National Semiconductor

November 1994

LF111/LF211/LF311 Voltage Comparators

General Description

The LF111, LF211 and LF311 are FET input voltage comparators that virtually eliminate input current errors. Designed to operate over a 5.0V to ±15V range the LF111 can be used in the most critical applications.

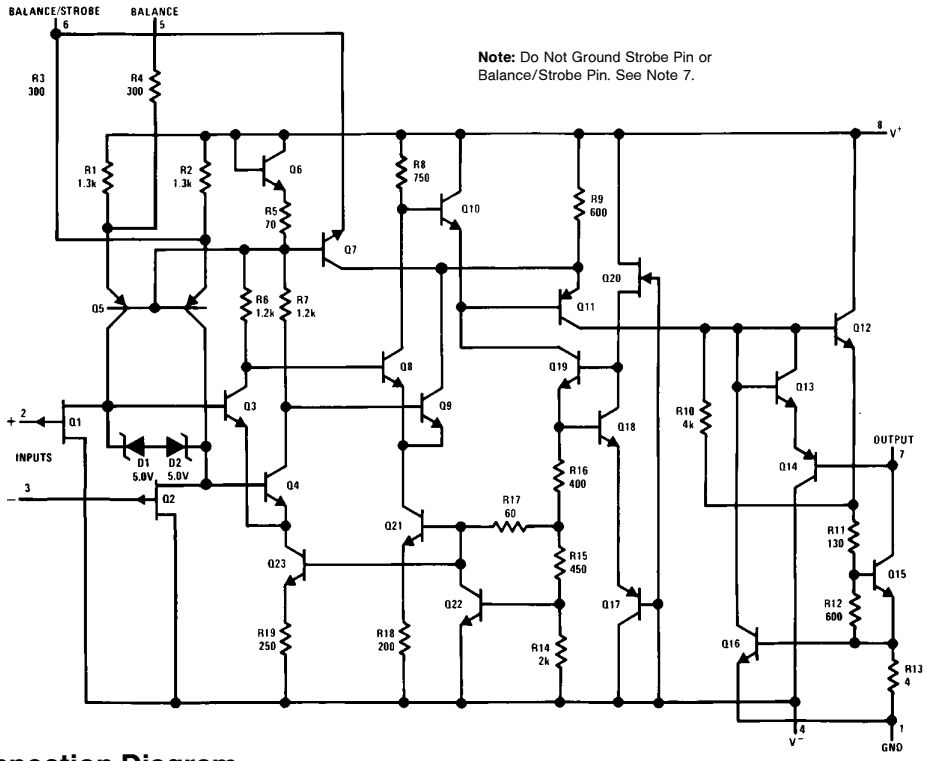
The extremely low input currents of the LF111 allows the use of a simple comparator in applications usually requiring input current buffering. Leakage testing, long time delay circuits, charge measurements, and high source impedance voltage comparisons are easily done.

Further, the LF111 can be used in place of the LM111 eliminating errors due to input currents. See the ''application hints'' of the LM311 for application help.

Features

- Eliminates input current errors
- Interchangeable with LM111
- No need for input current buffering

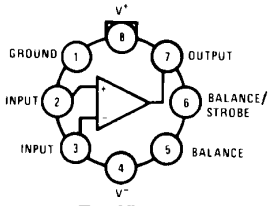
Schematic Diagram



TL/H/5703 2

Connection Diagram

Metal Can Package



TL/H/5703 1

Top View
Order Number LF111H, LF111H-MIL or LF311H
See NS Package Number H08C

©1995 National Semiconductor Corporation RRD B30M115/Printed in U S A

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

(Note 8)

	LF111/LF211	LF311
Total Supply Voltage (V_{84})	36V	36V
Output to Negative Supply Voltage (V_{74})	50V	40V
Ground to Negative Supply Voltage (V_{14})	30V	30V
Differential Input Voltage	±30V	±30V
Input Voltage (Note 1)	±15V	±15V
Power Dissipation (Note 2)	500 mW	500 mW
Output Short Circuit Duration	10 seconds	10 seconds

	LF111/LF211	LF311
Operating Temp. Range		
LF111	−55°C to +125°C	
LF211	−25°C to +85°C	
LF311		0°C to +70°C
Storage Temp. Range	−65°C to +150°C	−65°C to +150°C
Lead Temp. (Soldering, 10 seconds)	260°C	260°C

ESD rating to be determined.

