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Philips Semiconductors

| Data sheet | |
|---|---|
| status | Objective specification |
| date of issue | October 1991 |

# UAA2090T
## 900 MHz front end circuit for cordless communication

INTEGRATED CIRCUITS
IC03

### FEATURES

- Operating frequency range up to 870 MHz
- Wide pre-amplifier AGC range
- IF frequency range from 0 up to 1 MHz
- Low noise figure
- Mode select input for one IF mixer/amplifier
- Supply voltage down to 3 V
- Low current consumption
- Stand-by mode
- Reference voltage output

### QUICK REFERENCE DATA

| SYMBOL | PARAMETER | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{P1}$ | supply voltage (pin 3) | 3 | 5 | 5.5 | V |
| $V_{P2}$ | supply voltage (pin 17) | 3 | 5 | 5.5 | V |
| $I_P$ | supply current ($I_3$+$I_{17}$) | - | 7.5 | 9 | mA |
| | stand-by current | - | 20 | 40 | µA |
| $V_{ref}$ | reference output voltage (pin 13) | 1.44 | 1.6 | 1.76 | V |
| $f_{i\ RF}$ | radio input frequency | - | 870 | - | MHz |
| $G_v$ | pre-amplifier gain range | - | 28 | - | dB |
| NF | noise figure pre-amplifier | - | 3.0 | - | dB |
| $T_{amb}$ | operating ambient temperature | −10 | - | 70 | °C |

### GENERAL DESCRIPTION

The UAA2090T is provided for cordless telephone applications according to CT2 standard; and it can be used in low-power applications (handsets) due to its low supply voltage and low power consumption. Independent of the receiver architecture, the UAA2090T can perform a convenient mix-down from radio frequencies to baseband level by mode selection. Further control functions reduce the amount of components and thus the size of handsets. The isolation between mixer injection frequency and RF input signal has been optimized.

### ORDERING INFORMATION

| EXTENDED TYPE NUMBER | PACKAGE | | | |
|---|---|---|---|---|
| | PINS | PIN POSITION | MATERIAL | CODE |
| UAA2090T | 20 | mini-pack | plastic | SOT163A |



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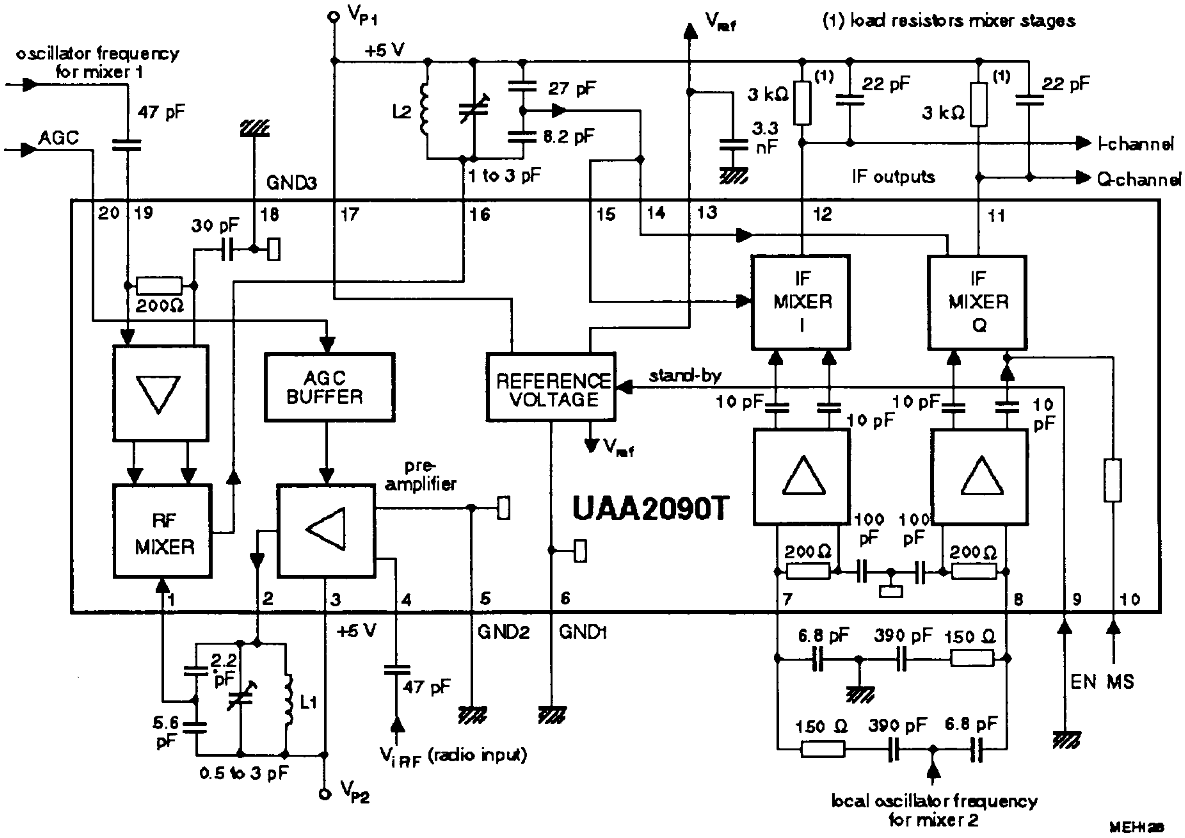



