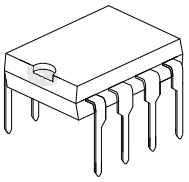
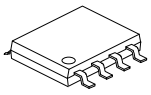
LOW POWER GROUND FAULT INTERRUPTER



DIP-8



SOP-8

■ DESCRIPTION

The UTC **GV4145A** is a low power controller for AC outlet ground fault interrupters. These devices detect hazardous grounding conditions, such as equipment (connected to opposite phases of the AC line) in contact with a pool of water and open circuits the line before a harmful or lethal shock occurs.

Contained internally are a 26V zener shunt regulator, an opamp, and an SCR driver. With the addition of two sense transformers, a bridge rectifier, an SCR, a relay, and a few additional components, the UTC **GV4145A** will detect and protect against both hot wire to ground and neutral wire to ground faults. Ease of application and long-term reliability.

■ FEATURES

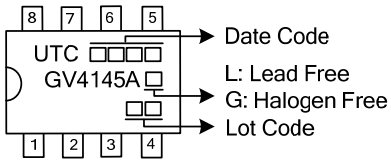
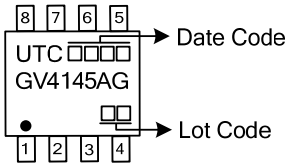
* No potentiomenter required
* Direct interface to SCR
* Supply voltage derived from AC line-26V shunt
* Adjustable sensitivity
* Grounded neutral fault detection
* Meets U.L.943 standards
* 450μA quiescent current
* I deal for 120V or 220V systems

■ ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
GV4145AG-D08-T	GV4145AG-D08-T	DIP-8	Tube
-	GV4145AG-S08-R	SOP-8	Tape Reel

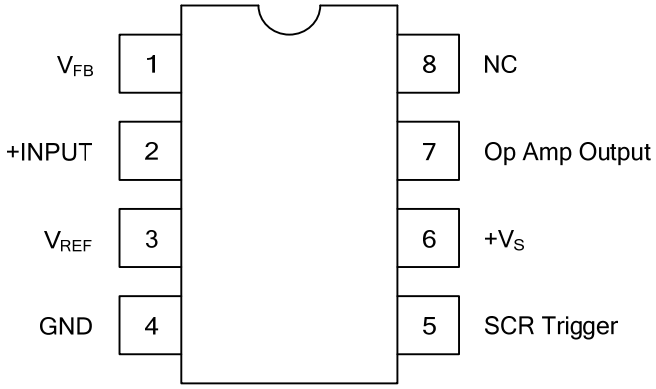
GV4145AL-S08-R (1)Packing Type (2)Package Type (3)Green Package	(1) T: Tube, R: Tape Reel (2) D08: DIP-8, S08: SOP-8 (3) L: Lead Free, G: Halogen Free and Lead Free

