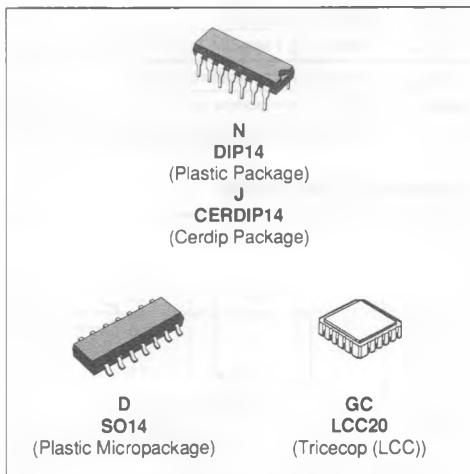


LOW POWER DIFFERENTIAL INPUT QUAD OP-AMPs

- SHORT-CIRCUIT PROTECTED OUTPUTS
- CLASS AB OUTPUT STAGE FOR MINIMAL CROSSOVER DISTORTION
- SINGLE SUPPLY OPERATION : +3 V TO +36 V
- DUAL SUPPLIES : ± 1.5 V TO ± 18 V
- LOW INPUT BIAS CURRENT : 500 nA MAX
- INTERNALLY COMPENSATED
- SIMILAR PERFORMANCE TO POPULAR UA741

DESCRIPTION

The MC3403 is a low-cost, quad operational amplifier with true differential inputs. The device has electrical characteristics similar to the popular UA741. 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 volts or as high as 36 volts with quiescent currents about one third of those associated with the UA741 (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.

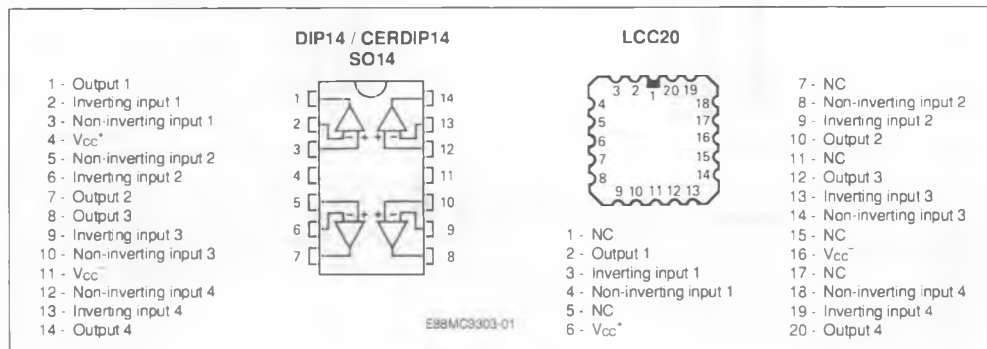


ORDER CODES

Part Number	Temperature Range	Package			
		J	N	D	GC
MC3303	-40 °C to +105 °C	•	•	•	
MC3403	0 °C to +70 °C	•	•	•	
MC3503	-55 °C to +125 °C	•			•

Note : Hi-Rel Versions Available
Examples : MC3503J, MC3403N

PIN CONNECTIONS (top views)

