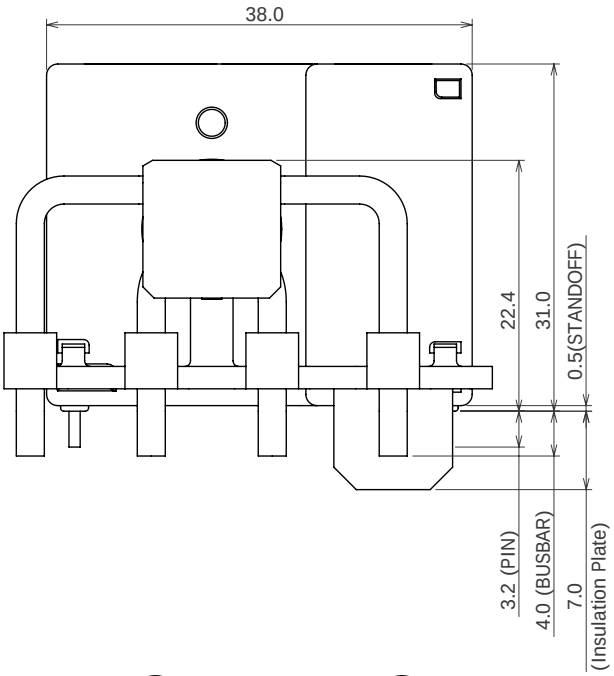
Ordering Information

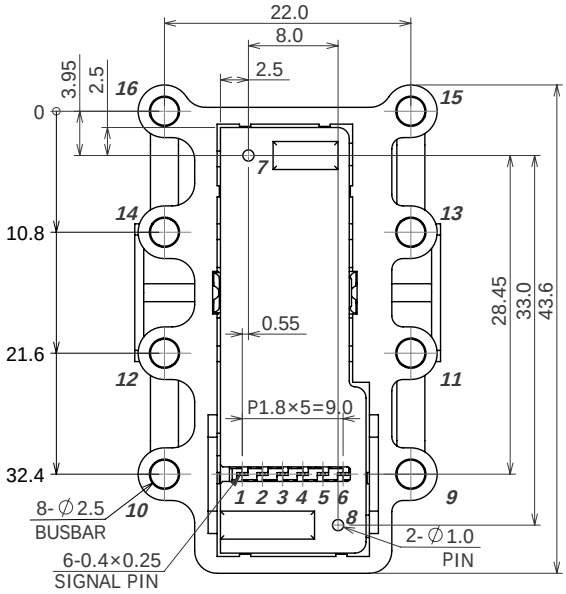
FG-	R14-	6A
Series	Shape	Current Detection Standards
FG	R14 = Vertical with busbar, with updated ASIC	6A = Full compliant to IEC 62752:2016/A1:2018 and UL 2231-2, IEC 62955:2018[1] 6B = Full compliant to IEC 62752:2016/A1:2018, IEC 62955:2018[1]

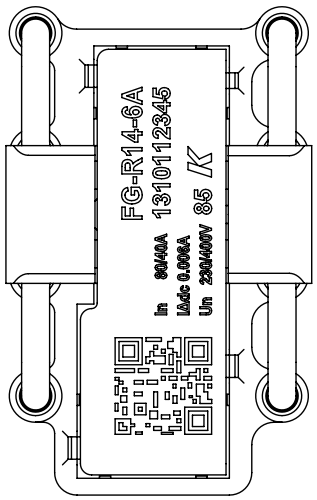
[1] *Conditional and dependant on the circuit/system designed as explained in the section Recommended Circuit of this datasheet.*

