HEWLETT PACKARD

new

90 V/1.0 Ω, Hermetically Sealed, Power MOSFET Optocoupler

Technical Data

HSSR-7110

Features

- **Hermetically Sealed 8-Pin Dual In-Line Package**
- **Small Size and Weight**
- **Performance Guaranteed over -55°C to +125°C Ambient Temperature Range**
- **Compact Solid-State Bidirectional Switch**
- **ac/dc Signal & Power Switching**
- **Connection A 0.8 A, 1.0 Ω**
- **Connection B 1.6 A, 0.25 Ω**
- **1500 Vdc Withstand Test Voltage**
- **High Transient Immunity**
- **5 Amp Output Surge Current**
- **Shock and Vibration Resistant**

Applications

- **Military/High Reliability Systems**
- **Standard 28 Vdc and 48 Vdc Load Driver**
- **Standard 24 Vac Load Driver**
- **Aircraft Controls**
- **ac/dc Electromechanical and Solid State Relay Replacement**
- **I/O Modules**

Description

The HSSR-7110 is a single channel, hermetically sealed, power MOSFET optocoupler. The device operates exactly like a solid-state relay. The product is capable of operation and storage over the full military temperature range and can be purchased as a standard product (HSSR-7110), or with special testing (QSSR-71XX). All products are in eight-pin, hermetic, dual in-line, ceramic packages.

As of December 1992, Hewlett-Packard has started to qualify this manufacturing line to MIL-STD-1772 and to be listed on QML-MIL-H-38534. Upon completion, a compliant part identified as HSSR-7111 will be available and will meet Class H test level of MIL-STD-883 (see note below).

The part is normally shipped with gold plated leads. Solder dipped leads are available by adding option #200 to the part number.

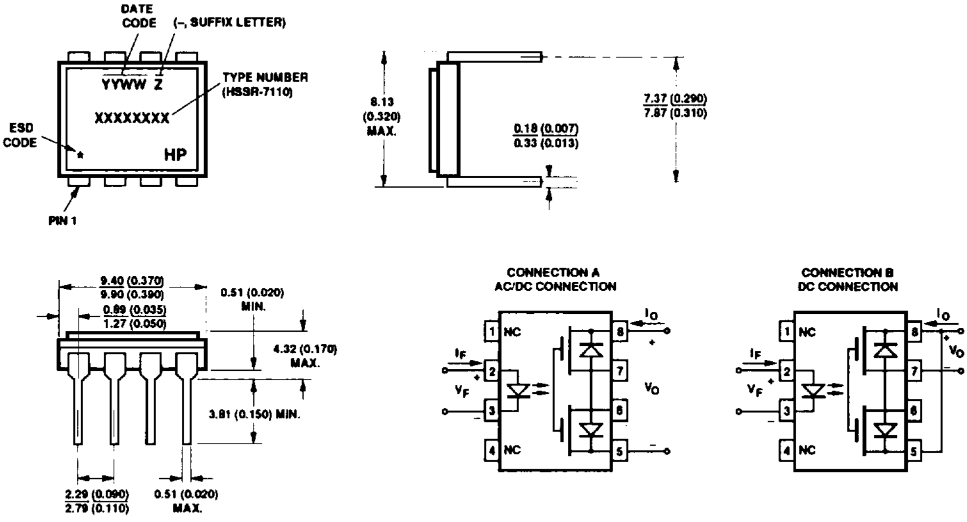
The device contains an AlGaAs light emitting diode optically coupled to a photovoltaic diode stack which drives two discrete n-channel enhancement mode power MOSFETs. The device operates as a solid-state replacement for single-pole, normally open, (1 Form A) relays used for general purpose switching of signals and loads in high reliability applications.

The part's logic level input control and very low output on-resistance makes it suitable for both ac and dc loads. Connection A, as shown in the schematic, allows the unit to switch either ac or dc loads. Connection B, with the polarity and pin configuration as indicated in the schematic, allows the device to switch dc loads only. The advantage of Connection B is that the on-resistance is significantly reduced, and the output current capability increases by a factor of two.

NOTE: Contact your local Hewlett-Packard field sales office for the availability of the HSSR-7111.

