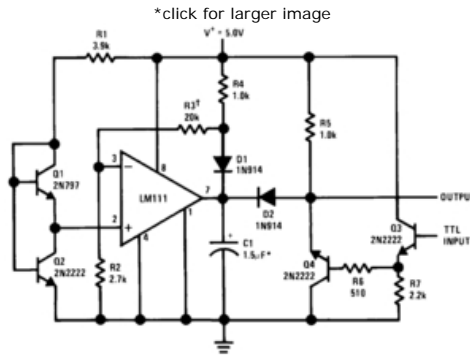


# LM111 - Voltage Comparator

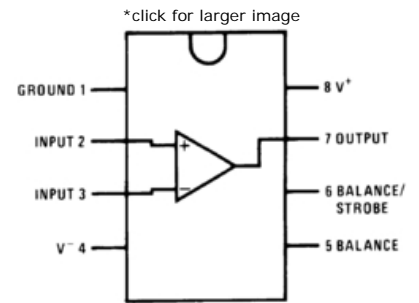
## Features

- Operates from single 5V supply
- Input current: 150 nA max. over temperature
- Offset current: 20 nA max. over temperature
- Differential input voltage range:  $\pm 30V$
- Power consumption: 135 mW at  $\pm 15V$

## Typical Application



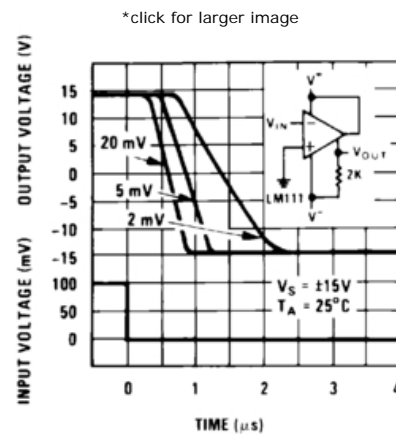
## Connection Diagram



## Parametric Table

Response Time	0.2, 0.1 us
Output Bus	Open Drain
Supply Min	5 Volt
Supply Max	36 Volt
Channels	1 Channels
Offset Voltage max, 25C	3 mV
Output Current	50 mA
Input Range	Not R-R
Supply Current Per Channel	5.1 mA
PowerWise Rating 3	1020, 510 uA x us
Max Input Bias Current	150 nA
Special Features	Offset Adjust, Strobe
Temperature Min	-55 deg C
Temperature Max	125 deg C
Function	Comparator
AEC Q-100 Automotive Grade	0

## Typical Performance





RoHS Compliance Information

LM111/LM211/LM311 Voltage Comparator
LM111JAN Voltage Comparator
LM111QML Voltage Comparator