Dimensions in mm





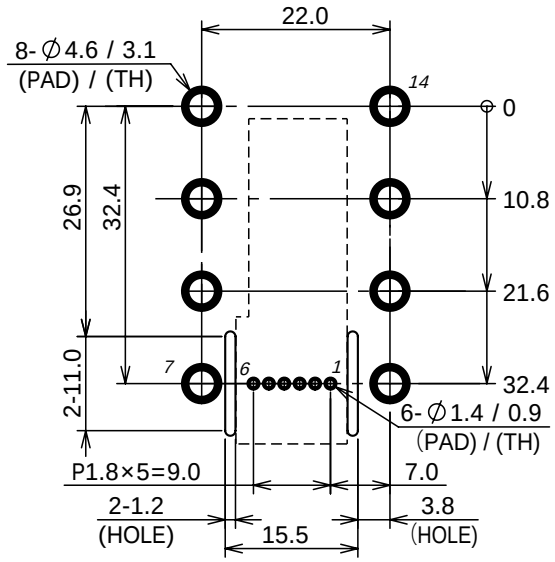




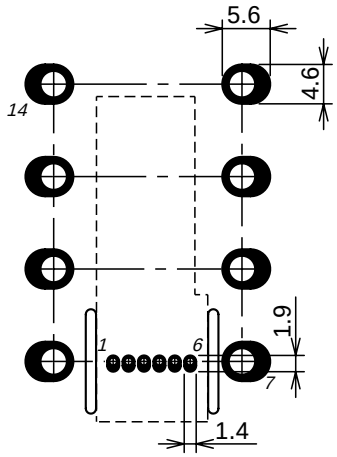
Pin Number	Symbol
	FG-R14-6A, FG-R14-6B
1	VDD
2	GND
3	AOUT
4	DC Fault
5	AC Fault
6	TEST
7-8	Dummy
9-16	Busbar for Primary Wires

PCB Footprint - Top View

Component side



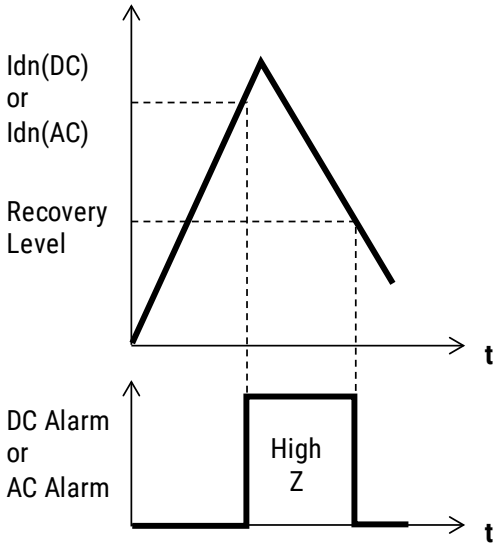
Solder side



Output Characteristics

Switching Operation

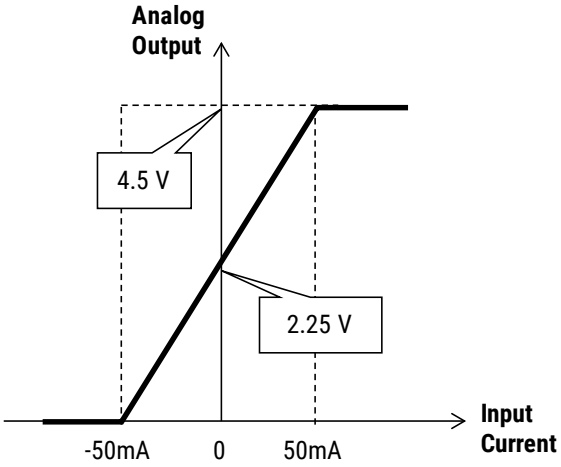
Input Current



When the residual current exceeds the threshold level (Idn(DC) or Idn(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.

Output Characteristics (cont.)

PIN 3 Analog Output – DC Characteristics



Output State

FG-R14-6A

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 us to 100 ms.