L1 = 4.7 nH ($Q_{min}$ = 20 at 870 MHz)
L2 = 100 nH ($Q_{min}$ = 30 at 150 MHz)

Fig.1 Block diagram and application circuit.

## PINNING

| SYMBOL | PIN | DESCRIPTION |
|---|---|---|
| $V_{i\,M1}$ | 1 | RF input signal to mixer 1 |
| $V_{o\,RF}$ | 2 | RF pre-amplifier output signal |
| $V_{P2}$ | 3 | +5 V supply voltage for pre-amplifier |
| $V_{i\,RF}$ | 4 | RF pre-amplifier input |
| GND2 | 5 | ground 2 (0 V) for pre-amplifier |
| GND1 | 6 | ground 1(0 V) |
| $V_{osMI}$ | 7 | local oscillator signal to mixer 2a (I-channel) |
| $V_{osMQ}$ | 8 | local oscillator signal to mixer 2b (Q-channel) |
| EN | 9 | enable active LOW, switching from stand-by to run |
| MS | 10 | mode select |
| $V_{o\,Q}$ | 11 | IF output signal of Q-channel |
| $V_{o\,I}$ | 12 | IF output signal of I-channel |
| $V_{ref}$ | 13 | 1.6 V reference voltage output |
| $V_{i\,MQ}$ | 14 | IF input signal of mixer 2b (Q-channel) |
| $V_{i\,MI}$ | 15 | IF input signal of mixer 2a (I-channel) |
| $V_{o\,M1}$ | 16 | mixer 1 output signal |
| $V_{P1}$ | 17 | +5 V supply voltage |
| GND3 | 18 | ground 3 (0 V) for mixer 1 |
| $V_{osM1}$ | 19 | oscillator signal for mixer 1 |
| AGC | 20 | AGC input voltage for the pre-amplifier |

## PIN CONFIGURATION

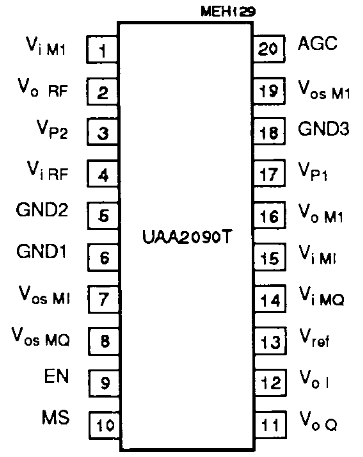



Fig.2 Pin configuration.

## FUNCTIONAL DESCRIPTION

### Pre-amplifier

The pre-amplifier has a diode-biased input with a typical bias current of 1 mA and input impedance of 50 Ω . The AGC voltage on pin 20 determines the pre-amplifier gain over a wide range. Since the output is open-collector, the maximum voltage gain is determined by the Q-factor of the external resonant circuit.

### RF mixer

The RF mixer is an active, single-balanced mixer with typical bias current of 1 mA and with an open-collector output. The local oscillator input signal is fed to the mixer via a buffer amplifier. The input impedance is 200 Ω.

### IF mixers (I and Q)

Two separate IF mixers are provided to generate the I-channel IF and the Q-channel IF. The IF mixers are active, single-balanced mixers with typical bias currents of 1 mA and with open-collector outputs. The local oscillator input signals are fed to the mixers via buffer amplifiers with input impedances of 200 Ω (at 150 MHz).

### Mode select (MS)

One of the IF mixers can be used as a simple linear amplifier for different applications in telephone sets (MS connected to GND via a 20 kΩ resistor). The mixer can be switched off for other applications to reduce the supply current (MS connected to $V_{P1}$). MS is open-circuit for applications with two separate IF mixers,.

### Stand-by (EN)

When the voltage on pin 9 is EN > $V_{P1}/2 + 0.5$ V the band gap reference voltage is powered down. As a result, all bias currents are removed and the circuit is in the stand-by mode (supply current $I_P < 40$ μA).