Outline Drawings and Schematic

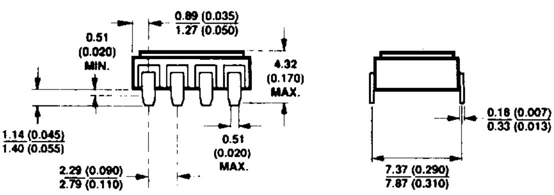
8-pin Ceramic Dual In-Line Package



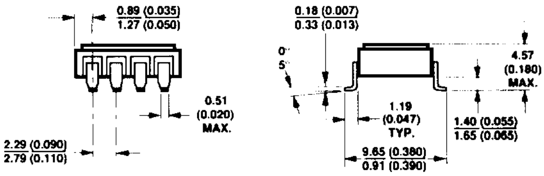
DIMENSIONS IN MILLIMETERS AND (INCHES).

8-PIN CERAMIC DUAL IN-LINE PACKAGE
TYPICAL WEIGHT: 0.7 GRAMS

Butt-Joint Surface Mount Option 100



Gull-Wing Surface Mount Option 300



The device is a convenient replacement for mechanical and solid state relays where high component reliability in standard footprint lead configuration is desirable. The eight pin dual in-line package allows easy board construction with both through hole and surface mount methods. Butt joint and gull wing lead options are available by ordering option #100 or #300 respectively (see Outline Drawings).

The HSSR-7110 is designed to switch loads on 28 Vdc power systems. It meets 80 V surge and ±600 V spike requirements. The part is suitable for military applications.

Absolute Maximum Ratings

Storage Temperature Range .... -65°C to +150°C
Operating Ambient Temperature – T_A .... -55°C to +125°C
Junction Temperature – T_J .... +150°C
Operating Case Temperature – T_C .... +145°C[1]
Lead Solder Temperature .... 260°C for 10 s
(1.6 mm below seating plane)
Average Input Current – I_F .... 20 mA
Peak Repetitive Input Current – I_{FPK} .... 40 mA
(Pulse Width < 100 ms; duty cycle < 50%)
Peak Surge Input Current – I_{FPK} surge .... 100 mA
(Pulse Width < 0.2 ms; duty cycle < 0.1%)
Reverse Input Voltage – V_R .... 5 V
Average Output Current – Figure 2
Connection A – I_O .... 0.8 A
Connection B – I_O .... 1.6 A
Single Shot Output Current – Figure 3
Connection A – I_{OPK} surge (Pulse width < 10 ms) .... 5.0 A
Connection B – I_{OPK} surge (Pulse width < 10 ms) .... 10.0 A
Output Voltage
Connection A – V_O .... -90 V to +90 V
Connection B – V_O .... 0 V to +90 V
Average Output Power Dissipation – Figure 4 .... 800 mW[2]

Thermal Resistance

Maximum Output MOSFET Junction to Case – θ_{JC} = 15°C/W

Demonstrated ESD Performance

Human Body Model: MIL-STD-883 Method 3015.7 – Class 2

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units
Input Current (on)	$I_{F(ON)}$	5	20	mA
Input Voltage (off)	$V_{F(OFF)}$	0	0.6	Volt
Operating Temperature	T_A	-55	+125	°C

Electrical Specifications

T_A =-55°C to +125°C, unless otherwise specified.