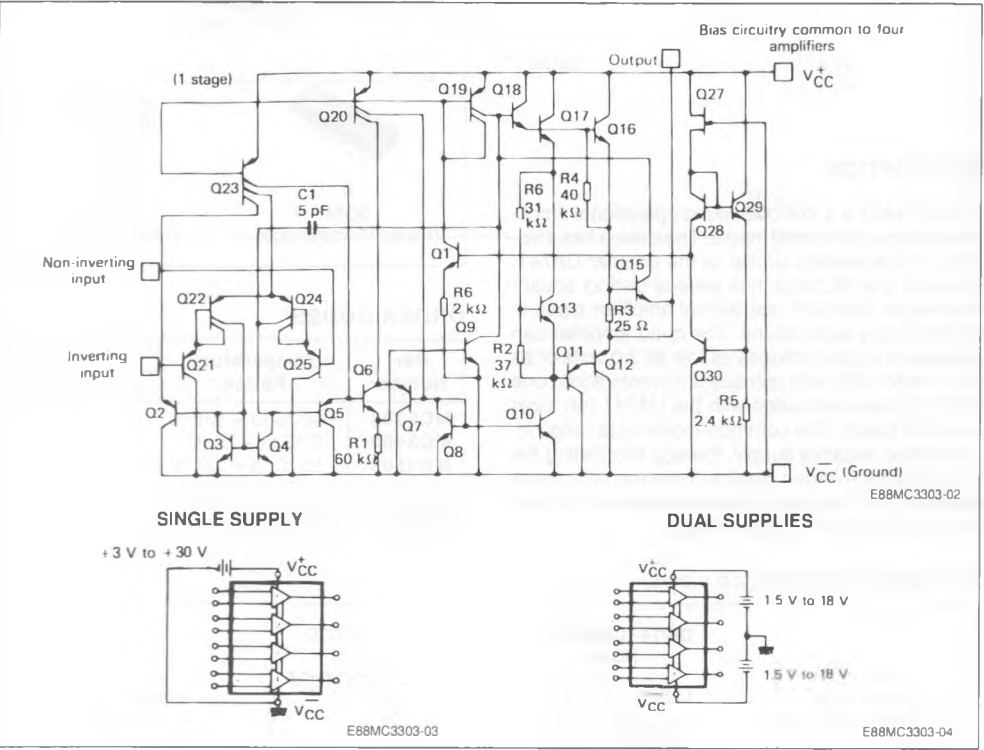


ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	MC3503	MC3403	MC3303	Unit
V_{CC}	Supply Voltage	± 18	± 18	± 18	V
V_{ID}	Differential Input Voltage	± 36	± 36	± 36	V
V_I	Input Voltage (note 1)	± 18	± 18	± 18	V
—	Output Short-circuit Duration (note 2)	Indefinite	Indefinite	Indefinite	—
P_{tot}	Power Dissipation	500	500	500	mW
T_{oper}	Operating Free-air Temperature Range	-55 to $+125$	0 to $+70$	-40 to $+105$	$^{\circ}\text{C}$
T_{stg}	Storage Temperature Range	-65 to $+150$	-65 to $+150$	-65 to $+150$	$^{\circ}\text{C}$

Notes : 1. For supply voltages less than ± 15 V, 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.

SCHEMATIC DIAGRAM



Case	Outputs	Inverting Inputs	Non-inverting Inputs	V_{CC}^{-}	V_{CC}^{+}	N. C.
DIP14 Cerdip14 SO14	1, 7, 8, 14	2, 6, 9, 13	3, 5, 10, 12	11	4	
LCC20	1, 2, 12, 20	3, 9, 13, 19	4, 8, 14, 18	16	6	*

* LCC20 Other pins are not connected

ELECTRICAL CHARACTERISTICS

MC3403 : $0 \leq T_{amb} \leq +70^{\circ}\text{C}$ MC3303 : $-40 \leq T_{amb} \leq +105^{\circ}\text{C}$ MC3503 : $-55 \leq T_{amb} \leq +125^{\circ}\text{C}$ $V_{CC} = \pm 15\text{ V}$ $V_{CC} = \pm 15\text{ V}$ $V_{CC} = \pm 15\text{ V}$