Package Availability, Models

Part Number	Package						Factory Lead Time		Models	Std Pack Size	Package Marking Format
	Type	Pins	Spec.	MSL Rating	Peak Reflow	RoHS Report	Weeks	Qty			
LM111J-8	CERDIP	8	STD	1	NA	RoHS	Full production		LM111.MOD	rail of 40	NSUZXYTT LM111J -8
							6 weeks	500			
LM111H	TO-99	8	STD	1	NA	RoHS	Full production		LM111.MOD	box of 500	NSZXYTTE# LM111H
			NOPB	1	NA		6 weeks	2000			
LM111 MD8	Unpackaged Die						Full production		LM111.MOD	tray of N/A	-
							N/A	5000			
LM111 MW8	Wafer						Full production		LM111.MOD	wafer jar of N/A	-
							N/A	10000			
5962-8687701Q2A (LM111E-SMD)	LCC	20				RoHS	Obsolete		LM111.MOD	rail of 50	NSZSSXXYYA Q 5962- 8687701Q2A
							10 weeks	100			
LM111E/883	LCC	20	STD	1	NA	RoHS	Obsolete		LM111.MOD	rail of 50	NSZSSXXYYA LM111E /883 Q
							8 weeks	500			
5962-8687701QGA (LM111H-SMD)	TO-99	8				RoHS	Obsolete		LM111.MOD	tray of 20	NSZSSXXYYA Q 5962-8687701QGA
							8 weeks	100			
LM111H/883	TO-99	8	STD	1	NA	RoHS	Full production		LM111.MOD	tray of 20	NSZSSXXYYA LM111H/883 Q
							15 weeks	1000			
5962-8687701QPA (LM111J-8-SMD)	CERDIP	8				RoHS	Obsolete		LM111.MOD	rail of 40	NSZSSXXYYA Q 5962 8687701QPA
							8 weeks	2000			
LM111J-8/883	CERDIP	8	STD	1	NA	RoHS	Full production		LM111.MOD	rail of 40	NSZSSXXYYA LM111J-8 /883 Q
							7 weeks	1000			
LM111J/883	CERDIP	14	STD	1	NA	RoHS	Full production		LM111.MOD	rail of 25	NSZSSXXYYA LM111J/883 Q
							6 weeks	1000			
LM111W/883	CERPACK	10	STD	1	NA	RoHS	Obsolete		LM111.MOD	rail of 19	NS LM111W /883 Q ZSSXXYYA
							10 weeks	100			
5962-8687701QZA (LM111WG-SMD)	CERPACK	10				RoHS	Obsolete		LM111.MOD	tray of 54	NSZSS XXYYA 5962- 868770 1QZA Q
							10 weeks	500			
LM111WG/883	CERPACK	10	STD	1	NA	RoHS	Full production		LM111.MOD	tray of 54	NS LM111WG /883 Q ZSSXXYYA
							10 weeks	500			
JM38510/10304BGA (JL111BGA)	TO-99	8				RoHS	Full production		N/A	tray of 20	NS ZSSXXYYA 27014 Q JM38510/10304BGA
							8 weeks	500			
JM38510/10304BPA (JL111BPA)	CERDIP	8				RoHS	Obsolete		N/A	rail of 40	NS JM38510 /10304BPA 27014 Q ZSSXXYYA
							8 weeks	100			
JM38510/10304BCA (JL111BCA)	CERDIP	14				RoHS	Obsolete		N/A	rail of 25	NS ZSSXXYYA JM38510/10304BCA 27014 Q
							6 weeks	500			
JM38510/10304BHA (JL111BHA)	CERPACK	10				RoHS	Obsolete		N/A	rail of 19	NS JM38510/ 10304BHA 27014 Q ZSSXXYYA
							13 weeks	500			
JL111SGA	TO-99	8	STD	1	NA	RoHS	Obsolete		N/A	tray of N/A	NS ZSSXXYYA JM38510/10304SGA
							N/A	100			
										tray	NSZSSXXYYA

Part Number	Package	QTY	STD	1	NA	RoHS	Obsolete		LM111.MOD				of	N/A	LM111HPQV Q 5962P0052401VGA
							N/A	N/A							
LM111HPQMLV	TO-99	8	STD	1	NA	RoHS			LM111.MOD						
5962L0052401VGA (LM111HLQMLV)	TO-99	8				RoHS		Full production	LM111.MOD				tray		NSZSSXXYYA LM111HLQV Q 5962L0052401VGA
5962R0052402VGA (LM111HRLQMLV)	TO-99	8				RoHS		Full production 6 weeks	LM111.MOD				tray		NSZSSXXYYA LM111HRLQV Q 5962R0052402VGA
JL111SPA	CERDIP	8	STD	1	NA	RoHS		Obsolete	N/A				rail		NSZSSXXYYA JM38510 /10304SPA 27014 Q
5962L0052401VPA (LM111J-8LQMLV)	CERDIP	8				RoHS		Full production	LM111.MOD				rail		NSZSSXXYYA LM111J-8L QV Q 5962L 0052401VPA
5962R0052402VPA (LM111J-8RLQMLV)	CERDIP	8				RoHS		Full production	LM111.MOD				rail		NSZSSXXYYA LM111J-8RL QV Q 5962R 0052402VPA
JL111SHA	CERPACK	10	STD	1	NA	RoHS		Obsolete	N/A				rail		NS JM38510 /10304SHA 27014 Q ZSSXXYYA
5962L0052401VHA (LM111WLQMLV)	CERPACK	10				RoHS		Full production	LM111.MOD				rail		NSLM111W LQV Q ZSSXXYYA 5962L005 2401VHA
5962R0052402VHA (LM111WRLQMLV)	CERPACK	10				RoHS		Full production	LM111.MOD				rail		NSLM111W RLQV Q ZSSXXYYA 5962R005 2402VHA
JL111SZA	CERPACK	10	STD	1	NA	RoHS		Obsolete	N/A				tray		NS JM38510 /10304SZA 27014 Q ZSSXXYYA
LM111WGPQMLV	CERPACK	10	STD	1	NA	RoHS		Obsolete	LM111.MOD				tray		NSLM111W GPV Q 5962P005 2401VZA ZSSXXYYA
5962L0052401VZA (LM111WGLQMLV)	CERPACK	10				RoHS		Full production	LM111.MOD				tray		NSLM111W GLQV Q 5962L005 2401VZA ZSSXXYYA
5962R0052402VZA (LM111WGRLQMLV)	CERPACK	10				RoHS		Full production	LM111.MOD				tray		NSLM111W GRLQV Q 5962R005 2402VZA ZSSXXYYA