Parameter	Connection	Sym.	Min.	Typ.*	Max.	Units	Test Conditions	Fig.	Notes
Output Withstand Voltage		$\lvert V_{O(OFF)} \rvert$	90	110		V	V_F = 0.6 V, I_O = 250 μA,	5	
Output On-Resistance	A	$R_{(ON)}$		0.40	1.0	Ω	I_F = 10 mA, I_O = 800 mA, (pulse duration ≤ 30 ms)	6,7	3
	B			0.12	0.25		I_F = 10 mA, I_O = 1.6 A, (pulse duration ≤ 30 ms)		
Output Leakage Current		$I_{O(OFF)}$		10^{-4}	250	μA	V_F = 0.6 V, V_O = 90 V,	8	
Input Forward Voltage		V_F	1.0	1.24	1.7	V	I_F = 10 mA	9	
Input Reverse Breakdown Voltage		V_R	5.0			V	I_R = 10 μA		
Input-Output Insulation		I_{I-O}			1.0	μA	RH ≤ 45%, t = 5 s, V_{I-O} = 1500 Vdc, T_A = 25°C		4,5
Turn On Time		t_{ON}		1.25	6.0	ms	I_F = 10 mA, V_{DD} = 28 V, I_O = 800 mA	1,10, 11,12, 13	6
Turn On Time With Peaking		t_{ON}		0.22		ms	I_{FPK} = 100 mA, I_{FSS} = 10 mA V_{DD} = 28 V, I_O = 800 mA	1	
Turn Off Time		t_{OFF}		0.02	0.25	ms	I_F = 10 mA, V_{DD} = 28 V, I_O = 800 mA	1,10, 14,15	
Output Transient Rejection		$\left\lvert \frac{dVo}{dt} \right\rvert$	1000			V/μs	V_{PEAK} = 50 V, C_M = 1000 pF, C_L = 15 pF, R_M ≥ 1 MΩ	17	
Input-Output Transient Rejection		$\left\lvert \frac{dVio}{dt} \right\rvert$	500			V/μs	V_{DD} = 5 V, $V_{I-O(PEAK)}$ = 50 V, R_L = 20 kΩ, C_L = 15 pF	18	

*All typical values are at T_A = 25°C, $I_{F(ON)}$ = 10 mA, $V_{F(OFF)}$ = 0.6 V unless otherwise specified.

Typical Characteristics

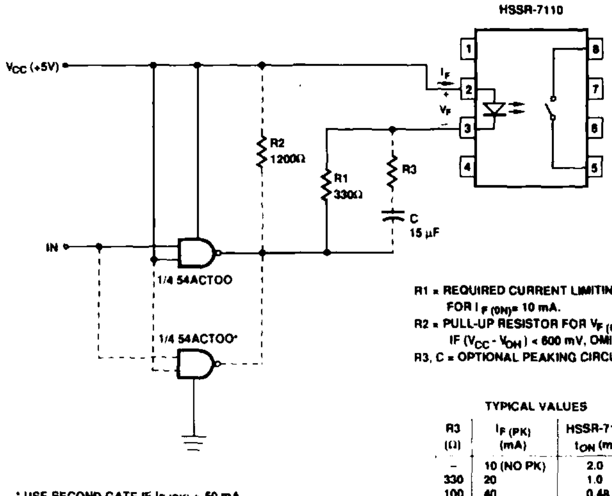
All typical values are at $T_A = 25°C$, $I_{F(ON)} = 10$ mA, $V_{F(OFF)} = 0.6$ V unless otherwise specified.

Parameter	Symbol	Test Conditions	Typ.	Units	Fig.	Notes
Output Off-Capacitance	$C_{O(OFF)}$	$V_O = 28$ V, f = 1 MHz	145	pF	16	
Output Offset Voltage	$\|V_{OS}\|$	$I_F = 10$ mA, $I_O = 0$ mA	2	µV	19	7
Input Diode Temperature Coefficient	$\Delta V_F/\Delta T_A$	$I_F = 10$ mA	-1.4	mV/C		
Input Capacitance	C_{IN}	$V_F = 0$ V, f = 1 MHz	20	pF		8
Input-Output Capacitance	C_{I-O}	$V_{I-O} = 0$ V, f = 1 MHz	1.5	pF		4
Input-Output Resistance	R_{I-O}	$V_{I-O} = 500$ V, t = 60 s	10^{13}	Ω		4

Notes:

1. Maximum junction to case thermal resistance for the device is 15°C/W, where case temperature, T_C, is measured at the center of the package bottom.
2. For rating, see Figure 4. The output power P_O rating curve is obtained when the part is handling the maximum average output current I_O as shown in Figure 2.
3. During the pulsed R_{ON} measurement (I_O duration <30 ms), ambient (T_A) and case temperature (T_C) are equal.
4. Device considered a two terminal device: pins 1 through 4 shorted together and pins 5 through 8 shorted together.
5. This is a momentary withstand test, not an operating condition.
6. For a faster turn-on time, the optional peaking circuit shown in Figure 1 may be implemented.
7. V_{OS} is a function of I_F, and is defined between pins 5 and 8, with pin 5 as the reference. V_{OS} must be measured in a stable ambient (free of temperature gradients).
8. Zero-bias capacitance measured between the LED anode and cathode.

