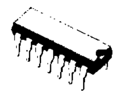
SGS-THOMSON
MICROELECTRONICS

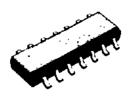
MC3303
MC3403-MC3503

LOW POWER DIFFERENTIAL INPUT QUAD OP-AMPs

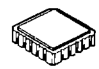
- SHORT-CIRCUIT PROTECTED OUTPUTS
- CLASS AB OUTPUT STAGE FOR MINIMAL CROSSOVER DISTORTION
- SINGLE SUPPLY OPERATION : + 3 V TO + 36 V
- DUAL SUPPLIES : ± 1.5 V TO ± 18 V
- LOW INPUT BIAS CURRENT : 500 nA MAX
- INTERNALLY COMPENSATED
- SIMILAR PERFORMANCE TO POPULAR UA741



N
DIP14
(Plastic Package)
J
CERDIP14
(Cerdip Package)



D
SO14
(Plastic Micropackage)



GC
LCC20
(Tricecop (LCC))

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

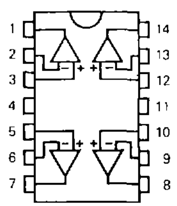
Part Number	Temperature Range	Package			
		J	N	D	GC
MC3303	– 40 °C to + 105 °C	•	•	•	
MC3403	0 °C to + 70 °C	•	•	•	
MC3503	– 55 °C to + 125 °C	•			•

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

PIN CONNECTIONS (top views)

DIP14 / CERDIP14
SO14

1 - Output 1
2 - Inverting input 1
3 - Non-inverting input 1
4 - V_{CC}^{+}
5 - Non-inverting input 2
6 - Inverting input 2
7 - Output 2
8 - Output 3
9 - Inverting input 3
10 - Non-inverting input 3
11 - V_{CC}^{-}
12 - Non-inverting input 4
13 - Inverting input 4
14 - Output 4



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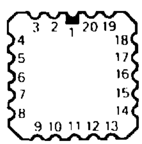
LCC20



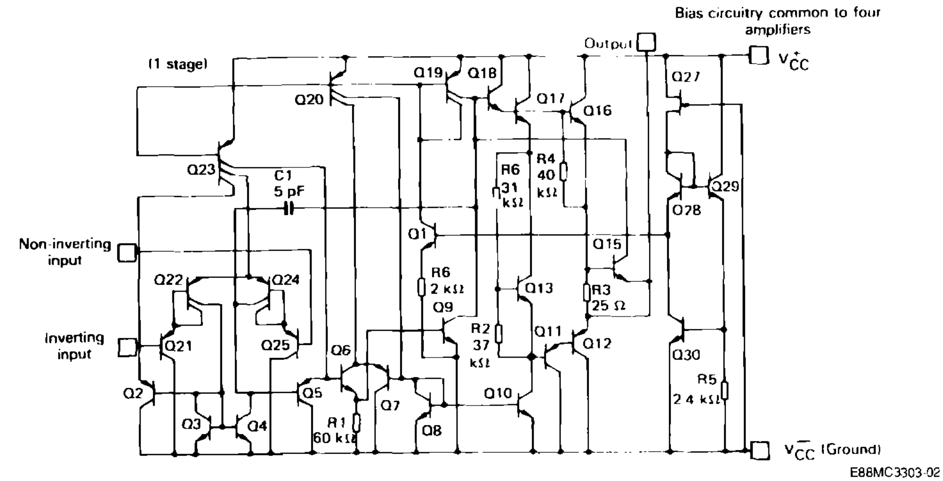
1 - NC
2 - Output 1
3 - Inverting input 1
4 - Non-inverting input 1
5 - NC
6 - V_{CC}^{+}
7 - NC
8 - Non-inverting input 2
9 - Inverting input 2
10 - Output 2
11 - NC
12 - Output 3
13 - Inverting input 3
14 - Non-inverting input 3
15 - NC
16 - V_{CC}^{-}
17 - NC
18 - Non-inverting input 4
19 - Inverting input 4
20 - Output 4

