

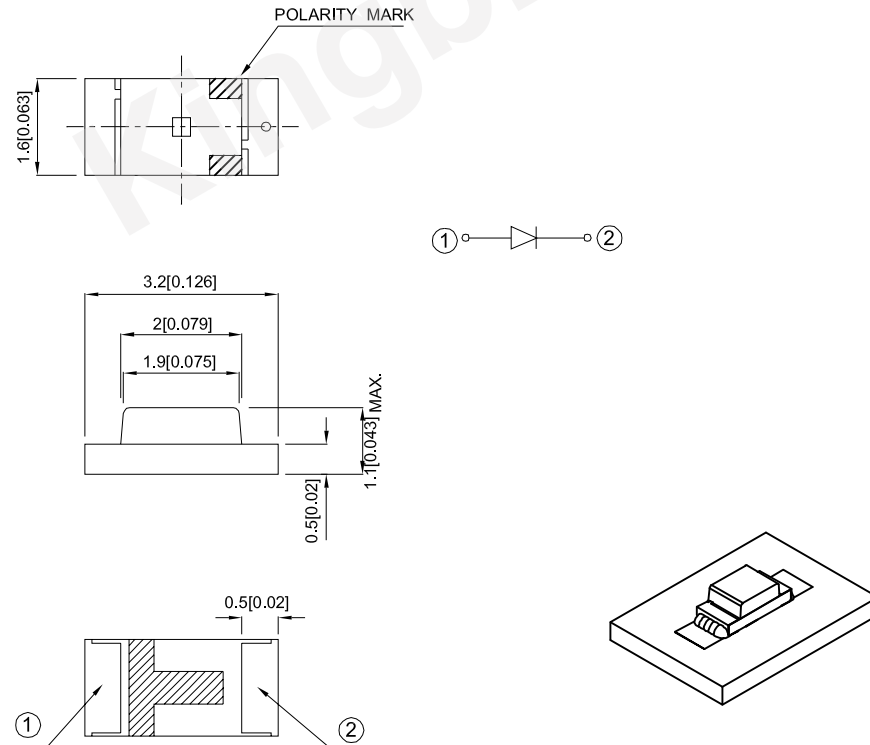
Features

- 3.2mmx1.6mm SMT LED, 1.1mm thickness.
- Low power consumption.
- Wide viewing angle.
- Ideal for backlight and indicator.
- Package : 2000pcs / reel.
- Moisture sensitivity level : level 3.
- RoHS compliant.

Description

The Super Bright Green source color devices are made with Gallium Phosphide Green Light Emitting Diode.

Package Dimensions



Notes:

1. All dimensions are in millimeters (inches).
2. Tolerance is ± 0.2 (0.0079") unless otherwise noted.
3. The specifications, characteristics and technical data described in the datasheet are subject to change without prior notice.
4. The device has a single mounting surface. The device must be mounted according to the specifications.



Selection Guide

Part No.	Emitting Color (Material)	Lens Type	Iv (mcd) [2] @ 20mA		Viewing Angle [1]
			Min.	Typ.	2θ1/2
KP-3216SGC	Super Bright Green (GaP)	Water Clear	5	12	120°

Notes:

1. θ1/2 is the angle from optical centerline where the luminous intensity is 1/2 of the optical peak value.
2. Luminous intensity / luminous Flux: +/-15%.
3. Luminous intensity value is traceable to the CIE127-2007 compliant national standards.

Electrical / Optical Characteristics at TA=25°C

Symbol	Parameter	Emitting Color	Typ.	Max.	Units	Test Conditions
λpeak	Peak Wavelength	Super Bright Green	565		nm	IF=20mA
λD [1]	Dominant Wavelength	Super Bright Green	568		nm	IF=20mA
Δλ1/2	Spectral Line Half-width	Super Bright Green	30		nm	IF=20mA
C	Capacitance	Super Bright Green	15		pF	Vf=0V;f=1MHz
Vf [2]	Forward Voltage	Super Bright Green	2.2	2.5	V	IF=20mA
IR	Reverse Current	Super Bright Green		10	uA	VR=5V

Notes:

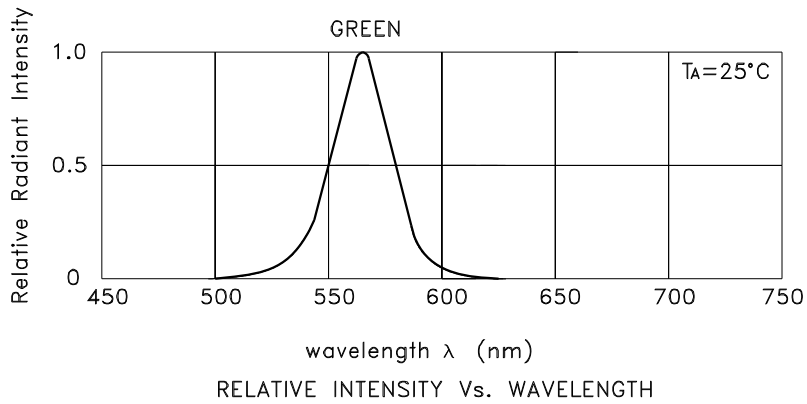
1. Wavelength: +/-1nm.
2. Forward Voltage: +/-0.1V.
3. Wavelength value is traceable to the CIE127-2007 compliant national standards.
4. Excess driving current and / or operating temperature higher than recommended conditions may result in severe light degradation or premature failure.

Absolute Maximum Ratings at TA=25°C

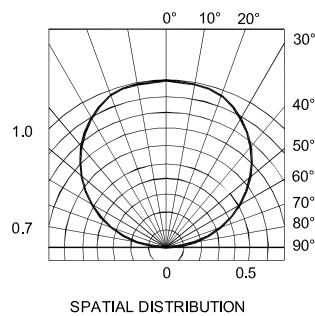
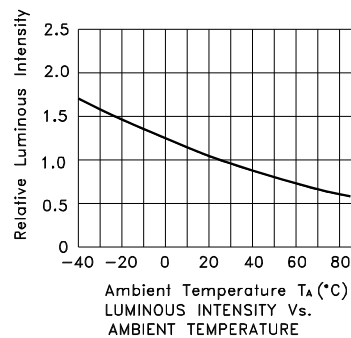
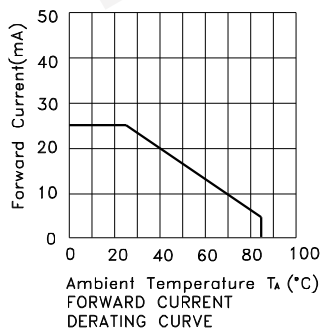
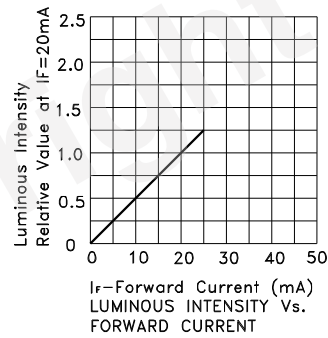
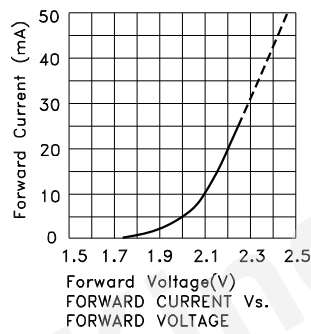
Parameter	Values	Units
Power dissipation	62.5	mW
DC Forward Current	25	mA
Peak Forward Current [1]	140	mA
Reverse Voltage	5	V
Operating Temperature	-40°C To +85°C	
Storage Temperature	-40°C To +85°C	

Note:

1. 1/10 Duty Cycle, 0.1ms Pulse Width.



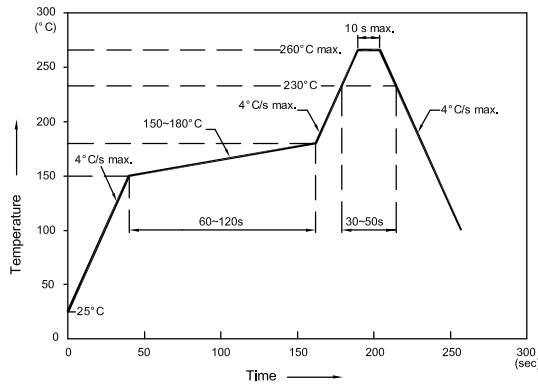
Super Bright Green KP-3216SGC



KP-3216SGC

Reflow soldering is recommended and the soldering profile is shown below.
Other soldering methods are not recommended as they might cause damage to the product.

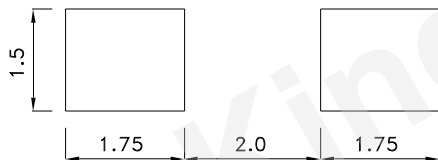
Reflow Soldering Profile For Lead-free SMT Process.



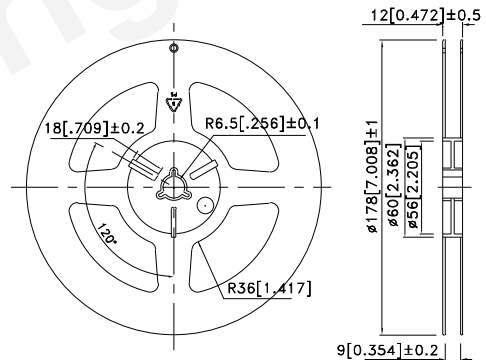
NOTES:

1. We recommend the reflow temperature 245°C (+/-5°C). The maximum soldering temperature should be limited to 260°C.
2. Don't cause stress to the epoxy resin while it is exposed to high temperature.
3. Number of reflow process shall be 2 times or less.

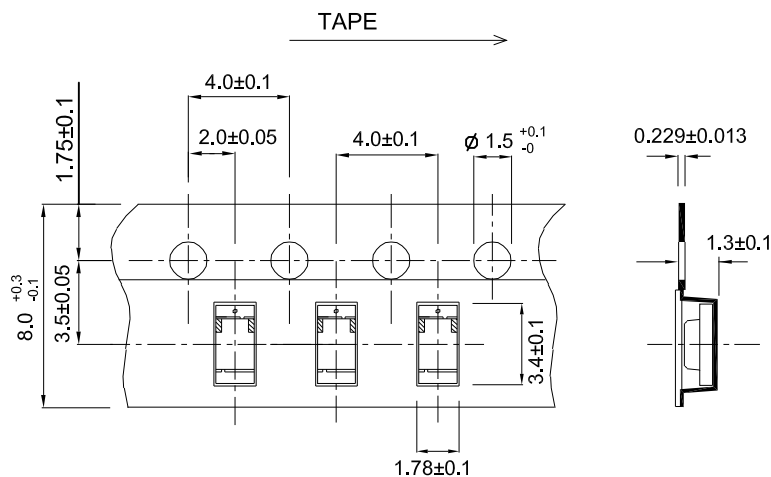
Recommended Soldering Pattern (Units : mm; Tolerance: ± 0.1)



Reel Dimension



Tape Dimensions (Units : mm)



xx555 Precision Timers

1 Features

- Timing From Microseconds to Hours
- Astable or Monostable Operation
- Adjustable Duty Cycle
- TTL-Compatible Output Can Sink or Source Up to 200 mA
- On Products Compliant to MIL-PRF-38535, All Parameters Are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testing of All Parameters.

2 Applications

- Fingerprint Biometrics
- Iris Biometrics
- RFID Reader

3 Description

These devices are precision timing circuits capable of producing accurate time delays or oscillation. In the time-delay or mono-stable mode of operation, the timed interval is controlled by a single external resistor and capacitor network. In the a-stable mode of operation, the frequency and duty cycle can be controlled independently with two external resistors and a single external capacitor.

The threshold and trigger levels normally are two-thirds and one-third, respectively, of V_{CC} . These levels can be altered by use of the control-voltage terminal. When the trigger input falls below the trigger level, the flip-flop is set, and the output goes high. If the trigger input is above the trigger level and the threshold input is above the threshold level, the flip-flop is reset and the output is low. The reset (RESET) input can override all other inputs and can be used to initiate a new timing cycle. When RESET goes low, the flip-flop is reset, and the output goes low. When the output is low, a low-impedance path is provided between discharge (DISCH) and ground.