■ MARKING

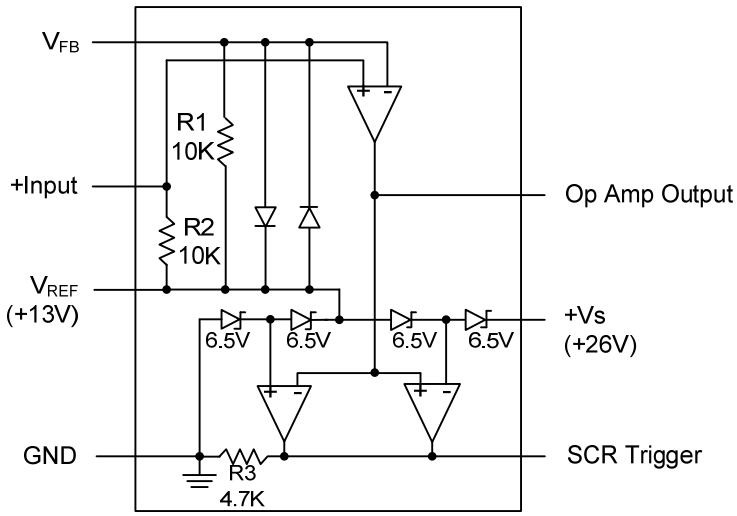
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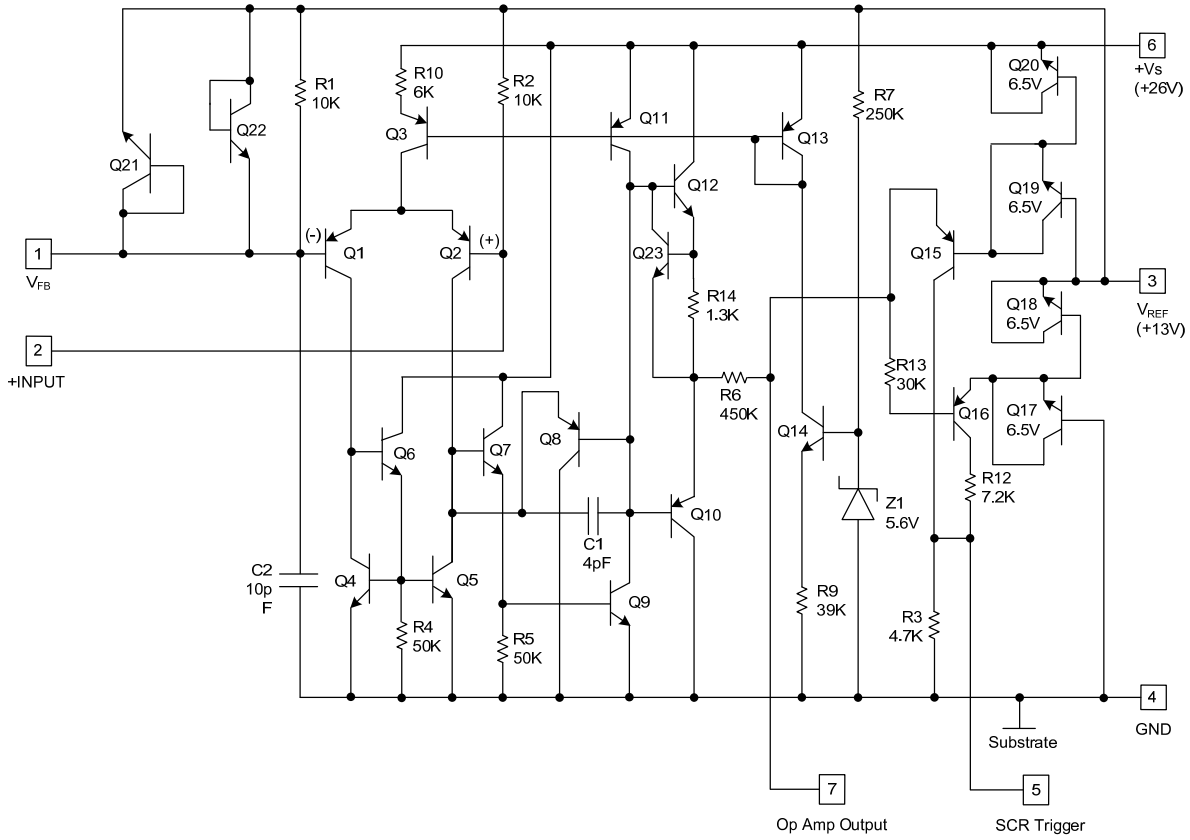
■ PIN CONFIGURATION



■ BLOCK DIAGRAM



■ INTERNAL SCHEMATIC DIAGRAM



■ ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Current	I_{CC}	18	mA
Power Dissipation	P_D	500	mW
Junction Temperature	T_J	125	°C
Operating Temperature	T_{OPR}	-35~+85	°C
Storage Temperature	T_{STG}	-65~+150	°C

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ THERMAL RESISTANCES CHARACTERISTICS

PARAMETER		SYMBOL	MIN	TYP	MAX	UNIT
Junction-to-Ambient	SOP-8	θ_{JA}		240		°C/W
	DIP-8			160		°C/W