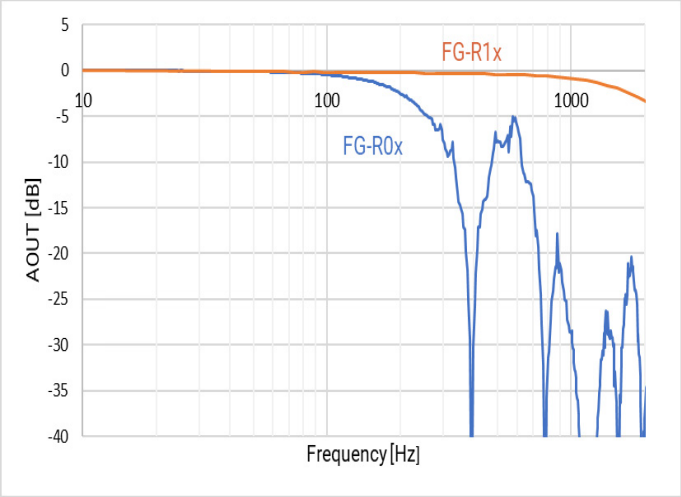
FG-R14-6B

DC Alarm	AC Alarm	State
GND	GND	Normal Condition
High Impedance	GND	DC Detection Current ≥ 6 mA
GND	High Impedance	AC Detection Current ≥ 30 mA
High Impedance	High Impedance	DC Detection Current ≥ 6 mA and AC Detection Current ≥ 30 mA

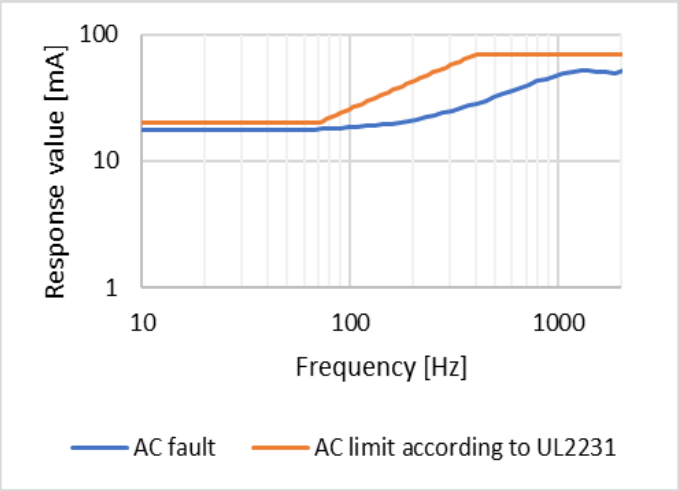
Temperature of primary wire should not exceed 105°C.
The rise time of the supply voltage is 50 us to 100 ms.

Output Characteristics (cont.)

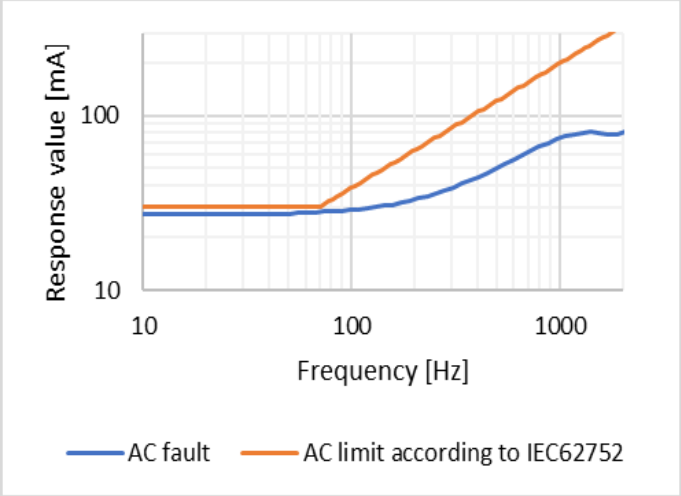
Frequency Characteristics of Analog Output



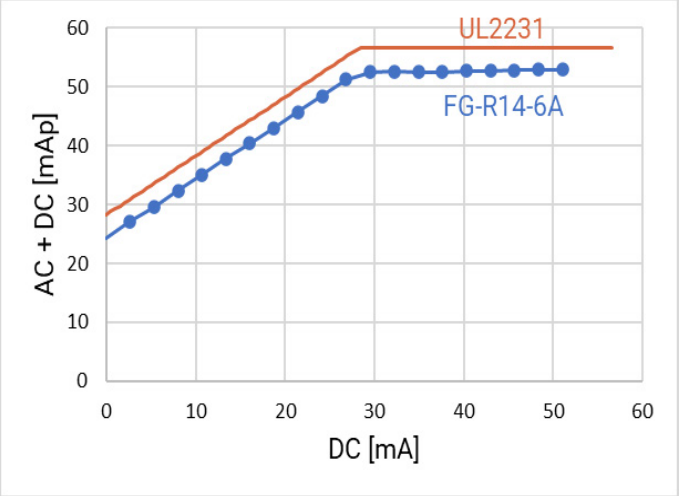
Frequency Characteristics of Response Value (FG-R14-6A)



Frequency Characteristics of Response Value (FG-R14-6B)



Trip Current of AC + DC



Environmental Compliance

FG sensors are RoHS compliant.