Symbol	Parameter	MC3303, MC3403, MC3503			Unit
		Min.	Typ.	Max.	
V_{IO}	Input Offset Voltage ($R_S \leq 10\text{ k}\Omega$) $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		1	5 6	mV
I_{IO}	Input Offset Current $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		2	20 40	nA
I_{IB}	Input Bias Current $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		40	100 200	nA
A_{VD}	Large Signal Voltage Gain ($V_O = \pm 10\text{ V}$, $R_L = 2\text{ k}\Omega$) $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	50 25	200		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \leq 10\text{ k}\Omega$) $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	77 77	90		dB
I_{CC}	Supply Current, all Amp, no Load $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$		2.8	4 5	mA
V_I	Input Voltage Range $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	-15 -15		+13 +13	V
CMR	Common Mode Rejection Ratio ($R_S \leq 10\text{ k}\Omega$) $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	70 70	90		dB
I_{OS}	Output Short-circuit Current $T_{amb} = 25^{\circ}\text{C}$	10	30	45	mA
$\pm V_{opp}$	Output Voltage Swing $T_{amb} = 25^{\circ}\text{C}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ $R_L = 10\text{ k}\Omega$ $T_{min} \geq T_{amb} \geq T_{max}$	12 10 10 12	13.5 13		V
S_{VO}	Slew Rate ($V_I = \pm 10\text{ V}$, $R_L = 2\text{ k}\Omega$) $C_L \leq 100\text{ pF}$, $T_{amb} = 25^{\circ}\text{C}$, unity gain)	0.45	0.7		V/ μs
t_r t_f	Rise Time and Fall Time ($V_O = \pm 20\text{ mV}$, $R_L = 2\text{ k}\Omega$, $C_L \leq 100\text{ pF}$) $T_{amb} = 25^{\circ}\text{C}$, unity gain)		0.18 0.18		μs
K_{OV}	Overshoot ($V_I = \pm 20\text{ mV}$, $R_L = 2\text{ k}\Omega$) $C_L \leq 100\text{ pF}$, $T_{amb} = 25^{\circ}\text{C}$, unity gain)		10		%
Z_I	Input Impedance, $T_{amb} = 25^{\circ}\text{C}$	0.3	1		M Ω
Z_O	Output Impedance, $T_{amb} = 25^{\circ}\text{C}$		75		Ω

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	MC3303, MC3403, MC3503			Unit
		Min.	Typ.	Max.	
B _{om}	Power Bandwidth (R _L = 2 kΩ, C _L = 100 pF A _v = 1, T _{amb} = 25 °C, V _O = 2 V _{pp} , THD ≤ 5 %)		9		kHz
B	Unity Gain Bandwidth (V _O = 10 mV, R _L = 2 kΩ, C _L ≤ 100 pF, T _{amb} = 25 °C, unity gain)		1		MHz
GBP	Gain Bandwidth Product (V _O = 10 mV, R _L = 2 kΩ, C _L ≤ 100 pF, f = 100 kHz, T _{amb} = 25 °C)	0.8	1	1.6	MHz
THD	Total Harmonic Distortion (f = 1 kHz, A _v = 20 dB, R _L = 2 kΩ, V _O = 2 V _{pp} C _L ≤ 100 pF, T _{amb} = 25 °C)		0.02		%
V _n	Equivalent Input Noise Voltage (f = 1 kHz, R _g = 100 Ω)		43		nV/√Hz
Φ _m	Phase Margin		60		Degrees
DV _{IO}	Input Offset Voltage Drift T _{min} ≤ T _{amb} ≤ T _{max}		10		μV/°C
DI _{IO}	Input Offset Current Drift T _{min} ≤ T _{amb} ≤ 25 °C		50		pA/°C
V _{O1} /V _{O2}	Channel Separation		120		dB

ELECTRICAL CHARACTERISTICS (continued)

V_{CC}⁺ = 5 V, V_{CC}⁻ = Ground (unless otherwise specified)

