# THOMSON SEMICONDUCTORS

# UA776

## PROGRAMMABLE SINGLE OP-AMPs

The UA776 programmable operational amplifier is characterized by high input impedance, low supply currents and low input noise over a wide range of operating supply voltages.

Coupled with programmable electrical characteristics it is an extremely versatile amplifier for use in high accuracy, low power consumption analog applications.

Input noise voltage and current, power consumption, and input current can be optimized by a single resistor or current source that sets the chip quiescent current for nano-watt power consumption or for characteristics similar to the UA741.

Internal frequency compensation, absence of latch up, high slew rate and short circuit protection assure ease of use in long time integrators, active filters, and sample and hold circuits.

- Micropower operation.
- No frequency compensation required.
- Wide programming range.
- High slew rate.
- Short-circuit protection.

### ORDERING INFORMATION

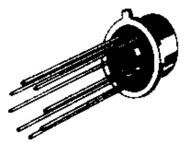
Hi-Rel versions available - See chapter 14

| PART NUMBER | TEMPERATURE RANGE | PACKAGE | | | |
|---|---|---|---|---|---|
| | | H | DP | GC | FP |
| UA776C | 0°C to + 70°C | • | • | | • |
| UA776M | – 55°C to + 125°C | • | | • | |
| **Examples :** UA776CH, UA776CDP, UA776CFP | | | | | |

## PROGRAMMABLE SINGLE OP-AMPs

### CASES

**CB-11** (TO-99)



**H SUFFIX** METAL CAN

**CB-98**

**DP SUFFIX** PLASTIC PACKAGE

**CB-705**

**GC SUFFIX** TRICECOP (LCC)

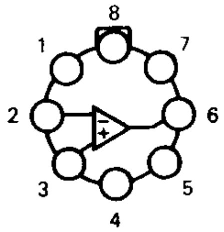
**CB-342**

**FP SUFFIX** PLASTIC MICROPACKAGE

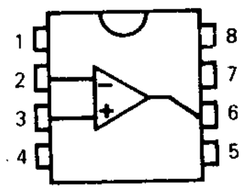
### PIN ASSIGNMENTS

**(Top views)**

**CB-11**



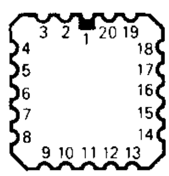

**CB-98**
**CB-342**




1 - Offset null
2 - Inverting input
3 - Non-inverting input
4 - $V_{CC}^-$
5 - Offset null
6 - Output
7 - $V_{CC}^+$
8 - $I_{set}$



**CB-705**




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

Réf. 00290

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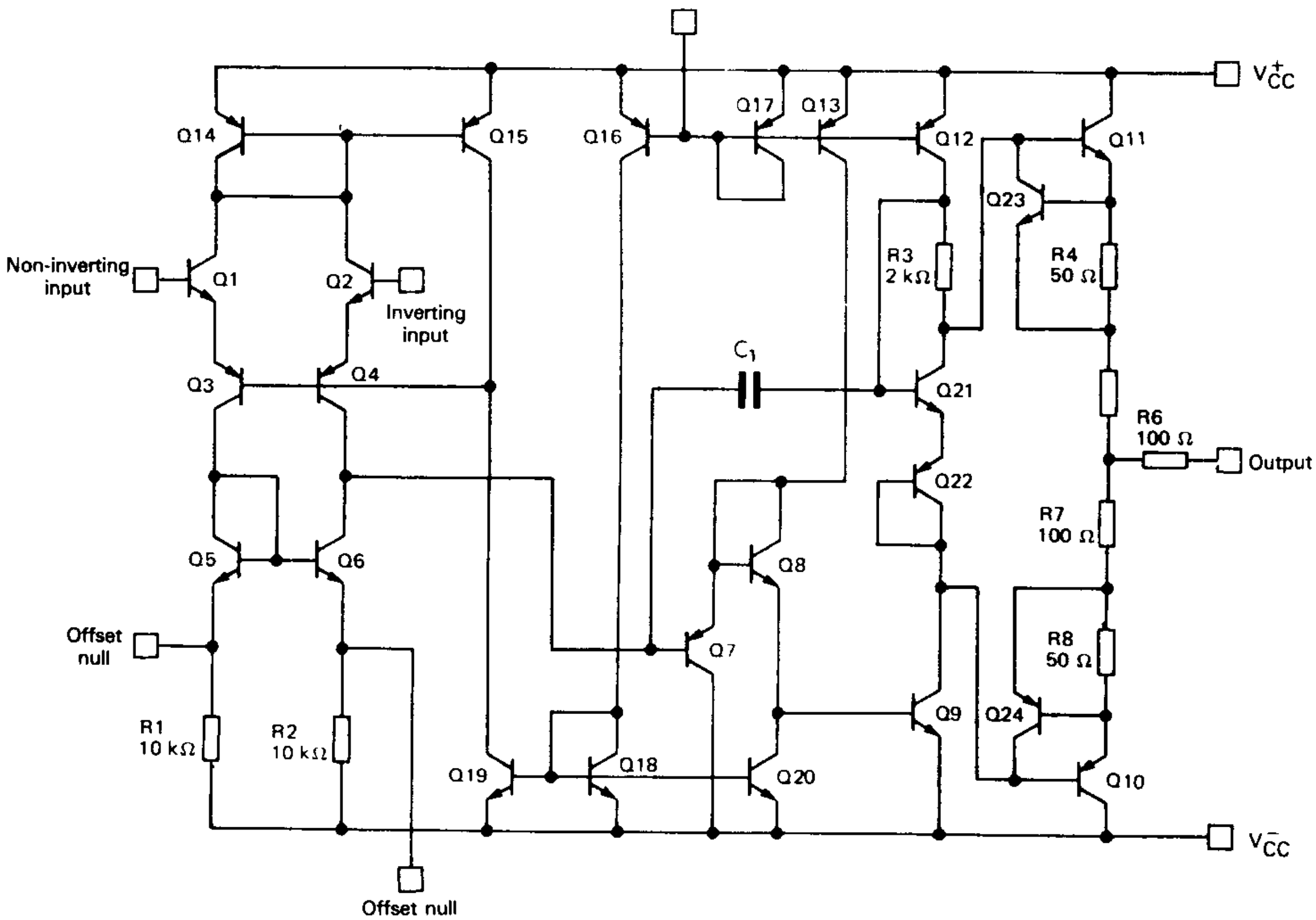
## MAXIMUM RATINGS

| Rating | Symbol | UA776M | UA776C | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | ± 18 | ± 18 | V |
| Differential input voltage | $V_{ID}$ | ± 30 | ± 30 | V |
| Input voltage (Note 1) | $V_I$ | ± 15 | ± 15 | V |
| Output short-circuit duration (Note 2) | – | Indefinite | Indefinite | – |
| Power dissipation<br>UA776GC<br>UA776CH | $P_{tot}$ | 500<br>665<br>– | 310<br>–<br>500 | mW |
| Operating free-air temperature range | $T_{oper}$ | – 55 to + 125 | 0 to + 70 | °C |
| Storage temperature range<br>UA776CH | $T_{stg}$ | – 65 to + 150<br>– | – 55 to + 125<br>– 65 to + 150 | °C |