Specifications

Item	Performance Characteristics
Primary Rated Voltage (Phase/Line)	230/400 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=2.0kΩ, C=150pF, U=+/-2kV * AEC-Q200 / IEC61000-4-2	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
IEC 62955 § 9.18.2 Surge current immunity test	Peak 3,000 A Virtual front time 8 µs Virtual time to half value 20 µs	Passed

Dielectric Strength

Parameter	Conditions	Values
$U_{W, prim-sec}$	Impulse(1.2 µs/50 µs), PIN1-6 vs Busbar (7-14), 5 pulse -> polarity +, 5 pulse -> polarity	6,000 V
$U_{W, prim-prim}$	Impulse(1.2 µs/50 µs) Busbar 7 vs 9, 9 vs 11, 11 vs 13 5 pulse -> polarity +, 5 pulse -> polarity	4,000 V
$U_{d, prim-sec}$	Test voltage, 60 seconds PIN1-6 vs Busbar (9-16)	4,000 V_{rms}
$U_{d, prim-prim}$	Test voltage, 5s Busbar 7 vs 9, 9 vs 11, 11 vs 13	1.5kV_{rms}
$U_{PDx1.5}$	Partial discharge voltage, PIN1-6 vs Busbar (7-14) Acc. to IEC 61800-5-1:2007 table 24	1.2kV_{rms}
$U_{PDx1.875}$	Partial discharge voltage, PIN1-6 vs Busbar (7-14) Acc. to IEC 61800-5-1:2007 table 24	1.5kV_{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-R14-6A	-50 - +50	4.5 typical 3 minimum 6 maximum	17.5 typical 15 minimum 20 maximum (at 55 Hz)	695 typical, 1,000 maximum (at measurement = 6 mA) 40 typical, 250 maximum (at measurement = 60 mA) 12 typical, 15 maximum (at measurement = 300 mA)	60 typical, 250 maximum (at measurement = 30 mArms) 25 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)
FG-R14-6B			27.5 typical 25 minimum 30 maximum (at 55 Hz)		170 typical, 250 maximum (at measurement = 30 mArms) 40 typical, 100 maximum (at measurement = 60 mArms) 15 typical, 20 maximum (at measurement = 150 mArms) 6 typical, 10 maximum (at measurement > 5 Arms)

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-R14-6A	40 typical	2.25 typical	-	-	32
FG-R14-6B					

Soldering Process

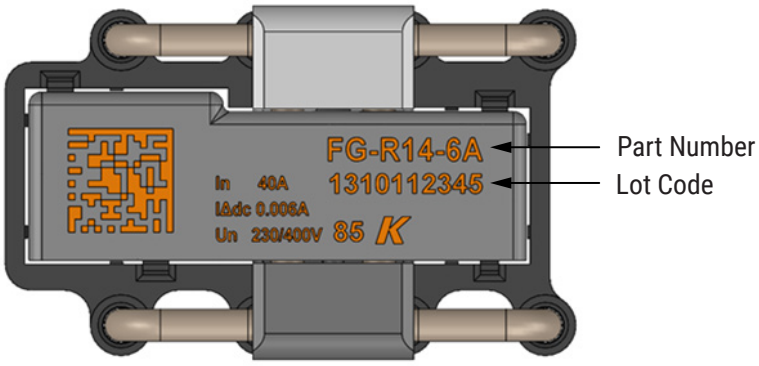
Wave Soldering	Preheating temperature	100 – 140°C
	Preheating time	within 40 seconds
	Heating temperature	260°C
	Heating time	within 10 seconds

Packaging

Type	Packaging Type	Pieces Per Box
FG	Tray	150

The product is packed in antistatic trays.