Symbol	Parameter	MC3303, MC3403, MC3503			Unit
		Min.	Typ.	Max.	
V _{IO}	Input Offset Voltage (R _S ≤ 10 kΩ) 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	20 40	nA
I _{IB}	Input Bias Current T _{amb} = 25 °C T _{min} ≤ T _{amb} ≤ T _{max}		40	100 200	nA
A _{VD}	Large Signal Voltage Gain (V _O = ± 10 V, R _L = 2 kΩ) T _{amb} = 25 °C T _{min} ≤ T _{amb} ≤ T _{max}	10 5	200		V/mV
SVR	Supply Voltage Rejection Ratio (R _S ≤ 10 kΩ) T _{amb} = 25 °C T _{min} ≤ T _{amb} ≤ T _{max}	77 77	90		dB
I _{CC}	Supply Current (all amp. V _O = 0 V)		2.5	4	mA
V _{opp}	Output Voltage Range (R _L = 10 kΩ) + 5 V ≤ V _{CC} ≤ + 30 V	V _{CC} ⁺ – 1.7 V	V _{CC} ⁺ – 1.5 V		V

CIRCUIT DESCRIPTION

The MC3403 is made using four internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices 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 pF) can be employed, thus saving chip area.

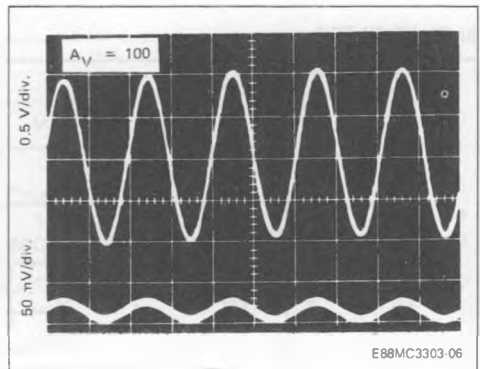
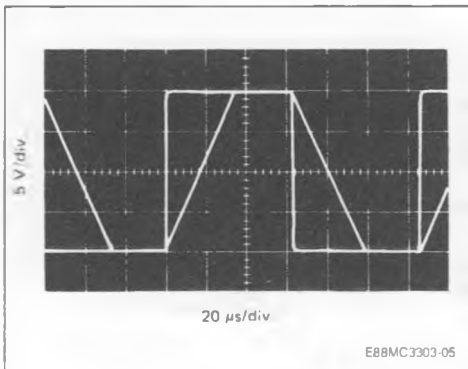
The transconductance reduction is accomplished by splitting the collectors of Q24 and Q22. Another feature of this input stage is that the input common-mode range can include the negative supply of

ground, in single supply operation, without saturation 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 operations. This is possible because class AB operation is utilized.

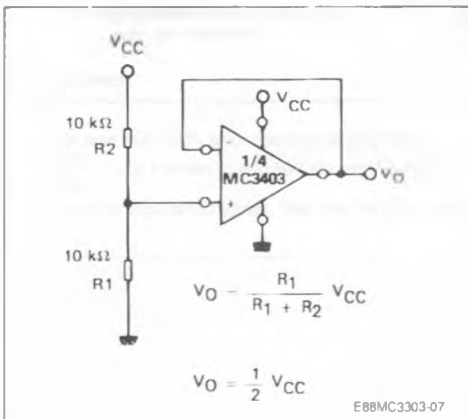
Each amplifier is biased from an internal voltage regulator which has a low temperature coefficient thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.