**Note 1** : For supply voltages less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.
**Note 2** : Short-circuit may be to ground or either supply. Rating applies to + 125°C package temperature serial M or + 75°C serial C ambient temperature for $I_{set} \leqslant 30\ \mu A$.
Devices bonded on a 6 cm × 3 cm × 0.15 cm glass-epoxy substrate with 30 mm² of 35 µm thick copper.

### SCHEMATIC DIAGRAM




| CASE | Offset null | Inverting input | Non-inverting input | Output | $V_{CC}^-$ | $V_{CC}^+$ | $I_{set}$ |
|---|---|---|---|---|---|---|---|
| CB-11/CB-98<br>CB-342 | 1, 5 | 2 | 3 | 6 | 4 | 7 | 8 |
| CB-705* | 2, 12 | 5 | 7 | 15 | 10 | 17 | 20 |

* **CB-705** : Other pins are not connected

## ELECTRICAL CHARACTERISTICS

**UA776M** : $-55°C \leq T_{amb} \leq +125°C$, $V_{CC} = \pm 15$ V
**UA776C** : $-\ 0°C \leq T_{amb} \leq +\ 70°C$, $V_{CC} = \pm 15$ V
(Unless otherwise specified)

| Characteristic | | Symbol | $I_{set} = 1.5\ \mu A$ | | | $I_{set} = 15\ \mu A$ | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| Input offset voltage $T_{amb} = +25°C$ | UA776M | $V_{IO}$ | – | 2 | 5 | – | 2 | 5 | mV |
| | UA776C | | – | 2 | 6 | – | 2 | 6 | |
| $T_{min} \leq T_{amb} \leq T_{max}$ | UA776M | | – | – | 6 | – | – | 6 | |
| | UA776C | | – | – | 7.5 | – | – | 7.5 | |
| Input offset current $T_{amb} = +25°C$ | UA776M | $I_{IO}$ | – | 0.7 | 3 | – | 2 | 15 | nA |
| | UA776C | | – | 0.7 | 6 | – | 2 | 25 | |
| $T_{amb} = T_{max}$ | UA776M | | – | – | 5 | – | – | 15 | |
| | UA776C | | – | – | 6 | – | – | 25 | |
| $T_{amb} = T_{min}$ | | | – | – | 10 | – | – | 40 | |
| Input bias current $T_{amb} = +25°C$ | UA776M | $I_{IB}$ | – | 2 | 7.5 | – | 15 | 50 | nA |
| | UA776C | | – | 2 | 10 | – | 15 | 50 | |
| $T_{amb} = T_{max}$ | UA776M | | – | – | 7.5 | – | – | 50 | |
| | UA776C | | – | – | 10 | – | – | 50 | |
| $T_{amb} = T_{min}$ | UA776M | | – | – | 20 | – | – | 120 | |
| | UA776C | | – | – | 20 | – | – | 100 | |
| Large signal voltage gain ($V_O = \pm 10$ V) $T_{amb} = +25°C$, $R_L \geq 5$ kΩ | UA776M | $A_{VD}$ | – | – | – | $10^5$ | $4.10^5$ | – | V/V |
| | UA776C | | – | – | – | $5.10^4$ | $4.10^5$ | – | |
| $T_{amb} = +25°C$, $R_L \geq 75$ kΩ | UA776M | | $2.10^5$ | $4.10^5$ | – | – | – | – | |
| | UA776C | | $5.10^4$ | $4.10^5$ | – | – | – | – | |
| $T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 75$ kΩ | UA776M | | $10^5$ | – | – | $7.5.10^4$ | – | – | |
| | UA776C | | $5.10^4$ | – | – | $5.10^4$ | – | – | |
| Supply voltage rejection ratio ($R_S \leq 10$ kΩ) | UA776M | SVR | – | 25 | 150 | – | 25 | 150 | µV/V |
| | UA776C | | – | 25 | 200 | – | 25 | 200 | |
| Supply current $T_{amb} = +25°C$ | UA776M | $I_{CC}$ | – | 20 | 25 | – | 160 | 180 | µA |
| | UA776C | | – | 20 | 30 | – | 160 | 190 | |
| $T_{min} \leq T_{amb} \leq T_{max}$ | UA776M | | – | – | 30 | – | – | 200 | |
| | UA776C | | – | – | 35 | – | – | 200 | |
| Power consumption $T_{amb} = +25°C$ | UA776M | $P_D$ | – | – | 0.75 | – | – | 5.4 | mW |
| | UA776C | | – | – | 0.9 | – | – | 5.7 | |
| $T_{min} \leq T_{amb} \leq T_{max}$ | UA776M | | – | – | 30 | – | – | 200 | |
| | UA776C | | – | – | 35 | – | – | 200 | |
| Input voltage range | | $V_I$ | ± 10 | – | – | ± 10 | – | – | V |
| Common-mode rejection ratio ($R_S \leq 10$ kΩ) | | CMR | 70 | 90 | – | 70 | 90 | – | dB |
| Output short-circuit current | | $I_{OS}$ | – | 3 | – | – | 12 | – | mA |
| Output voltage swing $T_{amb} = +25°C$, $R_L \geq 5$ kΩ | | $V_{OPP}$ | – | – | – | ± 10 | ± 13 | – | V |
| $R_L \geq 75$ kΩ | | | ± 12 | ± 14 | – | – | – | – | |
| $T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 75$ kΩ | | | ± 10 | – | – | ± 10 | – | – | |
| Offset voltage adjustement range ($T_{amb} = +25°C$) | | $V_{IOR}$ | – | 9 | – | – | 18 | – | mV |
| Slew rate ($R_L \geq 5$ kΩ, $T_{amb} = +25°C$) | | $S_{VO}$ | – | 0.1 | – | – | 0.8 | – | V/µs |
| Rise time ($V_I = +20$ mV, $C_L = 100$ pF, $R_L \geq 5$ kΩ, $T_{amb} = +25°C$) | | $t_r$ | – | 1.6 | – | – | 0.35 | – | µs |
| Input resistance ($T_{amb} = +25°C$) | | $R_I$ | – | 50 | – | – | 5 | – | MΩ |
| Output resistance ($T_{amb} = +25°C$) | | $R_O$ | – | 5 | – | – | 1 | – | kΩ |
| Overshoot factor ($V_I = +20$ mV, $C_L = 100$ pF, $R_L \geq 5$ kΩ, $T_{amb} = +25°C$) | | $K_{OV}$ | – | 0 | – | – | 10 | – | % |
| Differential input capacitance ($T_{amb} = +25°C$) | | $C_{ID}$ | – | 2 | – | – | 2 | – | pF |