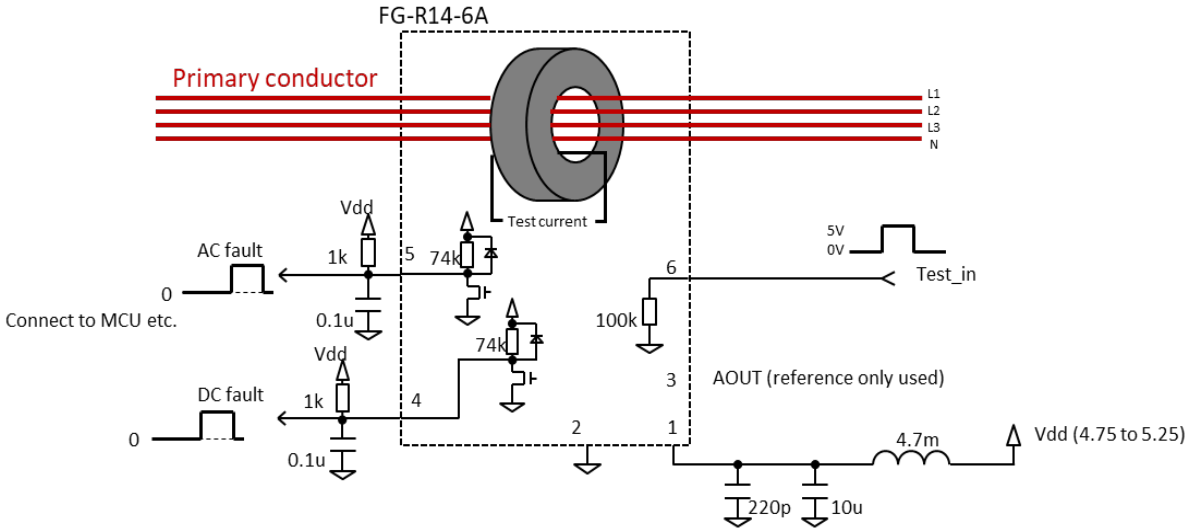
Marking



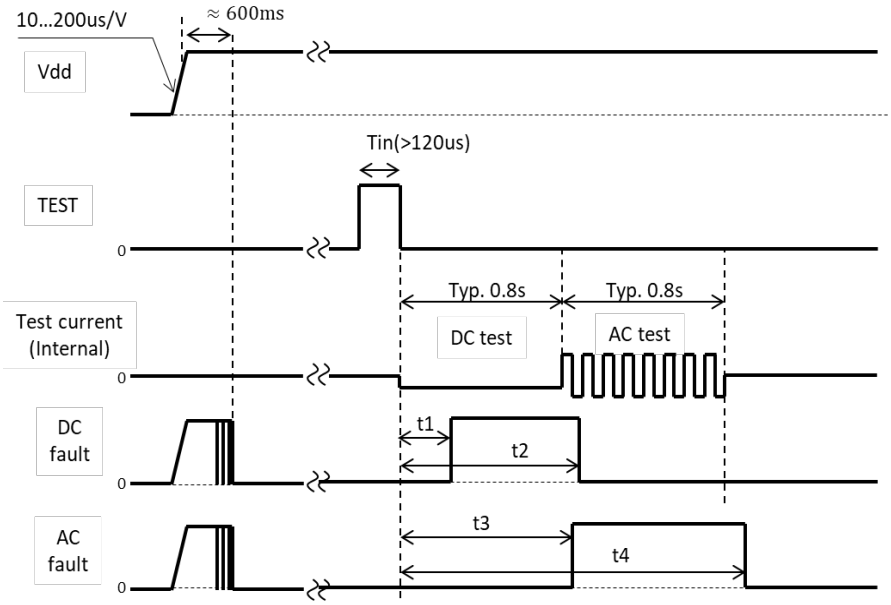
Lot Code	
1st digit = Manufacturing Line Number	1 : Line No.1 2 : Line No.2
2nd digit = Year	1 = 2021 2 = 2022 3 = 2023 A = 2030 B = 2031
3rd digit = Month of the Year	1 = January 2 = February to A = October B = November C = December
4th and 5th digit = Day of the Month	01 = 1st to 31 = 31st
6th to 10th digit = Serial Number	00001 00002 etc