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

| SYMBOL | PARAMETER | MIN. | MAX. | UNIT |
|---|---|---|---|---|
| $V_{P1}$ | supply voltage (pin 17) | −0.3 | 8.0 | V |
| $V_{P2}$ | supply voltage (pin 3) | −0.3 | 8.0 | V |
| $P_{tot}$ | total power dissipation | 0 | 500 | mW |
| $T_{stg}$ | storage temperature range | −55 | 125 | °C |
| $T_{amb}$ | operating ambient temperature range | −10 | 70 | °C |
| $V_{ESD}$ | electrostatic handling*<br>only for pins 6, 9, 13, 17 and 20 | - | ±2000 | V |

## CHARACTERISTICS

$V_{P1} = V_{P2} = 5$ V and $T_{amb} = -10$ to 70 °C (typical values measured at $T_{amb} = 25$ °C); measurements taken in Fig.3 (with resonance circuits L1, L2 and L3 short-circuited for DC measurements); input frequencies $f_{i\ RF} = 866$ MHz unmodulated and $f_{i\ IF} = 150$ MHz unmodulated unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{P1}$ | supply voltage range (pin 17) | | 3 | 5 | 5.5 | V |
| $V_{P2}$ | supply voltage range (pin 3) | | 3 | 5 | 5.5 | V |
| $I_P$ | supply current ($I_3 + I_{17}$) | $V_9 < 2V$ | - | 7.5 | 9 | mA |
| | supply current without mixers 2a and 2b | $V_{10} = V_{P1}$; $V_9 < 2V$ | - | 3.5 | - | mA |
| $I_{P\ off}$ | stand-by current | $V_9 > 3$ V | - | - | 40 | µA |
| **Stand-by** (pin 9) | | | | | | |
| $V_9$ | input voltage for stand-by | | $V_P/2+0.5$ | - | $V_{P1}$ | V |
| | input voltage for run | | 0 | - | $V_P/2-0.5$ | V |
| $t_{rec}$ | recovery time | from stand-by to run | - | - | 1 | ms |
| **Reference voltage** (pin 13) | | | | | | |
| $V_{ref}$ | reference output voltage | $I_{13} = -100$ µA | 1.44 | 1.6 | 1.76 | V |
| $I_{13}$ | reference output current | note 1 | - | - | −100 | µA |
| **Mode select switch MS** (pin 10) | | | | | | |
| $V_{10}$ | input voltage for both IF mixers active | Fig.3 | - | open-circuit | | - |
| | input voltage for one IF mixer active | mixer Q operates as a linear amplifier | - | $V_{ref}$ | - | V |
| | input voltage for IF mixers inactive | $I_P = 3.5$ mA | - | $V_{P1}$ | - | V |

* Equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **RF pre-amplifier** | | EMF1 = 866 MHz | | | | |
| $V_{i\,RF}$ | re-radiation of oscillator signals | measured on pin 4 | - | - | –35 | dBm |
| $Z_{4\text{-}5}$ | input impedance | | - | 50 | - | Ω |
| $G_P$ | conversion power gain | $V_{20} = V_{ref}$ –175 mV | - | 12 | - | dB |
| $\Delta G_p$ | control range | $V_{20} = V_{ref}$ +175 mV | –28 | - | - | dB |
| EMF1 | 3rd order intercept point | | –13 | –10 | - | dBm |
| NF | noise figure | $T_{amb}$ = 25 °C | - | 3.0 | 6 | dB |
| | | $T_{amb}$ = –10 to 70 °C | - | - | 7 | dB |
| **AGC** (pin 20) | | | | | | |
| $V_{20}$ | input voltage range | note 1 | | tbf | | V |
| $R_{20}$ | input resistance | | - | 100 | - | kΩ |
| **RF mixer** (pins 1 and 19) | | | | | | |
| $R_1$ | input resistance | f = 866 MHz | - | 870 | - | Ω |
| $C_1$ | input capacitance | | - | 1.2 | - | pF |
| $Z_{19}$ | input impedance | for EMF3 signal | - | 200 | - | Ω |
| $G_P$ | conversion power gain | | - | 2 | - | dB |
| EMF2 | 3rd order intercept point | | - | –8 | –11 | dBm |
| NF | noise figure | | - | 15 | 17 | dB |
| **IF mixers I and Q** (pins 7, 8, 14 and 15) | | note 2 | | | | |
| $R_{14,\,15}$ | input resistance | f = 150 MHz | - | tbf | - | Ω |
| $C_{14,\,15}$ | input capacitance | | - | tbf | - | pF |
| $Z_{7,\,8}$ | input impedance | for EMF5 signal | - | 200 | - | Ω |
| $G_P$ | conversion power gain | | 7 | 9 | - | dB |
| EMF4 | 3rd order intercept point | | 0 | 2 | - | dBm |
| NF | noise figure | | - | 13 | 16 | dB |
| $\Delta\varphi$ | quadrature balance | | - | - | ±4 | deg |
| $\Delta A$ | amplitude balance | | - | - | ±0.5 | dB |

**Notes to the characteristics**

1. The internal band gap reference voltage is internally decoupled. An AGC reference voltage of 1.6 V ($I_{13}$ < –100 μA) derived from the band gap reference must be externally decoupled.
2. All measurements and calculations are based on $R_S$ = 300 Ω that is provided by the transformation network at the IF mixer input.