ABSOLUTE MAXIMUM RATINGS

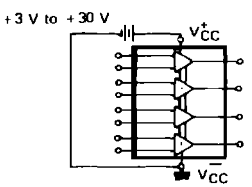
Symbol	Parameter	MC3503	MC3403	MC3303	Unit
V_{CC}	Supply Voltage	± 18	± 18	± 18	V
V_{ID}	Differential Input Voltage	± 36	± 36	± 36	V
V_I	Input Voltage (note 1)	± 18	± 18	± 18	V
–	Output Short-circuit Duration (note 2)	Indefinite	Indefinite	Indefinite	–
P_{tot}	Power Dissipation	500	500	500	mW
T_{oper}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



SINGLE SUPPLY



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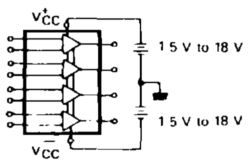
DUAL SUPPLIES



E88MC3303-04

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 $\le T_{amb} \le$ + 70 °C V_{CC} = ± 15 V
MC3303 : – 40 $\le T_{amb} \le$ + 105 °C V_{CC} = ± 15 V
MC3503 : – 55 $\le T_{amb} \le$ + 125 °C V_{CC} = ± 15 V

Symbol	Parameter	MC3303, MC3403, MC3503			Unit
		Min.	Typ.	Max.	
V_{IO}	Input Offset Voltage ($R_S \le$ 10 kΩ) T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$		 1	 5 6	mV
I_{IO}	Input Offset Current T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$		 2	 20 40	nA
I_{IB}	Input Bias Current T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$		 40	 100 200	nA
A_{VD}	Large Signal Voltage Gain (V_O = ± 10 V, R_L = 2 kΩ) T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$	 50 25	 200		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \le$ 10 kΩ) T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$	 77 77	 90		dB
I_{CC}	Supply Current, all Amp, no Load T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$		 2.8	 4 5	mA
V_i	Input Voltage Range T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$	 – 15 – 15		 + 13 + 13	V
CMR	Common Mode Rejection Ratio ($R_S \le$ 10 kΩ) T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$	 70 70	 90		dB
I_{OS}	Output Short-circuit Current T_{amb} = 25 °C	 10	 30	 45	mA
± V_{opp}	Output Voltage Swing T_{amb} = 25 °C R_L = 10 kΩ R_L = 2 kΩ $T_{min} \ge T_{amb} \ge T_{max}$ R_L = 2 kΩ R_L = 10 kΩ	 12 10 10 12	 13.5 13		V
S_{VO}	Slew Rate (V_I = ± 10 V R_L = 2 kΩ $C_L \le$ 100 pF, T_{amb} = 25 °C, unity gain)	 0.45	 0.7		V/μs
t_r t_f	Rise Time and Fall Time (V_O = ± 20 mV, R_L = 2 kΩ, $C_L \le$ 100 pF T_{amb} = 25 °C, unity gain)		 0.18 0.18		μs
K_{OV}	Overshoot (V_I = ± 20 mV, R_L = 2 kΩ $C_L \le$ 100 pF, T_{amb} = 25 °C, unity gain)		 10		%
Z_I	Input Impedance, T_{amb} = 25 °C	0.3	1		MΩ
Z_O	Output Impedance, T_{amb} = 25 °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
Φm	Phase Margin		60		Degrees
DV_{IO}	Input Offset Voltage Drift $T_{min} \le T_{amb} \le T_{max}$		10		µV/°C
DI_{IO}	Input Offset Current Drift $T_{min} \le T_{amb} \le 25$ °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 $T_{min} \le T_{amb} \le T_{max}$		1	5 6	mV
I_{IO}	Input Offset Current T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$		2	20 40	nA
I_{IB}	Input Bias Current T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$		40	100 200	nA
A_{VD}	Large Signal Voltage Gain (V_O = ± 10 V, R_L = 2 kΩ) T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$	10 5	200		V/mV
SVR	Supply Voltage Rejection Ratio (R_S ≤ 10 kΩ) T_{amb} = 25 °C $T_{min} \le T_{amb} \le T_{max}$	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