**ELECTRICAL CHARACTERISTICS (continued)**

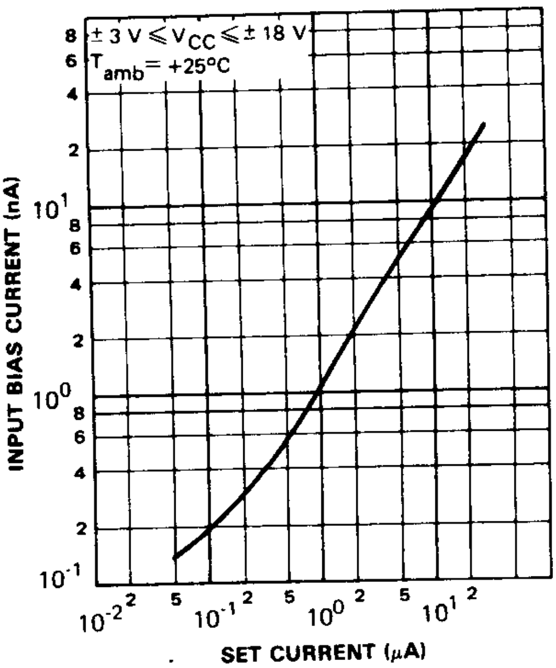
**UA776M** : $-55°C \leq T_{amb} \leq +125°C$, $V_{CC} = \pm 3$ V

**UA776C** : $-\ 0°C \leq T_{amb} \leq +\ 70°C$, $V_{CC} = \pm 3$ V

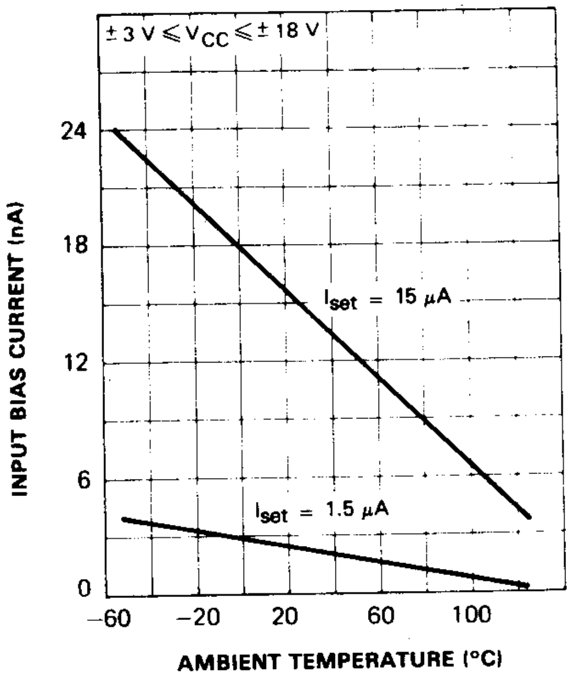
(Unless otherwise specified)

| Characteristic | | Symbol | $I_{set} = 1.5\ \mu A$ | | | $I_{set} = 15\ \mu A$ | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| Input offset voltage | | $V_{IO}$ | | | | | | | mV |
| $T_{amb} = +25°C$ | UA776M | | – | 2 | 5 | – | 2 | 5 | |
| | UA776C | | – | 2 | 6 | – | 2 | 6 | |
| $T_{min} \leq T_{amb} \leq T_{max}$ | UA776M | | – | – | 6 | – | – | 6 | |
| | UA776C | | – | – | 7.5 | – | – | 7.5 | |
| Input offset current | | $I_{IO}$ | | | | | | | nA |
| $T_{amb} = +25°C$ | UA776M | | – | 0.7 | 3 | – | 2 | 15 | |
| | UA776C | | – | 0.7 | 6 | – | 2 | 25 | |
| $T_{amb} = T_{max}$ | UA776M | | – | – | 5 | – | – | 15 | |
| | UA776C | | – | – | 6 | – | – | 25 | |
| $T_{amb} = T_{min}$ | | | – | – | 10 | – | – | 40 | |
| Input bias current | | $I_{IB}$ | | | | | | | nA |
| $T_{amb} = +25°C$ | UA776M | | – | 2 | 7.5 | – | 15 | 50 | |
| | UA776C | | – | 2 | 10 | – | 15 | 50 | |
| $T_{amb} = T_{max}$ | UA776M | | – | – | 7.5 | – | – | 50 | |
| | UA776C | | – | – | 10 | – | – | 50 | |
| $T_{amb} = T_{min}$ | UA776M | | – | – | 20 | – | – | 120 | |
| | UA776C | | – | – | 20 | – | – | 100 | |
| Large signal voltage gain ($V_O = \pm 1$ V) | | $A_{VD}$ | | | | | | | V/V |
| $T_{amb} = +25°C$, $R_L \geq 5\ k\Omega$ | UA776M | | – | – | – | $5.10^4$ | $2.10^5$ | – | |
| | UA776C | | – | – | – | $2.5.10^4$ | $2.10^5$ | – | |
| $R_L \geq 75\ k\Omega$ | UA776M | | $5.10^4$ | $2.10^5$ | – | – | – | – | |
| | UA776C | | $2.5.10^4$ | $2.10^5$ | – | – | – | – | |
| $T_{min} \leq T_{amb} \leq T_{max}$, $R_L \geq 5\ k\Omega$ | | | – | – | – | $2.5.10^4$ | – | – | |
| $R_L \geq 75\ k\Omega$ | | | $2.5.10^4$ | – | – | – | – | – | |
| Supply voltage rejection ratio ($R_S \leq 10\ k\Omega$) | | SVR | | | | | | | µV/V |
| | UA776M | | – | 25 | 150 | – | 25 | 150 | |
| | UA776C | | – | 25 | 200 | – | 25 | 200 | |
| Supply current | | $I_{CC}$ | | | | | | | µA |
| $T_{amb} = +25°C$ | UA776M | | – | 13 | 20 | – | 130 | 160 | |
| | UA776C | | – | 13 | 20 | – | 130 | 170 | |
| $T_{min} \leq T_{amb} \leq T_{max}$ | | | – | – | 25 | – | – | 180 | |
| Power consumption | | $P_D$ | | | | | | | µW |
| $T_{amb} = +25°C$ | UA776M | | – | 78 | 120 | – | 780 | 960 | |
| | UA776C | | – | 78 | 120 | – | 780 | 1020 | |
| $T_{min} \leq T_{amb} \leq T_{max}$ | UA776M | | – | – | 150 | – | – | 1080 | |
| | UA776C | | – | – | 150 | – | – | 1080 | |
| Input voltage range | | $V_I$ | ±1 | – | – | ±1 | – | – | V |
| Common-mode rejection ratio ($R_S \leq 10\ k\Omega$) | | CMR | 70 | 86 | – | 70 | 86 | – | dB |
| Output short-circuit current ($T_{amb} = +25°C$) | | $I_{OS}$ | – | 3 | – | – | 5 | – | mA |
| Output voltage swing | | $V_{OPP}$ | | | | | | | V |
| $R_L \geq 5\ k\Omega$ | UA776C | | – | – | – | ±2 | +2.1 | – | |
| | UA776M | | – | – | – | ±1.9 | ±2.1 | – | |
| $R_L \geq 75\ k\Omega$ | | | ±2 | ±2.4 | – | ±2 | ±2.4 | – | |
| Offset voltage adjustement range ($T_{amb} = +25°C$) | | $V_{IOR}$ | – | 9 | – | – | 18 | – | mV |
| Slew rate ($R_L \geq 5\ k\Omega$, $T_{amb} = +25°C$) | | $S_{VO}$ | – | 0.03 | – | – | 0.35 | – | V/µs |
| Rise time ($V_I = +20$ mV, $C_L = 100$ pF, $R_L \geq 5\ k\Omega$, $T_{amb} = +25°C$) | | $t_r$ | – | 3 | – | – | 0.6 | – | µs |
| Input resistance ($T_{amb} = +25°C$) | | $R_I$ | – | 50 | – | – | 5 | – | MΩ |
| Output resistance ($T_{amb} = +25°C$) | | $R_O$ | – | 5 | – | – | 1 | – | kΩ |
| Overshoot factor ($V_I = +20$ mV, $C_L = 100$ pF, $R_L \geq 5\ k\Omega$, $T_{amb} = +25°C$) | | $K_{OV}$ | – | 0 | – | – | 5 | – | % |
| Differential input capacitance ($T_{amb} = +25°C$) | | $C_{ID}$ | – | 2 | – | – | 2 | – | pF |