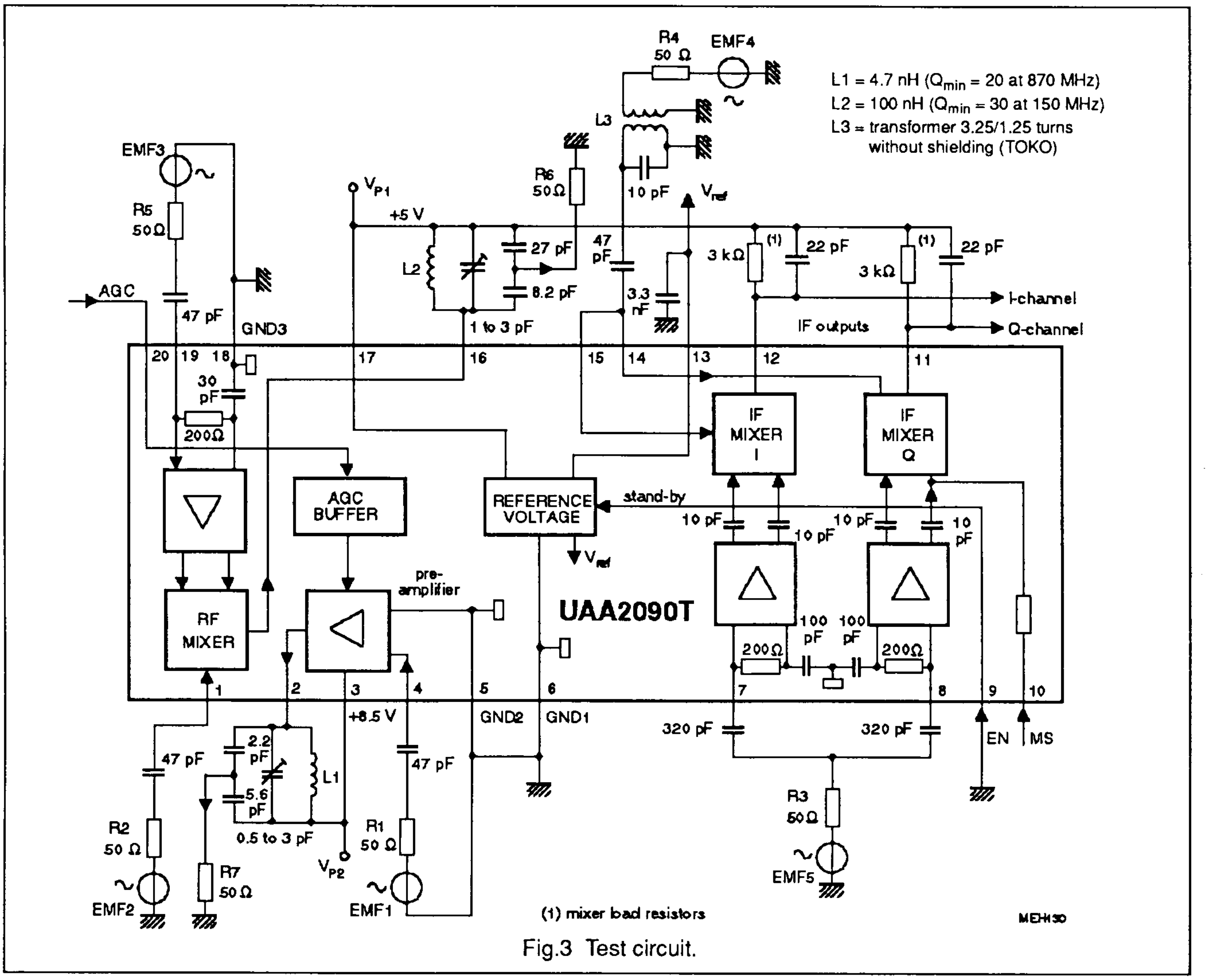



Fig.3 Test circuit.