The output circuit is capable of sinking or sourcing current up to 200 mA. Operation is specified for supplies of 5 V to 15 V. With a 5-V supply, output levels are compatible with TTL inputs.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
xx555	PDIP (8)	9.81 mm × 6.35 mm
	SOP (8)	6.20 mm × 5.30 mm
	TSSOP (8)	3.00 mm × 4.40 mm
	SOIC (8)	4.90 mm × 3.91 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

4 Simplified Schematic

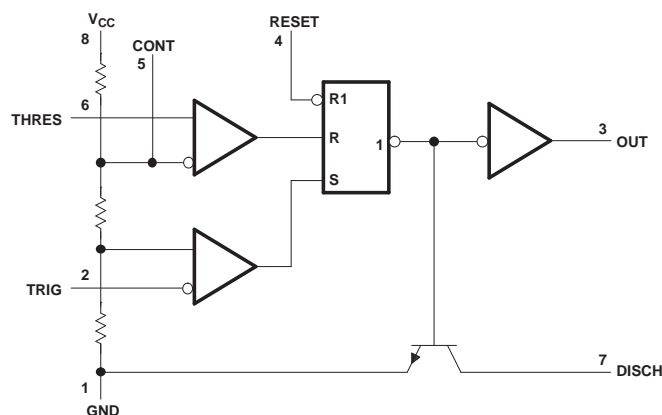


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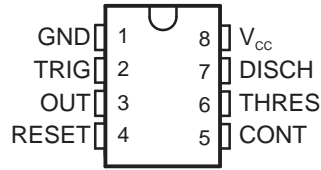
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5 Revision History

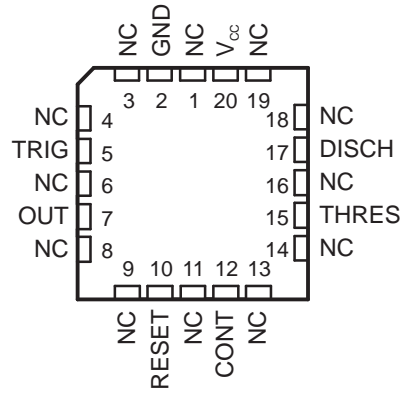
Changes from Revision H (June 2010) to Revision I	Page
• Updated document to new TI enhanced data sheet format.	1
• Deleted Ordering Information table.	1
• Added Military Disclaimer to Features list.	1
• Added Applications.	1
• Added Device Information table.	1
• Moved T _{stg} to Handling Ratings table.	4
• Added DISCH switch on-state voltage parameter.	5
• Added Device and Documentation Support section.	19
• Added ESD warning.	19
• Added Mechanical, Packaging, and Orderable Information section.	19

6 Pin Configuration and Functions

NA555...D OR P PACKAGE
NE555...D, P, PS, OR PW PACKAGE
SA555...D OR P PACKAGE
SE555...D, JG, OR P PACKAGE
(TOP VIEW)



SE555...FK PACKAGE
(TOP VIEW)



NC – No internal connection

Pin Functions

NAME	PIN		I/O	DESCRIPTION
	D, P, PS, PW, JG	FK		
	NO.			
CONT	5	12	I/O	Controls comparator thresholds, Outputs 2/3 VCC, allows bypass capacitor connection
DISCH	7	17	O	Open collector output to discharge timing capacitor
GND	1	2	–	Ground
NC		1, 3, 4, 6, 8, 9, 11, 13, 14, 16, 18, 19	–	No internal connection
OUT	3	7	O	High current timer output signal
RESET	4	10	I	Active low reset input forces output and discharge low.
THRES	6	15	I	End of timing input. THRES > CONT sets output low and discharge low
TRIG	2	5	I	Start of timing input. TRIG < 1/2 CONT sets output high and discharge open
V _{CC}	8	20	–	Input supply voltage, 4.5 V to 16 V. (SE555 maximum is 18 V)

7 Specifications

7.1 Absolute Maximum Ratings⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V _{CC}	Supply voltage ⁽²⁾		18	V
V _I	Input voltage	CONT, RESET, THRES, TRIG		V _{CC}
I _O	Output current		±225	mA
θ _{JA}	Package thermal impedance ⁽³⁾⁽⁴⁾	D package	97	°C/W
		P package	85	
		PS package	95	
		PW package	149	
θ _{JC}	Package thermal impedance ⁽⁵⁾⁽⁶⁾	FK package	5.61	°C/W
		JG package	14.5	
T _J	Operating virtual junction temperature		150	°C
	Case temperature for 60 s	FK package	260	°C
	Lead temperature 1,6 mm (1/16 in) from case for 60 s	JG package	300	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to GND.
- (3) Maximum power dissipation is a function of T_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} - T_A) / θ_{JA}. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.
- (5) Maximum power dissipation is a function of T_{J(max)}, θ_{JC}, and T_C. The maximum allowable power dissipation at any allowable case temperature is P_D = (T_{J(max)} - T_C) / θ_{JC}. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (6) The package thermal impedance is calculated in accordance with MIL-STD-883.

7.2 Handling Ratings

PARAMETER	DEFINITION	MIN	MAX	UNIT
T _{stg}	Storage temperature range	-65	150	°C

7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT	
V _{CC}	Supply voltage	NA555, NE555, SA555	4.5	16	V
		SE555	4.5	18	
V _I	Input voltage	CONT, RESET, THRES, and TRIG		V _{CC}	
I _O	Output current		±200	mA	
T _A	Operating free-air temperature	NA555	-40	105	°C
		NE555	0	70	
		SA555	-40	85	
		SE555	-55	125	

7.4 Electrical Characteristics

 $V_{CC} = 5\text{ V to }15\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SE555			NA555 NE555 SA555			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
THRES voltage level	$V_{CC} = 15\text{ V}$		9.4	10	10.6	8.8	10	11.2	V
	$V_{CC} = 5\text{ V}$		2.7	3.3	4	2.4	3.3	4.2	
THRES current ⁽¹⁾				30	250		30	250	nA
TRIG voltage level	$V_{CC} = 15\text{ V}$		4.8	5	5.2	4.5	5	5.6	V
		$T_A = -55^\circ\text{C to }125^\circ\text{C}$	3		6				
	$V_{CC} = 5\text{ V}$		1.45	1.67	1.9	1.1	1.67	2.2	
		$T_A = -55^\circ\text{C to }125^\circ\text{C}$			1.9				
TRIG current	TRIG at 0 V			0.5	0.9		0.5	2	μA
RESET voltage level			0.3	0.7	1	0.3	0.7	1	V
	$T_A = -55^\circ\text{C to }125^\circ\text{C}$				1.1				
RESET current	RESET at V_{CC}			0.1	0.4		0.1	0.4	mA
	RESET at 0 V			-0.4	-1		-0.4	-1.5	
DISCH switch off-state current				20	100		20	100	nA
DISCH switch on-state voltage	$V_{CC} = 5\text{ V}$, $I_O = 8\text{ mA}$						0.15	0.4	V
CONT voltage (open circuit)	$V_{CC} = 15\text{ V}$		9.6	10	10.4	9	10	11	V
		$T_A = -55^\circ\text{C to }125^\circ\text{C}$	9.6		10.4				
	$V_{CC} = 5\text{ V}$		2.9	3.3	3.8	2.6	3.3	4	
		$T_A = -55^\circ\text{C to }125^\circ\text{C}$	2.9		3.8				
Low-level output voltage	$V_{CC} = 15\text{ V}$, $I_{OL} = 10\text{ mA}$			0.1	0.15		0.1	0.25	V
		$T_A = -55^\circ\text{C to }125^\circ\text{C}$			0.2				
	$V_{CC} = 15\text{ V}$, $I_{OL} = 50\text{ mA}$			0.4	0.5		0.4	0.75	
		$T_A = -55^\circ\text{C to }125^\circ\text{C}$			1				
	$V_{CC} = 15\text{ V}$, $I_{OL} = 100\text{ mA}$			2	2.2		2	2.5	
		$T_A = -55^\circ\text{C to }125^\circ\text{C}$			2.7				
	$V_{CC} = 15\text{ V}$, $I_{OL} = 200\text{ mA}$			2.5			2.5		
	$V_{CC} = 5\text{ V}$, $I_{OL} = 3.5\text{ mA}$	$T_A = -55^\circ\text{C to }125^\circ\text{C}$			0.35				
$V_{CC} = 5\text{ V}$, $I_{OL} = 5\text{ mA}$			0.1	0.2		0.1	0.35		
	$T_A = -55^\circ\text{C to }125^\circ\text{C}$			0.8					
$V_{CC} = 5\text{ V}$, $I_{OL} = 8\text{ mA}$			0.15	0.25		0.15	0.4		
High-level output voltage	$V_{CC} = 15\text{ V}$, $I_{OH} = -100\text{ mA}$		13	13.3		12.75	13.3	V	
		$T_A = -55^\circ\text{C to }125^\circ\text{C}$	12						
	$V_{CC} = 15\text{ V}$, $I_{OH} = -200\text{ mA}$			12.5			12.5		
	$V_{CC} = 5\text{ V}$, $I_{OH} = -100\text{ mA}$		3	3.3		2.75	3.3		
$T_A = -55^\circ\text{C to }125^\circ\text{C}$		2							
Supply current	Output low, No load	$V_{CC} = 15\text{ V}$		10	12		10	15	mA
		$V_{CC} = 5\text{ V}$		3	5		3	6	
	Output high, No load	$V_{CC} = 15\text{ V}$		9	10		9	13	
		$V_{CC} = 5\text{ V}$		2	4		2	5	

(1) This parameter influences the maximum value of the timing resistors R_A and R_B in the circuit of Figure 12. For example, when $V_{CC} = 5\text{ V}$, the maximum value is $R = R_A + R_B \approx 3.4\text{ M}\Omega$, and for $V_{CC} = 15\text{ V}$, the maximum value is $10\text{ M}\Omega$.

7.5 Operating Characteristics

 $V_{CC} = 5\text{ V to }15\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS ⁽¹⁾	SE555			NA555 NE555 SA555			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
Initial error of timing interval ⁽²⁾	Each timer, monostable ⁽³⁾	$T_A = 25^\circ\text{C}$	0.5	1.5 ⁽⁴⁾		1	3	%	
	Each timer, astable ⁽⁵⁾		1.5			2.25			
Temperature coefficient of timing interval	Each timer, monostable ⁽³⁾	$T_A = \text{MIN to MAX}$	30	100 ⁽⁴⁾		50		ppm/ °C	
	Each timer, astable ⁽⁵⁾		90			150			
Supply-voltage sensitivity of timing interval	Each timer, monostable ⁽³⁾	$T_A = 25^\circ\text{C}$	0.05	0.2 ⁽⁴⁾		0.1	0.5	%V	
	Each timer, astable ⁽⁵⁾		0.15			0.3			
Output-pulse rise time		$C_L = 15\text{ pF}$, $T_A = 25^\circ\text{C}$	100	200 ⁽⁴⁾		100	300	ns	
Output-pulse fall time		$C_L = 15\text{ pF}$, $T_A = 25^\circ\text{C}$	100	200 ⁽⁴⁾		100	300	ns	

- (1) For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
- (2) Timing interval error is defined as the difference between the measured value and the average value of a random sample from each process run.
- (3) Values specified are for a device in a monostable circuit similar to [Figure 9](#), with the following component values: $R_A = 2\text{ k}\Omega$ to $100\text{ k}\Omega$, $C = 0.1\text{ }\mu\text{F}$.
- (4) On products compliant to MIL-PRF-38535, this parameter is not production tested.
- (5) Values specified are for a device in an astable circuit similar to [Figure 12](#), with the following component values: $R_A = 1\text{ k}\Omega$ to $100\text{ k}\Omega$, $C = 0.1\text{ }\mu\text{F}$.

7.6 Typical Characteristics

Data for temperatures below -40°C and above 105°C are applicable for SE555 circuits only.

