LM324S

■ INTRODUCTION:

The LM324S consists of four independent, high gain and internally frequency compensated operational amplifiers, it is specifically designed to operate from a single power supply. Operation from split power sup-ply is also possible and the low power supply current drain is independent of the magnitude of the power supply voltages

■ APPLICATIONS:

- Digital Still and Video Cameras
- Portable Applications Using Single Li+ Cell
- Bus Powered USB Hosts
- USB Hosts Without Native 5-V Supplies
- Portable Audio Players
- LCD Bias Supplies
- White LED Lighting
- Wireless Handsets
- GPS Receivers
- Personal Medical Products

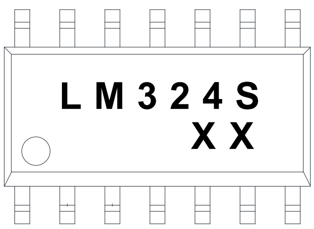
■ FEATURES:

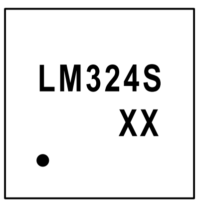
- Internally Frequency Compensated for Unity Gain
- Large Voltage Gain: 100dB (Typical)
- Low Input Bias Current: 45nA (Typical)
- Low Input Offset Voltage: 2mV (Typical)
- Low Supply Current: 0.6mA (Typical)
- Wide Power Supply Voltage Range:3V to 24V
- Input Common Mode Voltage Range Includes Ground
- Large Output Voltage Swing: 0V to V_{CC}-1.5V
- Power Drain Suitable for Battery Operation

■ AVAILABLE PACKAGE:

PART NUMBER	PACKAGE
LM324S-PHN	SOP14
LM324S-QCN	QFNWB3×3-16L

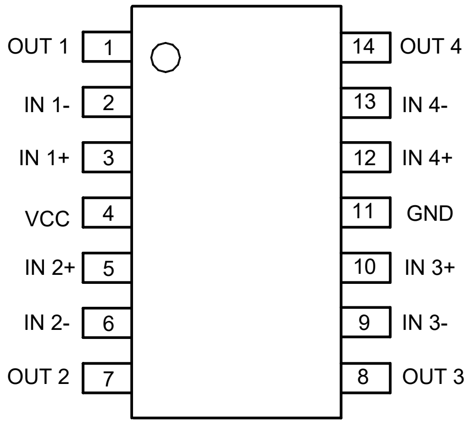
■ MARKING



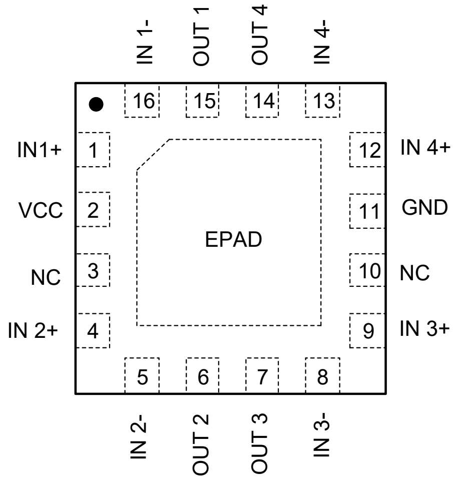


"**LM324S**": Device number.
"**XX**": Code, indicates weekly record information.

■ PIN CONFIGURATION:



SOP14



QFNWB3×3-16L

PIN NAME	LM324S-PHN	LM324S-QCN	I / O	DESCRIPTION
	SOP14	QFNWB3×3-16L		
OUT 1	1	15	O	Output of the operational amplifier 1.
IN 1-	2	16	I	Negative input of the operational amplifier 1.
IN 1+	3	1	I	Positive input of the operational amplifier 1.
VCC	4	2	-	Pow supply.
IN 2+	5	4	I	Positive input of the operational amplifier 2.
IN 2-	6	5	I	Negative input of the operational amplifier 2.
OUT 2	7	6	O	Output of the operational amplifier 2.
OUT 3	8	7	O	Output of the operational amplifier 3
IN 3-	9	8	I	Negative input of the operational amplifier 3.
IN 3+	10	9	I	Positive input of the operational amplifier 3.
GND	11	11	-	Ground.
IN 4+	12	12	I	Positive input of the operational amplifier 4.
IN 4-	13	13	I	Negative input of the operational amplifier 4.
OUT 4	14	14	O	Output of the operational amplifier 4.
NC	-	3,10	-	Do not connect.
EPAD	-	-	-	Exposed pad.Connected to GND or left floating.