## AC TEST CONDITIONS

**Noise figures,** measured with gain and noise meter (Fig.4).

Pre-amplifier input signal (pin 4): EMF1; f = 866.000 MHz

RF mixer input signal (pin 1): EMF2; f = 866.000 MHz
RF mixer local oscillator signal (pin 19): EMF3 = –20 dBm; f = 716.000 MHz

IF mixer input signal (pin 15 or 14): EMF4; f = 150.000 MHz
IF mixer local oscillator signal (pin 7 or 8): EMF5 = –20 dBm; f = 150.100 MHz

**Available power gain $G_P$**

$G_P = 10 \log ((4 V_L^2 / V_S^2) * (R_S / R_L))$

**Re-radiation,** measurements are taken from the 50 Ω series resistors of the oscillator signal inputs
EMS3 = –20 dBm; EMS5 = –20 dBm

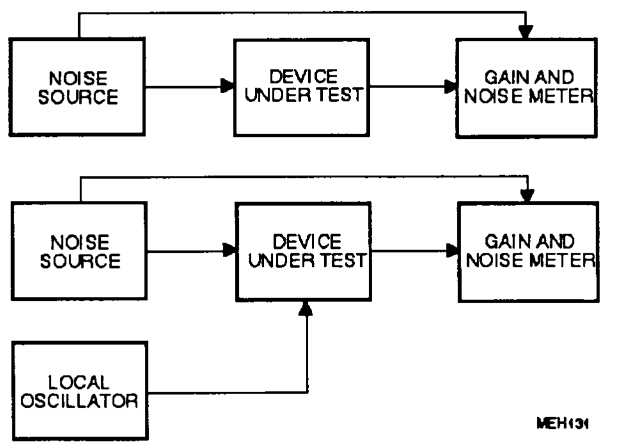



Fig.4 Noise measurements.

**3rd order interception point IP3** (Fig.5)

Input signal (pin 4): EMF1 = –30 dBm; f2 = 866.010 MHz

Input signal (pin 1): EMF2 = –30 dBm; f1 = 866.000 MHz

$V_{IP3}$ = EMF2/dBm – $IL_{PC}$/dB + 0.5 IM3/dB    $IL_{PC}$ = insertion loss of power combiner

**Baseband output,** amplitude and phase balance for I-channel and Q-channel
Local oscillator input signal (pin 7 or 8): EMF3 = –20 dBm
Amplitude balance is derived from voltage gain measurements;
phase balance is measured with a differential phase meter.

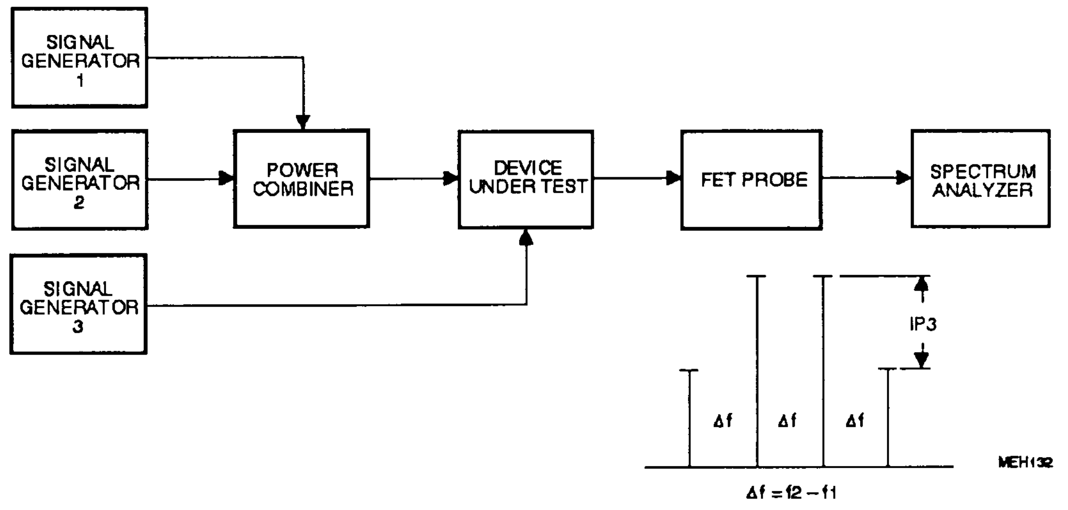



Fig.5 Measurement configuration for IP3.