CAUTION: Maximum Switching Frequency – Care should be taken during repetitive switching of loads so as not to exceed the maximum output current, maximum output power dissipation, maximum case temperature, and maximum junction temperature.



R1 = REQUIRED CURRENT LIMITING RESISTOR FOR $I_{F(ON)}$ = 10 mA.
R2 = PULL-UP RESISTOR FOR $V_{F(OFF)}$ < 600 mV; IF (V_{CC} - V_{OH}) < 600 mV, OMIT R2.
R3, C = OPTIONAL PEAKING CIRCUIT.

TYPICAL VALUES

R3 (Ω)	$I_{F(PK)}$ (mA)	HSSR-7110 t_{ON} (ms)
–	10 (NO PK)	2.0
330	20	1.0
100	40	0.48
33	100	0.22

* USE SECOND GATE IF $I_{F(PK)}$ > 50 mA
REMINDER: TIE ALL UNUSED INPUTS TO GROUND OR V_{CC}

Figure 1. Recommended Input Circuit.

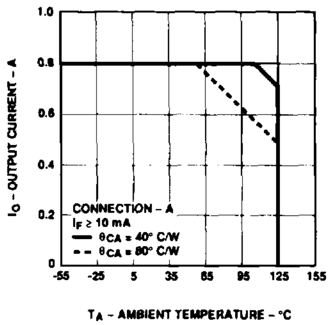


Figure 2. Maximum Average Output Current Rating vs. Ambient Temperature.

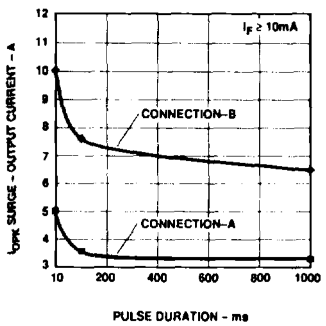


Figure 3. Single Shot (non-repetitive) Output Current vs. Pulse Duration.

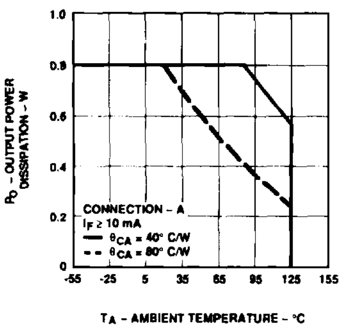


Figure 4. Output Power Rating vs. Ambient Temperature.

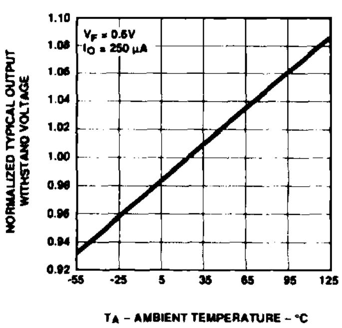


Figure 5. Normalized Typical Output Withstand Voltage vs. Temperature.

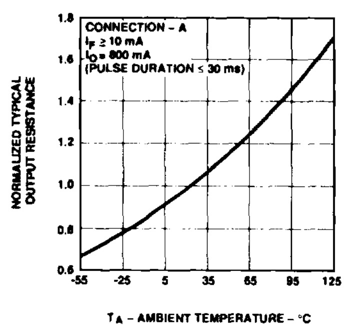


Figure 6. Normalized Typical Output Resistance vs. Temperature.

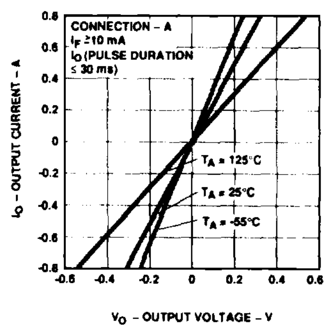


Figure 7. Typical On State Output I-V Characteristics.