Electrical Characteristics (LF111/LF211) (Note 3)

Parameter	Conditions	Min	Typ	Max	Units
Input Offset Voltage (Note 4)	T_A 25°C, $R_S \leq$ 50k		0.7	4.0	mV
Input Offset Current (Note 4)	T_A 25°C, V_{CM} 0 (Note 6)		5.0	25	pA
Input Bias Current	T_A 25°C, V_{CM} 0 (Note 6)		20	50	pA
Voltage Gain	T_A 25°C	40	200		V/mV
Response Time (Note 5)	T_A 25°C		200		ns
Saturation Voltage	$V_{IN} \leq -5.0$ mV, I_{OUT} 50 mA, T_A 25°C		0.75	1.5	V
Strobe On Current	T_A 25°C		3.0		mA
Output Leakage Current	$V_{IN} \leq 5.0$ mV, V_{OUT} 35V, T_A 25°C		0.2	10	nA
Input Offset Voltage (Note 4)	$R_S \leq$ 50k			6.0	mV
Input Offset Current (Note 4)	V_S ±15V, V_{CM} 0 (Note 6)		2.0	3.0	nA
Input Bias Current	V_S ±15V, V_{CM} 0 (Note 6)		5.0	7.0	nA
Input Voltage Range		−13.5	±14	13.0	V
Saturation Voltage	$V^+ \geq 4.5$V, V 0 $V_{IN} \leq -6.0$ mV, $I_{OUT} \leq 8.0$ mA		0.23	0.4	V
Output Leakage Current	$V_{IN} \geq 5.0$ mV, V_{OUT} 35V		0.1	0.5	μA
Positive Supply Current	T_A 25°C		5.1	6.0	mA
Negative Supply Current	T_A 25°C		4.1	5.0	mA

Note 1: This rating applies for ±15V supplies. The positive input voltage limit is 30V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30V below the positive supply, whichever is less.

Note 2: The maximum junction temperature of the LF111 is +150°C, the LF211 is +110°C and the LF311 is +85°C. For operating at elevated temperatures, devices in the H08 package must be derated based on a thermal resistance of +65°C/W junction to ambient (in 400 linear feet/min air flow), +165°C/W junction to ambient (in static air), or +20°C/W junction to case.

Note 3: These specifications apply for V_S ±15V, and the Ground pin at ground, and 55°C$\leq T_A \leq$ +125°C for the LF111, unless otherwise stated. With the LF211, however, all temperature specifications are limited to 25°C$\leq T_A \leq$ ±85°C and for the LF311 0°C$\leq T_A \leq$ +70°C. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5.0V supply up to ±15V supplies.

Note 4: The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with a 1.0 mA load. Thus, these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.

Note 5: The response time specified (see definitions) is for a 100 mV input step with 5.0 mV overdrive.

Note 6: For input voltages greater than 15V above the negative supply the bias and offset currents will increase—see typical performance curves.

Note 7: This specification gives the current that must be drawn from the strobe pin to ensure the output is properly disabled. Do not short the strobe pin to ground; it should be current driven at 3 to 5 mA.

Note 8: Refer to RETSF111X for LF111H military specifications.