### Obsolete Versions

Obsolete Part	Alternate Part or Supplier	Source	Last Time Buy Date
LM111E-MLS	JL111SZA	National Semiconductor	12/06/2005
LM111E-SMD	LM111WG/883	NATIONAL SEMICONDUCTOR CORP	12/03/2008
LM111E-SMD	UA111	NATIONAL SEMICONDUCTOR CORP	12/03/2008
LM111E/883	LM111WG/883	NATIONAL SEMICONDUCTOR CORP	12/03/2008
LM111E/883	UA111	NATIONAL SEMICONDUCTOR CORP	12/03/2008
LM111H-MLS	JL111SGA	NATIONAL SEMICONDUCTOR	09/08/99
LM111H-MLS	NONE	NONE	02/21/2006
LM111H-SMD	UA111	NATIONAL SEMICONDUCTOR CORP	12/03/2008
LM111HPQMLV	None	None	09/06/2005
LM111J	NONE	NATIONAL SEMICONDUCTOR	12/07/93
LM111J-8-SMD	LM111J-8/883	NATIONAL SEMICONDUCTOR CORP	12/03/2008
LM111J-8PQMLV	JL111SPA	NATIONAL SEMI.	12/06/2005
LM111W-MLS	JL111SHA	NSC	03/05/2008
LM111WG-SMD	UA111	NATIONAL SEMICONDUCTOR CORP	11/16/2008
LM111WGPQMLV	A111	NATIONAL SEMICONDUCTOR	09/06/2005
LM111WPQMLV	None	None	09/06/2005
LM111W/883	UA111	NATIONAL SEMICONDUCTOR CORP	12/03/2008

### General Description

The LM111, LM211 and LM311 are voltage comparators that have input currents nearly a thousand times lower than devices like the LM106 or LM710. They are also designed to operate over a wider range of supply voltages: from standard  $\pm 15V$  op amp supplies down to the single 5V supply used for IC logic. Their output is compatible with RTL, DTL and TTL as well as MOS circuits. Further, they can drive lamps or relays, switching voltages up to 50V at currents as high as 50 mA.

Both the inputs and the outputs of the LM111, LM211 or the LM311 can be isolated from system ground, and the output can drive loads referred to ground, the positive supply or the negative supply. Offset balancing and strobe capability are provided and outputs can be wire OR'ed. Although slower than the LM106 and LM710 (200 ns response time vs 40 ns) the devices are also much less prone to spurious oscillations. The LM111 has the same pin configuration as the LM106 and LM710.

# LM111/LM211/LM311 Voltage Comparator

## 1.0 General Description

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the devices are also much less prone to spurious oscillations. The LM111 has the same pin configuration as the LM106 and LM710.

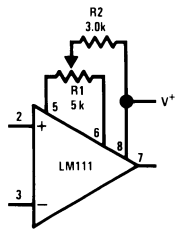
The LM211 is identical to the LM111, except that its performance is specified over a  $-25^{\circ}C$  to  $+85^{\circ}C$  temperature range instead of  $-55^{\circ}C$  to  $+125^{\circ}C$ . The LM311 has a temperature range of  $0^{\circ}C$  to  $+70^{\circ}C$ .

