

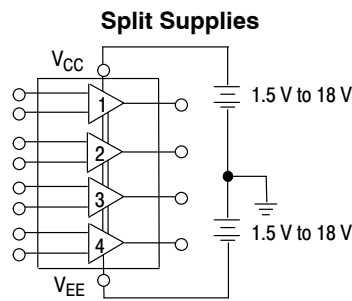
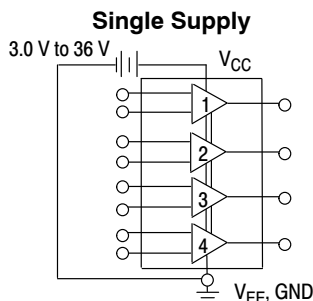
# Single Supply Quad Operational Amplifiers

## MC3403, MC3303

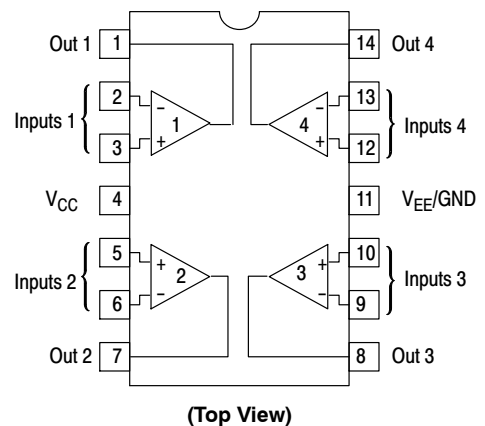
The MC3403 is a low cost, quad operational amplifier with true differential inputs. The device has electrical characteristics similar to the popular MC1741C. However, the MC3403 has several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 V or as high as 36 V with quiescent currents about one third of those associated with the MC1741C (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

### Features

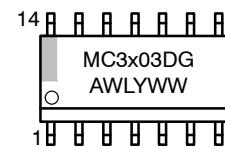
- Short Circuit Protected Outputs
- Class AB Output Stage for Minimal Crossover Distortion
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 36 V
- Split Supply Operation:  $\pm 1.5$  V to  $\pm 18$  V
- Low Input Bias Currents: 500 nA Max
- Four Amplifiers Per Package
- Internally Compensated
- Similar Performance to Popular MC1741C
- Industry Standard Pin-outs
- ESD Diodes Added for Increased Ruggedness
- Pb-Free Packages are Available



### PIN CONNECTIONS



### MARKING DIAGRAM



- x = 3 or 4
- A = Assembly Location
- WL = Wafer Lot
- Y = Year
- WW = Work Week

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

NOTE: Some of the devices on this data sheet have been **DISCONTINUED**. Please refer to the table on page 8.

## MC3403, MC3303

### MAXIMUM RATINGS

Symbol	Rating	Value	Unit
$V_{CC}$ $V_{CC}, V_{EE}$	Power Supply Voltages Single Supply Split Supplies	36 $\pm 18$	Vdc
$V_{IDR}$	Input Differential Voltage Range (Note 1)	$\pm 36$	Vdc
$V_{ICR}$	Input Common Mode Voltage Range (Notes 1 and 2)	$\pm 18$	Vdc
$T_{stg}$	Storage Temperature Range	-55 to +125	°C
$T_A$	Operating Ambient Temperature Range MC3303 MC3403	-40 to +85 0 to +70	°C
$T_J$	Junction Temperature	150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Split power supplies.

2. For supply voltages less than  $\pm 18$  V, the absolute maximum input voltage is equal to the supply voltage.

# MC3403, MC3303

## ELECTRICAL CHARACTERISTICS

( $V_{CC} = +15\text{ V}$ ,  $V_{EE} = -15\text{ V}$  for MC3403;  $V_{CC} = +14\text{ V}$ ,  $V_{EE} = \text{GND}$  for MC3303  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