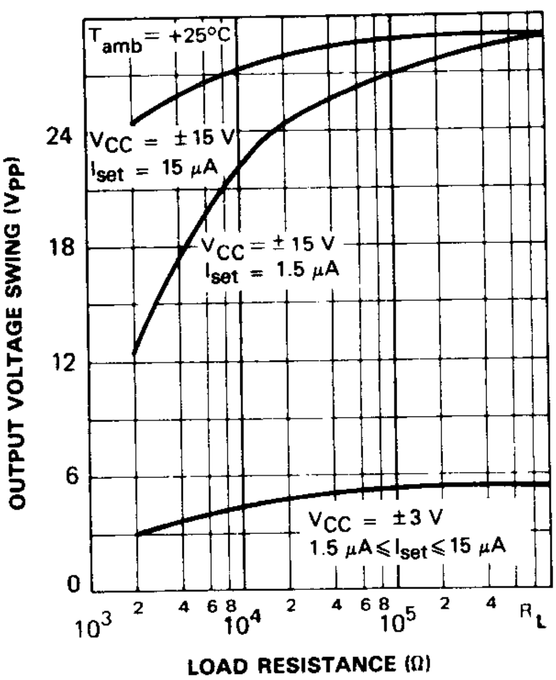
INPUT BIAS CURRENT



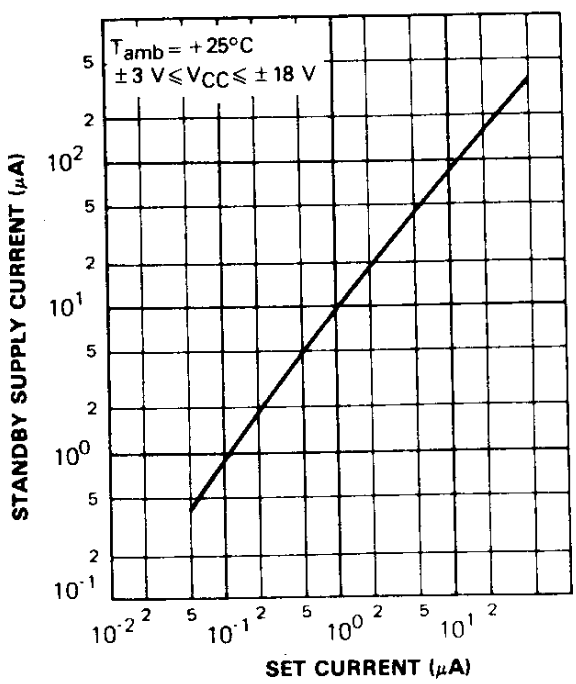

INPUT BIAS CURRENT



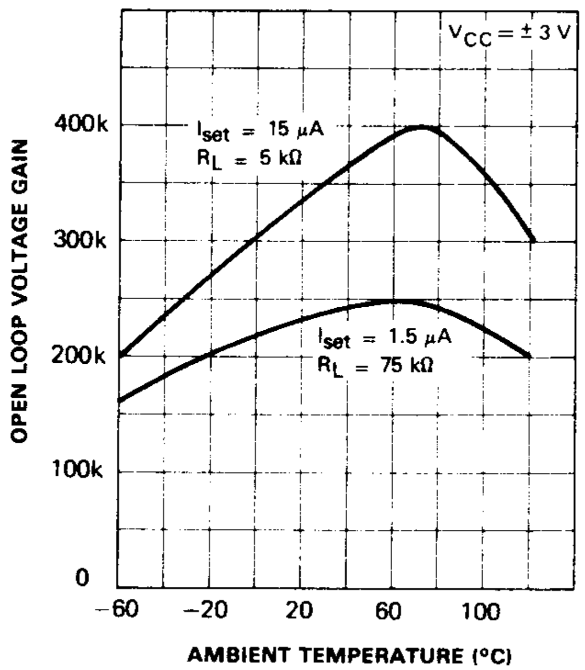

OUTPUT VOLTAGE SWING



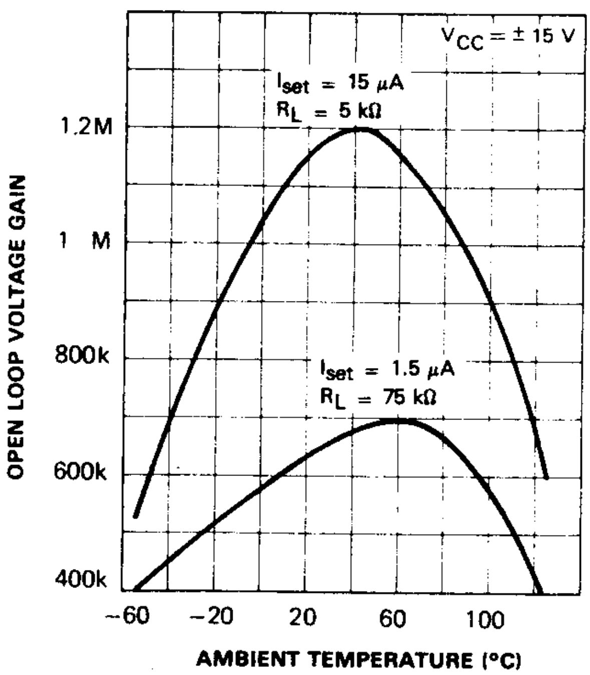

STANDBY SUPPLY CURRENT VERSUS SET CURRENT



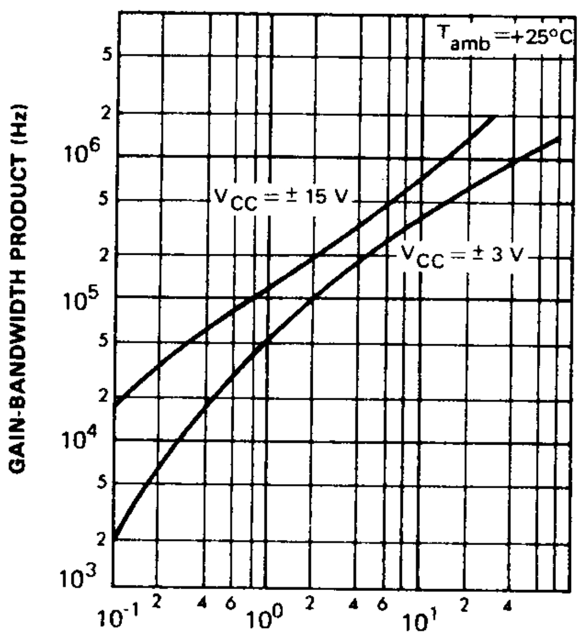
### OPEN LOOP VOLTAGE GAIN



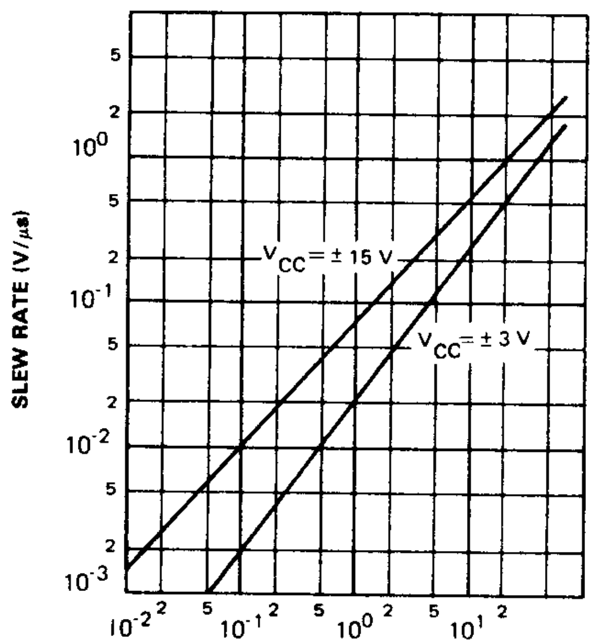

### OPEN LOOP VOLTAGE GAIN



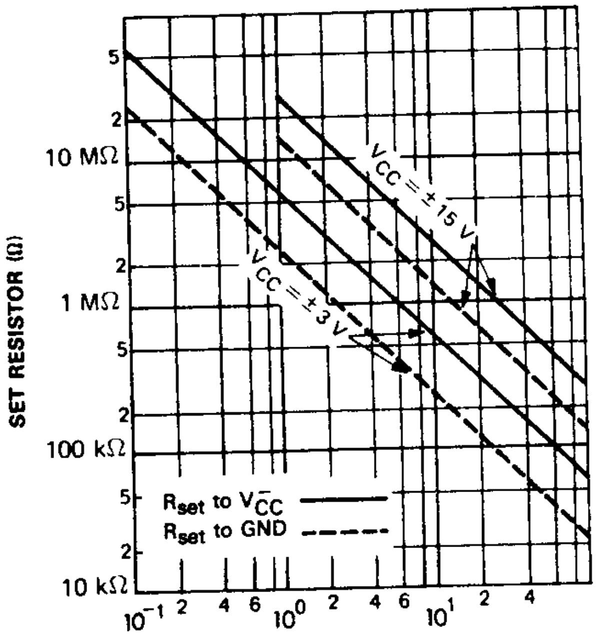

### GAIN-BANDWIDTH




### SLEW RATE



SET RESISTOR vs SET CURRENT




**$I_{set}$ EQUATIONS**

$$I_{set} = \frac{V_{CC}^+ - 0.7 - V_{CC}^-}{R_{set}}$$

when $R_{set}$ is connected to $V_{CC}^-$.

$$I_{set} = \frac{V_{CC}^+ - 0.7}{R_{set}}$$

when $R_{set}$ is connected to ground.