ABSOLUTE MAXIMUM RATINGS

(over operating ambient temperature range, unless otherwise specified)[(1)]

CHARACTERISTIC	SYMBOL	VALUE	UNIT
Maximum power supply	V_{CC}	30	V
Maximum differential input range[(2)]	V_{ID}	-30 ~ 30	V
Maximum input range (either input)	V_{IN}	-0.3 ~ 30	V
Duration of output short circuit (one amplifier) to ground (or below) at T_A = 25°C, V_S ≤ 15V	t_{SC}	Continuous[(3)]	s
Maximum junction temperature	$T_{J\ MAX}$	125	°C
Storage temperature	T_{stg}	-55 ~ 125	°C
Soldering temperature & time	T_{solder}	260°C, 10s	-

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum rated conditions for extended periods may affect device reliability.

(2) Differential voltages are at IN+, with respect to IN−.

(3) Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction. A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

RECOMMEND OPERATING CONDITION

PARAMETER	SYMBOL	MIN.	NOM.	MAX.	UNIT
Power supply range	V_{CC}	3.0	-	24	V
Common-mode voltage range	V_{CM}	0	-	V_{CC} -1.5	V
Operating ambient temperature	T_A	0	-	70	°C

THERMAL INFORMATION

THERMAL METRIC[(4)]	SYMBOL	LM324S	UNIT
		SOP14	
Junction-to-ambient thermal resistance	$R_{\Theta JA}$	160.0	°C/W
Junction-to-case thermal resistance	$R_{\Theta JC}$	45.0	°C/W
Reference maximum power dissipation (continuous)	$P_{D\ Ref}$	0.65	W

(4) T_A = 25°C, measured on evaluation board with 1oz. copper traces of minimum pad size, all device outputs were active.

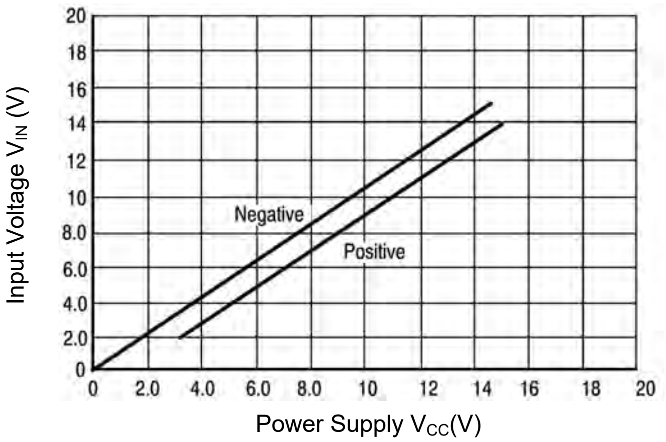
ELECTRICAL CHARACTERISTICS

LM324S (for V_{CC} = 5.0V, V_{CM} = 0V, T_A = 25°C, unless otherwise specified)