Symbol	Characteristic	MC3403			MC3303			Unit
		Min	Typ	Max	Min	Typ	Max	
$V_{IO}$	Input Offset Voltage $T_A = T_{\text{high}}$ to $T_{\text{low}}$ (Note 3)	– –	2.0 –	10 12	– –	2.0 –	8.0 10	mV
$I_{IO}$	Input Offset Current $T_A = T_{\text{high}}$ to $T_{\text{low}}$	– –	30 –	50 200	– –	30 –	75 250	nA
$A_{VOL}$	Large Signal Open Loop Voltage Gain $V_O = \pm 10\text{ V}$ , $R_L = 2.0\text{ k}\Omega$ $T_A = T_{\text{high}}$ to $T_{\text{low}}$	20 15	200 –	– –	20 15	200 –	– –	V/mV
$I_{IB}$	Input Bias Current $T_A = T_{\text{high}}$ to $T_{\text{low}}$	– –	–200 –	–500 –800	– –	–200 –	–500 –1000	nA
$z_o$	Output Impedance $f = 20\text{ Hz}$	–	75	–	–	75	–	$\Omega$
$z_i$	Input Impedance $f = 20\text{ Hz}$	0.3	1.0	–	0.3	1.0	–	M $\Omega$
$V_O$	Output Voltage Range $R_L = 10\text{ k}\Omega$ $R_L = 2.0\text{ k}\Omega$ $R_L = 2.0\text{ k}\Omega$ , $T_A = T_{\text{high}}$ to $T_{\text{low}}$	$\pm 12$ $\pm 10$ $\pm 10$	$\pm 13.5$ $\pm 13$ –	– – –	12 10 10	12.5 12 –	– – –	V
$V_{ICR}$	Input Common Mode Voltage Range	+13 V – $V_{EE}$	+13 V – $V_{EE}$	–	+12 V – $V_{EE}$	+12.5 V – $V_{EE}$	–	V
CMR	Common Mode Rejection $R_S \leq 10\text{ k}\Omega$	70	90	–	70	90	–	dB
$I_{CC}$ , $I_{EE}$	Power Supply Current ( $V_O = 0$ ) $R_L = \infty$	–	2.8	7.0	–	2.8	7.0	mA
$I_{SC}$	Individual Output Short-Circuit Current (Note 4)	$\pm 10$	$\pm 20$	$\pm 45$	$\pm 10$	$\pm 30$	$\pm 45$	mA
PSRR+	Positive Power Supply Rejection Ratio	–	30	150	–	30	150	$\mu\text{V/V}$
PSRR–	Negative Power Supply Rejection Ratio	–	30	150	–	30	150	$\mu\text{V/V}$
$\Delta I_{IO}/\Delta T$	Average Temperature Coefficient of Input Offset Current $T_A = T_{\text{high}}$ to $T_{\text{low}}$	–	50	–	–	50	–	$\text{pA}/^\circ\text{C}$
$\Delta V_{IO}/\Delta T$	Average Temperature Coefficient of Input Offset Voltage $T_A = T_{\text{high}}$ to $T_{\text{low}}$	–	10	–	–	10	–	$\mu\text{V}/^\circ\text{C}$
BWp	Power Bandwidth $A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 20\text{ V(p-p)}$ , THD = 5%	–	9.0	–	–	9.0	–	kHz
BW	Small-Signal Bandwidth $A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 50\text{ mV}$	–	1.0	–	–	1.0	–	MHz
SR	Slew Rate $A_V = 1$ , $V_i = -10\text{ V}$ to $+10\text{ V}$	–	0.6	–	–	0.6	–	V/ $\mu\text{s}$
$t_{TLH}$	Rise Time $A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 50\text{ mV}$	–	0.35	–	–	0.35	–	$\mu\text{s}$
$t_{TLH}$	Fall Time $A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 50\text{ mV}$	–	0.35	–	–	0.35	–	$\mu\text{s}$
os	Overshoot $A_V = 1$ , $R_L = 10\text{ k}\Omega$ , $V_O = 50\text{ mV}$	–	20	–	–	20	–	%
$\phi_m$	Phase Margin $A_V = 1$ , $R_L = 2.0\text{ k}\Omega$ , $V_O = 200\text{ pF}$	–	60	–	–	60	–	$^\circ$
–	Crossover Distortion ( $V_{in} = 30\text{ mVpp}$ , $V_{out} = 2.0\text{ Vpp}$ , $f = 10\text{ kHz}$ )	–	1.0	–	–	1.0	–	%

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. MC3303:  $T_{\text{low}} = -40^\circ\text{C}$ ,  $T_{\text{high}} = +85^\circ\text{C}$ , MC3403:  $T_{\text{low}} = 0^\circ\text{C}$ ,  $T_{\text{high}} = +70^\circ\text{C}$