Self-Test Operation

FG-R14-6A & FG-R14-6B

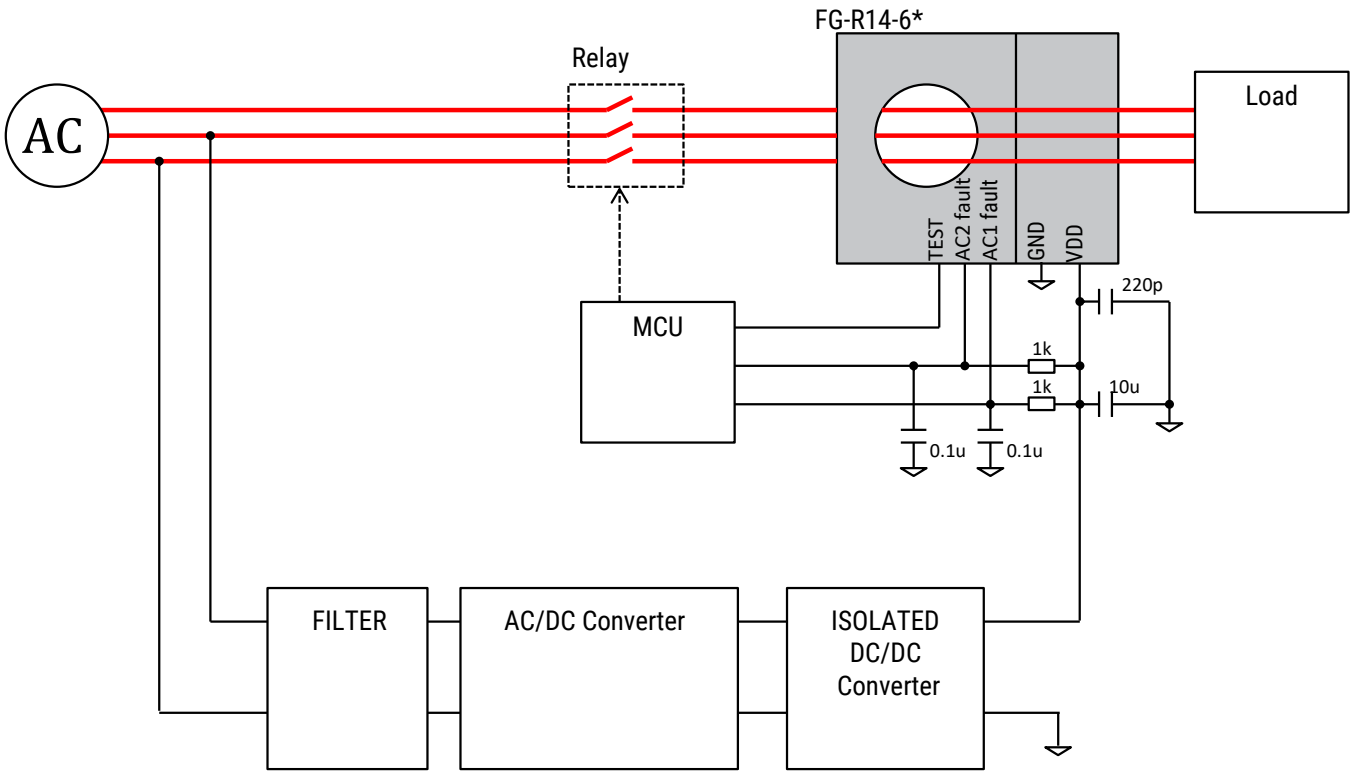


Time Chart



Parameter	Minimum	Maximum
t1	0.24	0.80
t2	0.85	1.50
t3	0.70	1.20
t4	1.40	2.10

Recommended Circuit



Application Hints

• Adding a capacitor of a few hundred pF or less to the VDD improve high frequency noise immunity.
• Adding capacitors to between the AC / DC fault 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 desiging the primary wire, be careful of clearance and creepage distance from the input/output terminal.

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