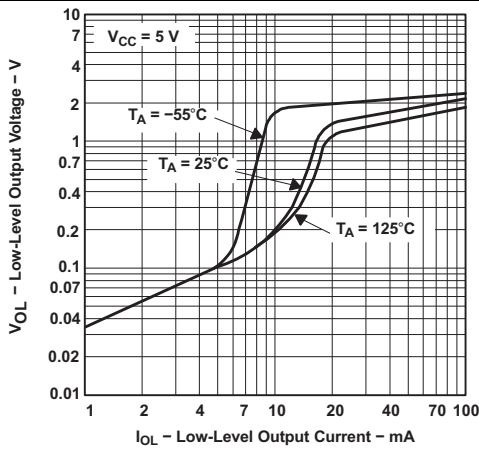


Figure 1. Low-Level Output Voltage vs Low-Level Output Current

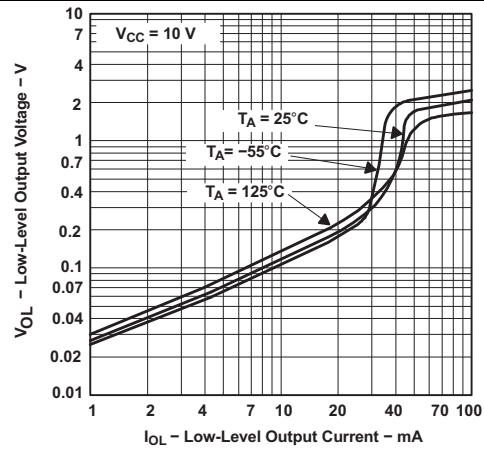


Figure 2. Low-Level Output Voltage vs Low-Level Output Current

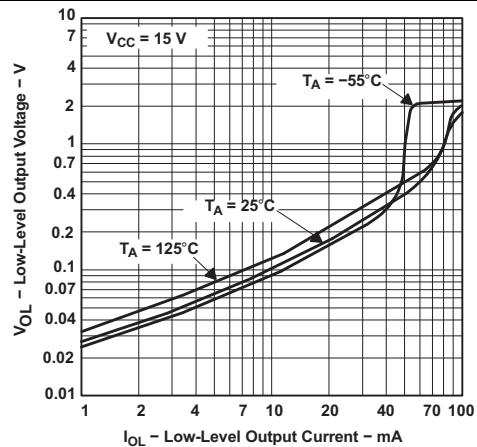


Figure 3. Low-Level Output Voltage vs Low-Level Output Current

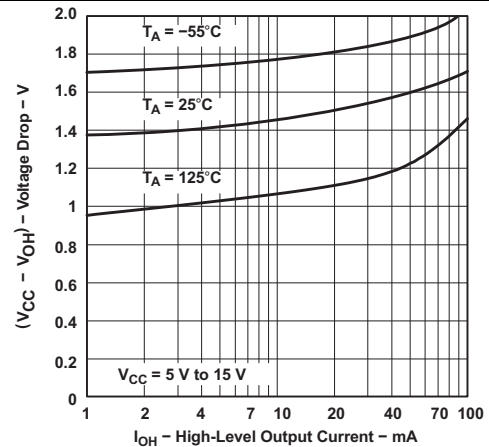


Figure 4. Drop Between Supply Voltage and Output vs High-Level Output Current

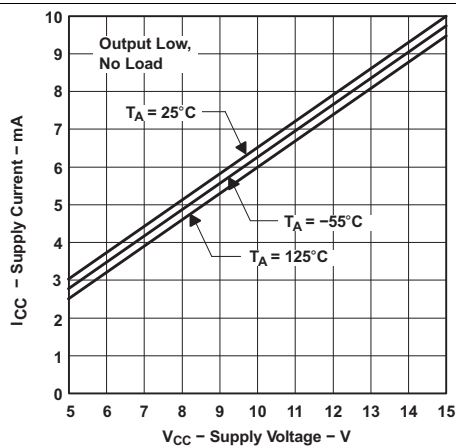


Figure 5. Supply Current vs Supply Voltage

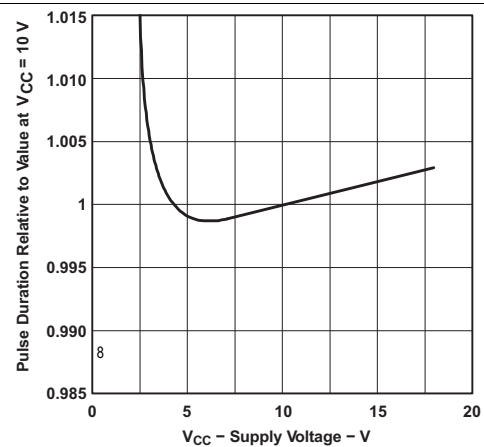


Figure 6. Normalized Output Pulse Duration (Monostable Operation) vs Supply Voltage

Typical Characteristics (continued)

Data for temperatures below -40°C and above 105°C are applicable for SE555 circuits only.

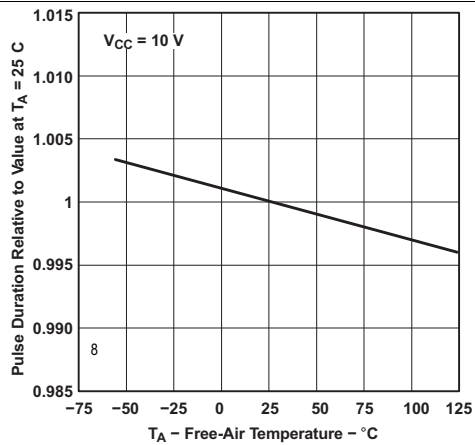


Figure 7. Normalized Output Pulse Duration (Monostable Operation) vs Free-Air Temperature

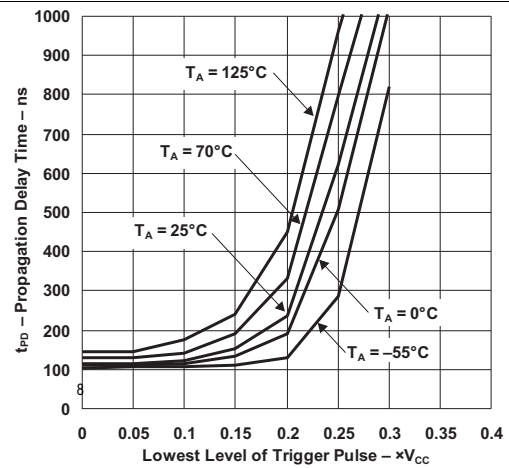


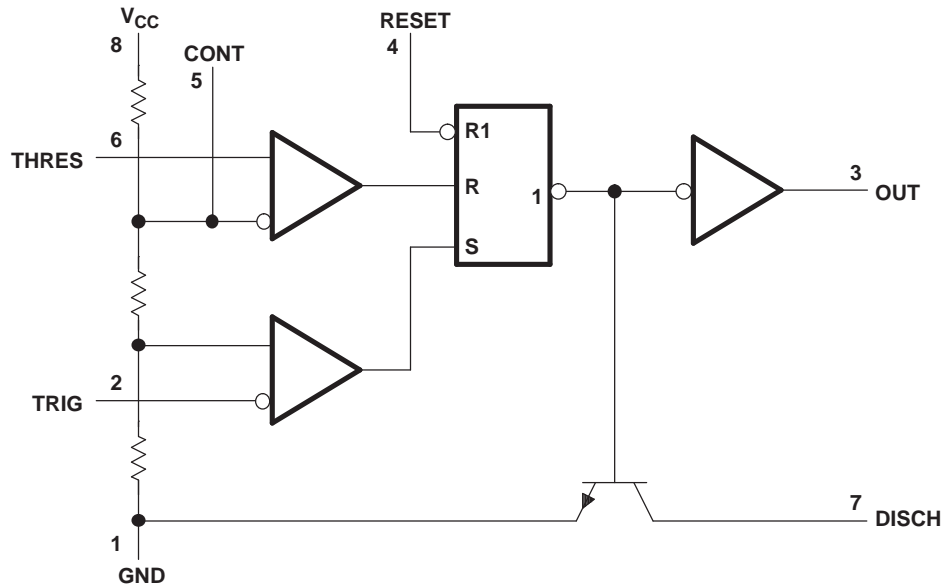
Figure 8. Propagation Delay Time vs Lowest Voltage Level of Trigger Pulse

8 Detailed Description

8.1 Overview

The xx555 timer is a popular and easy to use for general purpose timing applications from 10 μ s to hours or from < 1MHz to 100 kHz. In the time-delay or mono-stable mode of operation, the timed interval is controlled by a single external resistor and capacitor network. In the a-stable mode of operation, the frequency and duty cycle can be controlled independently with two external resistors and a single external capacitor. Maximum output sink and discharge sink current is greater for higher VCC and less for lower VCC.

8.2 Functional Block Diagram

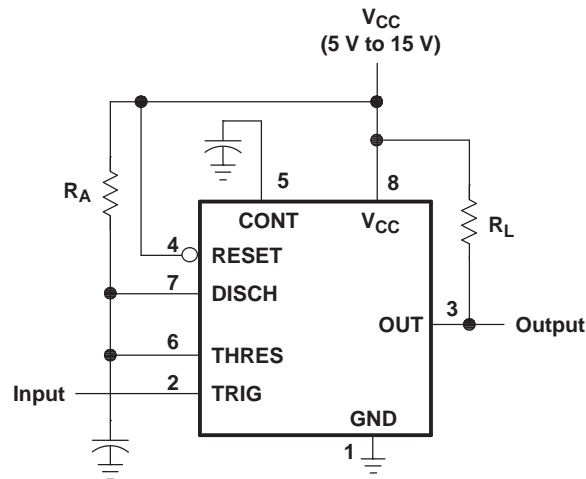


- A. Pin numbers shown are for the D, JG, P, PS, and PW packages.
- B. RESET can override TRIG, which can override THRES.

8.3 Feature Description

8.3.1 Mono-stable Operation

For mono-stable operation, any of these timers can be connected as shown in [Figure 9](#). If the output is low, application of a negative-going pulse to the trigger (TRIG) sets the flip-flop (\bar{Q} goes low), drives the output high, and turns off Q1. Capacitor C then is charged through R_A until the voltage across the capacitor reaches the threshold voltage of the threshold (THRES) input. If TRIG has returned to a high level, the output of the threshold comparator resets the flip-flop (\bar{Q} goes high), drives the output low, and discharges C through Q1.

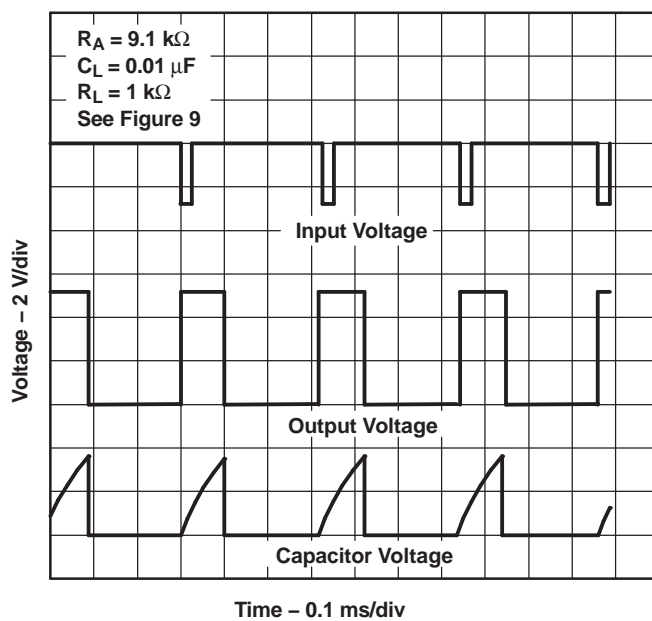
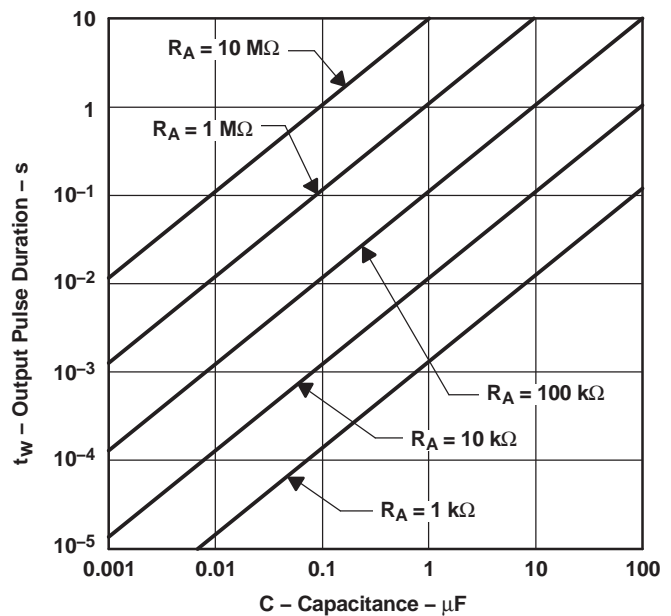
Feature Description (continued)


Pin numbers shown are for the D, JG, P, PS, and PW packages.

Figure 9. Circuit for Monostable Operation

Monostable operation is initiated when TRIG voltage falls below the trigger threshold. Once initiated, the sequence ends only if TRIG is high for at least $10\ \mu\text{s}$ before the end of the timing interval. When the trigger is grounded, the comparator storage time can be as long as $10\ \mu\text{s}$, which limits the minimum monostable pulse width to $10\ \mu\text{s}$. Because of the threshold level and saturation voltage of Q1, the output pulse duration is approximately $t_w = 1.1R_A C$. [Figure 11](#) is a plot of the time constant for various values of R_A and C . The threshold levels and charge rates both are directly proportional to the supply voltage, V_{CC} . The timing interval is, therefore, independent of the supply voltage, so long as the supply voltage is constant during the time interval.