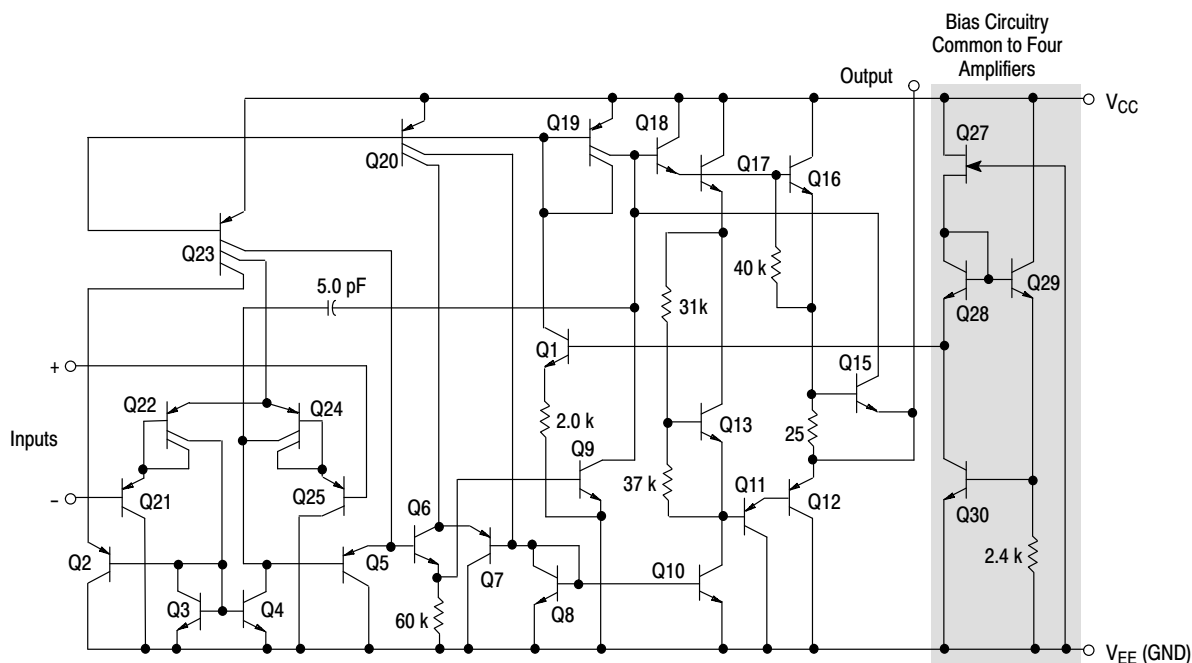
4. Not to exceed maximum package power dissipation.

# MC3403, MC3303

**ELECTRICAL CHARACTERISTICS** ( $V_{CC} = 5.0\text{ V}$ ,  $V_{EE} = \text{GND}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

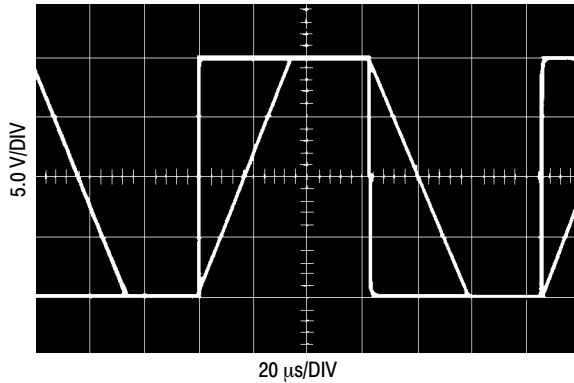
Symbol	Characteristic	MC3403			MC3303			Unit
		Min	Typ	Max	Min	Typ	Max	
$V_{IO}$	Input Offset Voltage	–	2.0	10	–	–	10	mV
$I_{IO}$	Input Offset Current	–	30	50	–	–	75	nA
$I_{IB}$	Input Bias Current	–	–200	–500	–	–	–500	nA
$A_{VOL}$	Large Signal Open Loop Voltage Gain $R_L = 2.0\text{ k}\Omega$	10	200	–	10	200	–	V/mV
PSRR	Power Supply Rejection Ratio	–	–	150	–	–	150	$\mu\text{V/V}$
$V_{OR}$	Output Voltage Range (Note 5) $R_L = 10\text{ k}\Omega$ , $V_{CC} = 5.0\text{ V}$ $R_L = 10\text{ k}\Omega$ , $5.0 \leq V_{CC} \leq 30\text{ V}$	3.3 $V_{CC}-2.0$	3.5 $V_{CC}-1.7$	– –	3.3 $V_{CC}-2.0$	3.5 $V_{CC}-1.7$	– –	$V_{pp}$
$I_{CC}$	Power Supply Current	–	2.5	7.0	–	2.5	7.0	mA
CS	Channel Separation $f = 1.0\text{ kHz to } 20\text{ kHz}$ (Input Referenced)	–	–120	–	–	–120	–	dB