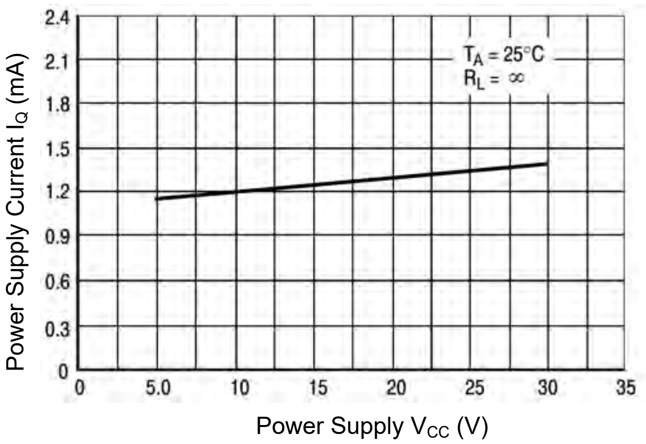
CHARACTERISTIC	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Offset Voltage							
Input offset voltage	V_{OS}	V_{CC} = 5.0V, V_{CM} = 0V, V_{OUT} = 1.4V		-	±2.0	±7.0	mV
Input offset voltage vs power supply (ΔV_{IO} / ΔV_{CC})	PSRR	V_{CC} = 5.0 to 24V		65	100	-	dB
Channel Separation	CS	V_{CC} = 5.0 to 24V		0	120	-	dB
Input Voltage Range							
Common-mode voltage range	V_{CM}	V_{CC} = 5.0 to 24V		V-	-	V_{CC} - 1.5	V
Common-mode rejection ratio	CMRR	-		65	90	-	dB
Power Supply							
Quiescent current per amplifier	I_Q	R_L = ∞	V_{CC} = 5.0V	-	0.6	2.0	mA
			V_{CC} = 24V	-	1.5	3.0	mA
Input Bias Current							
Input bias current	I_{IB}	V_{CM} = 0V, V_{OUT} = 1.4V		-	±45	±250	nA
Input offset current	I_{OS}	V_{CM} = 0V, V_{OUT} = 1.4V		-	±3.0	±50	nA
Output							
Voltage output swing from rail	V_{OUT}	V_{CC} = 5V, R_L = 10kΩ		0	-	V_{CC} - 1.5	V
Output current	I_{OUT}	V_{IN+} = 1V, V_{IN-} = 0V	Source	20	40	-	mA
		V_{IN+} = 0V, V_{IN-} = 1V	Sink	10	20	-	mA
Open-loop Gain							
Open-loop voltage gain	A_{OL}	V_{CC} = 15V, R_L ≥ 2kΩ		25	100	-	mV / V
Frequency Response							
Gain bandwidth product	GBW	-		-	1.2	-	MHz
Slew rate	SR	G = ±1		-	0.5	-	V / μs