■ ELECTRICAL CHARACTERISTICS (T_A=25°C, I_S=1.5mA)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Detector Reference Voltage	$V_{REF(DET)}$	Pin 7 ~ Pin 3	6.8	7.2	8.1	±V
SHUNT REGULATOR						
Zener Voltage	V_Z	Pin 6 ~ Pin 4	25	26	29.2	V
Reference Voltage	V_{REF}	Pin 3 ~ Pin 4	12.5	13	14.6	V
Quiescent Current	I_Q	+V_s=24V		450	750	μA
OPERATIONAL AMPLIFIER						
Offset Voltage	V_{OS}	PIN 2 ~ PIN 3	-3.0	0.5	+3.0	MV
+Output Voltage Swing	V_{OH}	Pin 7 ~ Pin 3	6.8	7.2	8.1	V
- Output Voltage Swing	V_{OL}	Pin 7 ~ Pin 3	-9.5	-11.2	-13.5	V
+Output Source Current	$I_{O(SOURC}$	Pin 7 ~ Pin 3		650		μA
- Output Source Current	$I_{O(SINK)}$	Pin 7 ~ Pin 3		1.0		mA
Gain Bandwidth Product	GBW	F=50KHZ	1.0	1.8		MHz
R_1 Resistors	R_1	Pin 1 ~ Pin 3 ,I_S=0mA		10		KΩ
R_2 Resistors	R_2	Pin 2 ~ Pin 3 ,I_S=0mA		10		KΩ
R_3 Resistors	R_3	Pin 5 ~ Pin 4 ,I_S=0mA	3.5	4.7	5.9	KΩ
SCR Trigger Voltage Detector ON	$V_{ON(SCR)}$	Pin 5 ~ Pin 4	1.5	2.8		V
SCR Trigger Voltage Detector OFF	$V_{OFF(SCR)}$	Pin 5 ~ Pin 4	0	1	10	mV

■ ELECTRICAL CHARACTERISTICS (-35°C ≤ T_A ≤ +85°C, I_S=1.5mA)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Detector Reference Voltage	$V_{REF(DET)}$	Pin 7 ~ Pin 3	6.5	7.2	8.3	±V
Shunt Regulator						
Zener Voltage	Vz	Pin 6 ~ Pin 4	24	26	30	V
Reference Voltage	V_{REF}	Pin 3 ~ Pin 4	12	13	15	V
Quiescent Current(Is)	I_Q	+Vs=23V		500		μA
Operational Amplifier						
Offset Voltage	V_{OS}	Pin 2 ~ Pin 3	-5.0	0.5	+5.0	mV
+Output Voltage Swing	V_{OH}	Pin 7 ~ Pin 3	6.5	7.2	8.3	V
- Output Voltage Swing	V_{OL}	Pin 7 ~ Pin 3	-9.	-11.2	-14	V
Gain Bandwidth Product	GBW	F=50KHZ		1.8		MHz
Resistors R1	R1	Pin 1 ~ Pin 3, I_S=0mA		10		KΩ
Resistors R2	R2	Pin 2 ~ Pin 3, I_S=0mA		10		KΩ
Resistors R3	R3	Pin 5 ~ Pin 4, I_S=0mA	3.5	4.7	5.9	KΩ
SCR Trigger Voltage Detector On	$V_{ON(SCR)}$	Pin 5 ~ Pin 4	1.3	2.8		V
SCR Trigger Voltage Detector Off	$V_{OFF(SCR)}$	Pin 5 ~ Pin 4	0	3	50	mV

■ PRINCIPLES OF OPERATION

PRINCIPLES OF OPERATION

The 26V shunt regulator voltage generated by the string of zener diodes is divided into three reference voltages:3/4Vs, 1/2Vs, and 1/4Vs. V_{REF} is at 1/2Vs and is used as a reference to create an artifical ground of +13V at the op amp noniverting input.

Figure 1 shows a three-wire 120V AC outlet GFI application using an UTC **GV4145A**, Fault signals from the sense transformer are AC coupled into the input and are amplified according to the following equation:

$V7=R_{SENSE}\times I_{SENSE}/N$

Where V7 is the RMS voltage at pin7 relative to pin 3, R_{SENSE} is the value of the feedback resistor connected from pin 7 to pin 1, I_{SENSE} is the fault current in amps RMS and N is the turns ratio of the transformer. When V7 exceeds plus or minus 7.2V relative to pin 3 the SCR Trigger output will go high and fire the external SCR.

