



Self Test With Lockout Ground Fault Circuit Interrupter (GFCI)

NCS37010

The NCS37010 is a fully UL943 compliant signal processor for GFCI applications with self test and lockout. The device integrates a flexible power supply (including both shunt and LDO regulators), differential fault, and grounded–neutral detection circuits. Proprietary impedance measurement and signal processing techniques are used to minimize the number of external components and improve performance. The device also includes a specialized DSP controller that offers best in class immunity to nuisance loads without the need for external analog filters. At power up the NCS37010 performs a self test at 60 ms and removes the lockout if the test passes. This self test consists of a differential, ground–neutral and solenoid test.

Features

- 6.0 – 12 V Operation (120 – 480 V AC Mains with the Appropriate Series Impedance)
- –40 to 85°C
- Very low power consumption: < 15 mW @ 6 V
- 16 Pin QFN or 20 Pin TSSOP Package
- Single Current Transformer (CT) Detection of Both Differential and Neutral Faults

NCS37010

QFN PIN DESCRIPTION

Pin #	Name	Pad Description
0	Ground	QFN center slug
1	MLD	Mains Level Detect (Zero Cross)
2	CtresGN	Determines IV converter gain for detection threshold / matched to CT turns ratio (Ground-Neutral)
3	Ctbias	Direct connection to the CT
4	Ctstim	Direct connection to the CT
5	CTresD	Determines IV converter gain for detection threshold / matched to CT turns ratio (Differential Current)
6	IDF	Front end noise filter capacitor
7	GFtst	Output to induce external differential current.
8	GnEN	Ground-Neutral fault detection enable pin.
9	SCRtstEN	SCR/solenoid self test enable pin.
10	TE	Tie to Ground or leave floating.
11	PTT	Push to test input.
12	LObar	Load monitor input.
13	LED[0]	LED[0] output driver.
14	LO	Lockout SCR output driver.
15	SCRdrv	Used to trigger the solenoid at a fault detection
16	Supply	Power supply

TSSOP PIN DESCRIPTION

Pin #	Name	Pad Description
1	CTstim	Differential and ground to neutral stimulus point for the current transformer.
2	Ground	Ground connection for IC.
3	CTresD	Determines IV converter gain for detection threshold / matched to CT turns ratio (Differential Current).
4	IDF	Determines corner frequency of the differential current path filter.
5	GFtst	Output to induce external differential current.
6	GnEN	Ground-Neutral fault detection enable pin.
7	SCRtstEN	SCR/solenoid self test enable pin.
8	TE	Tie to Ground or leave floating.
9	PTT	Push to test input.
10	LObar	Load monitor input.
11	Ground	Ground connection for IC.
12	LED[0]	LED[0] output driver.
13	LO	Lockout SCR output driver.
14	SCRdrv	Used to trigger the solenoid at a fault detection.
15	DVDD	Internal digital 5 V regulated supply.
16	AVDD	

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage Range	V _S	6.0 to 14	V
Supply Current Range	I _S	10	mA
Input Voltage Range (Note 1)	V _{in}	-0.3 to 6.0	V
Output Voltage Range	V _{out}	-0.3 to 6.0 V or (V _{in} + 0.3), whichever is lower	V
Maximum Junction Temperature	T _{J(max)}	140	°C
Storage Temperature Range	T _{STG}	-65 to 150	°C
ESD Capability, Human Body Model (Note 2)	ESD _{HBM}	2	kV
ESD Capability, Machine Model (Note 2)	ESD _{MM}	200	V
Lead Temperature Soldering Reflow (SMD Styles Only), Pb-Free Versions (Note 3)	T _{SLD}	260	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

- Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
- This device series incorporates ESD protection and is tested by the following methods:
ESD Human Body Model tested per AEC-Q100-002 (EIA/JESD22-A114)
ESD Machine Model tested per AEC-Q100-003 (EIA/JESD22-A115)
Latchup Current Maximum Rating: ≤ 150 mA per JEDEC standard: JESD78
- For information, please refer to our Soldering and Mounting Techniques Reference Manual, SOLDERRM/D

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Characteristics, QFN16, 3x3.3 mm (Note 4) Thermal Resistance, Junction-to-Air (Note 5)	R _{θJA}	64	°C/W
Thermal Characteristics, TSSOP-20 (Note 4) Thermal Resistance, Junction-to-Air (Note 5)	R _{θJA}	See note above.	°C/W

- Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
- Values based on copper area of 645 mm² (or 1 in²) of 1 oz copper thickness and FR4 PCB substrate.