5. Output will swing to ground with a  $10\text{ k}\Omega$  pull down resistor.



**Figure 1. Representative Schematic Diagram**  
(1/4 of Circuit Shown)

## CIRCUIT DESCRIPTION



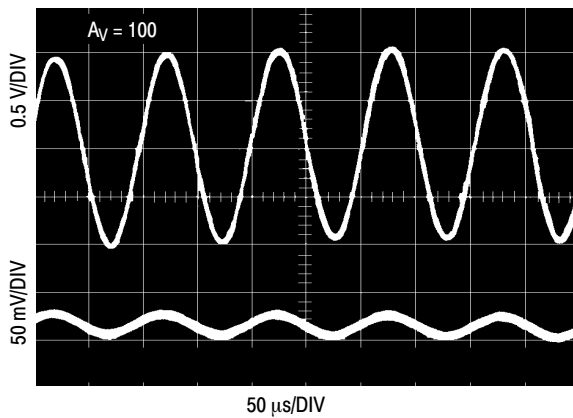
**Figure 2. Inverter Pulse Response**

The MC3403/3303 is made using four internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input device Q24 and Q22 with input buffer transistors Q25 and Q21 and the differential to single ended converter Q3 and Q4. The first

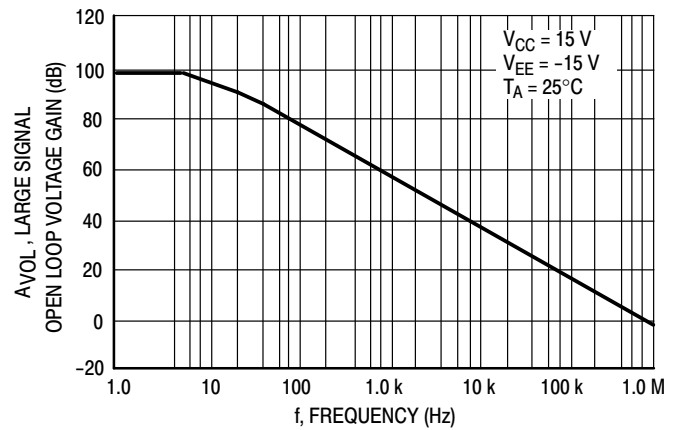
stage performs not only the first stage gain function but also performs the level shifting and Transconductance reduction functions. By reducing the Transconductance, a smaller compensation capacitor (only 5.0 pF) can be employed, thus saving chip area. The Transconductance reduction is accomplished by splitting the collectors of Q24 and Q22. Another feature of this input stage is that the input common mode range can include the negative supply or ground, in single supply operation, without saturating either the input devices or the differential to single-ended converter. The second stage consists of a standard current source load amplifier stage.

The output stage is unique because it allows the output to swing to ground in single supply operation and yet does not exhibit any crossover distortion in split supply operation. This is possible because Class AB operation is utilized.

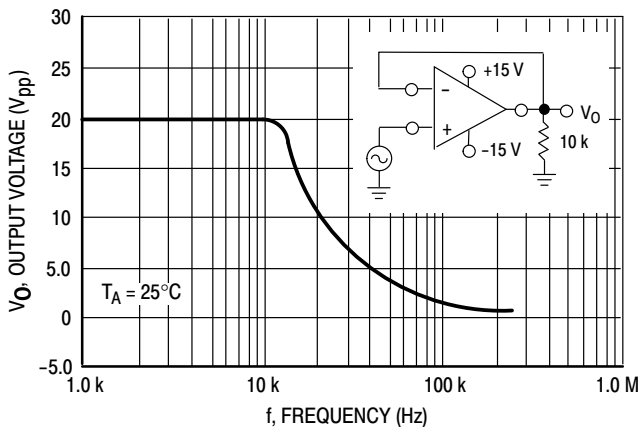
Each amplifier is biased from an internal voltage regulator which has a low temperature coefficient, thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.