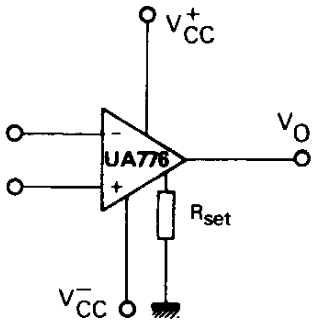
**QUIESCENT CURRENT SETTING RESISTOR ($I_{set}$ to $V_{CC}^-$)**

| $V_{CC}$ | $I_{set}$ | |
|---|---|---|
| | 1.5 μA | 15 μA |
| ± 1.5 V | 1.7 MΩ | 170 kΩ |
| ± 3 V | 3.6 MΩ | 360 kΩ |
| ± 6 V | 7.5 MΩ | 750 kΩ |
| ± 15 V | 20 MΩ | 2 MΩ |

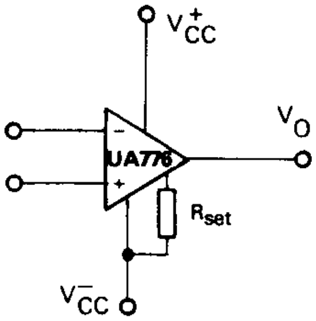
**Note** : The UA776 may be operated with $R_{set}$ connected to ground or $V_{CC}^-$.

## BIASING CIRCUITS

### RESISTOR BIASING

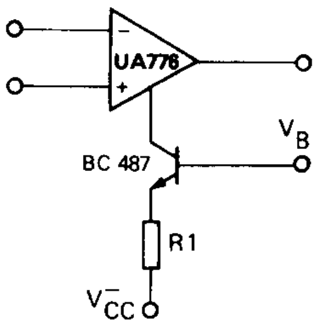



$R_{set}$ connected to ground.