## APPLICATION INFORMATION

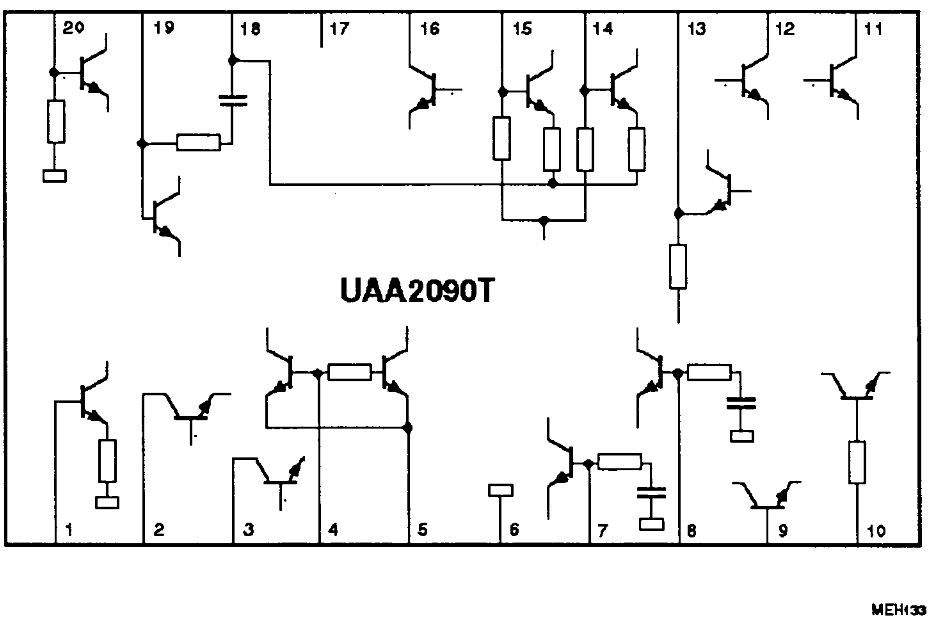



Fig.6 Internal circuit.

## PRINT LAYOUT

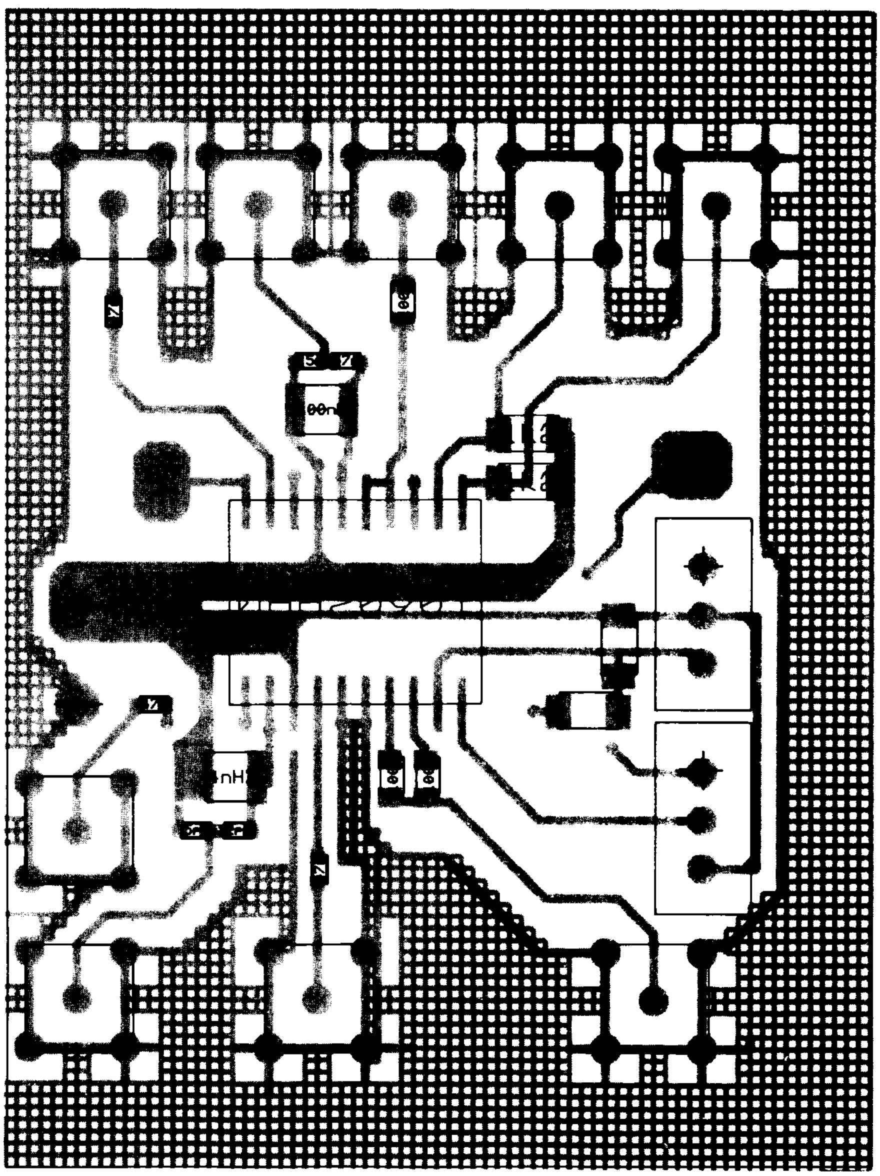


Fig.7 Print layout of side 1 (lower drawing with components).