OPERATING RANGES (Note 6)

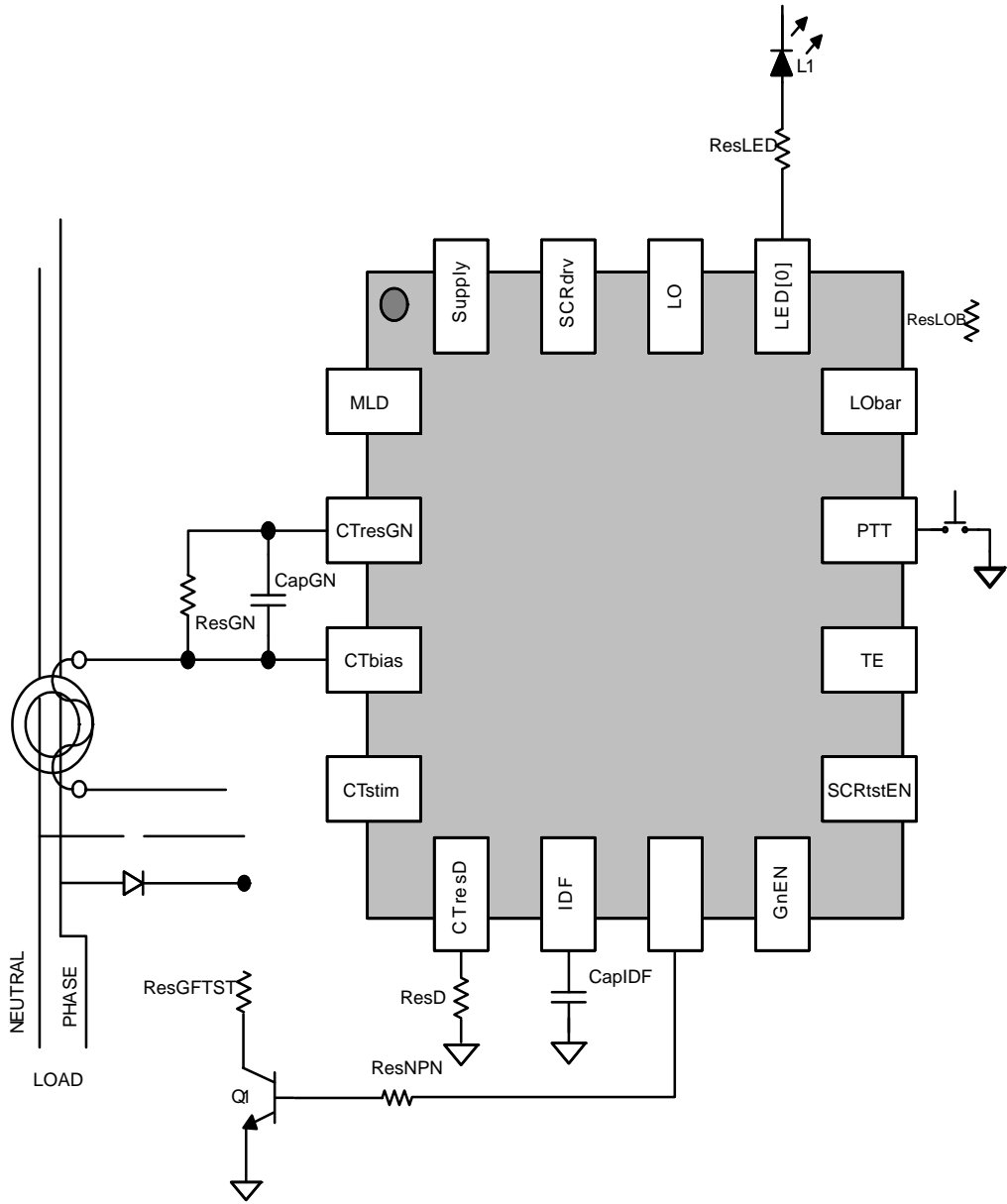
Parameter	Conditions	Min	Typ	Max	Unit
Operating Temperature		-40		85	C
V _S in typical power state		6		13	V
I _S in typical power state			2		mA
Stimulus Generator Frequency	Tri-tone	3.1		3.4	kHz
SCR Trigger Current				8	mA
SCR Trigger output voltage	With 5 V supply	4.5		5.5	V
Fault Current Sensitivity	Programmable with CTresD	4.6	4.8	5	mA
Ground Fault Response Time	5 – 20 mA		150		ms
Ground Fault Response Time	20 – 40 mA		75		ms
Ground Fault Response Time	>40 mA		25		ms
Saturation Fault Response Time	>300 mA		1.4		ms
CT Turns Ratio		200		300	
Ground – Neutral Detection Threshold	Total series impedance (R _n and R _g)	3		6	Ω
Internal Oscillator Frequency			2		MHz
CT Stimulus Current	Internally limited			1	mA
CT Driver Closed Loop BW				500	KHz