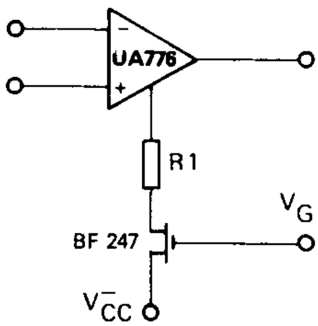



$R_{set}$ connected to $V_{CC}^{-}$.
Recommended for : $V_{CC} \leq \pm 6$ V

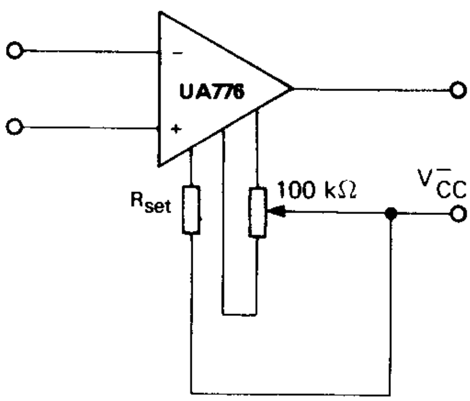
### TRANSISTOR CURRENT SOURCE BIASING



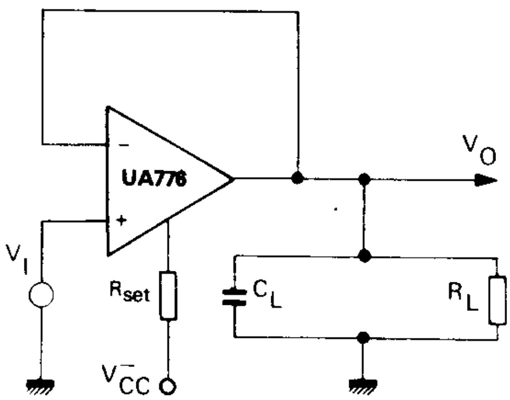

### FET CURRENT SOURCE BIASING




### VOLTAGE OFFSET NULL CIRCUIT

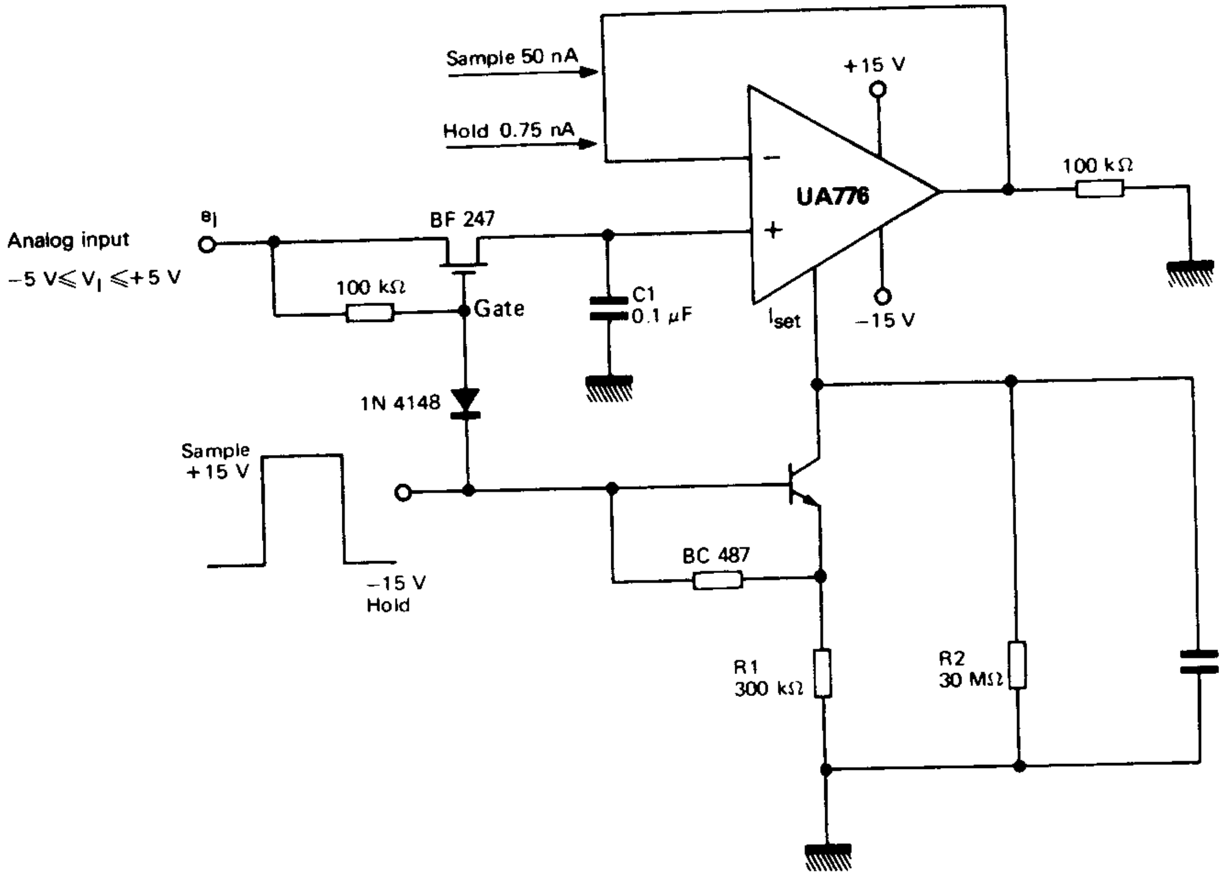



### TRANSIENT RESPONSE TIME TEST CIRCUIT

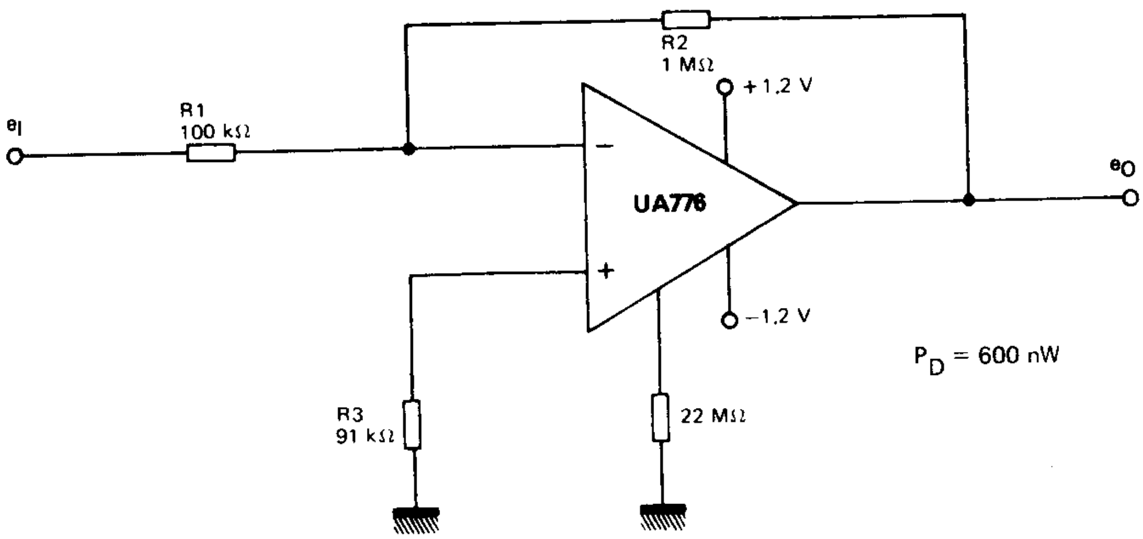


## TYPICAL APPLICATIONS

### HIGH ACCURACY SAMPLE AND HOLD

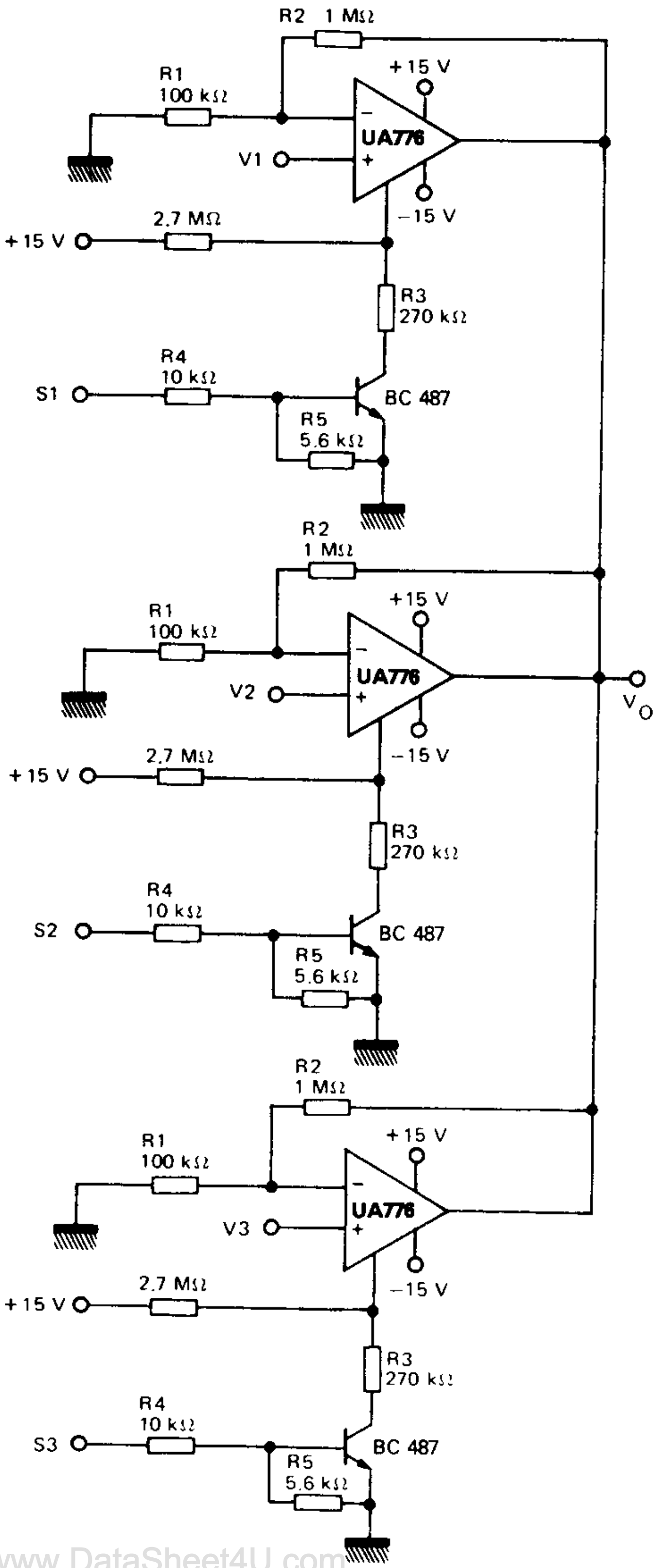



### NANO-WATT AMPLIFIER

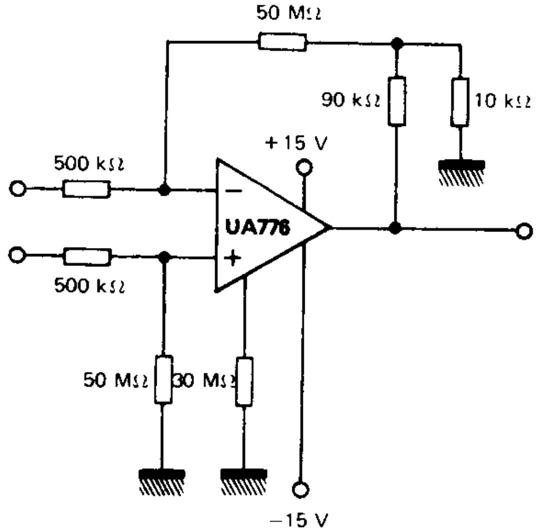