■ TYPICAL CHARACTERISTICS

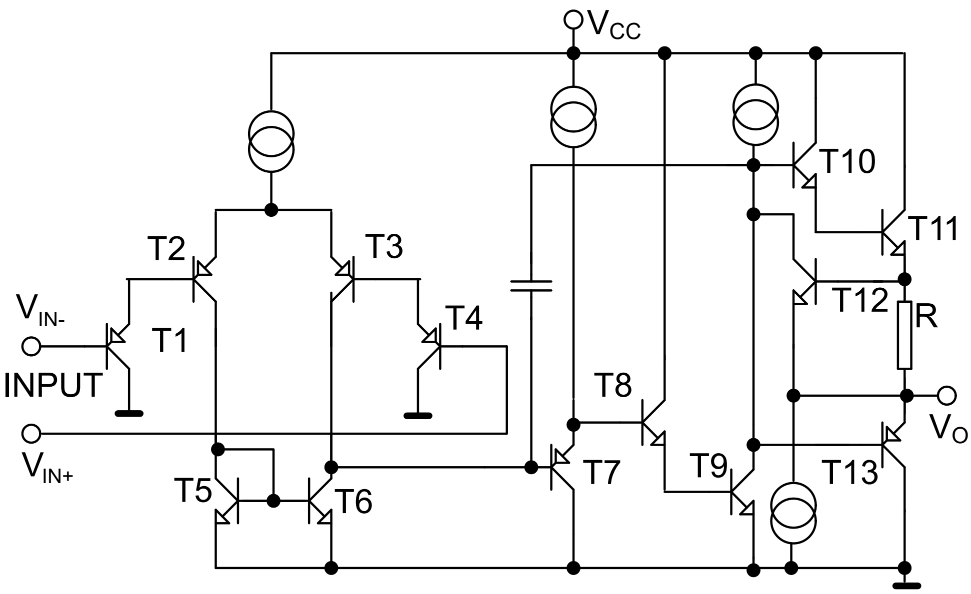
Input Voltage Range



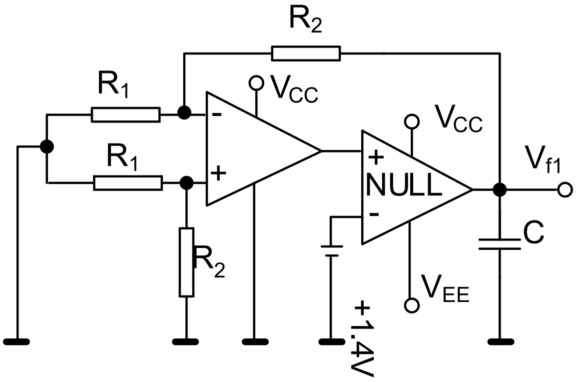
Power Supply Current



■ FUNCTIONAL BIOCK DIAGRAM

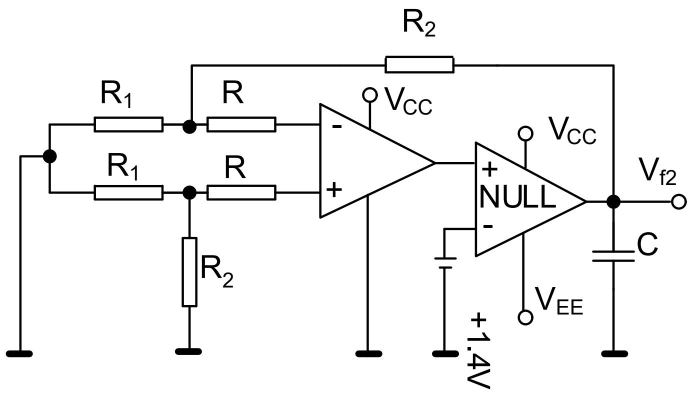


■ TEST CIRCUITS



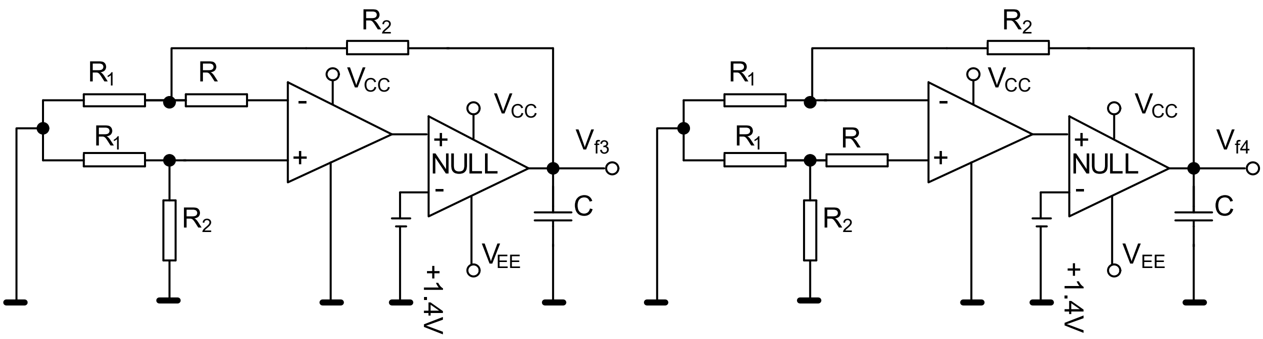