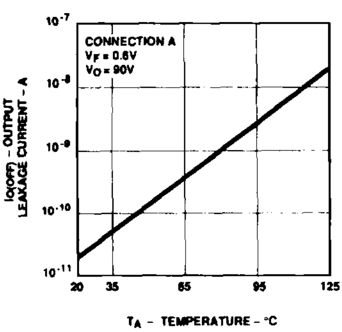


Figure 8. Typical Output Leakage Current vs. Temperature.

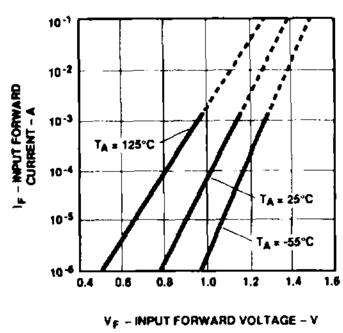


Figure 9. Typical Input Forward Current vs. Input Forward Voltage.

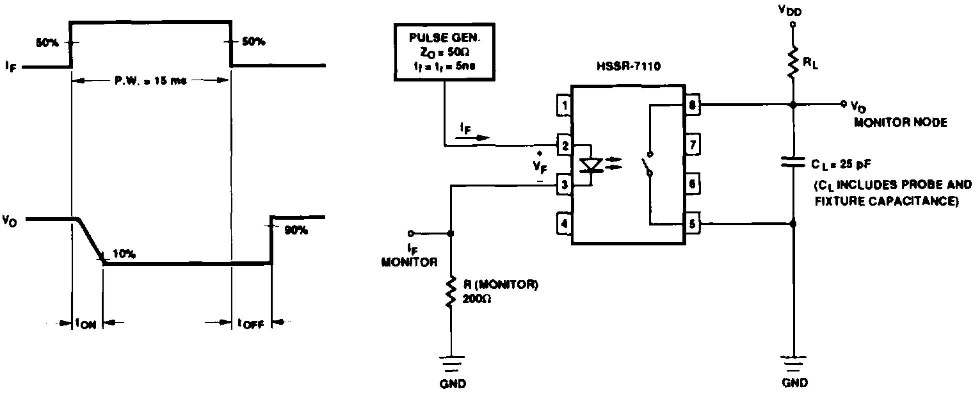


Figure 10. Switching Test Circuit for t_{ON}, t_{OFF}.

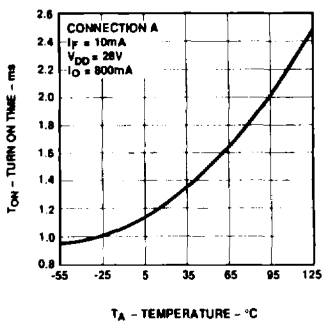


Figure 11. Typical Turn On Time vs. Temperature.

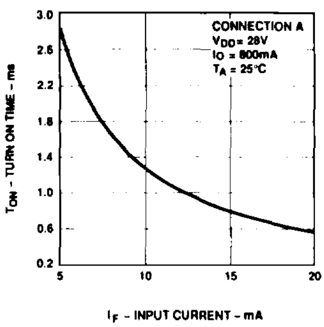


Figure 12. Typical Turn On Time vs. Input Current.

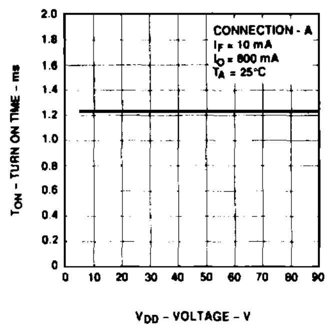


Figure 13. Typical Turn On Time vs. Voltage.

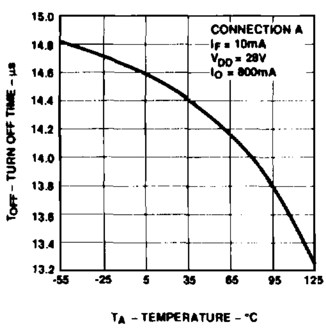


Figure 14. Typical Turn Off Time vs. Temperature.

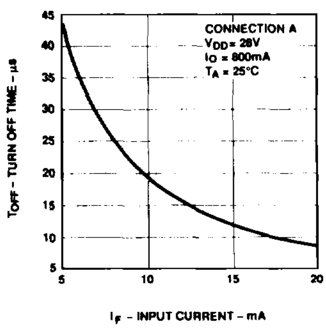


Figure 15. Typical Turn Off Time vs. Input Current.