Applying a negative-going trigger pulse simultaneously to RESET and TRIG during the timing interval discharges C and reinitiates the cycle, commencing on the positive edge of the reset pulse. The output is held low as long as the reset pulse is low. To prevent false triggering, when RESET is not used, it should be connected to V_{CC} .

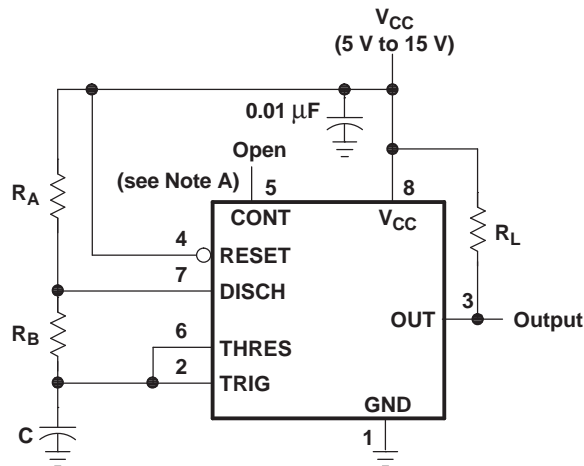

Figure 10. Typical Monostable Waveforms

Figure 11. Output Pulse Duration vs Capacitance

Feature Description (continued)

8.3.2 A-stable Operation

As shown in Figure 12, adding a second resistor, R_B , to the circuit of Figure 9 and connecting the trigger input to the threshold input causes the timer to self-trigger and run as a multi-vibrator. The capacitor C charges through R_A and R_B and then discharges through R_B only. Therefore, the duty cycle is controlled by the values of R_A and R_B .

This astable connection results in capacitor C charging and discharging between the threshold-voltage level ($\approx 0.67 \times V_{CC}$) and the trigger-voltage level ($\approx 0.33 \times V_{CC}$). As in the mono-stable circuit, charge and discharge times (and, therefore, the frequency and duty cycle) are independent of the supply voltage.



Pin numbers shown are for the D, JG, P, PS, and PW packages.
NOTE A: Decoupling CONT voltage to ground with a capacitor can improve operation. This should be evaluated for individual applications.

Figure 12. Circuit for Astable Operation

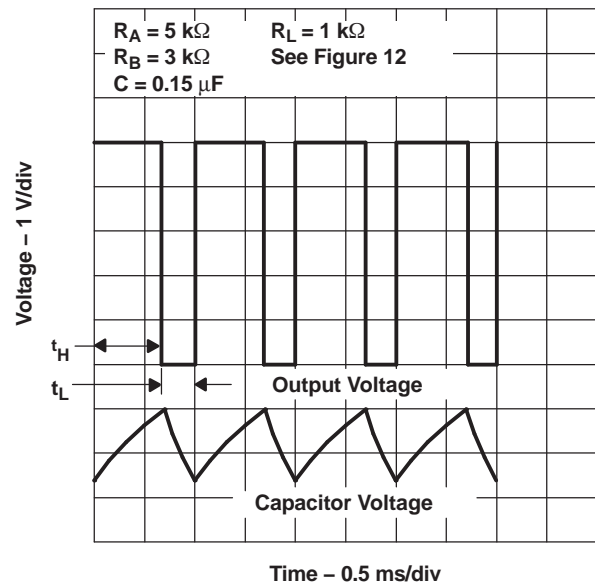


Figure 13. Typical Astable Waveforms

Figure 12 shows typical waveforms generated during astable operation. The output high-level duration t_H and low-level duration t_L can be calculated as follows:

$$t_H = 0.693(R_A + R_B)C \quad (1)$$

$$t_L = 0.693(R_B)C \quad (2)$$

Other useful relationships are shown below:

$$\text{period} = t_H + t_L = 0.693(R_A + 2R_B)C \quad (3)$$

$$\text{frequency} \approx \frac{1.44}{(R_A + 2R_B)C} \quad (4)$$

$$\text{Output driver duty cycle} = \frac{t_L}{t_H + t_L} = \frac{R_B}{R_A + 2R_B} \quad (5)$$

$$\text{Output waveform duty cycle} = \frac{t_H}{t_H + t_L} = 1 - \frac{R_B}{R_A + 2R_B} \quad (6)$$

$$\text{Low-to-high ratio} = \frac{t_L}{t_H} = \frac{R_B}{R_A + R_B} \quad (7)$$

Feature Description (continued)

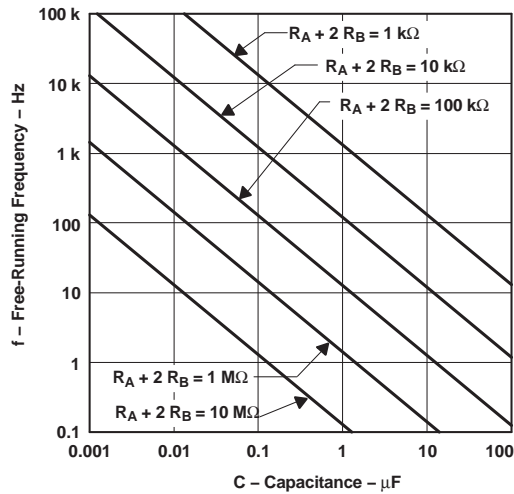


Figure 14. Free-Running Frequency

8.3.3 Frequency Divider

By adjusting the length of the timing cycle, the basic circuit of Figure 9 can be made to operate as a frequency divider. Figure 15 shows a divide-by-three circuit that makes use of the fact that re-triggering cannot occur during the timing cycle.

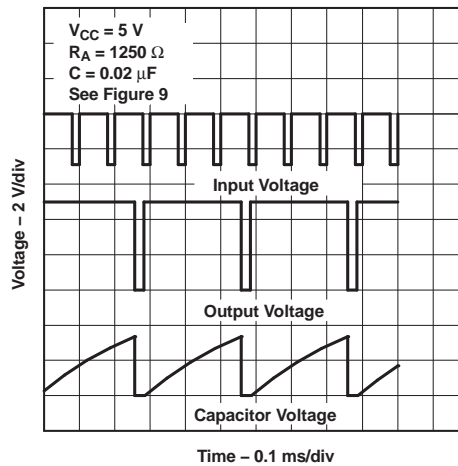


Figure 15. Divide-by-Three Circuit Waveforms

8.4 Device Functional Modes

Table 1. Function Table

RESET	TRIGGER VOLTAGE ⁽¹⁾	THRESHOLD VOLTAGE ⁽¹⁾	OUTPUT	DISCHARGE SWITCH
Low	Irrelevant	Irrelevant	Low	On
High	<1/3 V _{CC}	Irrelevant	High	Off
High	>1/3 V _{CC}	>2/3 V _{CC}	Low	On
High	>1/3 V _{CC}	<2/3 V _{CC}	As previously established	

(1) Voltage levels shown are nominal.

9 Applications and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

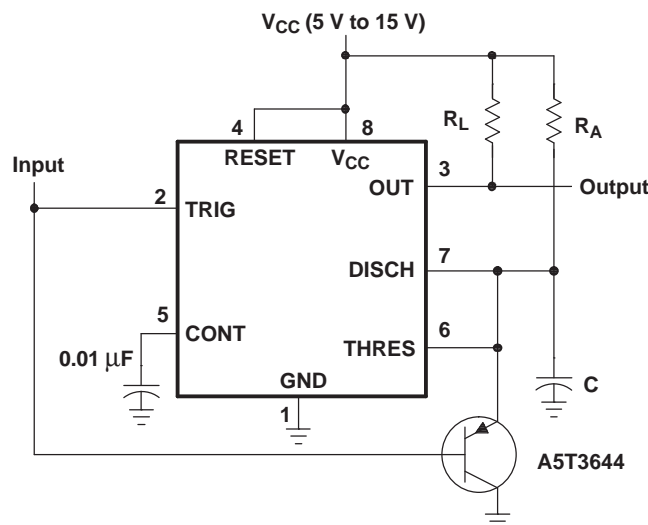
9.1 Application Information

The xx555 timer devices use resistor and capacitor charging delay to provide a programmable time delay or operating frequency. This section presents a simplified discussion of the design process.

9.2 Typical Applications

9.2.1 Missing-Pulse Detector

The circuit shown in [Figure 16](#) can be used to detect a missing pulse or abnormally long spacing between consecutive pulses in a train of pulses. The timing interval of the monostable circuit is re-triggered continuously by the input pulse train as long as the pulse spacing is less than the timing interval. A longer pulse spacing, missing pulse, or terminated pulse train permits the timing interval to be completed, thereby generating an output pulse as shown in [Figure 17](#).



Pin numbers shown are shown for the D, JG, P, PS, and PW packages.

Figure 16. Circuit for Missing-Pulse Detector

9.2.1.1 Design Requirements

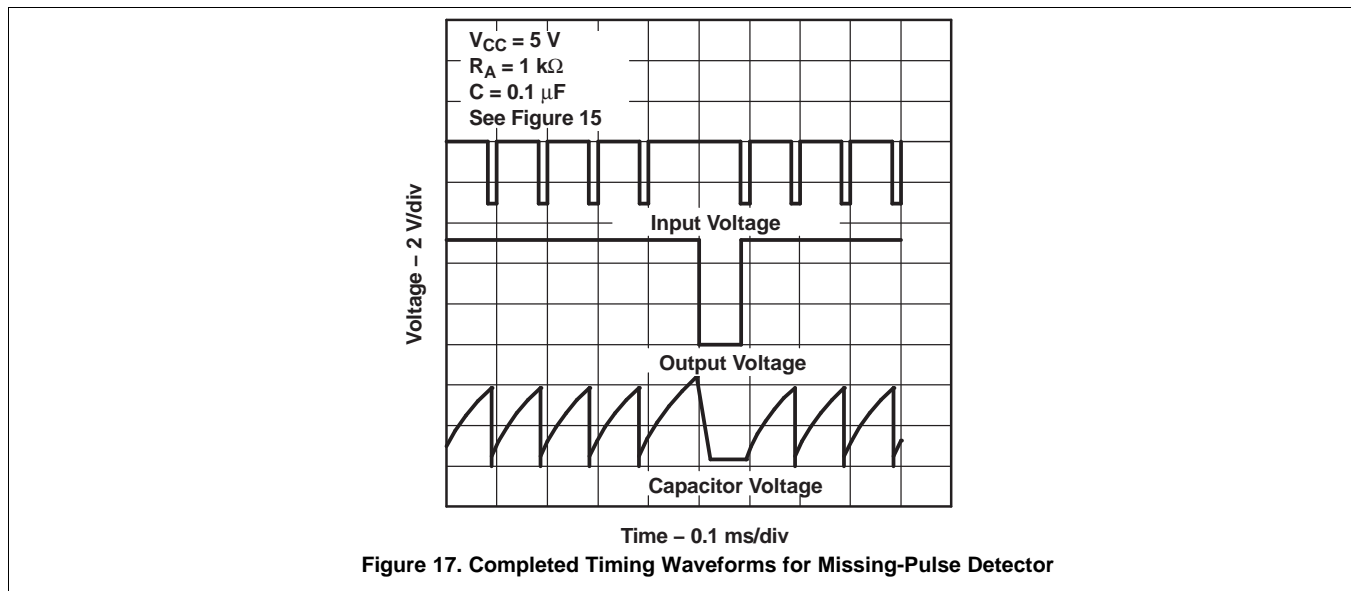
Input fault (missing pulses) must be input high. Input stuck low will not be detected because timing capacitor "C" will remain discharged.

9.2.1.2 Detailed Design Procedure

Choose R_A and C so that $R_A \times C > [\text{maximum normal input high time}]$. R_L improves V_{OH} , but it is not required for TTL compatibility.