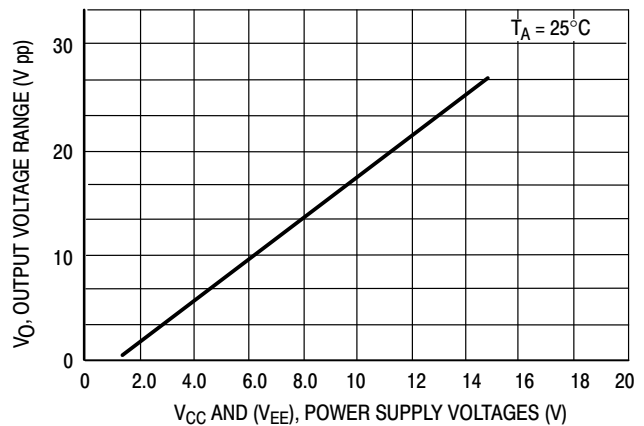
**Figure 3. Sine Wave Response**



**Figure 4. Open Loop Frequency Response**

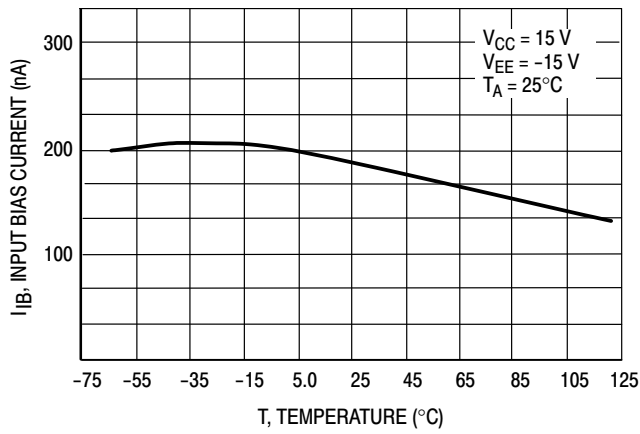


**Figure 5. Power Bandwidth**

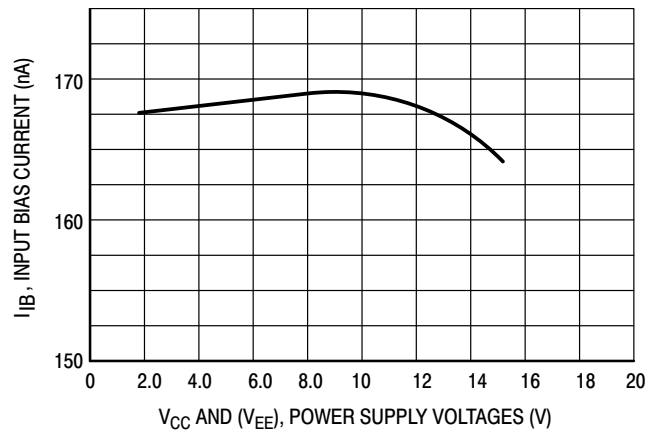


**Figure 6. Output Swing versus Supply Voltage**

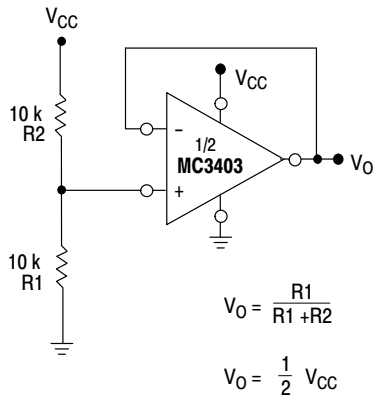
## MC3403, MC3303



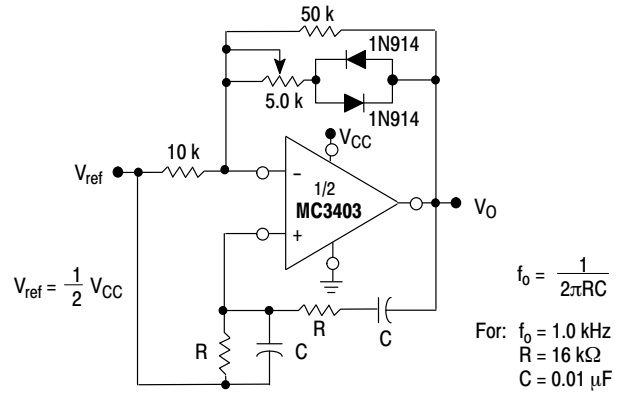
**Figure 7. Input Bias Current versus Temperature**