Electrical Characteristics (LF311) (Note 3)

Parameter	Conditions	Min	Typ	Max	Units
Input Offset Voltage (Note 4)	T_A 25°C, $R_S \leq 50k$		2.0	10	mV
Input Offset Current (Note 4)	T_A 25°C, V_{CM} 0 (Note 6)		5.0	75	pA
Input Bias Current	T_A 25°C, V_{CM} 0 (Note 6)		25	150	pA
Voltage Gain	T_A 25°C		200		V/mV
Response Time (Note 5)	T_A 25°C		200		ns
Saturation Voltage	$V_{IN} \leq -10$ mV, I_{OUT} 50 mA, T_A 25°C		0.75	1.5	V
Strobe On Current	T_A 25°C		3.0		mA
Output Leakage Current	$V_{IN} \geq 10$mV, V_{OUT} 35V, T_A 25°C		0.2	10	nA
Input Offset Voltage (Note 4)	$R_S \leq 50k$			15	mV
Input Offset Current (Note 4)	V_S ±15V, V_{CM} 0 (Note 6)		1.0		nA
Input Bias Current	V_S 15V, V_{CM} 0 (Note 6)		3.0		nA
Input Voltage Range			+14 −13.5		V V
Saturation Voltage	$V^+ \geq 4.5$V, V 0 $V_{IN} \leq -10$ mV, $I_{OUT} \leq 8.0$ mA		0.23	0.4	V
Positive Supply Current	T_A 25°C		5.1	7.5	mA
Negative Supply Current	T_A 25°C		4.1	5.0	mA

Note 1: This rating applies for ±15V supplies. The positive input voltage limit is 30V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30V below the positive supply, whichever is less.

Note 2: The maximum junction temperature of the LF111 is +150°C, the LF211 is +110°C and the LF311 is +85°C. For operating at elevated temperatures, devices in the H08 package must be derated based on a thermal resistance of +165°C/W, junction to ambient, or +20°C/W, junction to case.

Note 3: These specifications apply for V_S ±15V and 55°C $\leq T_A \leq$ +125°C for the LF111, unless otherwise stated. With the LF211, however, all temperature specifications are limited to 25°C $\leq T_A \leq$ +85°C and for the LF311 0°C $\leq T_A \leq$ +70°C. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5.0 mV supply up to ±15V supplies.

Note 4: The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with a 1.0 mA load. Thus, these parameters define an error band and take into account the worst case effects of voltage gain and input impedance.

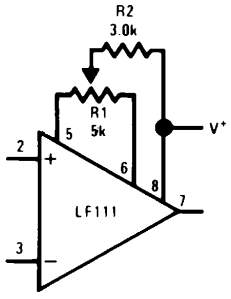
Note 5: The response time specified (see definitions) is for a 100 mV input step with 5.0 mV overdrive.

Note 6: For input voltages greater than 15V above the negative supply the bias and offset currents will increase—see typical performance curves.

Note 7: This specification gives the current that must be drawn from the strobe pin to ensure the output is properly disabled. Do not short the strobe pin to ground; it should be current driven at 3 to 5 mA.

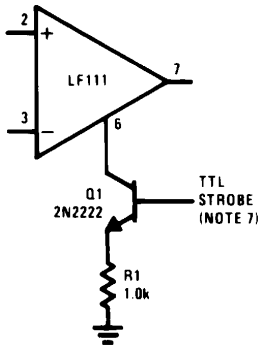
Auxiliary Circuits

Offset Balancing



TL/H/5703 13

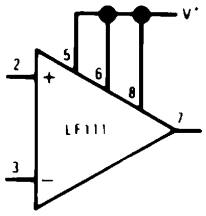
Strobing



TL/H/5703 14

Note: Do Not Ground Strobe Pin.

Increasing Input Stage Current*

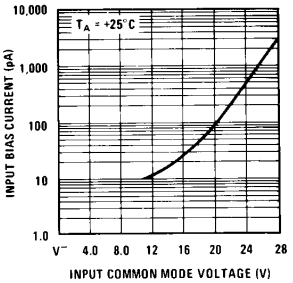


TL/H/5703 15

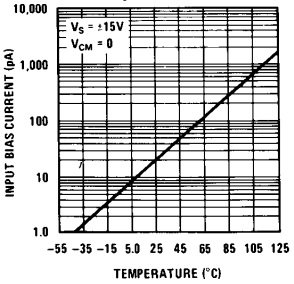
*Increases typical common mode slew from 7.0V/μs to 18V/μs