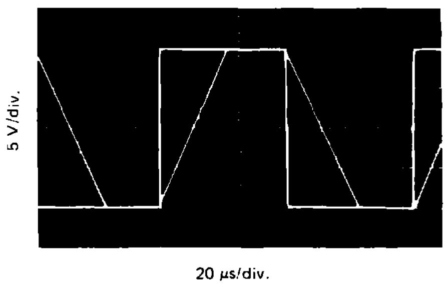
The MC3403 is made using four internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices Q24 and Q22 with input buffer transistors Q25 and Q21 and the differential to single ended converter Q3 and Q4. The first stage performs not only the 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



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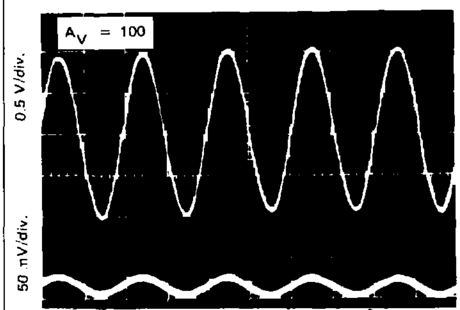
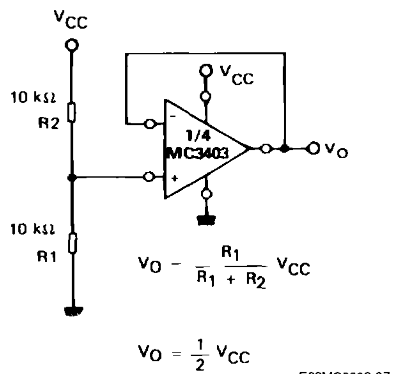


E88MC3303-06

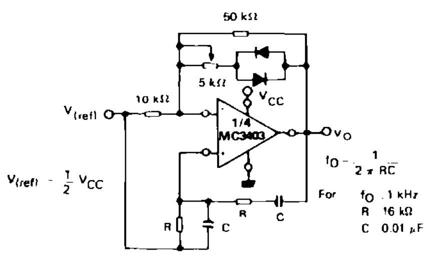
APPLICATION INFORMATION

VOLTAGE REFERENCE



E88MC3303-07

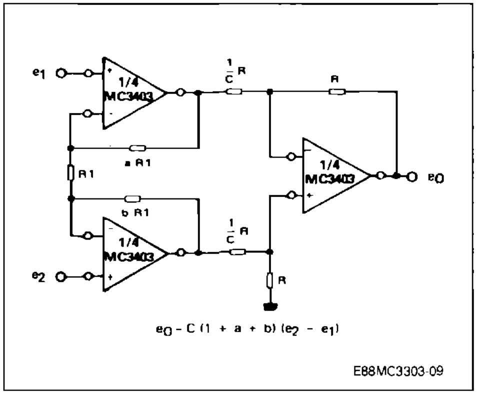
WIEN BRIDGE OSCILLATOR



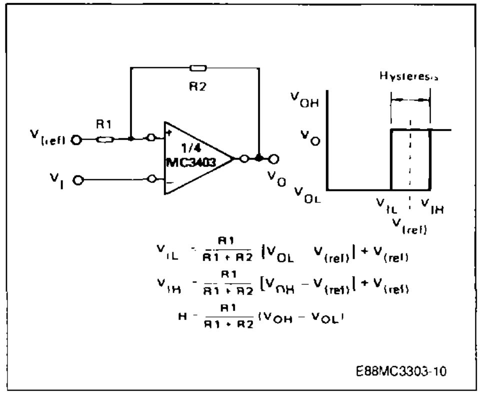
E88MC3303-08

APPLICATION INFORMATION (continued)