## 2.0 Features

- Operates from single 5V supply
- Input current: 150 nA max. over temperature
- Offset current: 20 nA max. over temperature
- Differential input voltage range:  $\pm 30V$
- Power consumption: 135 mW at  $\pm 15V$

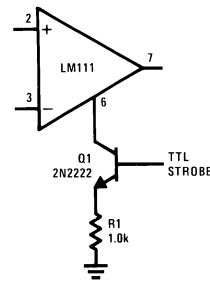
## 3.0 Typical Applications (Note 3)

**Offset Balancing**



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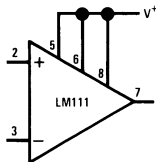
**Strobing**



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**Note:** Do Not Ground Strobe Pin. Output is turned off when current is pulled from Strobe Pin.

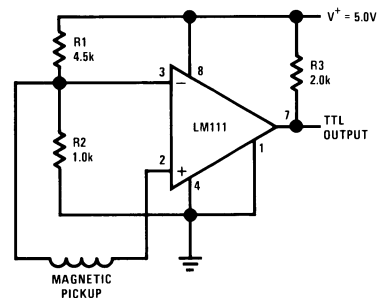
**Increasing Input Stage Current (Note 1)**



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**Note 1:** Increases typical common mode slew from  $7.0V/\mu s$  to  $18V/\mu s$ .

**Detector for Magnetic Transducer**



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## 4.0 Absolute Maximum Ratings for the LM111/LM211 (Note 10)

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

Total Supply Voltage ( $V_{84}$ )	36V
Output to Negative Supply Voltage ( $V_{74}$ )	50V
Ground to Negative Supply Voltage ( $V_{14}$ )	30V
Differential Input Voltage	$\pm 30V$
Input Voltage (Note 4)	$\pm 15V$
Output Short Circuit Duration	10 sec
Operating Temperature Range	

LM111	$-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$
LM211	$-25^{\circ}\text{C}$ to $85^{\circ}\text{C}$
Lead Temperature (Soldering, 10 sec)	$260^{\circ}\text{C}$
Voltage at Strobe Pin	$V^{+}-5V$
Soldering Information	
Dual-In-Line Package	
Soldering (10 seconds)	$260^{\circ}\text{C}$
Small Outline Package	
Vapor Phase (60 seconds)	$215^{\circ}\text{C}$
Infrared (15 seconds)	$220^{\circ}\text{C}$
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.	
ESD Rating (Note 11)	300V

## Electrical Characteristics (Note 6) for the LM111 and LM211

Parameter	Conditions	Min	Typ	Max	Units
Input Offset Voltage (Note 7)	$T_A=25^{\circ}\text{C}$ , $R_S \leq 50\text{k}$		0.7	3.0	mV
Input Offset Current	$T_A=25^{\circ}\text{C}$		4.0	10	nA
Input Bias Current	$T_A=25^{\circ}\text{C}$		60	100	nA
Voltage Gain	$T_A=25^{\circ}\text{C}$	40	200		V/mV
Response Time (Note 8)	$T_A=25^{\circ}\text{C}$		200		ns
Saturation Voltage	$V_{IN} \leq -5\text{ mV}$ , $I_{OUT} = 50\text{ mA}$ $T_A=25^{\circ}\text{C}$		0.75	1.5	V
Strobe ON Current (Note 9)	$T_A=25^{\circ}\text{C}$		2.0	5.0	mA
Output Leakage Current	$V_{IN} \geq 5\text{ mV}$ , $V_{OUT} = 35V$ $T_A=25^{\circ}\text{C}$ , $I_{STROBE} = 3\text{ mA}$		0.2	10	nA
Input Offset Voltage (Note 7)	$R_S \leq 50\text{ k}$			4.0	mV
Input Offset Current (Note 7)				20	nA
Input Bias Current				150	nA
Input Voltage Range	$V^{+} = 15V$ , $V^{-} = -15V$ , Pin 7 Pull-Up May Go To 5V	-14.5	13.8,-14.7	13.0	V
Saturation Voltage	$V^{+} \geq 4.5V$ , $V^{-} = 0$ $V_{IN} \leq -6\text{ mV}$ , $I_{OUT} \leq 8\text{ mA}$		0.23	0.4	V
Output Leakage Current	$V_{IN} \geq 5\text{ mV}$ , $V_{OUT} = 35V$		0.1	0.5	$\mu\text{A}$
Positive Supply Current	$T_A=25^{\circ}\text{C}$		5.1	6.0	mA
Negative Supply Current	$T_A=25^{\circ}\text{C}$		4.1	5.0	mA