Typical Performance Characteristics

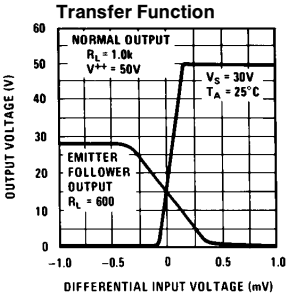
Input Bias Current vs Common Mode



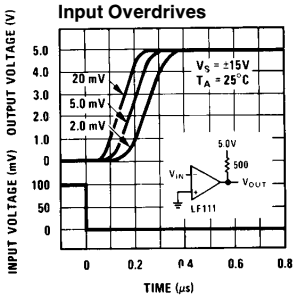
Input Bias Current vs Temperature



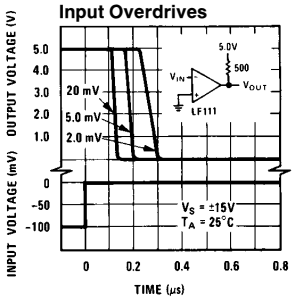
Transfer Function



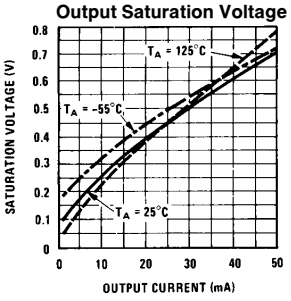
Response Time for Various Input Overdrives



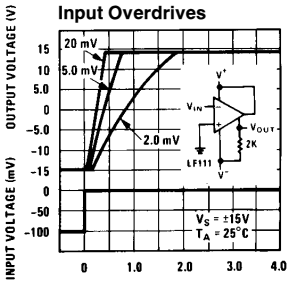
Response Time for Various Input Overdrives



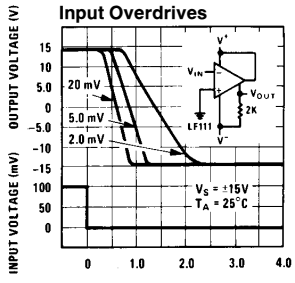
Output Saturation Voltage



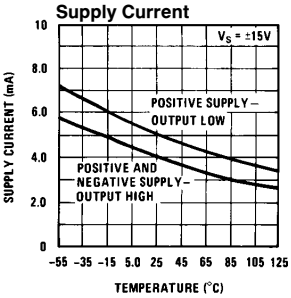
Response Time for Various Input Overdrives



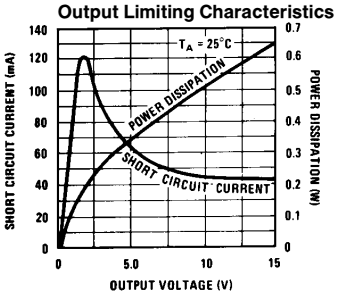
Response Time for Various Input Overdrives