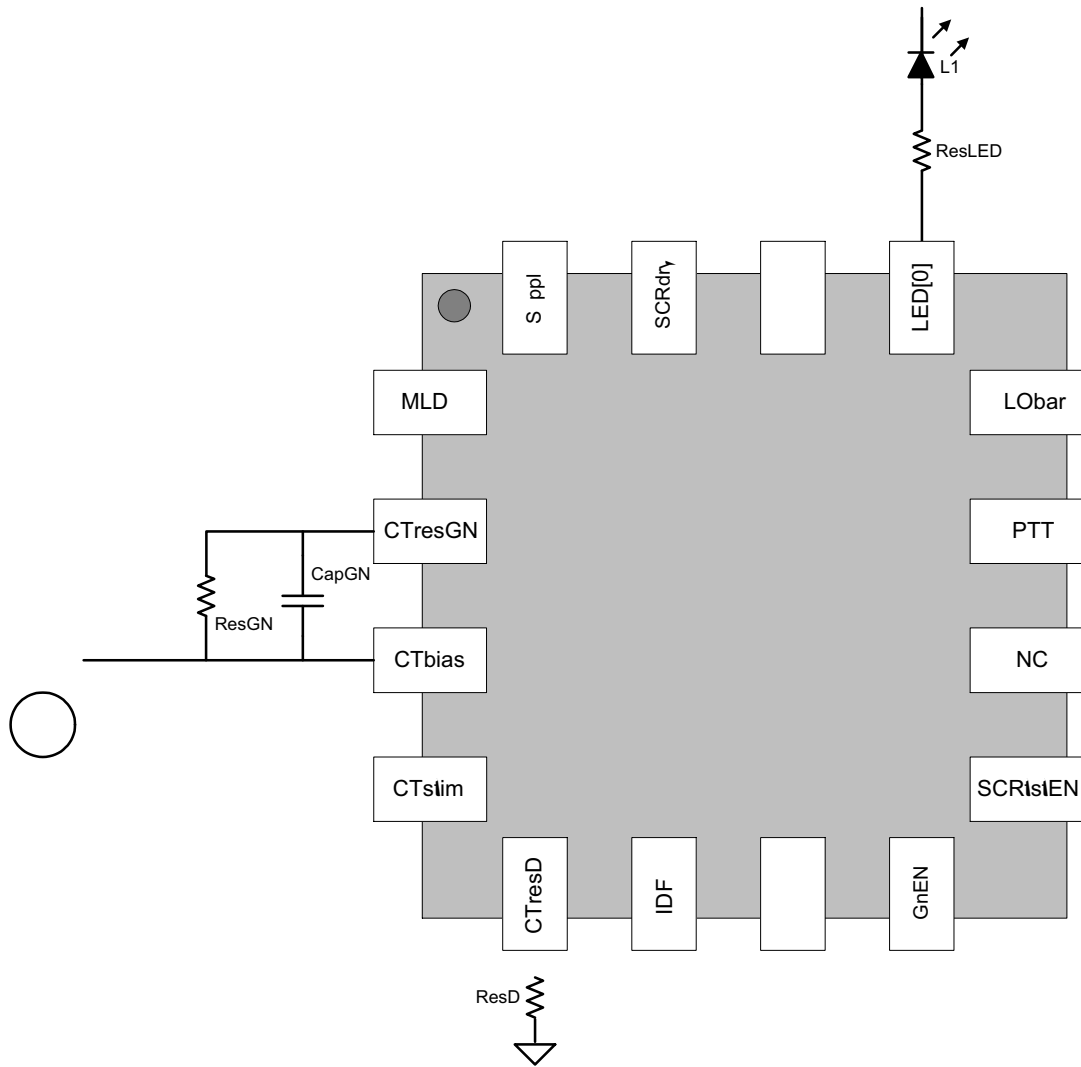
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

- Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.

NCS37010

NCS37010





LOAD

Figure 4. Self Test GFCI Receptacle with Lockout (SCR Test Enabled)

NCS37010

RECOMMENDED EXTERNAL COMPONENTS:

Component Type	Instance	Value	Note
SCR	Q2-Q3	-	ON-MCR08
Diode	Dx	-	ON-1N4007
NPN	Q1	-	ON-MMBT6517LT1G
NMOS	M1		ON-NTK3043K
LED	L1	-	LED pins drive opposite polarities
Capacitor	CapSUP	1 – 4.7 μ F	For a full bridge rectifier
Capacitor	CapGN	1 – 10 nF	Matched to current transformer
Capacitor	CapIDF	220 nF	Sets the differential corner frequency at 1 kHz
Capacitor	CapBias	10 nF	Filtering component for CTbias voltage.
Capacitor	CapCT	2.2 – 10 nF	Filtering and resonant capacitor for CT.
Capacitor	CapSCR	-	Filtering component.
Resistor	ResD	40 – 80k	Matched to current transformer.
Resistor	ResGN	100 – 400k	Matched to current transformer.
Resistor	ResMLD	400 – 800k	Limiting resistor for the Mains Level Detector (MLD) input.
Resistor	ResTI	400 – 800k	Limiting resistor for the Trip Indicator(TI) input.
Resistor	ResMAIN	8 – 45k	Full bridge rectifier power supply.
Resistor	ResGFTST	1.3	

Filtering

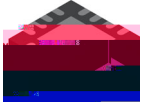
The analog signal capture portion of the IC includes a single pole filter that can be set externally with Cidf. This provides an additional layer of protection against false tripping under steady state noise conditions. High frequency steady state noise is common with pumps, motors or other cyclic noise generators.

$$Cidf = 220 \text{ nF} = 1 \text{ kHz low pass.}$$

For additional filtering suggestions please contact ON Semiconductor.

Setting Trip Sensitivity

The CTresD resistor sets the threshold for the differential current fault levels. Increasing CTresD causes the fault levels to trip at lower differential currents. CT efficiency at 60 Hz must be considered.

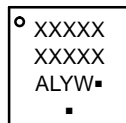


QFN16 3x3, 0.5P
CASE 485FQ
ISSUE B

DATE 12 JUL 2022

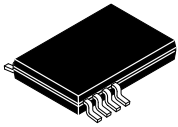
RECOMMENDED
MOUNTING FOOTPRINT

**GENERIC
MARKING DIAGRAM***



XXXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb-Free Package
(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.



SCALE 2:1

TSSOP-20 WB
CASE 948E
ISSUE D

DATE 17 FEB 2016

onsemi, **onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi**