**Note 4:** This rating applies for  $\pm 15$  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 5:** The maximum junction temperature of the LM111 is  $150^{\circ}\text{C}$ , while that of the LM211 is  $110^{\circ}\text{C}$ . For operating at elevated temperatures, devices in the H08 package must be derated based on a thermal resistance of  $165^{\circ}\text{C/W}$ , junction to ambient, or  $20^{\circ}\text{C/W}$ , junction to case. The thermal resistance of the dual-in-line package is  $110^{\circ}\text{C/W}$ , junction to ambient.

**Note 6:** These specifications apply for  $V_S = \pm 15V$  and Ground pin at ground, and  $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ , unless otherwise stated. With the LM211, however, all temperature specifications are limited to  $-25^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ . The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5V supply up to  $\pm 15V$  supplies.

**Note 7:** 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 mA load. Thus, these parameters define an error band and take into account the worst-case effects of voltage gain and  $R_S$ .

**Note 8:** The response time specified (see definitions) is for a 100 mV input step with 5 mV overdrive.

**Note 9:** This specification gives the range of current which 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 10:** Refer to RETS111X for the LM111H, LM111J and LM111J-8 military specifications.

**Note 11:** Human body model, 1.5 k $\Omega$  in series with 100 pF.

## 5.0 Absolute Maximum Ratings for the LM311 (Note 12)

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

Total Supply Voltage ( $V_{S4}$ )	36V
Output to Negative Supply Voltage ( $V_{74}$ )	40V
Ground to Negative Supply Voltage ( $V_{14}$ )	30V
Differential Input Voltage	$\pm 30V$
Input Voltage (Note 13)	$\pm 15V$
Power Dissipation (Note 14)	500 mW
ESD Rating (Note 19)	300V

Output Short Circuit Duration	10 sec
Operating Temperature Range	0° to 70°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (soldering, 10 sec)	260°C
Voltage at Strobe Pin	$V^+ - 5V$
Soldering Information	
Dual-In-Line Package	
Soldering (10 seconds)	260°C
Small Outline Package	
Vapor Phase (60 seconds)	215°C
Infrared (15 seconds)	220°C
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.	

## Electrical Characteristics (Note 15) for the LM311

Parameter	Conditions	Min	Typ	Max	Units
Input Offset Voltage (Note 16)	$T_A = 25^\circ C, R_S \leq 50k$		2.0	7.5	mV
Input Offset Current (Note 16)	$T_A = 25^\circ C$		6.0	50	nA
Input Bias Current	$T_A = 25^\circ C$		100	250	nA
Voltage Gain	$T_A = 25^\circ C$	40	200		V/mV
Response Time (Note 17)	$T_A = 25^\circ C$		200		ns
Saturation Voltage	$V_{IN} \leq -10 \text{ mV}, I_{OUT} = 50 \text{ mA}$ $T_A = 25^\circ C$		0.75	1.5	V
Strobe ON Current (Note 18)	$T_A = 25^\circ C$		2.0	5.0	mA
Output Leakage Current	$V_{IN} \geq 10 \text{ mV}, V_{OUT} = 35V$ $T_A = 25^\circ C, I_{STROBE} = 3 \text{ mA}$ $V^- = \text{Pin 1} = -5V$		0.2	50	nA
Input Offset Voltage (Note 16)	$R_S \leq 50K$			10	mV
Input Offset Current (Note 16)				70	nA
Input Bias Current				300	nA
Input Voltage Range		-14.5	13.8, -14.7	13.0	V
Saturation Voltage	$V^+ \geq 4.5V, V^- = 0$ $V_{IN} \leq -10 \text{ mV}, I_{OUT} \leq 8 \text{ mA}$		0.23	0.4	V
Positive Supply Current	$T_A = 25^\circ C$		5.1	7.5	mA
Negative Supply Current	$T_A = 25^\circ C$		4.1	5.0	mA