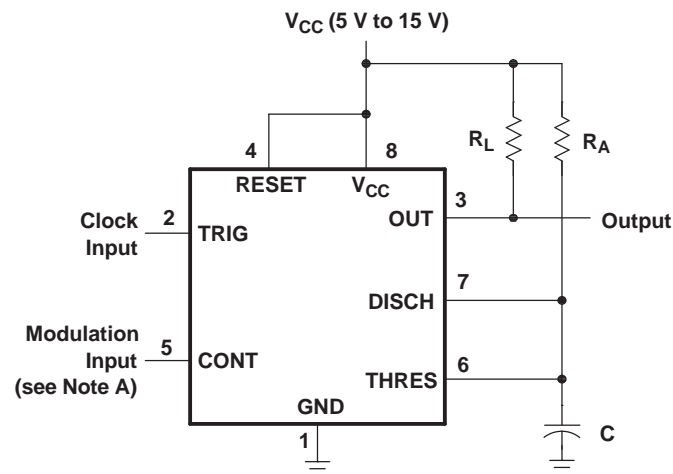
Typical Applications (continued)

9.2.1.3 Application Curves



9.2.2 Pulse-Width Modulation

The operation of the timer can be modified by modulating the internal threshold and trigger voltages, which is accomplished by applying an external voltage (or current) to CONT. Figure 18 shows a circuit for pulse-width modulation. A continuous input pulse train triggers the monostable circuit, and a control signal modulates the threshold voltage. Figure 19 shows the resulting output pulse-width modulation. While a sine-wave modulation signal is shown, any wave shape could be used.



NOTE A: The modulating signal can be direct or capacitively coupled to CONT. For direct coupling, the effects of modulation source voltage and impedance on the bias of the timer should be considered.

Figure 18. Circuit for Pulse-Width Modulation

Typical Applications (continued)

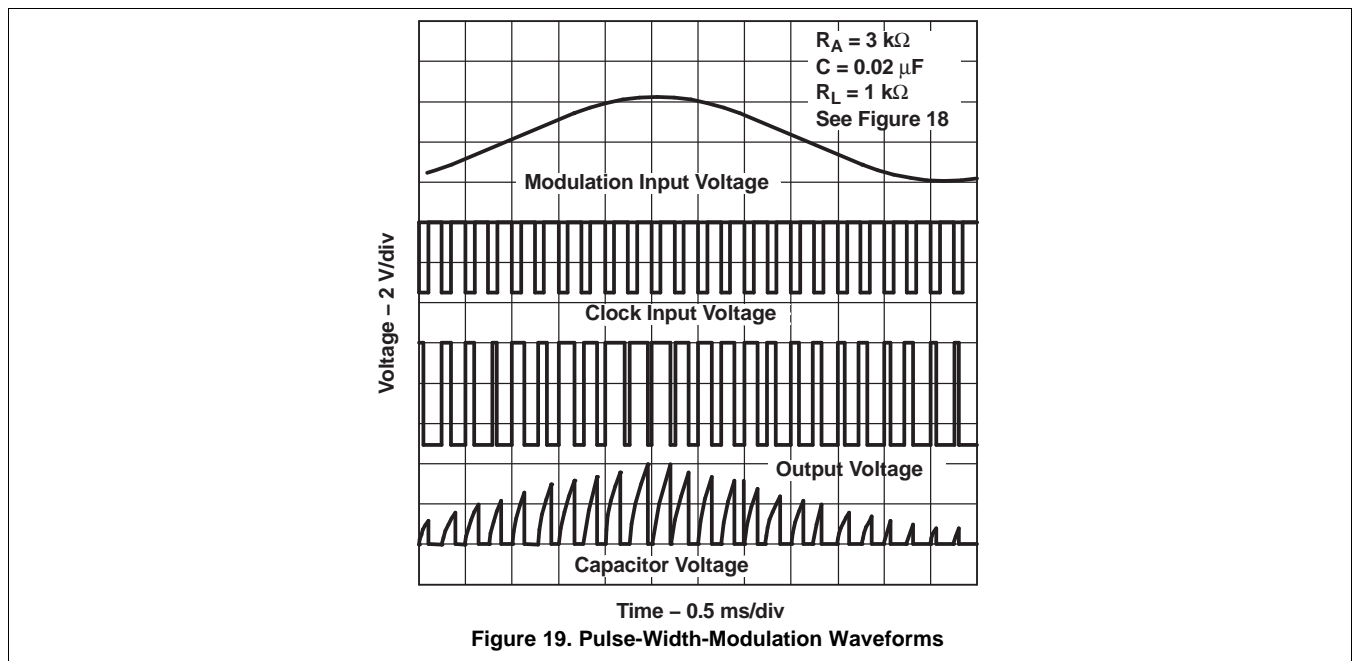
9.2.2.1 Design Requirements

Clock input must have V_{OL} and V_{OH} levels that are less than and greater than $1/3 V_{CC}$. Modulation input can vary from ground to V_{CC} . The application must be tolerant of a nonlinear transfer function; the relationship between modulation input and pulse width is not linear because the capacitor charge is based RC on an negative exponential curve.

9.2.2.2 Detailed Design Procedure

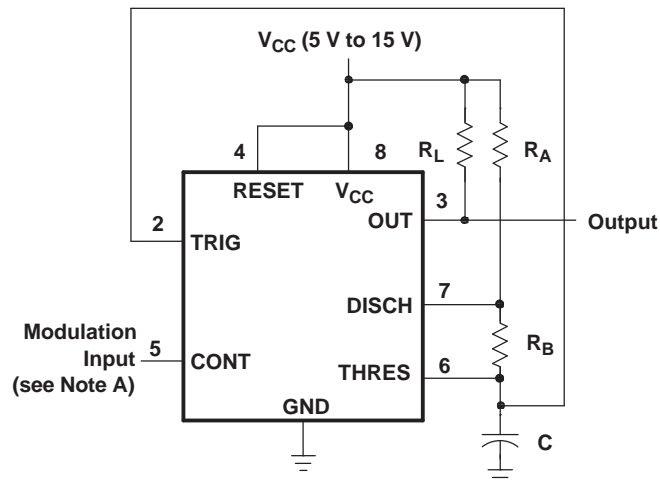
Choose R_A and C so that $R_A \times C = 1/4$ [clock input period]. R_L improves V_{OH} , but it is not required for TTL compatibility.

9.2.2.3 Application Curves



9.2.3 Pulse-Position Modulation

As shown in [Figure 20](#), any of these timers can be used as a pulse-position modulator. This application modulates the threshold voltage and, thereby, the time delay, of a free-running oscillator. [Figure 21](#) shows a triangular-wave modulation signal for such a circuit; however, any wave shape could be used.

Typical Applications (continued)


Pin numbers shown are for the D, JG, P, PS, and PW packages.

NOTE A: The modulating signal can be direct or capacitively coupled to CONT. For direct coupling, the effects of modulation source voltage and impedance on the bias of the timer should be considered.

Figure 20. Circuit for Pulse-Position Modulation

9.2.3.1 Design Requirements

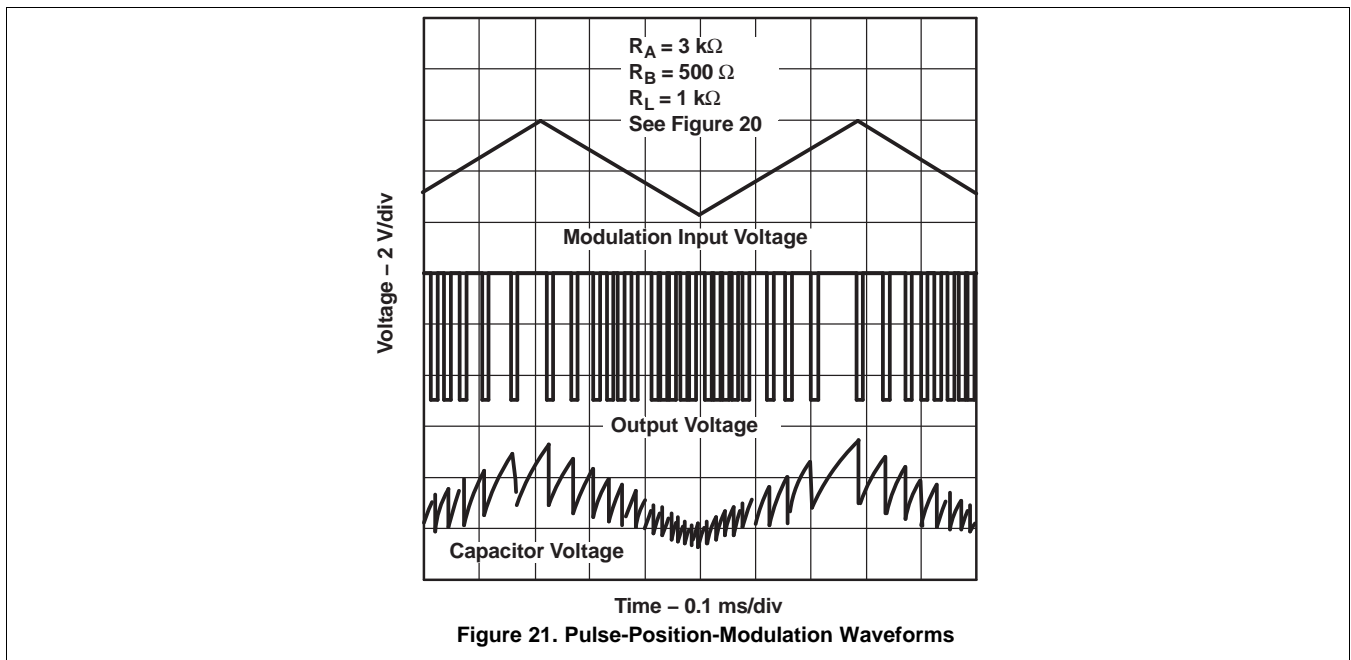
Both DC and AC coupled modulation input will change the upper and lower voltage thresholds for the timing capacitor. Both frequency and duty cycle will vary with the modulation voltage.

9.2.3.2 Detailed Design Procedure

The nominal output frequency and duty cycle can be determined using formulas in A-stable Operation section. R_L improves V_{OH}, but it is not required for TTL compatibility.

Typical Applications (continued)

9.2.3.3 Application Curves



9.2.4 Sequential Timer

Many applications, such as computers, require signals for initializing conditions during start-up. Other applications, such as test equipment, require activation of test signals in sequence. These timing circuits can be connected to provide such sequential control. The timers can be used in various combinations of astable or monostable circuit connections, with or without modulation, for extremely flexible waveform control. Figure 22 shows a sequencer circuit with possible applications in many systems, and Figure 23 shows the output waveforms.

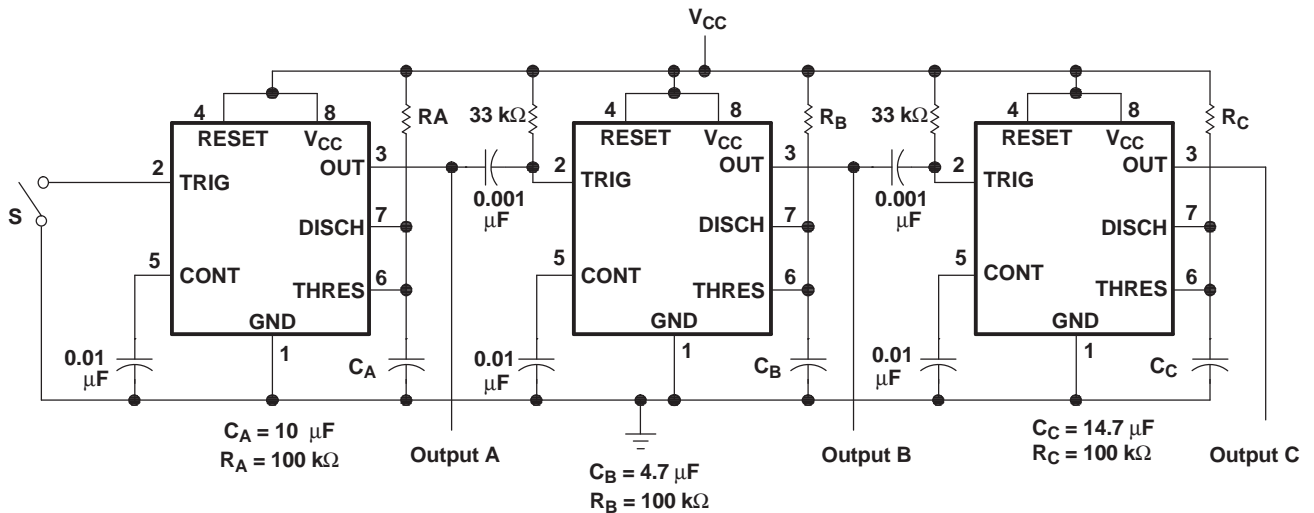


Figure 22. Sequential Timer Circuit

Typical Applications (continued)