$V_{IO} = V_{f1} / (1+R_2/R_1)$

V_{OS} test circuits



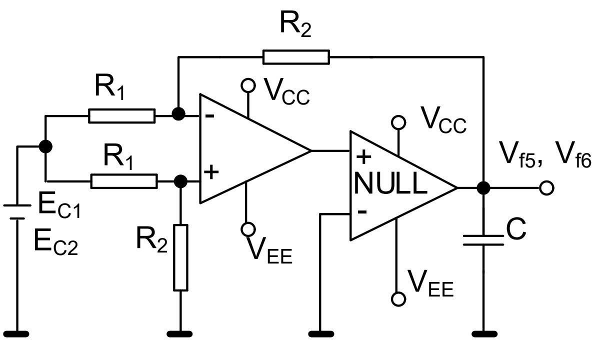
$I_{IO} = (V_{f2}-V_{f1}) / R (1+R_2/R_1)$

I_{IO} test circuits



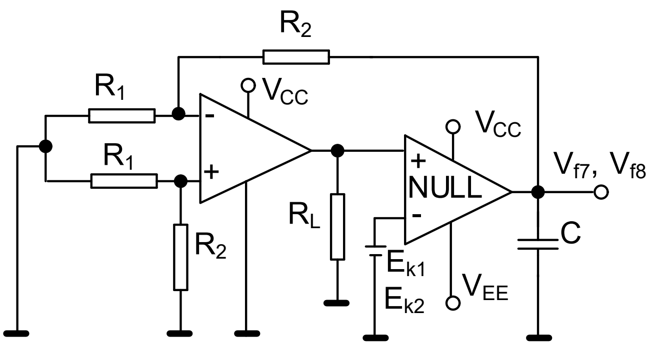
$I_{BA} = (V_{f4}-V_{f3}) / 2R (1+R_2/R_1)$