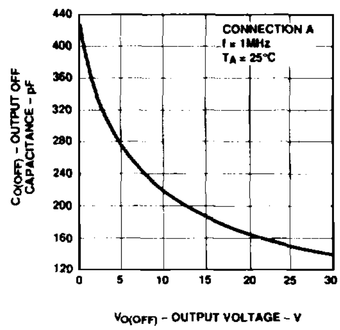
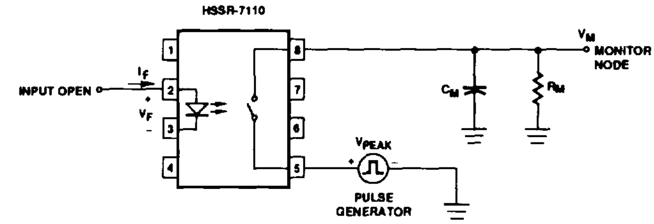
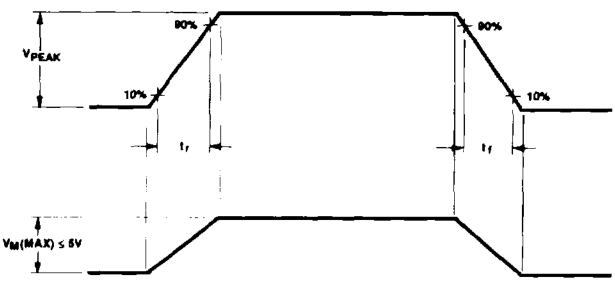


Figure 16. Typical Output Off Capacitance vs. Output Voltage.



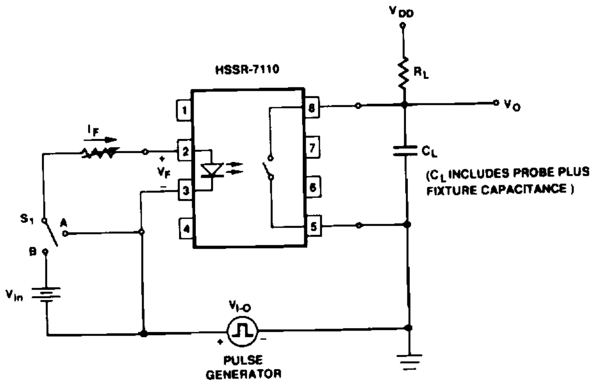
C_M INCLUDES PROBE AND FIXTURE CAPACITANCE
R_M INCLUDES PROBE AND FIXTURE RESISTANCE

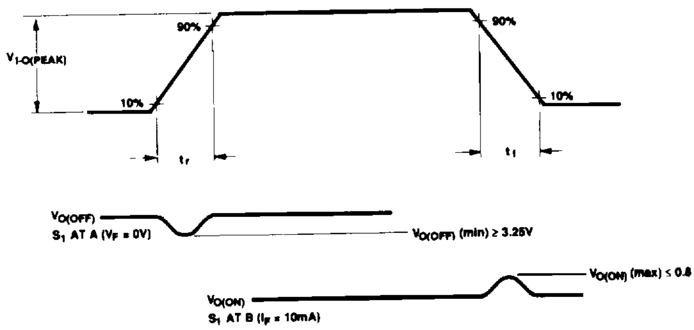


$$\frac{dV_o}{d_t} = \frac{(0.8)\ V_{(PEAK)}}{t_r} \text{ OR } \frac{(0.8)\ V_{(PEAK)}}{t_f}$$

OVERSHOOT ON V_{PEAK} IS TO BE ≤ 10%.

Figure 17. Output Transient Rejection Test Circuit.





$$\frac{dV_{I-O}}{dt} = \frac{(0.8)\,V_{I-O(PEAK)}}{t_r} \text{ OR } \frac{(0.8)\,V_{I-O\,(PEAK)}}{t_f}$$

OVERSHOOT ON $V_{I-O(PEAK)}$ IS TO BE ≤ 10%

Figure 18. Input-Output Transient Rejection Test Circuit.