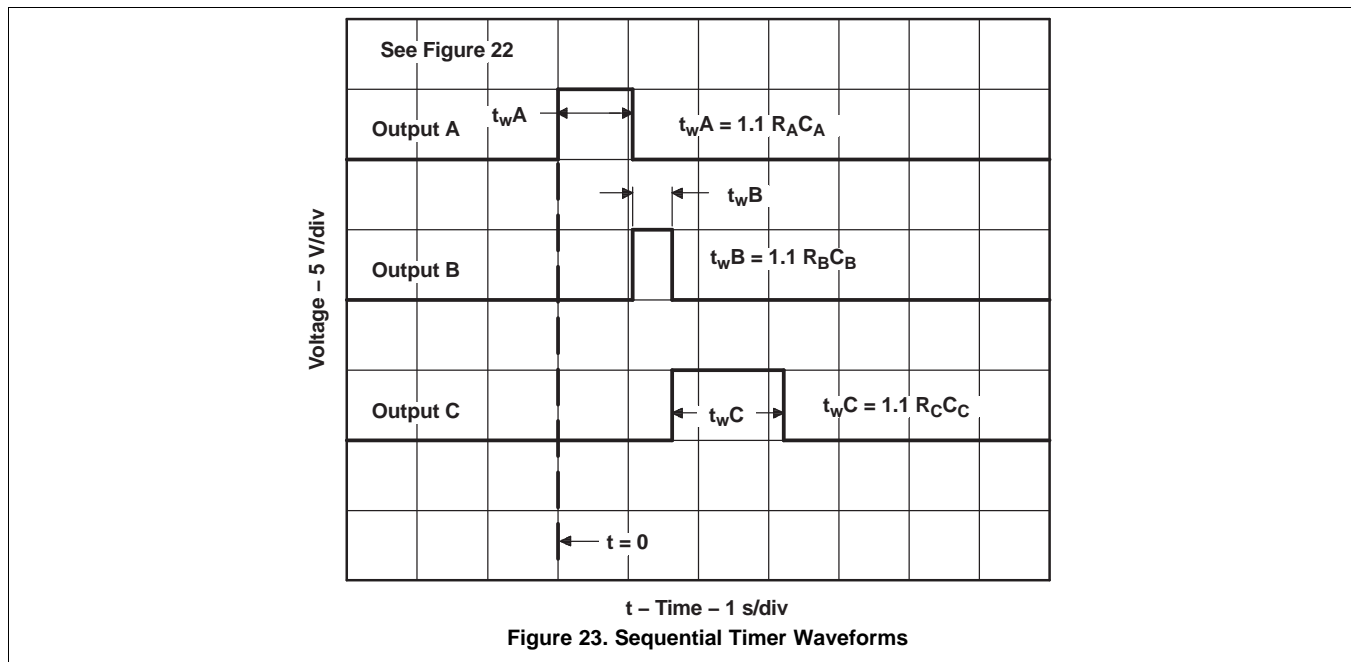
9.2.4.1 Design Requirements

The sequential timer application chains together multiple mono-stable timers. The joining components are the 33-kΩ resistors and 0.001-μF capacitors. The output high to low edge passes a 10-μs start pulse to the next monostable.

9.2.4.2 Detailed Design Procedure

The timing resistors and capacitors can be chosen using this formula. $t_w = 1.1 \times R \times C$.

9.2.4.3 Application Curves



10 Power Supply Recommendations

The devices are designed to operate from an input voltage supply range between 4.5 V and 16 V. (18 V for SE555). A bypass capacitor is highly recommended from VCC to ground pin; ceramic 0.1 μF capacitor is sufficient.

11 Device and Documentation Support

11.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 2. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
NA555	Click here	Click here	Click here	Click here	Click here
NE555	Click here	Click here	Click here	Click here	Click here
SA555	Click here	Click here	Click here	Click here	Click here
SE555	Click here	Click here	Click here	Click here	Click here

11.2 Trademarks

All trademarks are the property of their respective owners.

11.3 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

11.4 Glossary

[SLYZ022](#) — *TI Glossary*.

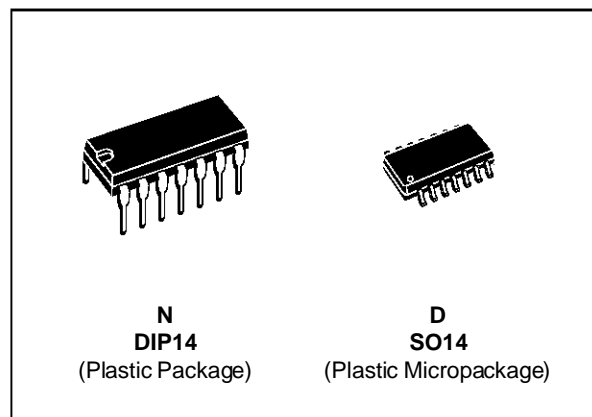
This glossary lists and explains terms, acronyms and definitions.

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

FOUR UA741 QUAD BIPOLAR OPERATIONAL AMPLIFIERS

- LOW SUPPLY CURRENT : 0.53mA/AMPLIFIER
- CLASS AB OUTPUT STAGE : NO CROSS-OVER DISTORTION
- PIN COMPATIBLE WITH LM124
- LOW INPUT OFFSET VOLTAGE : 1mV
- LOW INPUT OFFSET CURRENT : 2nA
- LOW INPUT BIAS CURRENT : 30nA
- GAIN BANDWIDTH PRODUCT : 1.3MHz
- HIGH DEGREE OF ISOLATION BETWEEN AMPLIFIERS : 120dB
- OVERLOAD PROTECTION FOR INPUTS AND OUTPUTS



ORDER CODES

Part Number	Temperature Range	Package	
		N	D
LM148	-55°C, +125°C	•	•
LM248	-40°C, +105°C	•	•
LM348	0°C, +70°C	•	•

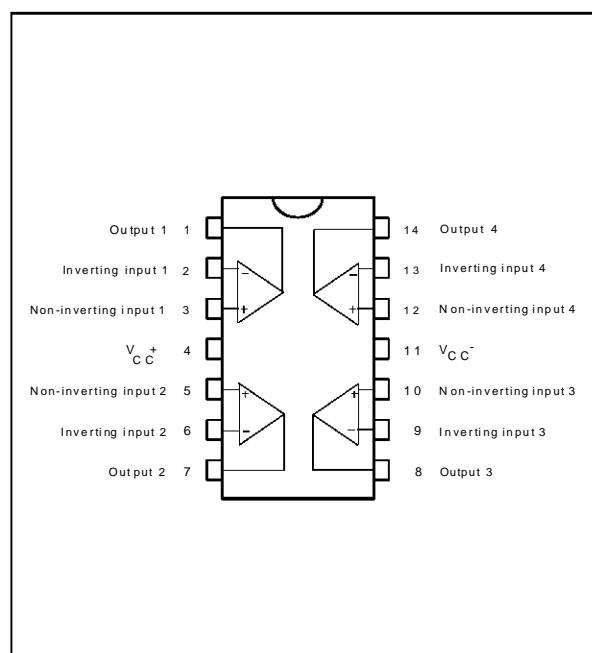
Example : LM348D

DESCRIPTION

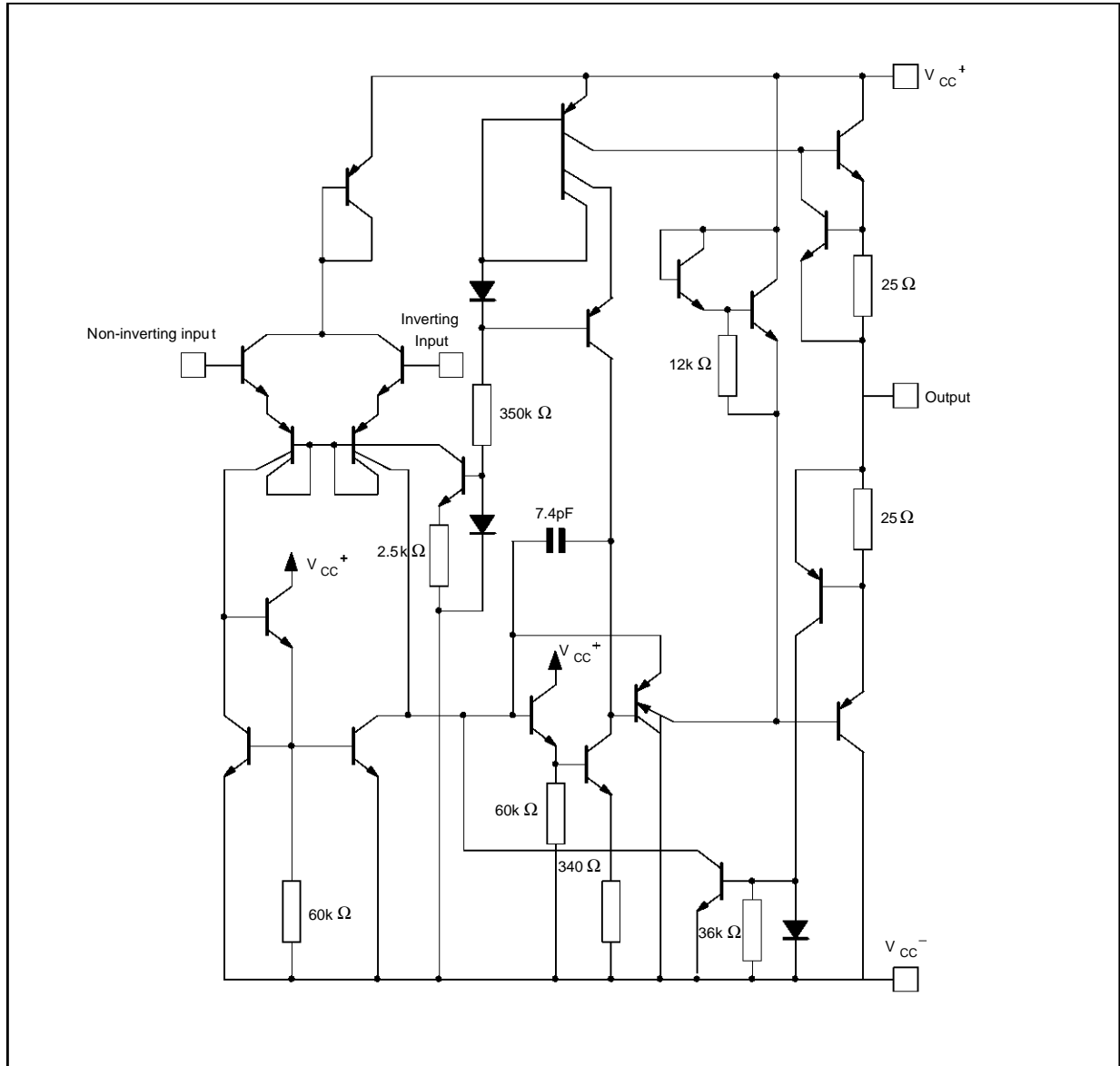
The LM148 consists of four independent, high gain internally compensated, low power operational amplifiers which have been designed to provide functional characteristics identical to those of the familiar UA741 operational amplifier. In addition the total supply current for all four amplifiers is comparable to the supply current of a single UA741 type op amp. Other features include input offset current and input bias current which are much less than those of a standard UA741. Also, excellent isolation between amplifiers has been achieved by independently biasing each amplifier and using layout techniques which minimize thermal coupling.

The LM148 can be used anywhere multiple UA741 type amplifiers are being used and in applications where amplifier matching or high packing density is required.