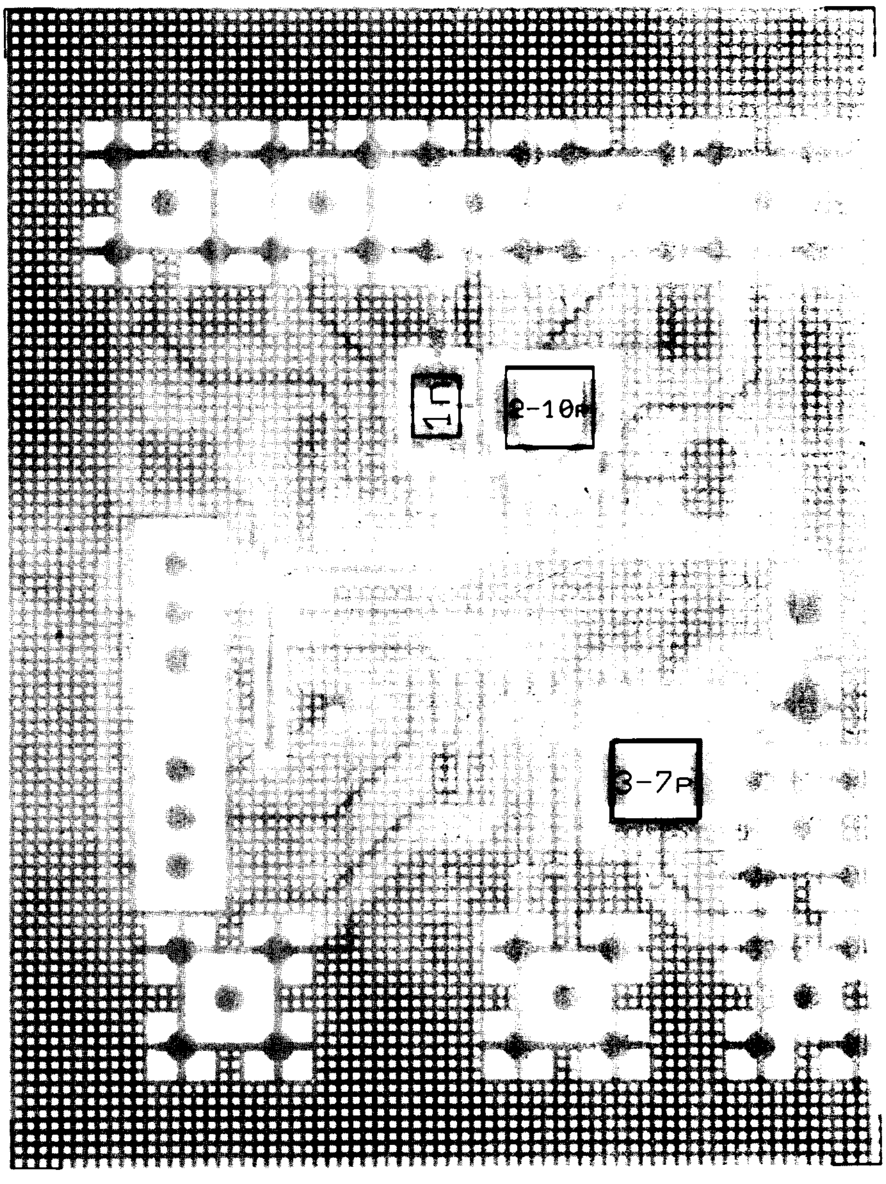
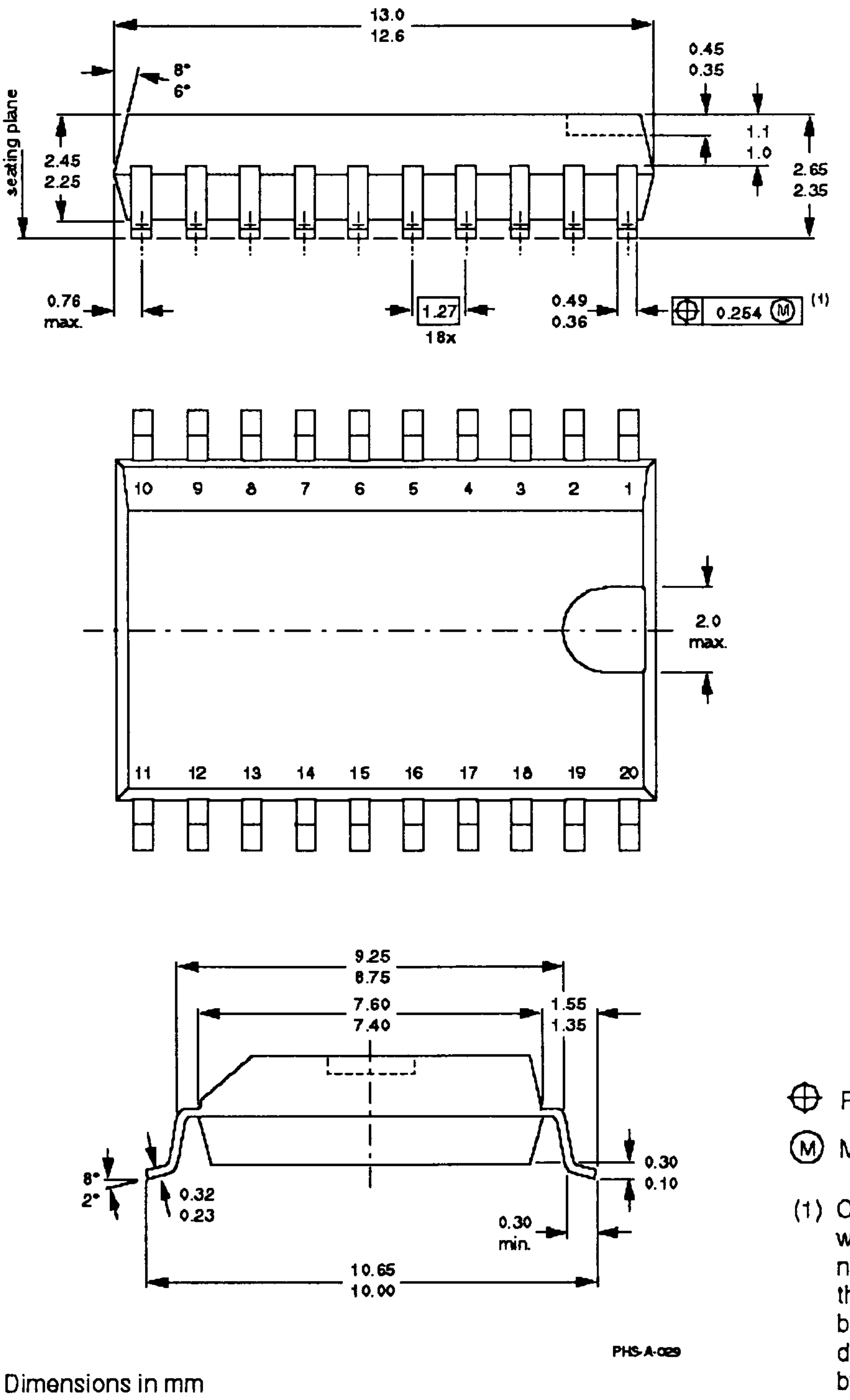