**Note 12:** "Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits."

**Note 13:** This rating applies for  $\pm 15V$  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 14:** The maximum junction temperature of the LM311 is 110°C. For operating at elevated temperature, 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. The thermal resistance of the dual-in-line package is 100°C/W, junction to ambient.

**Note 15:** These specifications apply for  $V_S = \pm 15V$  and Pin 1 at ground, and  $0^\circ C < T_A < +70^\circ C$ , unless otherwise specified. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5V supply up to  $\pm 15V$  supplies.

**Note 16:** The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with 1 mA load. Thus, these parameters define an error band and take into account the worst-case effects of voltage gain and  $R_S$ .

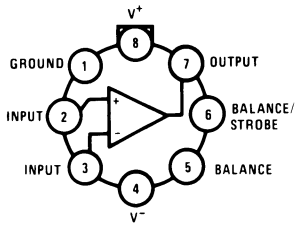
**Note 17:** The response time specified (see definitions) is for a 100 mV input step with 5 mV overdrive.

**Note 18:** This specification gives the range of current which 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 19:** Human body model, 1.5 k $\Omega$  in series with 100 pF.

# 11.0 Connection Diagrams

**Metal Can Package**



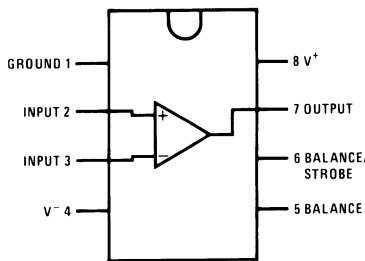
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**Note:** Pin 4 connected to case

**Top View**

**Order Number LM111H, LM111H/883(Note 21) , LM211H or LM311H**  
**See NS Package Number H08C**

**Dual-In-Line Package**

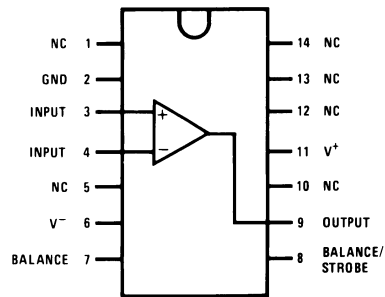


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**Top View**

**Order Number LM111J-8, LM111J-8/883(Note 21),**  
**LM311M, LM311MX or LM311N**  
**See NS Package Number J08A, M08A or N08E**