I_{BA} test circuits



$CMRR = 20\log\left| (E_{C1}-E_{C2}) (1+R_2/R_1) / (V_{f5}-V_{f6}) \right|$

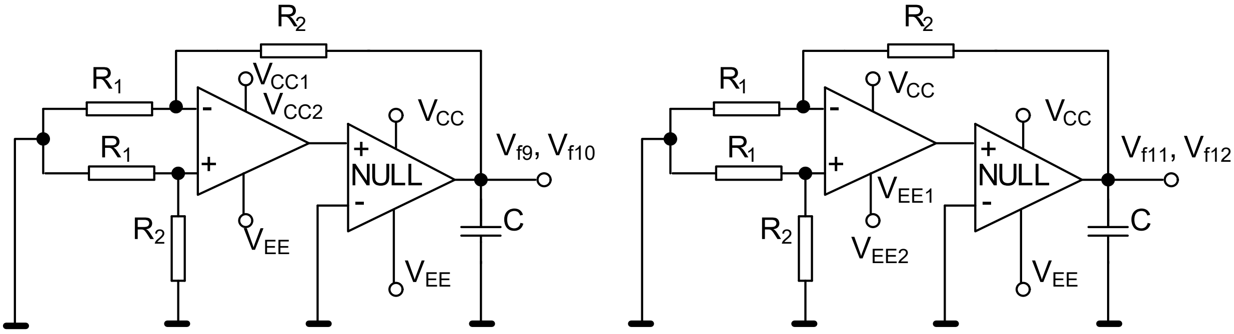
CMRR and VICM test circuits



$Gv = (E_{k1}-E_{k2}) (1+R_2/R_1) / (V_{f8}-V_{f7})$

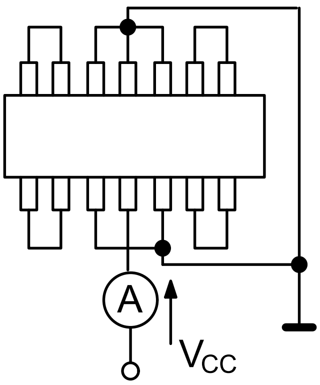
Gvtest circuits

TEST CIRCUITS

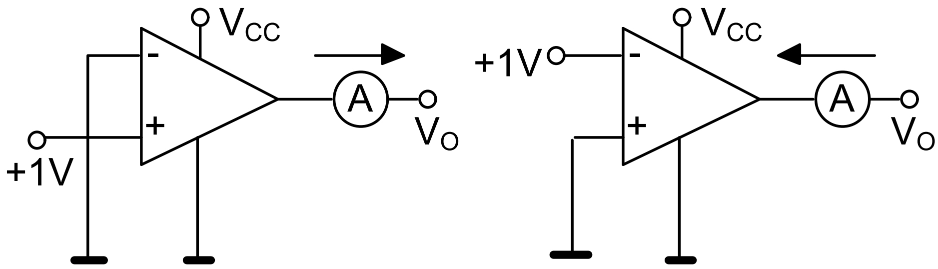


PSRR（+）= 20log｜$(V_{CC}1-V_{CC}2)(1+R_2/R_1)/(V_{f9}-V_{f10})$｜ PSRR（-）= 20log｜$(V_{EE1}-V_{EE2})(1+R_2/R_1)/(V_{f11}-V_{f12})$｜

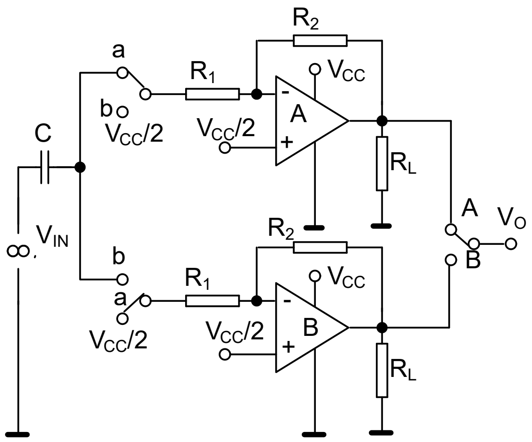
PSRR test circuits



I_{CC} test circuits



I_O test circuits



SW：A

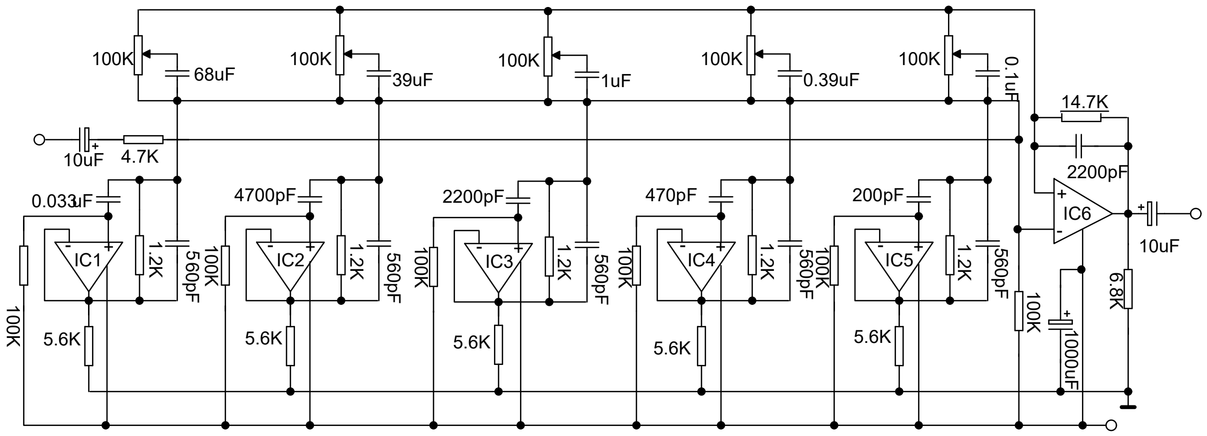
Cs（A　B）= $20\log(R_2{*}V_{OA})/(R1{*}V_{OB})$

SW：B

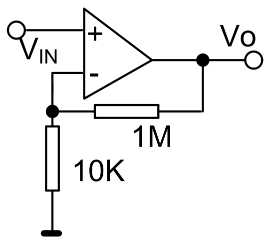
Cs（B　A）= $20\log(R_2{*}V_{OB})/(R_1{*}V_{OA})$