PIN CONNECTIONS (top view)



SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

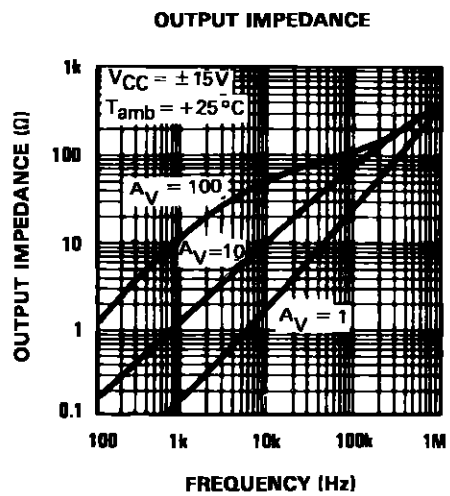
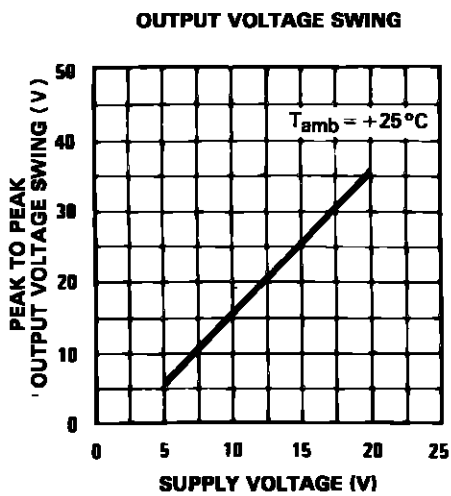
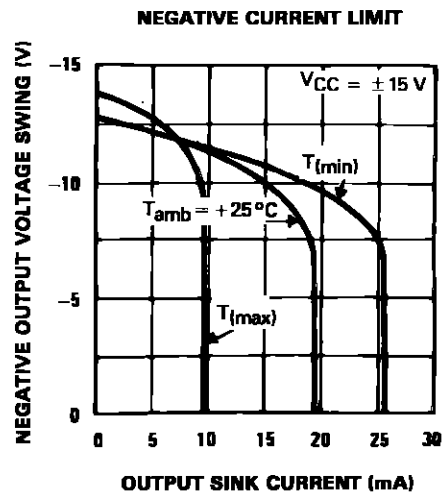
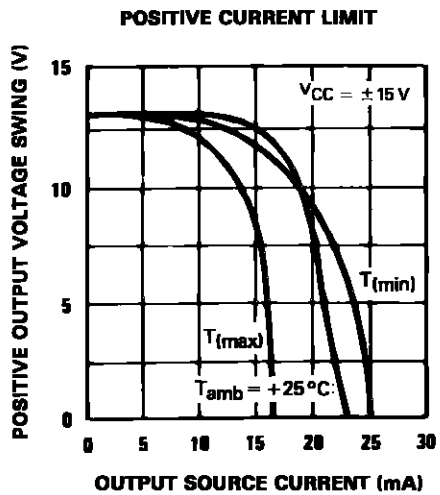
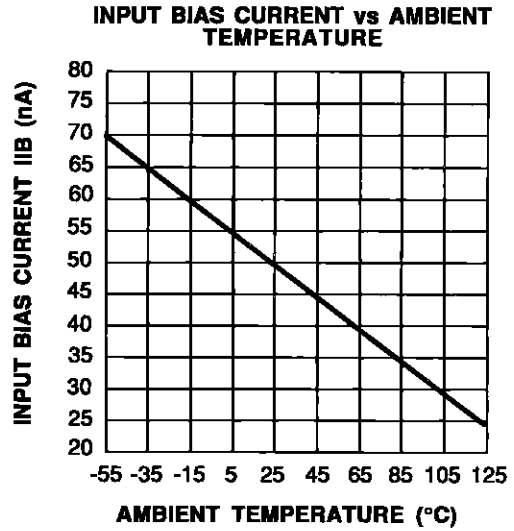
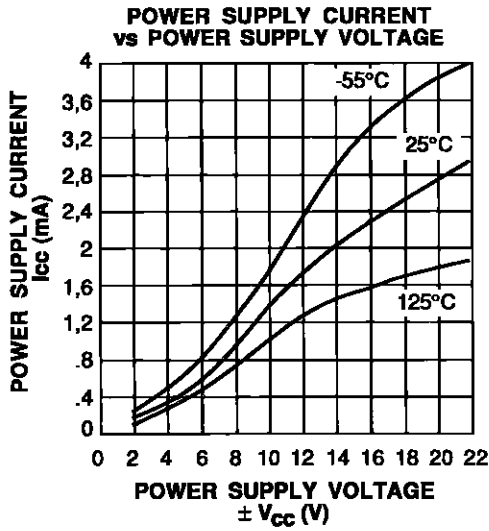
Symbol	Parameter	LM148	LM248	LM348	Unit
V_{CC}	Supply Voltage	± 22	± 22	± 22	V
V_{id}	Differential Input Voltage	± 44	± 44	± 44	V
V_i	Input Voltage (note 1)	± 22	± 22	± 22	V
P_{tot}	Power Dissipation	500	500	500	mW
	Output Short-circuit Duration (note 2)	Infinite			
T_{oper}	Operating Free-air Temperature Range	-55, +125	-40, +105	0, +70	°C
T_{stg}	Storage Temperature Range	-65, +150	-65, +150	-65, +150	°C

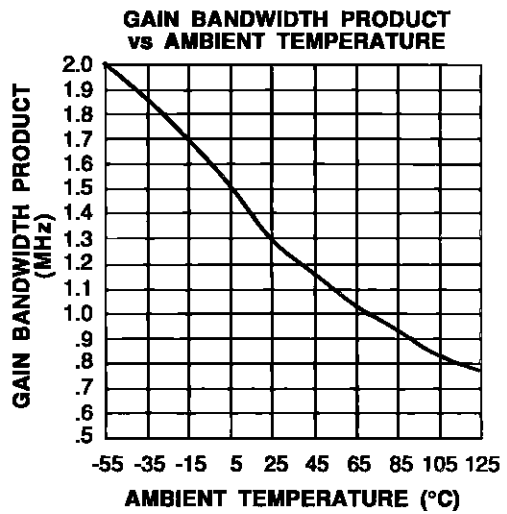
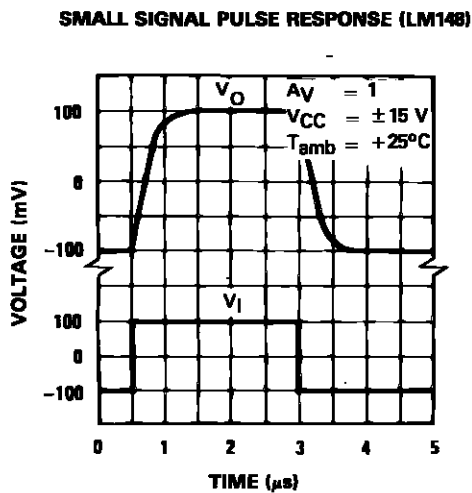
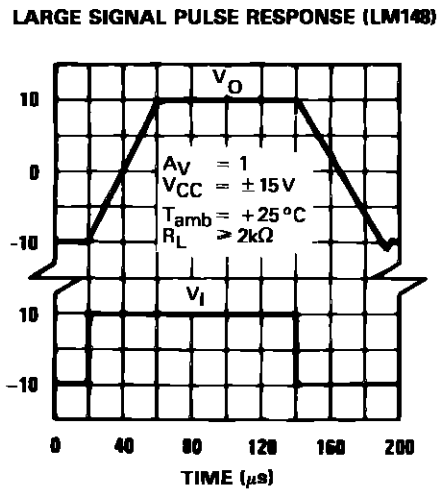
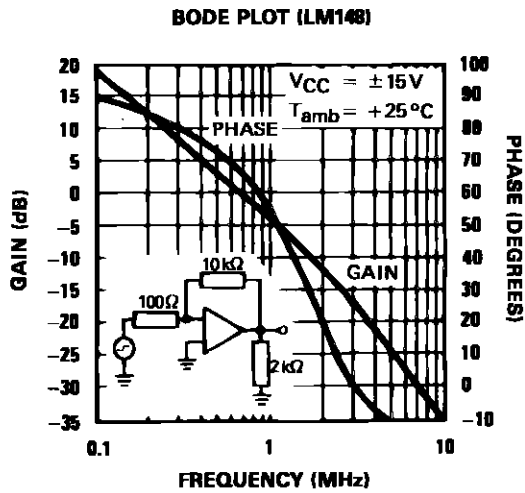
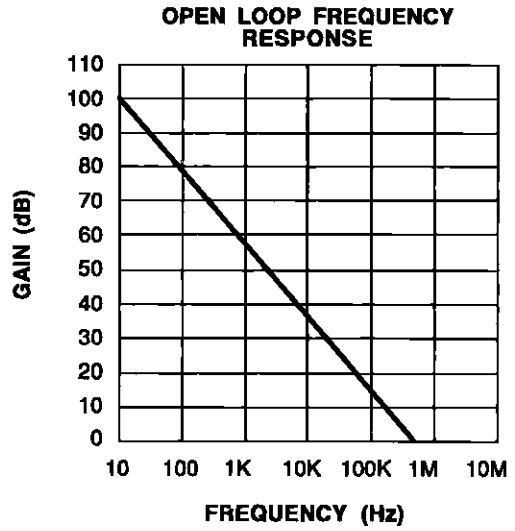
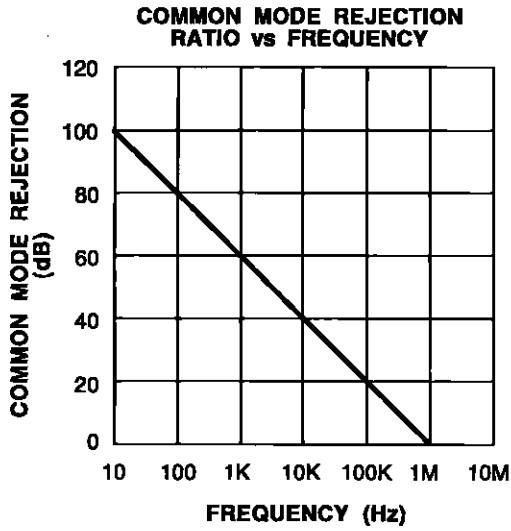
Notes : 1. For supply voltage less than maximum value, the absolute maximum input voltage is equal to the supply voltage.
 2. Any of the amplifier outputs can be shorted to ground indefinitely ; however, more than one should not be simultaneously shorted as the maximum junction temperature will be exceeded.

ELECTRICAL CHARACTERISTICS

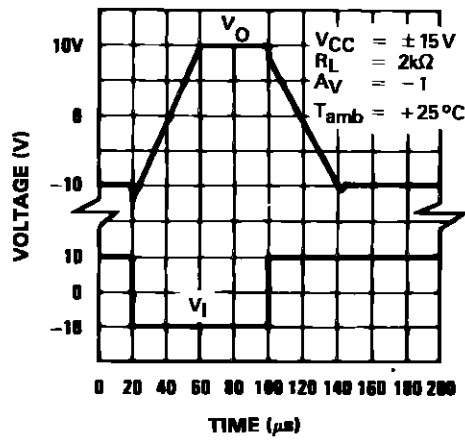
V_{CC} = ±15V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	LM148 - LM248 - LM348			Unit
		Min.	Typ.	Max.	
V _{io}	Input Offset Voltage (R _S ≤ 10kΩ) T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.}		1	5 6	mV
I _{io}	Input Offset Current T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.}		2	25 75	nA
I _{ib}	Input Bias Current T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.}		30	100 300	nA
A _{vd}	Large Signal Voltage Gain (V _o = ±10V, R _L = 2kΩ) T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.}	50 25	160		V/mV
SVR	Supply Voltage Rejection Ratio (R _S ≤ 10kΩ) T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.}	77 77	100		dB
I _{cc}	Supply Current, all Amp, no Load T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.}		2.1	3.6 4.8	mA
V _{icm}	Input Common Mode Voltage Range T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.}	±12 ±12			V
CMR	Common Mode Rejection Ratio (R _S ≤ 10kΩ) T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.}	70 70	110		dB
I _{os}	Output Short-circuit Current T _{amb} = 25°C	10	25	35	mA
± V _{opp}	Output Voltage Swing T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.} R _L = 10kΩ R _L = 2kΩ R _L = 10kΩ R _L = 2kΩ	12 10 12 10	13 12		V
SR	Slew Rate (V _I = ±10V, R _L = 10kΩ, C _L = 100pF, unity Gain)	0.25	0.5		V/μs
t _r	Rise Time (V _I = ±10V, R _L = 10kΩ, C _L = 100pF, unity Gain)		0.3		μs
K _{Ov}	Overshoot (V _I = ±10V, R _L = 10kΩ, C _L = 100pF, unity Gain)		5		%
R _I	Input Resistance	0.8	2.5		MΩ
GBP	Gain Bandwidth Product (V _I = 10 mV, R _L = 10kΩ, C _L = 100pF, f = 100kHz)	0.7	1.3		MHz
THD	Total Harmonic Distortion (f = 1kHz, A _v = 20dB, R _L = 10kΩ, C _L = 100pF, V _o = 2V _{pp})		0.08		%
e _n	Equivalent Input Noise Voltage (f = 1kHz, R _S = 100Ω)		40		$\frac{nV}{\sqrt{Hz}}$
V _{o1} /V _{o2}	Channel Separation		120		dB