TYPICAL PERFORMANCE CURVES

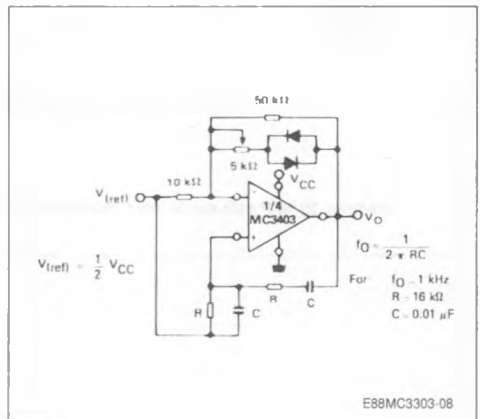


APPLICATION INFORMATION

VOLTAGE REFERENCE

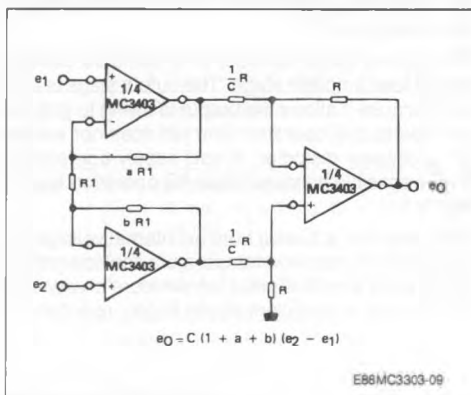


WIEN BRIDGE OSCILLATOR

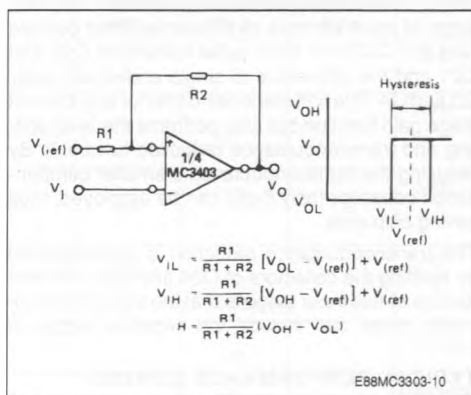


APPLICATION INFORMATION (continued)