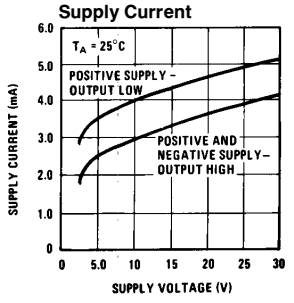
Supply Current



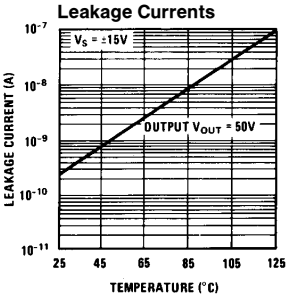
Output Limiting Characteristics



Supply Current



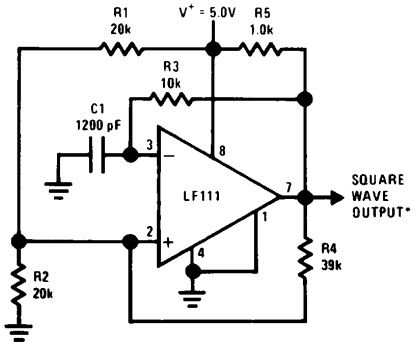
Leakage Currents



TL/H/5703 4

Typical Applications

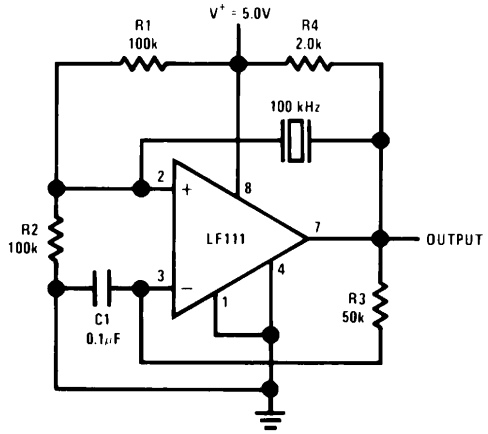
100 kHz Free Running Multivibrator



TL/H/5703 7

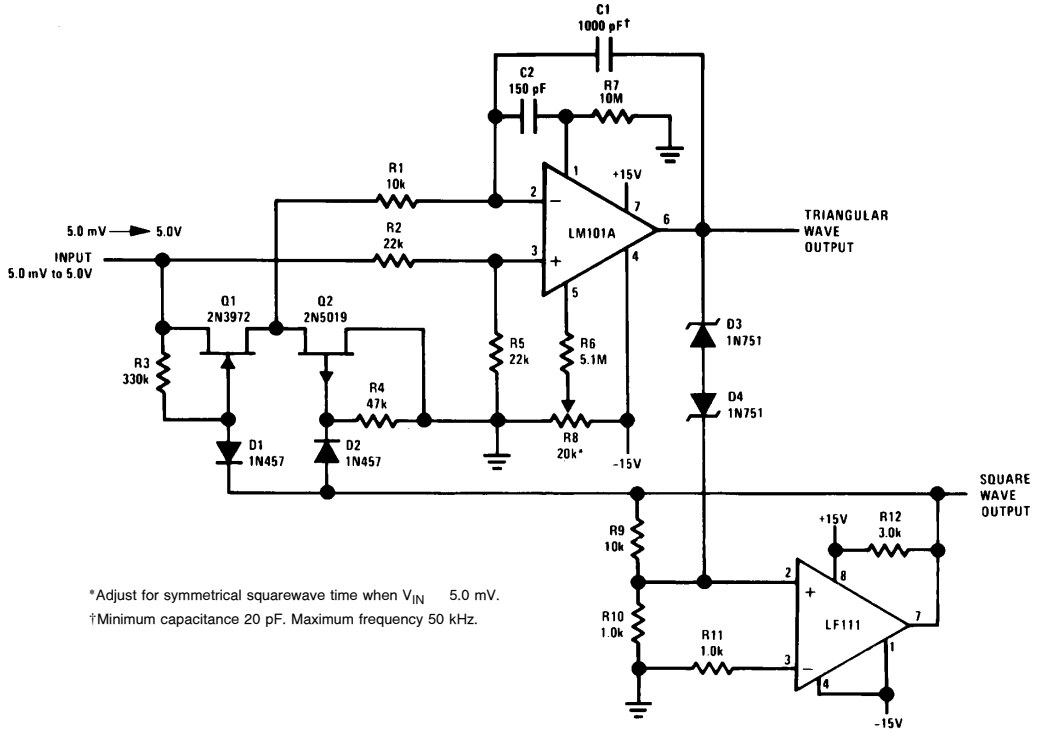
*TTL or DTL fanout of two.