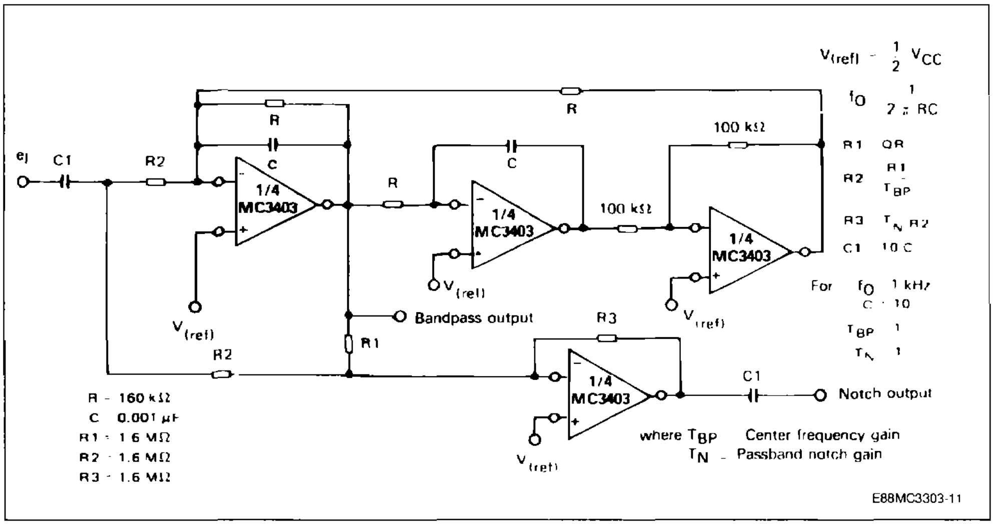
HIGH IMPEDANCE DIFFERENTIAL AMPLIFIER



COMPARATOR WITH HYSTERESIS

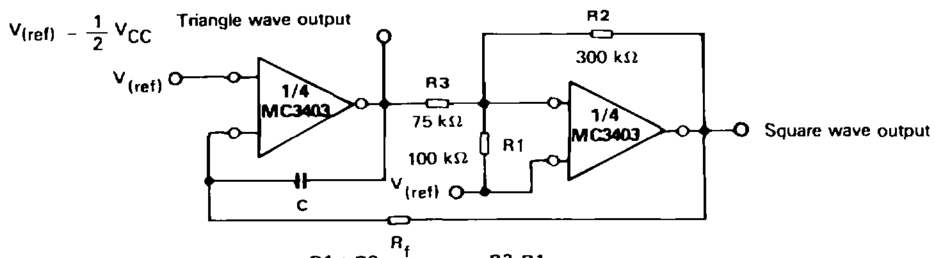


BI-QUAD FILTER



APPLICATION INFORMATION (continued)

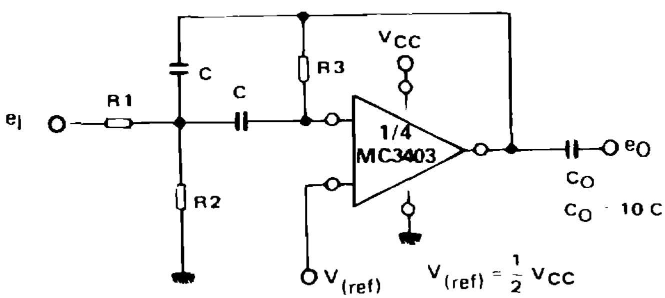
FUNCTION GENERATOR



$$f = \frac{R1 + R2}{4\,C R_f\,R1} \quad \text{if} \quad R3 = \frac{R2\ R1}{R2 + R1}$$

E88MC3303-12

MULTIPLE FEEDBACK BANDPASS FILTER



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Given f_O = Center frequency choose values f_O, C then : $R3 = \frac{Q}{\Pi f_O C}$

$A(f_O)$ = Gain at center frequency

$$R1 = \frac{R3}{2A\,(f_O)}$$

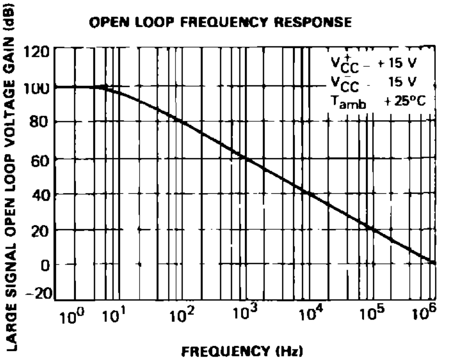
$$R2 = \frac{R1\ R5}{4Q^2\,R1 - R5}$$

For less than 10 % error operational amplifiers

$\frac{Q_O f_O}{BW} < 0.1$ where f_O 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