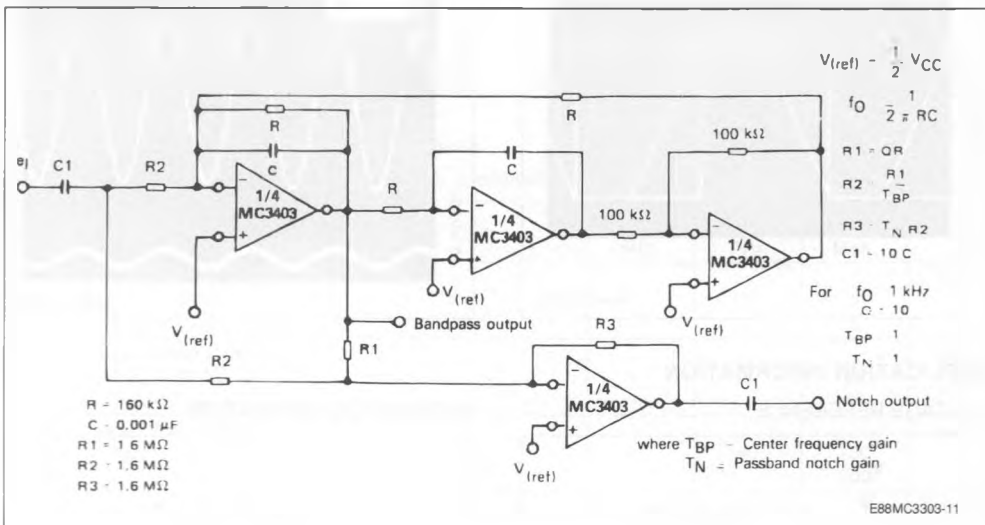
HIGH IMPEDANCE DIFFERENTIAL AMPLIFIER



COMPARATOR WITH HYSTERESIS

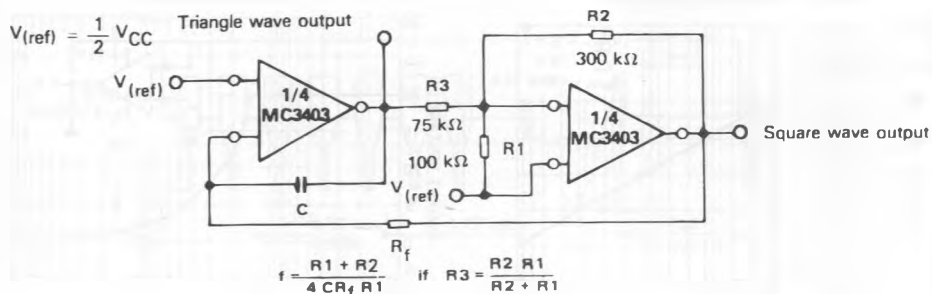


BI-QUAD FILTER



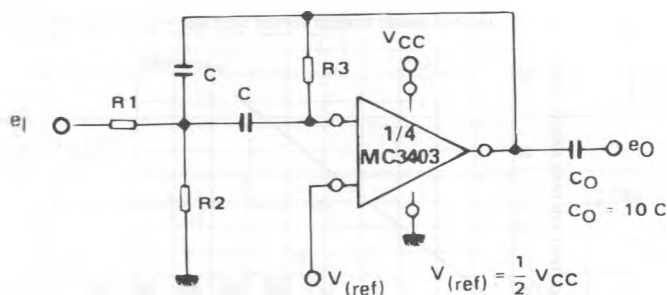
APPLICATION INFORMATION (continued)

FUNCTION GENERATOR



E88MC3303-12

MULTIPLE FEEDBACK BANDPASS FILTER



E88MC3303-13

Given f_0 = Center frequency choose values f_0 , C then : $R_3 = \frac{Q}{\pi f_0 C}$

$A(f_0)$ = Gain at center frequency

$$R_1 = \frac{R_3}{2A(f_0)}$$

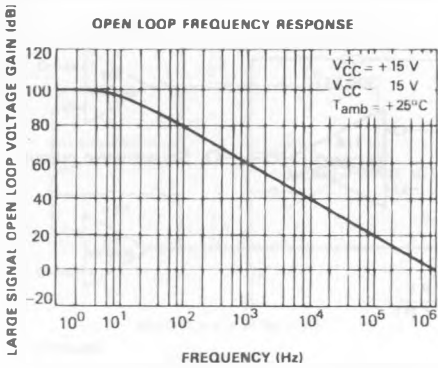
$$R_2 = \frac{R_1 R_5}{4Q^2 R_1 \cdot R_5}$$

For less than 10 % error operational amplifiers

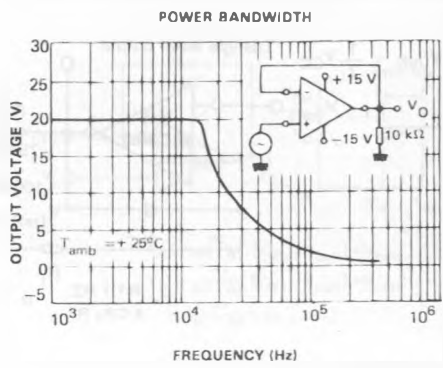
$\frac{Q_0 f_0}{BW} < 0.1$ where f_0 and BW are expressed in Hz