Crystal Oscillator



TL/H/5703 3

10 Hz to 10 kHz Voltage Controlled Oscillator



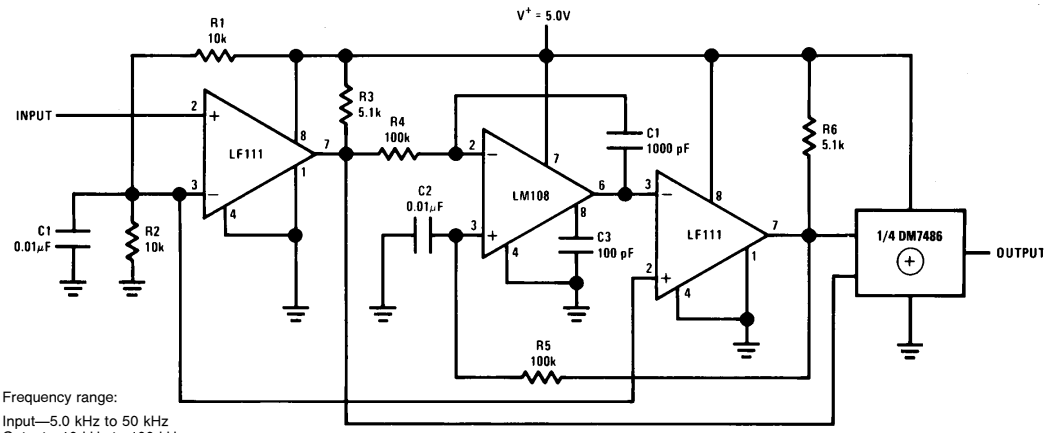
*Adjust for symmetrical squarewave time when V_{IN} 5.0 mV.

†Minimum capacitance 20 pF. Maximum frequency 50 kHz.

TL/H/5703 5

Typical Applications (Continued)

Frequency Doubler

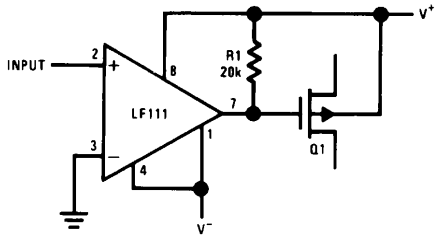


Frequency range:

Input—5.0 kHz to 50 kHz
Output—10 kHz to 100 kHz

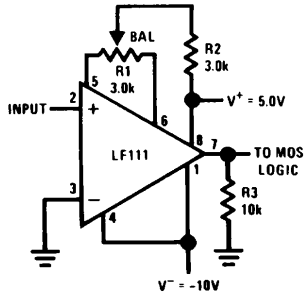
TL/H/5703 8

Zero Crossing Detector Driving MOS Switch



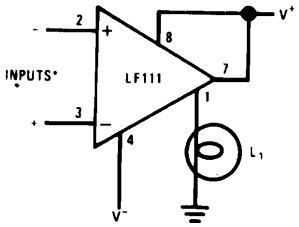
TL/H/5703 9

Zero Crossing Detector Driving MOS Logic



TL/H/5703 10

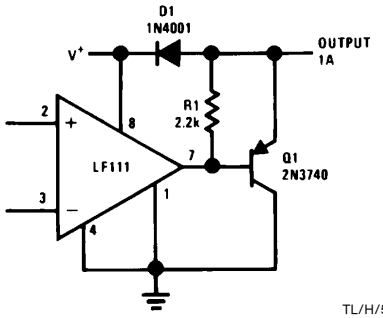
Driving Ground-Referred Load



TL/H/5703 11

*Input polarity is reversed when using pin 1 as output.