The formula for V7 is approximate because it does not include the sense transformer characteristics.

Grounded neutral fault detection is accomplished when a short or fault closes a magnetic path between the sense transformer and the grounded neutral transformer. The resultant AC coupling closes a positive feedback path around the op amp, and therefore the op amp oscillates. When the peaks of the oscillation voltage exceed the SCR trigger comparator thresholds, the SCR output will go high.

SHUNT REGULATOR

R_{LINE} limits the current into the shunt regulator; 220V applications will require substituting a 47kΩ 2W resistor. In addition to supplying power to the IC, the shunt regulator creates internal reference voltages(see above).

OPERATIONAL AMPLIFIER

R_{SENSE} is a feedback resistor that sets gain and therefore sensitivity to normal faults. To adjust R_{SENSE}, follow this procedure: apply the desired fault current (a difference in current of 5mA is the UL943 standard). Adjust R_{SENSE} upward until the SCR activates. A fixed resistor can be used for R_{SENSE}, since the resultant ±15% variation in sensitivity will meet UL's 943 4~6mA specification window.

The roll-off frequency is greater than the grounded neutral fault oscillation frequency, in order to preserve loop gain for oscillation (which is determined by the inductance of the 200:1 transformer and C4).

The sensitivity to grounded neutral faults is adjusted by changing the frequency of oscillation. Increasing the frequency reduces the sensitivity by reducing the loop gain of the positive feedback circuit. As frequency increases, the signal becomes attenuated and the loop gain decreases. With the values shown the circuit will detect a grounded neutral fault having resistance of 2Ωor less.

The input to the op amp are protected from overvoltage by back-to back diodes.

SCR DRIVER

The SCR used must have a high dV/dt rating to ensure that line noise (generated by noisy appliances such as a drill motor) does not falsely trigger the SCR. Also, the SCR must have a gate drive requirement of less than 200μA.C_F is a noise filter capacitor that prevents narrow pulses from firing the SCR.

The relay solenoid used should have a 3ms or less response time in order to meet the UL 943 timing requirement.

SENSE TRANSFORMERS AND CORES

The sense and grounded neutral transformer cores are usually fabricated using high permeability laminated steel rings. Their single turn primary is created by passing the line and neutral wires through the center of its core. The secondary is usually from 200 to 1500 turns.

TWO-WIRE APPLICATION CIRCUIT

Figure 2 shows the diagram of a 2-wire 120V AC outlet GFI circuit using an UTC **GV4145A**. This circuit is not designed to detect grounded neutral faults. Thus, the grounded neutral transformer and capacitors C3 and C4 of Figure 1 are not used.