Fig.8 Print layout of side 2 (lower drawing with components).

## PACKAGE OUTLINE




⊕ Positional accuracy.

(M) Maximum Material Condition.

(1) Centre-lines of all leads are within ±0.127 mm of the nominal position shown; in the worst case, the spacing between any two leads may deviate from nominal by ±0.254 mm.

Fig.9 20-lead mini-pack; plastic (SO20; SOT163A).

## SOLDERING

### Plastic mini-packs

BY WAVE

During placement and before soldering, the component must be fixed with a droplet of adhesive. After curing the adhesive, the component can be soldered. The adhesive can be applied by screen printing, pin transfer or syringe dispensing.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder bath is 10 seconds, if allowed to cool to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A modified wave soldering technique is recommended using two solder waves (dual-wave), in which a turbulant wave with high upward pressure is followed by a smooth, laminar wave. Using a mildly-activated flux eliminates the need for removal of corrosive residues in most applications.

BY SOLDER PASTE REFLOW

Reflow soldering requires the solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the substrate by screen printing, stencilling or pressure-syringe dispensing before device placement.

Several techniques exsist for reflowing, for example, thermal conduction by heated belt, infrared, and vapour-phase reflow. Dwell times vary between 50 and 300 seconds according to the method. Typical reflow temperatures range from 215 to 250 °C.

Pre-heating is necessary to dry the paste, to evaporate the binding agent.

Pre-heating duration: 45 minutes at 45 °C.

REPAIRING SOLDERED JOINTS (BY HAND-HELD SOLDERING IRON OR PULSE-HEATED SOLDER TOOL)

Fix the component by first soldering two, diagonally opposite end pins. Apply the heating tool to the flat part of the pin only. Contact time must be limited to 10 seconds up to 300 °C. When using proper tools, all other pins can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C. (Pulse-heated soldering is not recommended for SO packages).

For pulse-heated solder tool (resistance) soldering of VSO packages, solder is applied to the substrate by dipping or by an extra thick tin/lead plating before package placement.

## DEFINITIONS

| Data sheet status | |
|---|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |

**Limiting values**

Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of this specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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