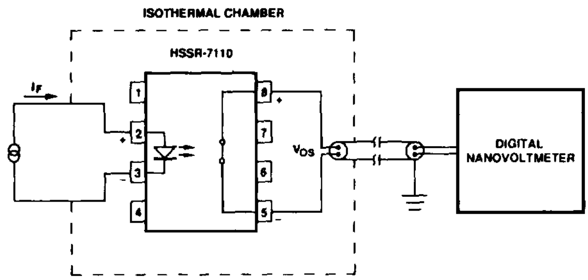


Figure 19. Voltage Offset Test Setup.

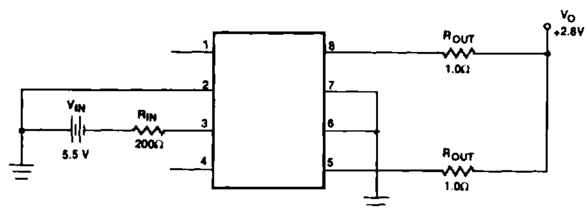
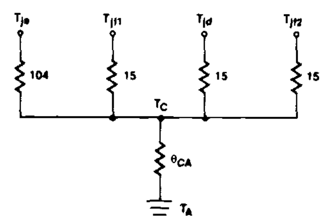


Figure 20. Burn-In Circuit.



T_{je} = LED JUNCTION TEMPERATURE
T_{jf1} = FET 1 JUNCTION TEMPERATURE
T_{jf2} = FET 2 JUNCTION TEMPERATURE
T_{jd} = FET DRIVER JUNCTION TEMPERATURE
T_C = CASE TEMPERATURE (MEASURED AT CENTER OF PACKAGE BOTTOM)
T_A = AMBIENT TEMPERATURE (MEASURED 6" AWAY FROM THE PACKAGE)
θ_{CA} = CASE-TO-AMBIENT THERMAL RESISTANCE

ALL THERMAL RESISTANCE VALUES ARE IN °C/W

Figure 21. Thermal Model.

Applications Information

Thermal Model

The steady state thermal model for the HSSR-7110 is shown in Figure 21. The thermal resistance values given in this model can be used to calculate the temperatures at each node for a given operating condition. The thermal resistances between the LED and other internal nodes are very large in comparison with the other terms and are omitted for simplicity. The components do, however, interact indirectly through θ_{CA}, the case-to-ambient thermal resistance. All heat generated flows through θ_{CA}, which raises the case temperature T_C accordingly. The value of θ_{CA} depends on the conditions of the board design and is, therefore, determined by the designer.

The maximum value for each output MOSFET junction-to-case thermal resistance is specified as 15°C/W. The thermal resistance from FET driver junction-to-case is also 15°C/W. The power dissipation in the FET driver, however, is negligible in comparison to the MOSFETs.

On-Resistance and Rating Curves

The output on-resistance, R_{ON}, specified in this data sheet, is the resistance measured across the output contact when a pulsed current signal (I_O = 800 mA) is applied to the output pins. The use of a pulsed signal (≤ 30 ms) implies that each junction temperature is equal to the ambient and case temperatures. The steady-state resistance, R_{SS}, on the other hand, is the value of the resistance measured across the output contact when a DC current signal is applied to the output pins for a duration sufficient to reach thermal equilibrium. R_{SS} includes the effects of the temperature rise of each element in the thermal model.

Rating curves are shown in Figures 2 and 4. Figure 2 specifies the maximum average output current allowable for a given ambient temperature. Figure 4 specifies the output power dissipation allowable for a given ambient temperature. Above 55°C (for θ_{CA} = 80°C/W) and 107°C (for θ_{CA} = 40°C/W), the maximum allowable output current and power dissipation are related by the expression $R_{SS} = P_O(max)/(I_O(max))^2$ from which R_{SS} can be calculated. Staying within the safe area assures that the steady-state junction temperatures remain less than 150°C. As an example, for T_A = 95°C and θ_{CA} = 80°C/W, Figure 2 shows that the output current should be limited to less than 610 mA. A check with Figure 4 shows that the output power dissipation at T_A = 95°C and I_O = 610 mA, will be limited to less than 0.35 W. This yields an R_{SS} of .94 Ω.