Cs test circuits

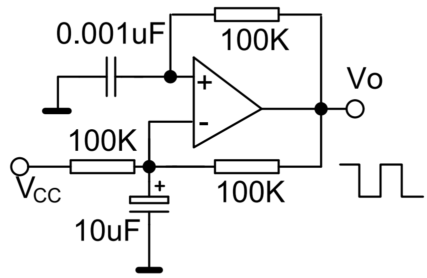
■ TYPICAL APPLICATION CIRCUITS



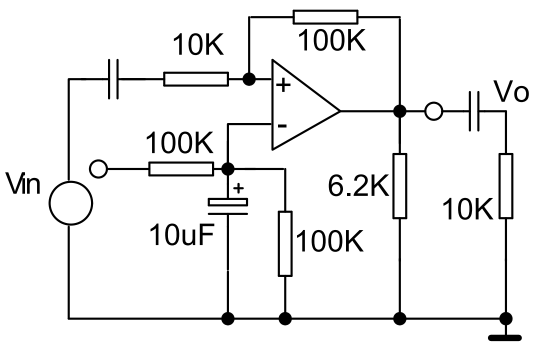
LM324S is used in five-frequency tone control circuit.



DC amplifier

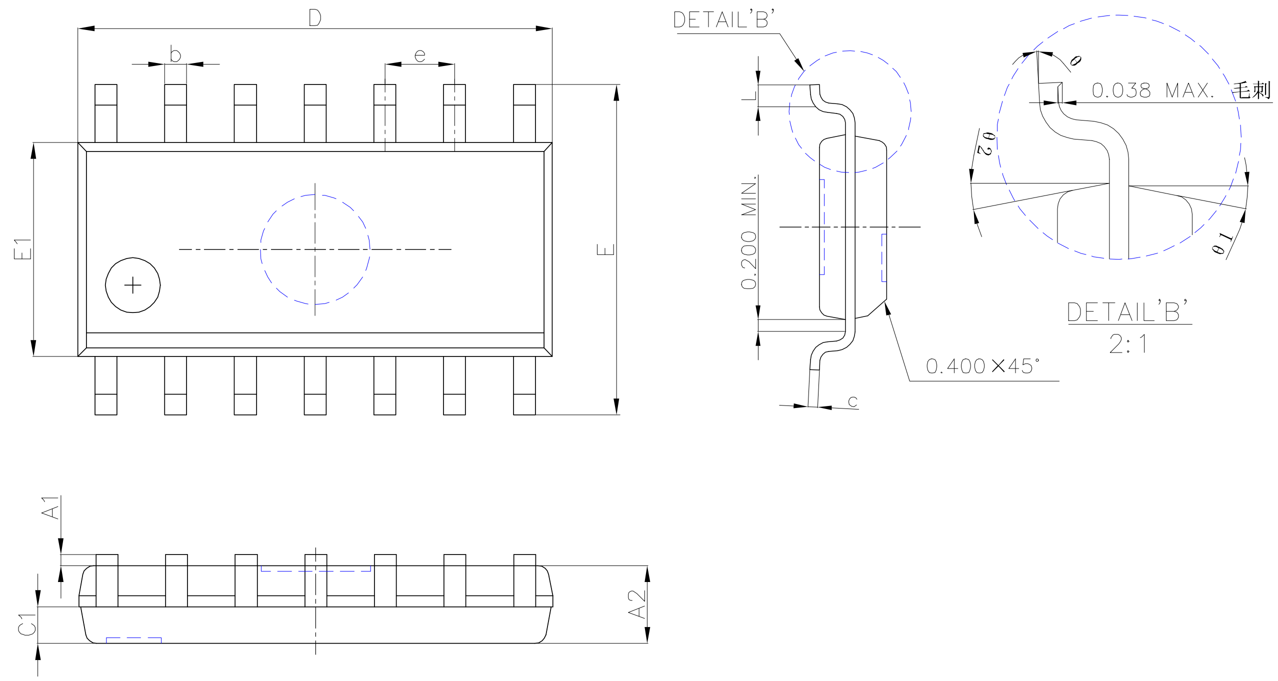


Square-wave oscillator



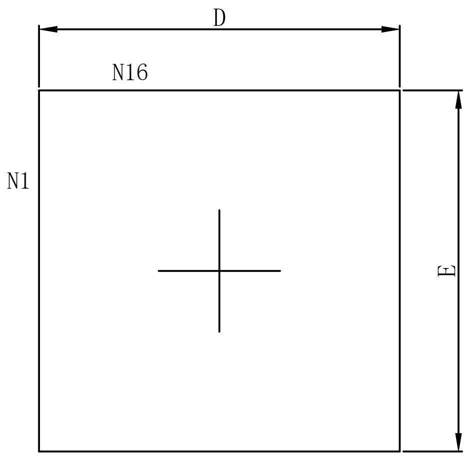
Paraphase amplifier

■ MECHANIAL INFORMATION

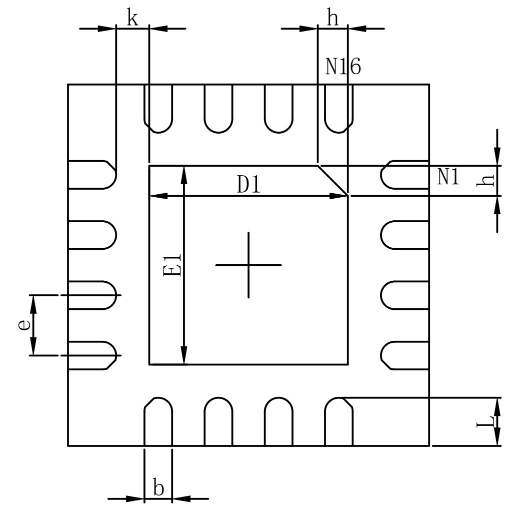


SYMBOL	DISMENSIONS IN MILLIMETERS			DISMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
D	8.550	8.650	8.750	0.337	0.341	0.344
b	0.356	0.400	0.456	0.014	0.016	0.018
e	1.270 Typ.			0.050 Typ.		
E1	3.800	3.900	4.000	0.150	0.154	0.157
E	5.800	6.000	6.200	0.228	0.236	0.244
A2	1.400	1.500	1.600	0.055	0.059	0.063
C1	0.600	0.670	0.700	0.024	0.026	0.028
A1	0.050	0.200	0.250	0.002	0.008	0.010