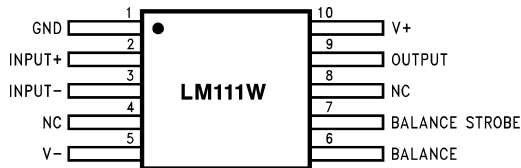
**Dual-In-Line Package**



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**Top View**

**Order Number LM111J/883(Note 21)**  
**See NS Package Number J14A or N14A**

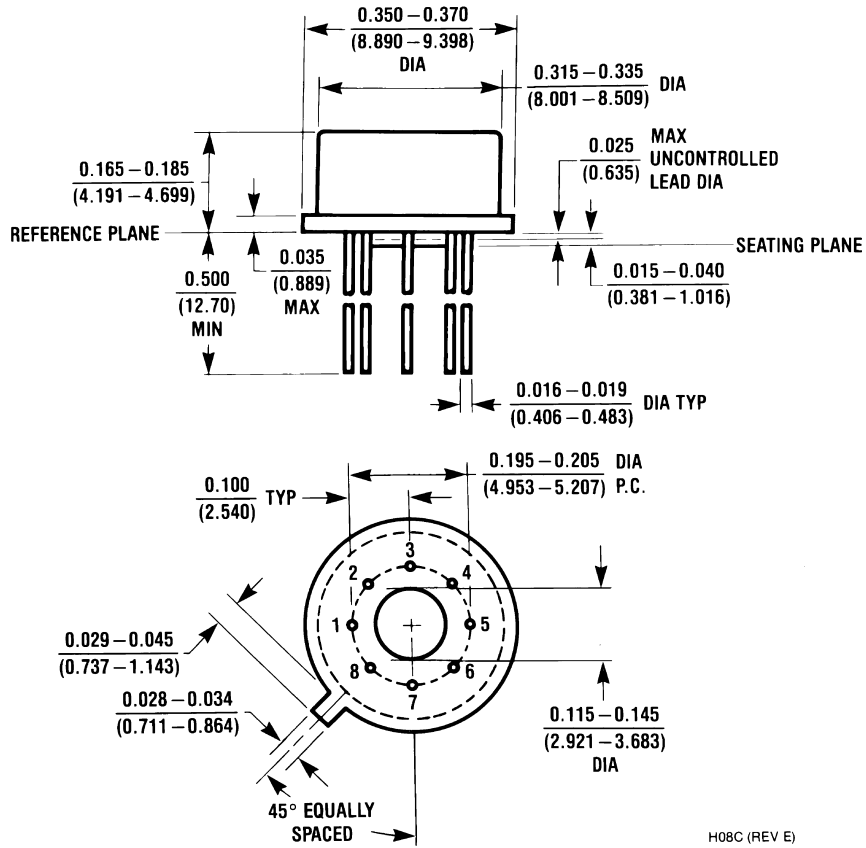


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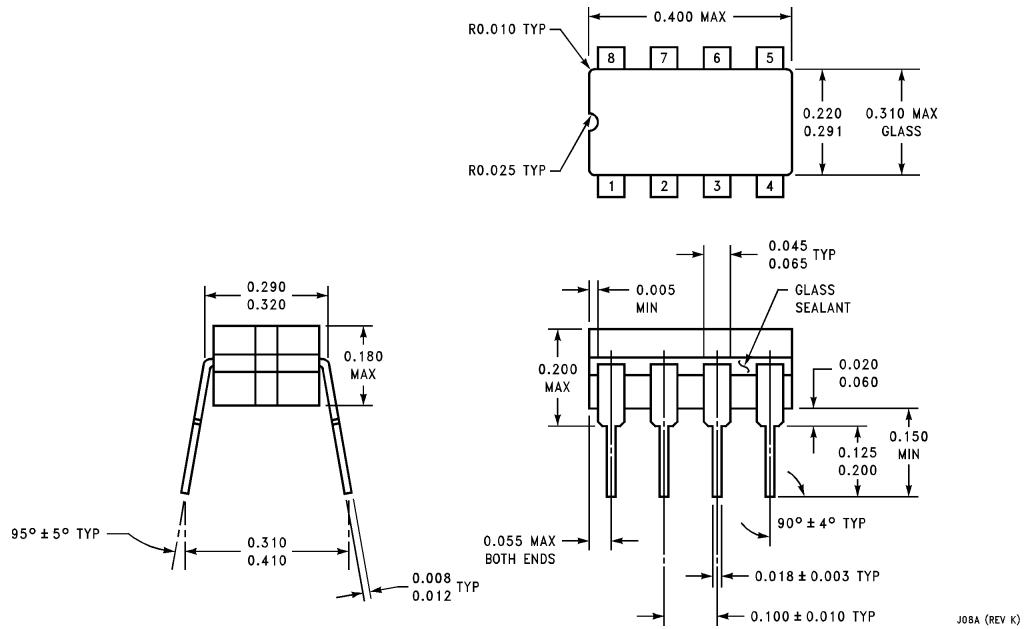
**Order Number LM111W/883(Note 21), LM111WG/883**  
**See NS Package Number W10A, WG10A**

**Note 21:** Also available per JM38510/10304

## 12.0 Physical Dimensions inches (millimeters) unless otherwise noted



**Metal Can Package (H)**  
 Order Number LM111H, LM111H/883, LM211H or LM311H  
 NS Package Number H08C



**Cavity Dual-In-Line Package (J)**  
 Order Number LM111J-8, LM111J-8/883  
 NS Package Number J08A