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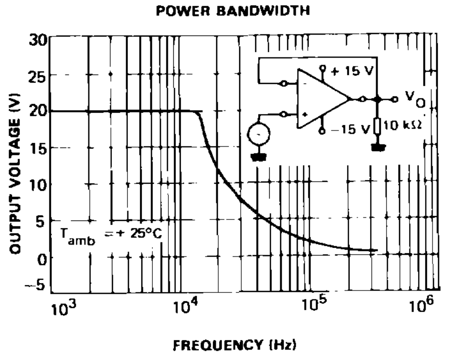
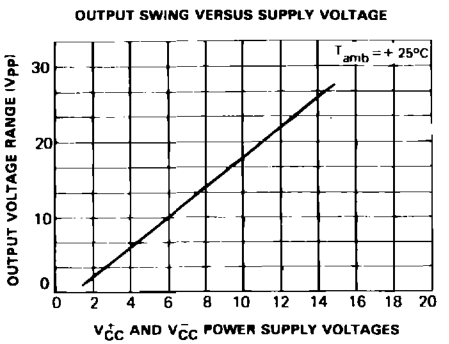


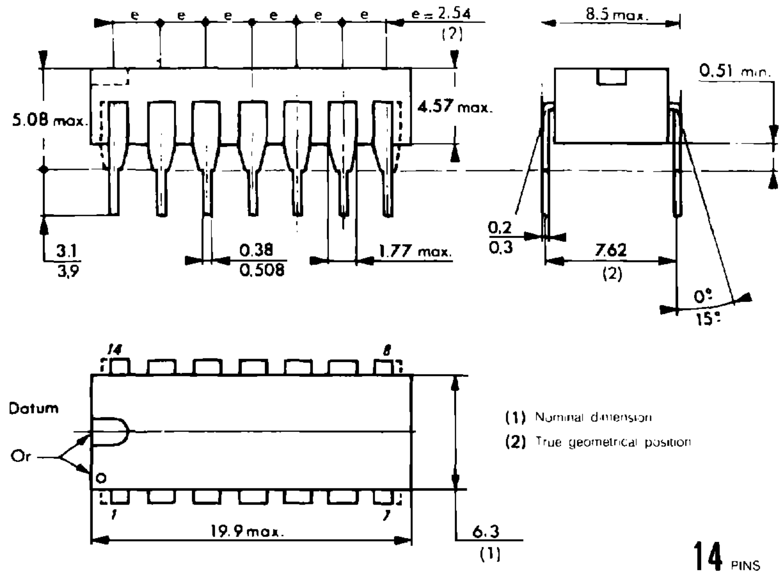
E88MC3303-15



E88MC3303-16

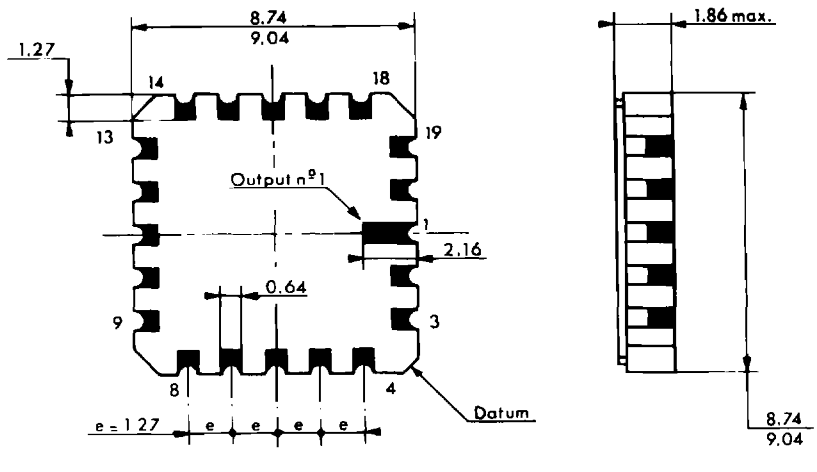
PACKAGE MECHANICAL DATA

14 PINS – PLASTIC DIP OR CERDIP



14 PINS

20 PINS – TRICECOP (LCC)



20 PINS

PACKAGE MECHANICAL DATA (continued)

14 PINS – PLASTIC MICROPACKAGE (SO)