If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

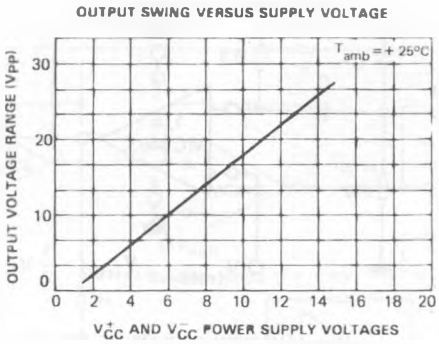
TYPICAL PERFORMANCE CURVES



E88MC3303-14



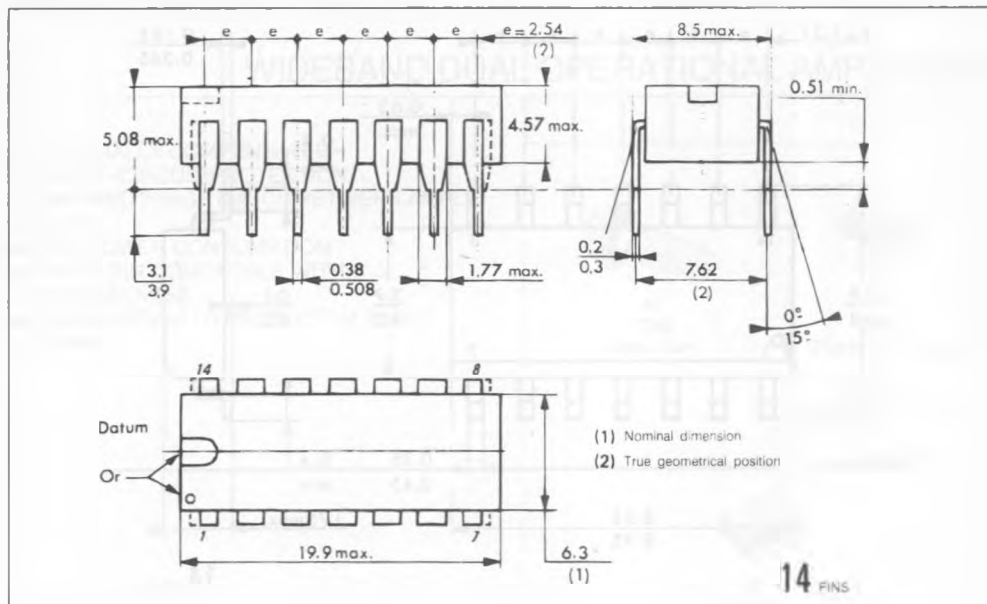
E88MC3303-15



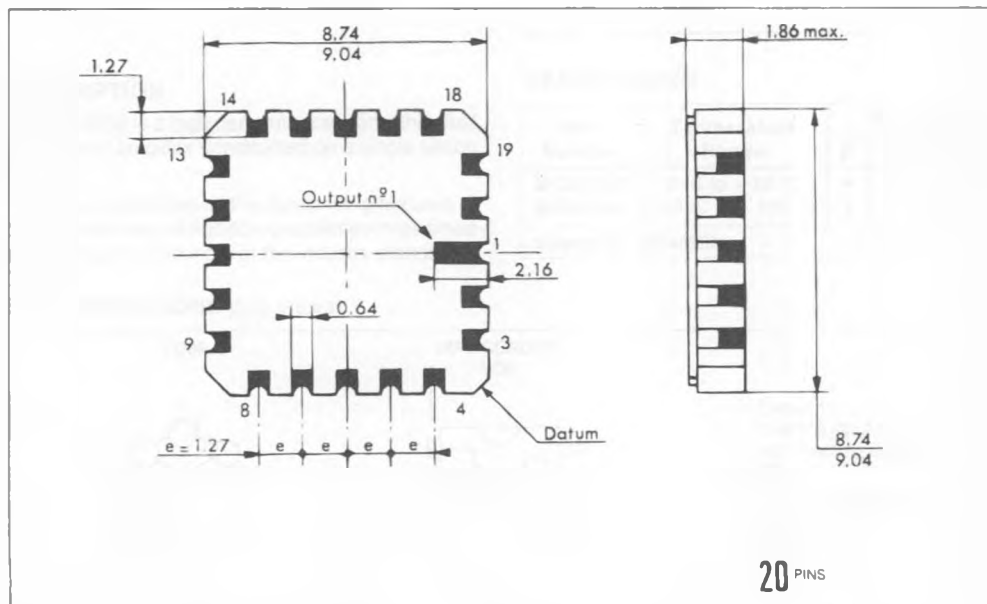
E88MC3303-16

PACKAGE MECHANICAL DATA

14 PINS – PLASTIC DIP OR CERP



20 PINS – TRICECOP (LCC)



PACKAGE MECHANICAL DATA (continued)

14 PINS – PLASTIC MICROPACKAGE (SO)