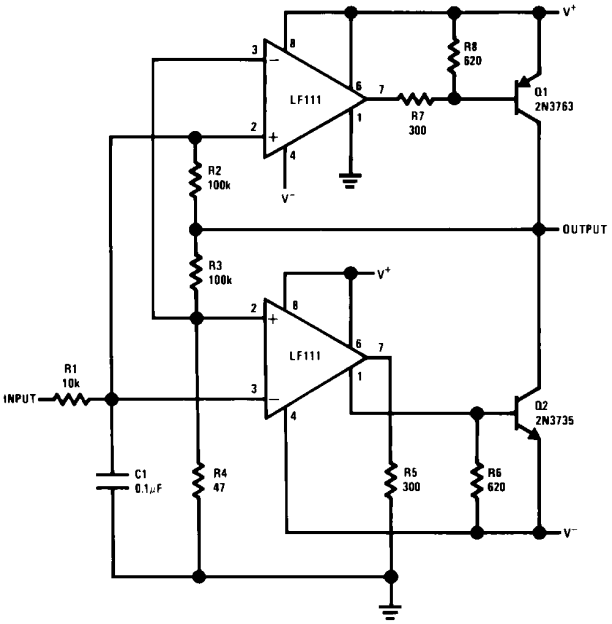
Comparator and Solenoid Driver



TL/H/5703 12

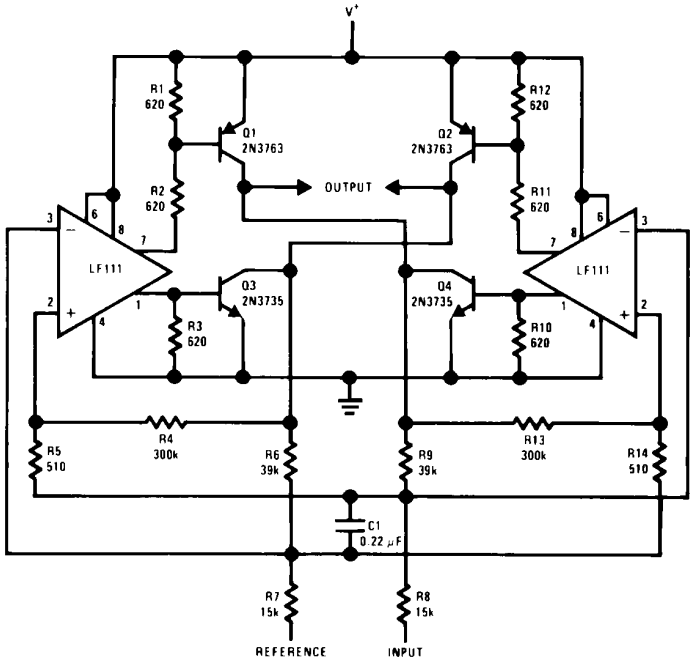
Typical Applications (Continued)

Switching Power Amplifier



TL/H/5703 16

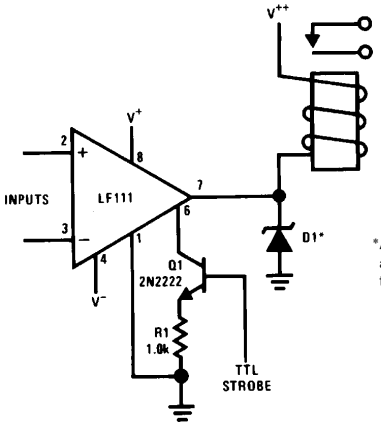
Switching Power Amplifier



TL/H/5703 17

Typical Applications (Continued)

Relay Driver with Strobe

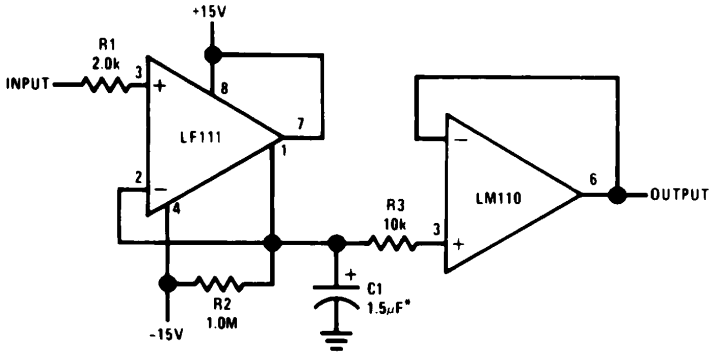


*Absorbs inductive kickback of relay and protects IC from severe voltage transients on V^{++} line.

TL/H/5703 18

Note: Do Not Ground Strobe Pin.