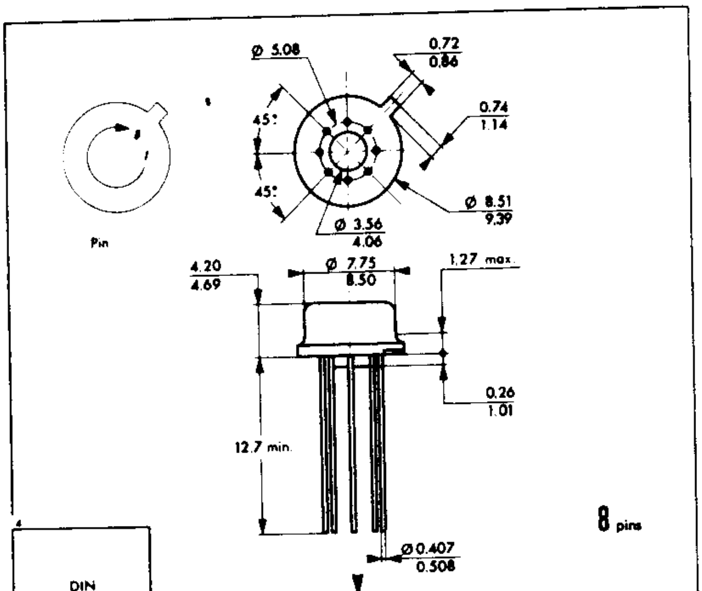
## TYPICAL APPLICATIONS (continued)

### MULTIPLEXING AND SIGNAL CONDITIONING WITHOUT FETs



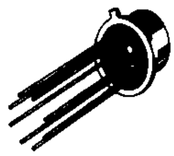

### HIGH INPUT IMPEDANCE AMPLIFIER



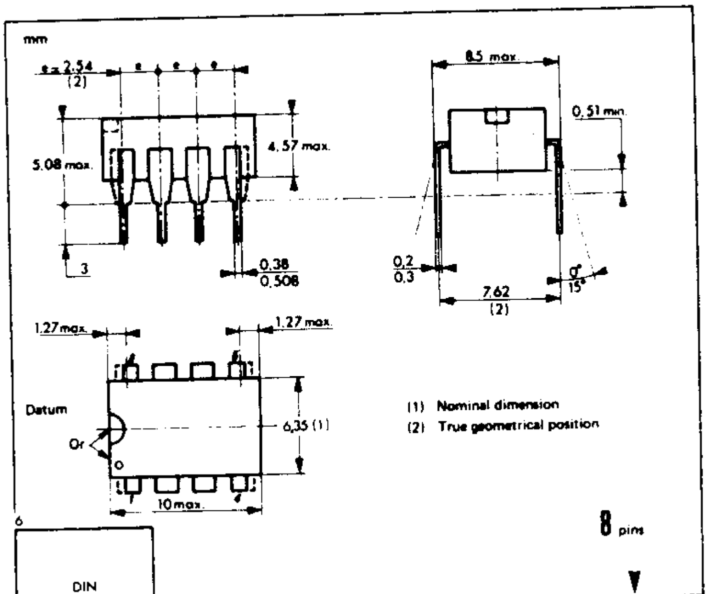



| DIN | | | | |
|---|---|---|---|---|
| Case : Base : C-23 CEI | TO-99 D.A.T.A. | TO-99 JEDEC | F 101 SITELESC | CB-11 THOMSON SEMICONDUCTORS |

**CB-11**
(TO-99)



**H SUFFIX**
METAL CAN

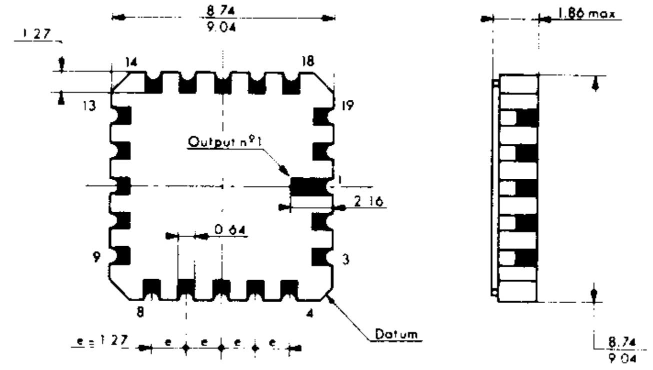



| DIN | | | | |
|---|---|---|---|---|
| A50D CEI | D.A.T.A. | JEDEC | F 116 A SITELESC | CB-98 THOMSON SEMICONDUCTORS |