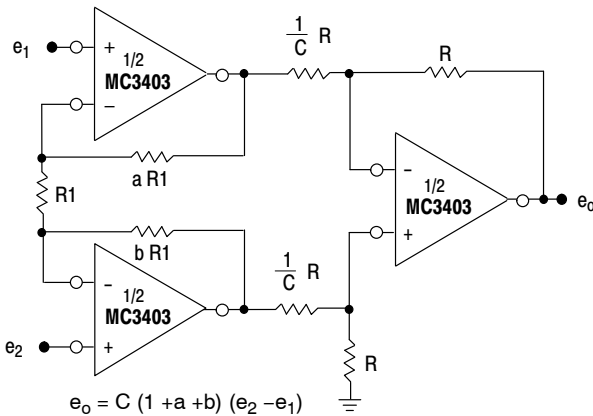
**Figure 8. Input Bias Current versus Supply Voltage**



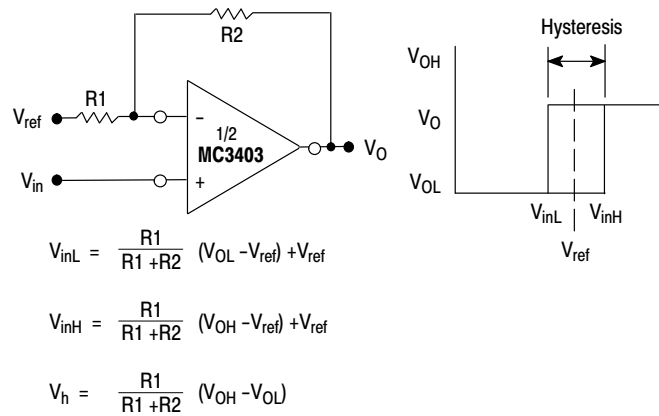
**Figure 9. Voltage Reference**



**Figure 10. Wien Bridge Oscillator**



**Figure 11. High Impedance Differential Amplifier**



**Figure 12. Comparator with Hysteresis**

## MC3403, MC3303

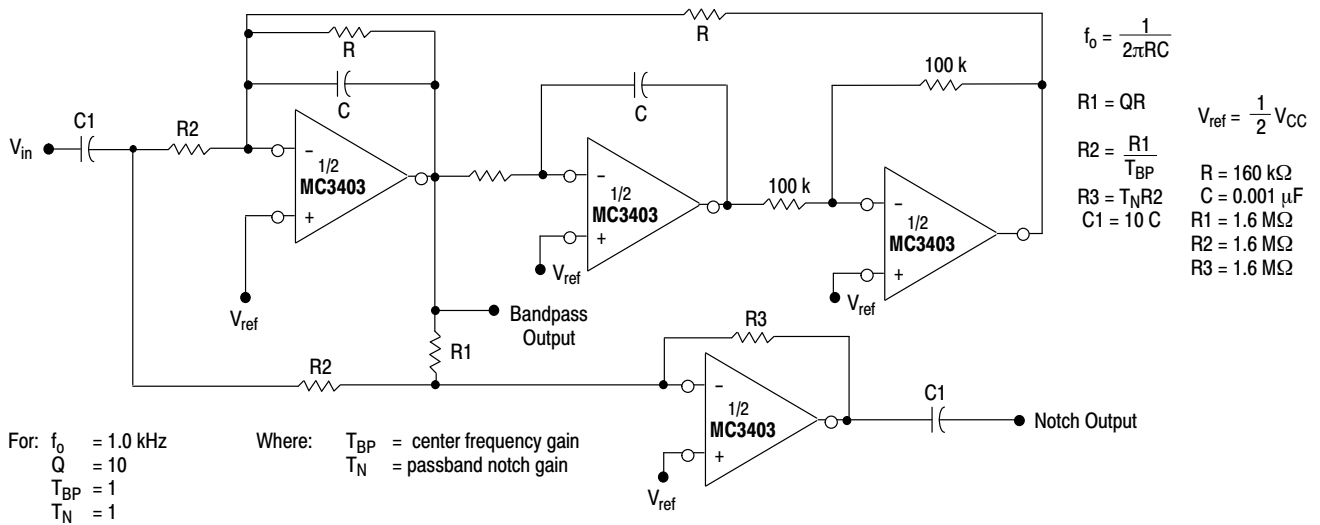


Figure 13. Bi-Quad Filter

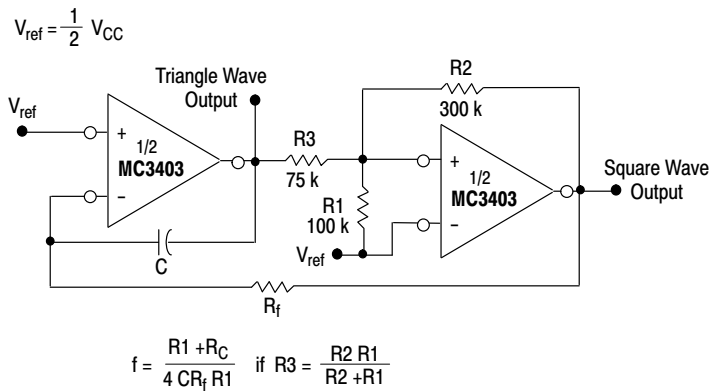


Figure 14. Function Generator

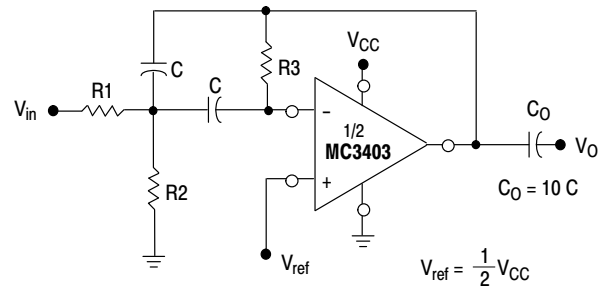


Figure 15. Multiple Feedback Bandpass Filter

## MC3403, MC3303

### ORDERING INFORMATION

Device	Package	Shipping†
MC3303DR2G	SOIC-14 (Pb-Free)	2,500 Tape & Reel
MC3403DR2G	SOIC-14 (Pb-Free)	2,500 Tape & Reel

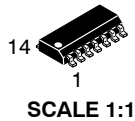
### DISCONTINUED (Note 6)

MC3303D	SOIC-14	55 Units / Rail