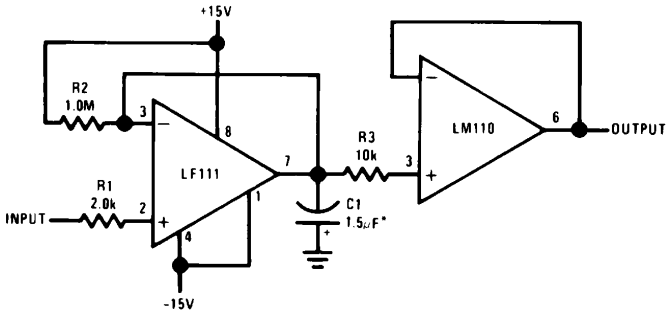
Positive Peak Detector



*Solid tantalum

TL/H/5703 19

Negative Peak Detector

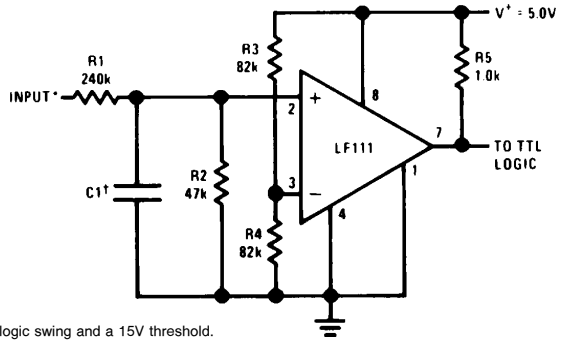


*Solid tantalum

TL/H/5703 20

Typical Applications (Continued)

TTL Interface with High Level Logic

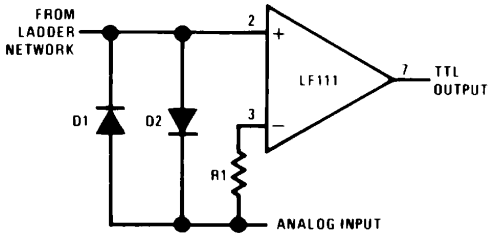


*Values shown are for a 0 to 30V logic swing and a 15V threshold.

TL/H/5703 21

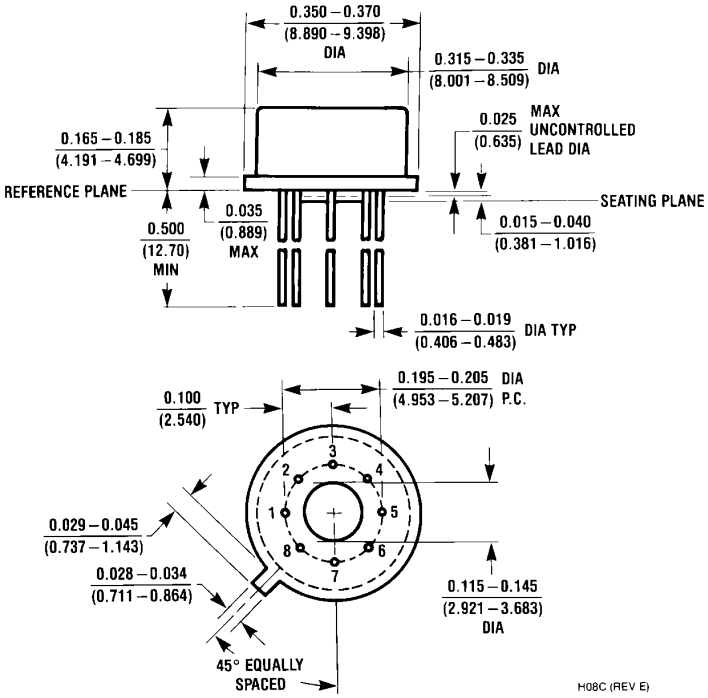
†May be added to control speed and reduce susceptibility to noise spikes

Using Clamp Diodes to Improve Response



TL/H/5703 6

Physical Dimensions inches (millimeters)



Metal Can Package (H)
Order Number LF111H, LF111H-MIL or LF311H
NS Package Number H08C

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2309
Fax: 81-043-299-2408

National does not assume any respons bility for use of any circuitry described, no circuit patent l censes are implied and National reserves the right at any t me without notice to change said circuitry and specificat ons