c	0.193	0.203	0.213	0.008	0.008	0.008
L	0.400	0.550	0.700	0.016	0.022	0.028
θ	0°	3°	8°	0°	3°	8°
θ 1	8°	11°	12°	8°	11°	12°
θ 2	8°	11°	12°	8°	11°	12°

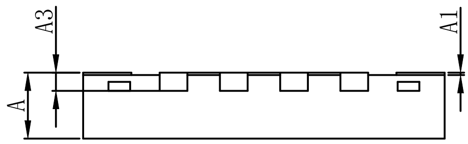
■ MECHANIAL INFORMATION



TOP VIEW
[顶视图]



BOTTOM VIEW
[背视图]



VERTICAL VIEW
[俯视图]

SYMBOL	DISMENSIONS IN MILLIMETERS			DISMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.700	0.750	0.800	0.028	0.030	0.031
A1	0.000	0.020	0.050	0.000	0.001	0.002
A3	0.203 Ref.			0.008 Ref.		
b	0.180	0.160	0.210	0.007	0.006	0.008
D	2.900	3.000	3.100	0.114	0.118	0.122
E	2.900	3.000	3.100	0.114	0.118	0.122
e	0.500 Bsc.			0.020 Bsc.		
D1	1.550	1.650	1.750	0.061	0.065	0.069
E1	1.550	1.650	1.750	0.061	0.065	0.069
L	0.300	0.400	0.500	0.012	0.016	0.020
K	0.200 Min.			0.008 Min.		
h	0.250 Ref.			0.010 Ref.		

DISCLAIMER