MC3303DG	SOIC-14 (Pb-Free)	
MC3303DR2	SOIC-14	2,500 Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, [BRD8011/D](#).

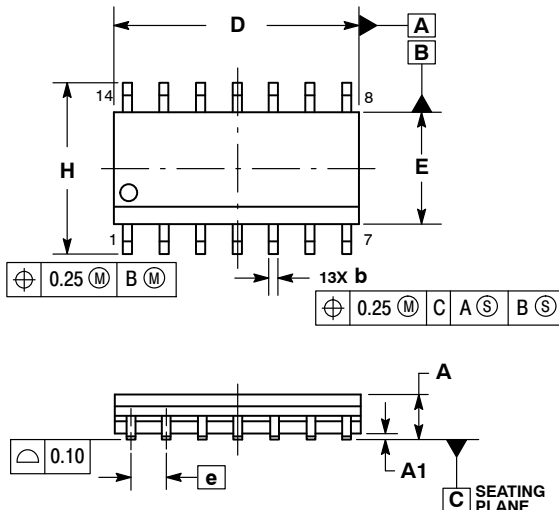
6. **DISCONTINUED:** These devices are not recommended for new design. Please contact your **onsemi** representative for information. The most current information on these devices may be available on [www.onsemi.com](http://www.onsemi.com).





**SOIC-14 NB**  
**CASE 751A-03**  
**ISSUE L**

DATE 03 FEB 2016

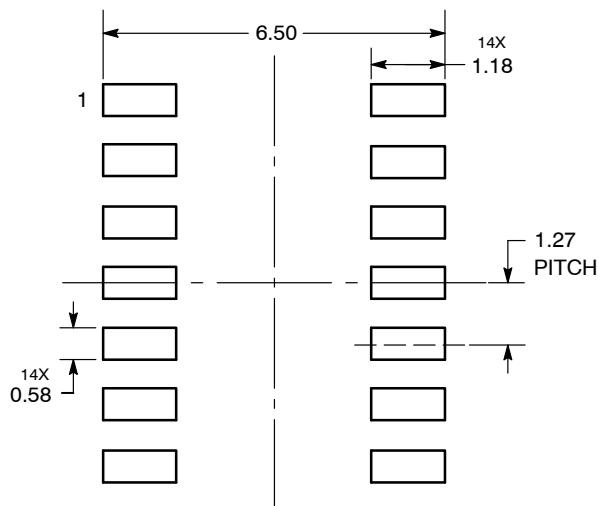


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.054	0.068
A1	0.10	0.25	0.004	0.010
A3	0.19	0.25	0.008	0.010
b	0.35	0.49	0.014	0.019
D	8.55	8.75	0.337	0.344
E	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.019
L	0.40	1.25	0.016	0.049
M	0°	7°	0°	7°