**CB-98**

**DP SUFFIX**
PLASTIC PACKAGE
**DG SUFFIX**
CERDIP PACKAGE

mm



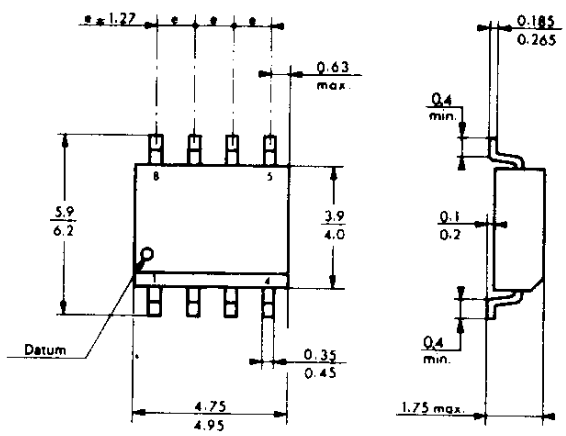

20 pins

| DIN | | | | |
|---|---|---|---|---|
| MS004 CB<br>CEI | D.A.T.A. | TMS004 CB<br>JEDEC | SITELESC | CB-705<br>THOMSON<br>SEMICONDUCTORS |

**CB-705**

**GC SUFFIX**
TRICECOP (LCC)

mm




8 pins

| DIN | SO8 | | | |
|---|---|---|---|---|
| CEI | D.A.T.A. | JEDEC | SITELESC | CB-342<br>THOMSON<br>SEMICONDUCTORS |

**CB-342**

**FP SUFFIX**
PLASTIC
MICROPACKAGE

These specifications are subject to change without notice.
Please inquire with our sales offices about the availability of the different packages.