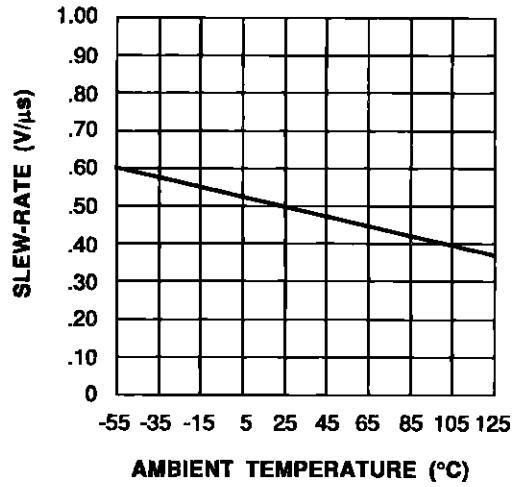




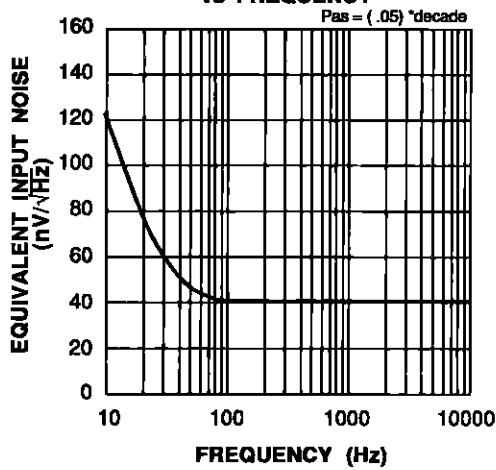
INVERTING LARGE SIGNAL PULSE RESPONSE (LM148)



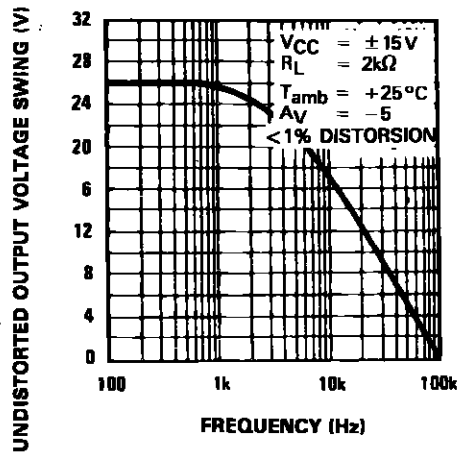
SLEW-RATE vs TEMPERATURE



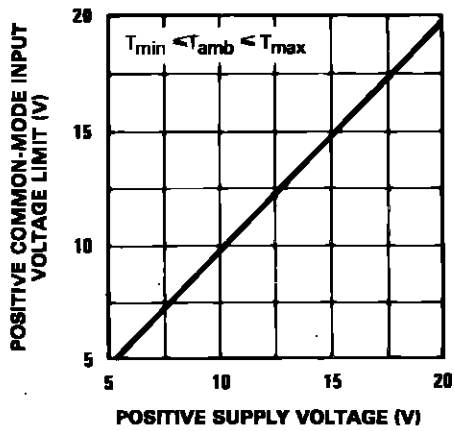
EQUIVALENT INPUT NOISE vs FREQUENCY



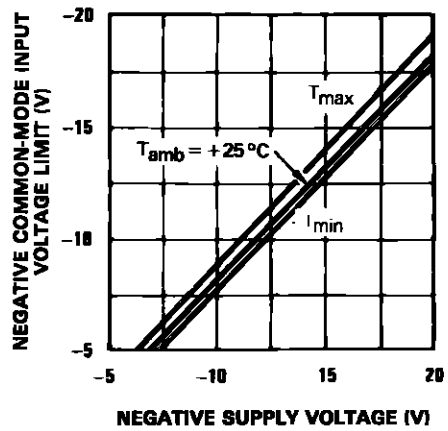
UNDISTORTED OUTPUT VOLTAGE SWING

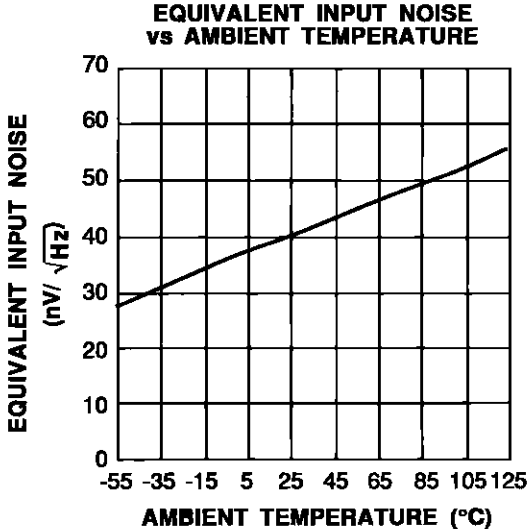
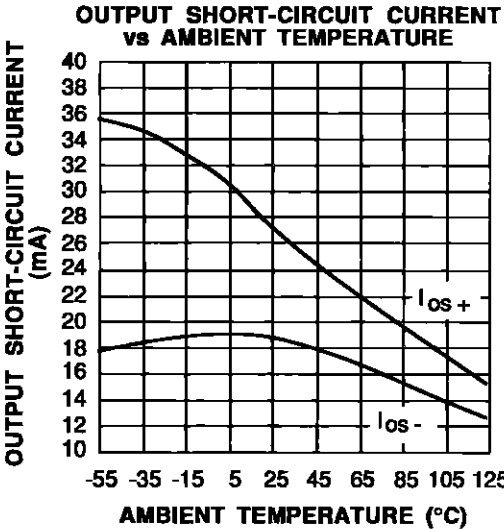


POSITIVE COMMON-MODE INPUT VOLTAGE LIMIT

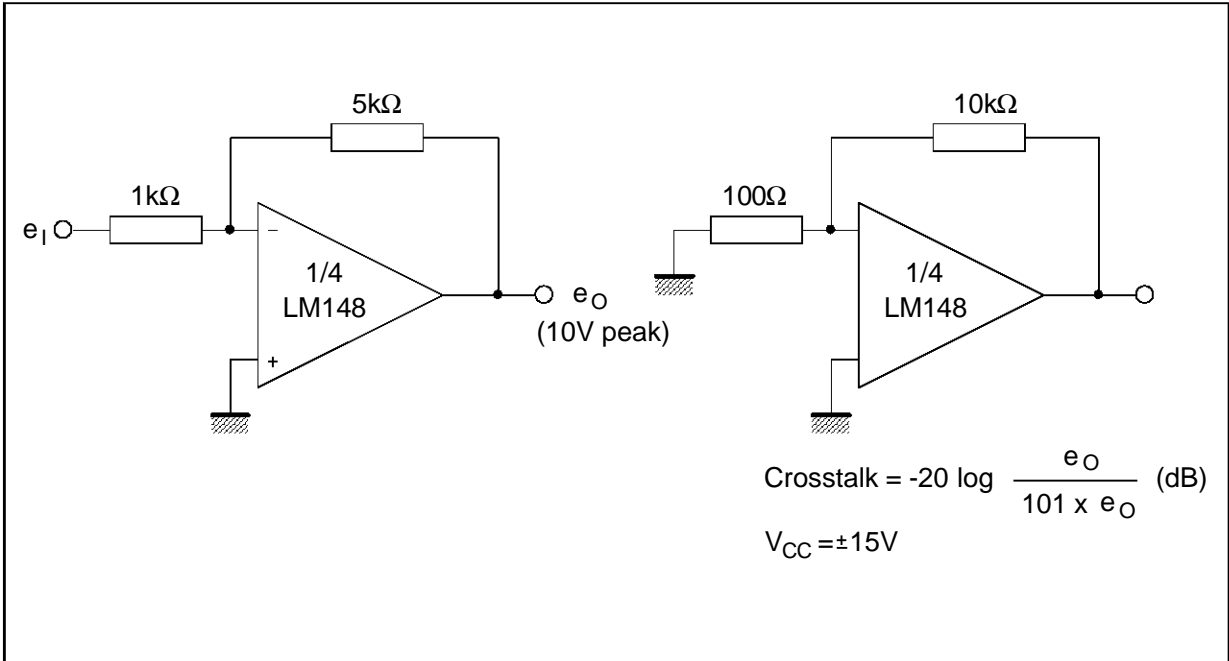


NEGATIVE COMMON-MODE INPUT VOLTAGE LIMIT

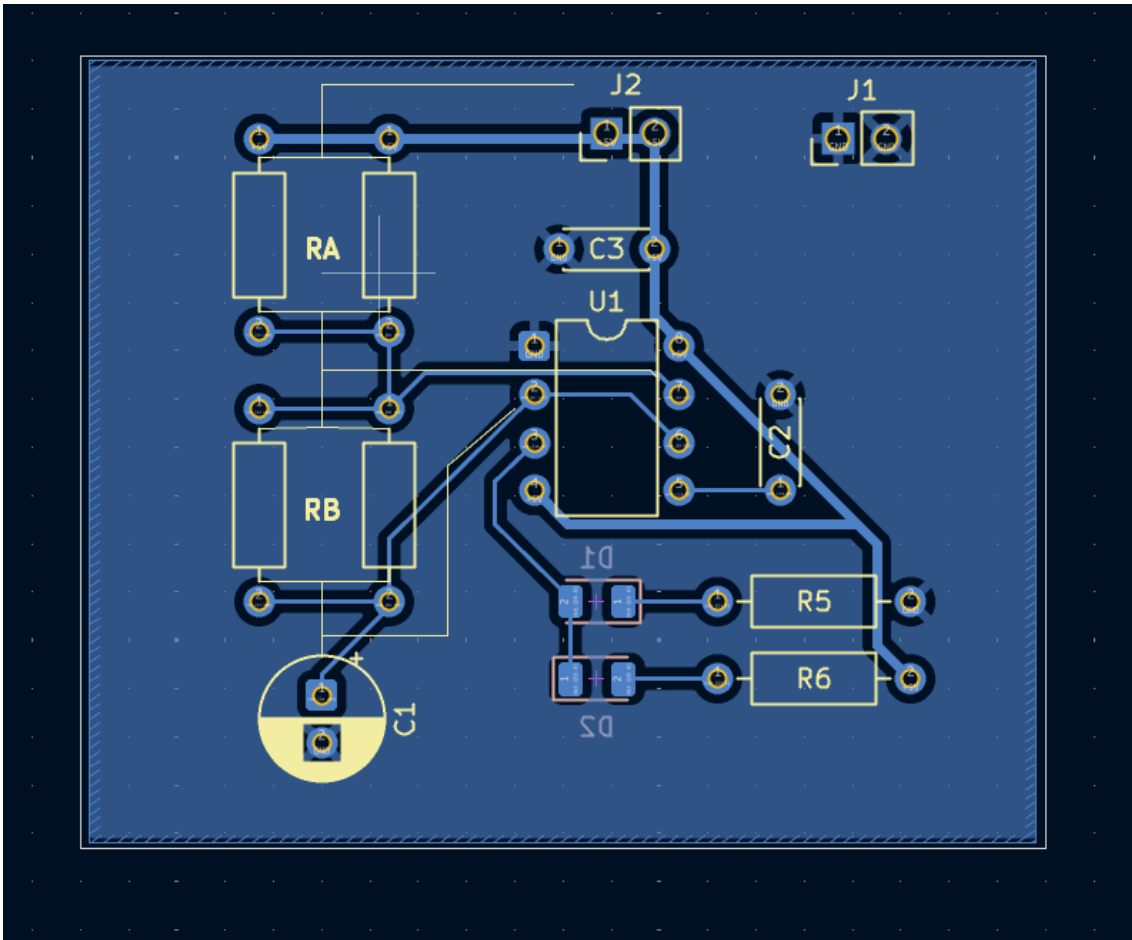




TEST CIRCUITS



PCB del examen



COMPONENTES SUMINISTRADOS EN LAS CAJAS DEL EXAMEN

Caja 1:

- 1 zócalo de 8 pines
- 1 integrado NE555P
- 1 condensador electrolítico de 100 uF
- 2 condensadores de 10nF
- 2 condensadores de 100nF
- 4 resistencias de 12K Ω
- 4 resistencias de 22K Ω
- 4 resistencias de 33K Ω
- 2 resistencias de 180 Ω
- 2 resistencias de 220 Ω
- 2 resistencias de 270 Ω
- 2 pines dobles
- 2 led SMD
- Placa electrónica

Caja 2:

- 1 resistencia de $68\text{K}\Omega$
- 1 resistencia de $82\text{K}\Omega$
- 1 resistencia de $39\text{K}\Omega$
- 1 resistencia de $10\text{K}\Omega$
- 1 resistencia de 220Ω
- 2 potenciómetros de $1\text{M}\Omega$
- 1 Amp. Op. LM348
- 1 diodo 1N4148
- 1 diodo Zener BZX55C3V3