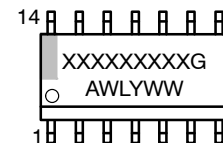
**SOLDERING FOOTPRINT\***



DIMENSIONS: MILLIMETERS

\*For additional information on our Pb-Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

**GENERIC MARKING DIAGRAM\***



XXXXXX = Specific Device Code  
 A = Assembly Location  
 WL = Wafer Lot  
 Y = Year  
 WW = Work Week  
 G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

**STYLES ON PAGE 2**

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SOIC-14  
CASE 751A-03  
ISSUE L

DATE 03 FEB 2016

STYLE 1:  
PIN 1. COMMON CATHODE  
2. ANODE/CATHODE  
3. ANODE/CATHODE  
4. NO CONNECTION  
5. ANODE/CATHODE  
6. NO CONNECTION  
7. ANODE/CATHODE  
8. ANODE/CATHODE  
9. ANODE/CATHODE  
10. NO CONNECTION  
11. ANODE/CATHODE  
12. ANODE/CATHODE  
13. NO CONNECTION  
14. COMMON ANODE

STYLE 2:  
CANCELLED

STYLE 3:  
PIN 1. NO CONNECTION  
2. ANODE  
3. ANODE  
4. NO CONNECTION  
5. ANODE  
6. NO CONNECTION  
7. ANODE  
8. ANODE  
9. ANODE  
10. NO CONNECTION  
11. ANODE  
12. ANODE  
13. NO CONNECTION  
14. COMMON CATHODE

STYLE 4:  
PIN 1. NO CONNECTION  
2. CATHODE  
3. CATHODE  
4. NO CONNECTION  
5. CATHODE  
6. NO CONNECTION  
7. CATHODE  
8. CATHODE  
9. CATHODE  
10. NO CONNECTION  
11. CATHODE  
12. CATHODE  
13. NO CONNECTION  
14. COMMON ANODE

STYLE 5:  
PIN 1. COMMON CATHODE  
2. ANODE/CATHODE  
3. ANODE/CATHODE  
4. ANODE/CATHODE  
5. ANODE/CATHODE  
6. NO CONNECTION  
7. COMMON ANODE  
8. COMMON CATHODE  
9. ANODE/CATHODE  
10. ANODE/CATHODE  
11. ANODE/CATHODE  
12. ANODE/CATHODE  
13. NO CONNECTION  
14. COMMON ANODE

STYLE 6:  
PIN 1. CATHODE  
2. CATHODE  
3. CATHODE  
4. CATHODE  
5. CATHODE  
6. CATHODE  
7. CATHODE  
8. ANODE  
9. ANODE  
10. ANODE  
11. ANODE  
12. ANODE  
13. ANODE  
14. ANODE

STYLE 7:  
PIN 1. ANODE/CATHODE  
2. COMMON ANODE  
3. COMMON CATHODE  
4. ANODE/CATHODE  
5. ANODE/CATHODE  
6. ANODE/CATHODE  
7. ANODE/CATHODE  
8. ANODE/CATHODE  
9. ANODE/CATHODE  
10. ANODE/CATHODE  
11. COMMON CATHODE  
12. COMMON ANODE  
13. ANODE/CATHODE  
14. ANODE/CATHODE

STYLE 8:  
PIN 1. COMMON CATHODE  
2. ANODE/CATHODE  
3. ANODE/CATHODE  
4. NO CONNECTION  
5. ANODE/CATHODE  
6. ANODE/CATHODE  
7. COMMON ANODE  
8. COMMON ANODE  
9. ANODE/CATHODE  
10. ANODE/CATHODE  
11. NO CONNECTION  
12. ANODE/CATHODE  
13. ANODE/CATHODE  
14. COMMON CATHODE

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