■ TYPICAL APPLICATION CIRCUIT

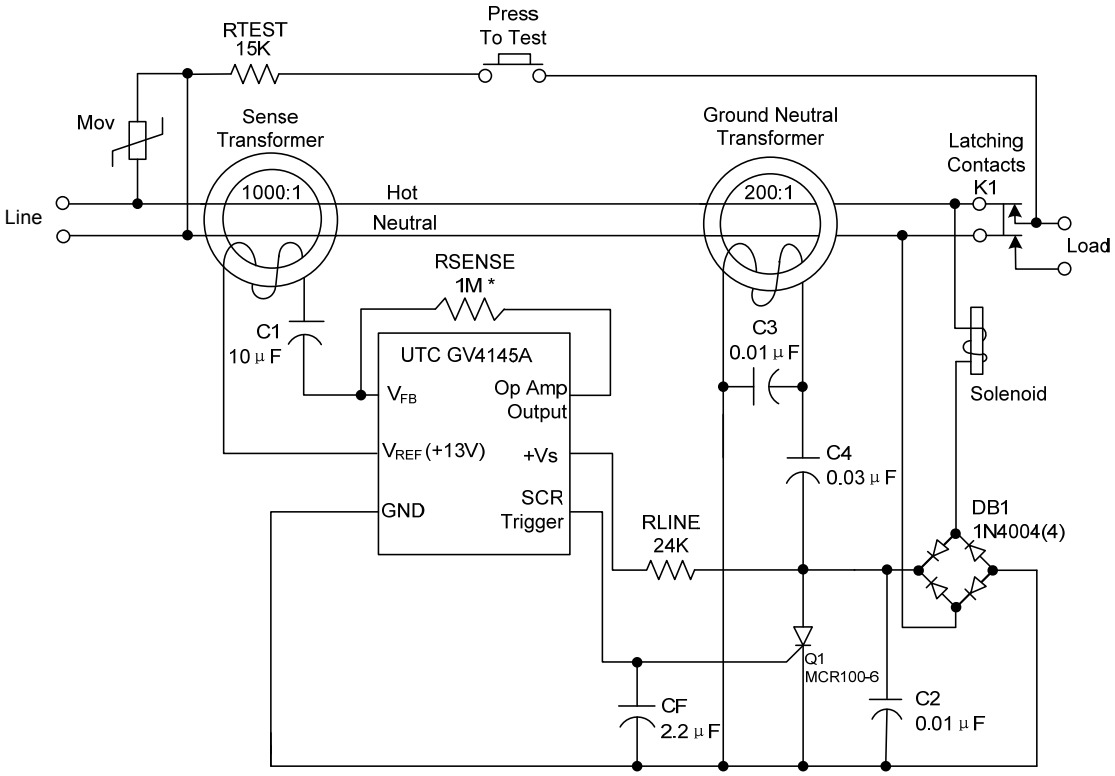


Figure 1. GFI Application Circuit (Three-Wire Outlet)

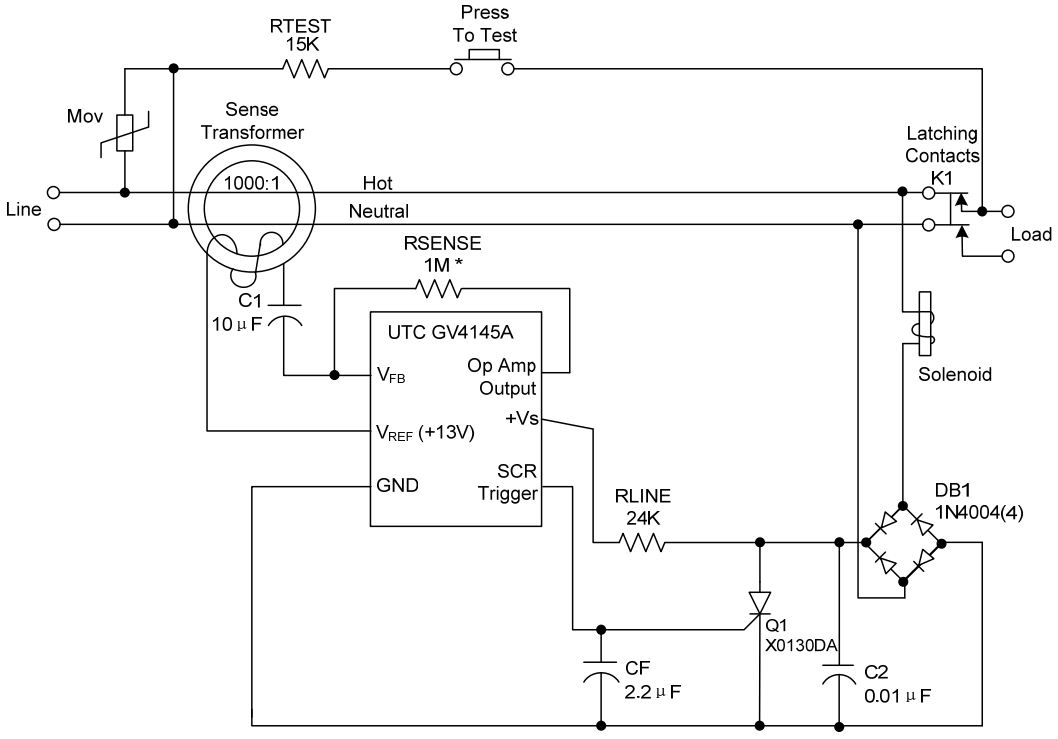


Figure 2. GFI Application Circuit (Two-Wire Outlet)

Note: Value depends on transformer characteristics.

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