# SiGe Power Amplifier for CW Applications

## Description

The T0930 is a monolithic integrated power amplifier IC. The device is manufactured in TEMIC Semiconductors' Silicon-Germanium (SiGe) technology and has been designed for use in 900-MHz two-way pagers, PDAs, meter readers and ISM phones.

With a single supply voltage operation of + 2.4 to 3.4 V and a neglectable leakage current in power-down mode, the pager amplifier needs less external components and thus helps to reduce system costs. It is suited for operation in CW mode.

## Features

- Up to 33 dBm output power in CW mode
- Power Added Efficiency (PAE) 47%
- Single supply operation at 2.4 V (1 W) or 3.2 V (2 W) no negative voltage necessary
- Current consumption in power-down mode ≤ 10 µA, no external power supply switch required
- Power ramp control
- Simple input and output matching
- Simple output matching for maximum flexibility
- SMD package (PSSOP16 with heat slug)

## Block Diagram

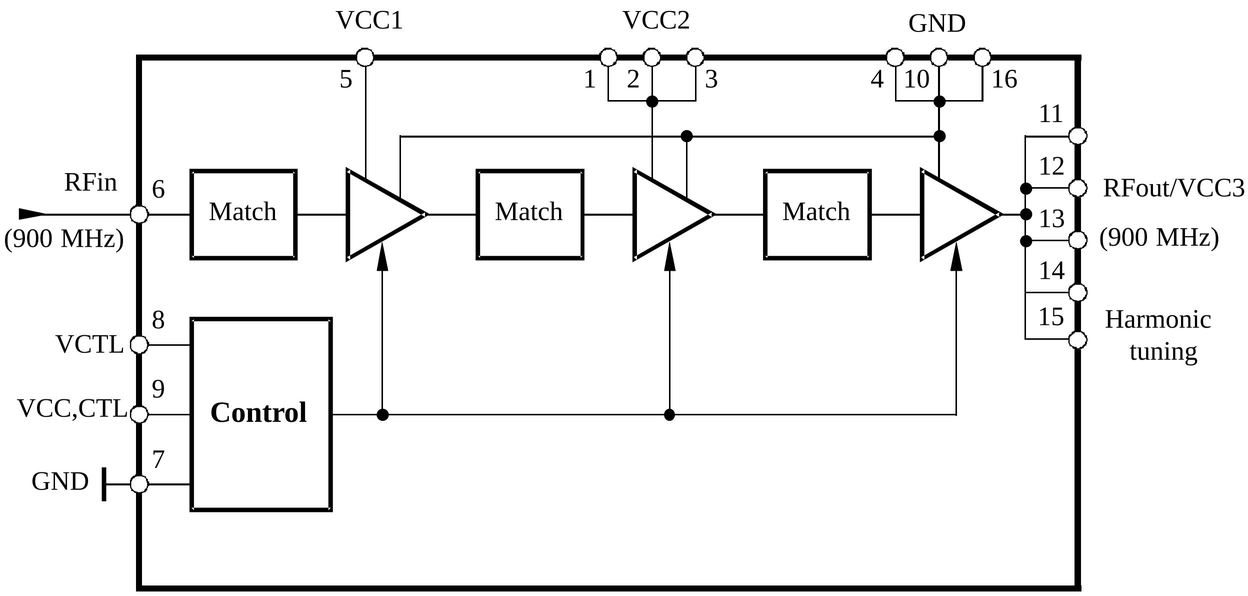



Figure 1. Block diagram

## Ordering Information

| Extended Type Number | Package | Remarks |
|---|---|---|
| T0930-TJT | PSSOP16 | Tube |
| T0930-TJQ | PSSOP16 | Taped and reeled |

## Pin Description

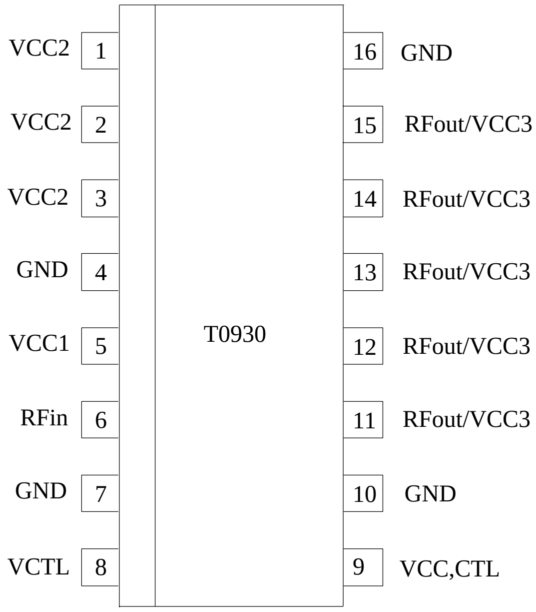



Figure 2. Pinning

| Pin | Symbol | Function |
|---|---|---|
| 1 | VCC2 | Supply voltage 2 |
| 2 | VCC2 | Supply voltage 2 |
| 3 | VCC2 | Supply voltage 2 |
| 4 | GND | Ground |
| 5 | VCC1 | Supply voltage 1 |
| 6 | RFin | RF input |
| 7 | GND | Ground (control) |
| 8 | VCTL | Control input |
| 9 | VCC,CTL | Supply voltage for control |
| 10 | GND | Ground (optional) |
| 11 | RFout/VCC3 | RF output / supply voltage 3 |
| 12 | RFout/VCC3 | RF output / supply voltage 3 |
| 13 | RFout/VCC3 | RF output / supply voltage 3 |
| 14 | RFout/VCC3 | RF output / supply voltage 3 |
| 15 | RFout/VCC3 | RF output / harmonic tuning |
| 16 | GND | Ground |

## Absolute Maximum Ratings

All voltages are referred to GND

| Parameters | | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply voltage $V_{CC}$ @ VCTL = 1.7 V | | | | | | |
| | Pin 5 | $V_{CC1}$ | | | 4.0 | V |
| | Pin 1, 2, 3 | $V_{CC2}$ | | | 4.0 | V |
| | Pins 11, 12, 13, 14 and 15 | $V_{CC3}$ | | | 4.0 | V |
| | Pin 9 | $V_{CC,\,CTL}$ | | | 4.0 | V |
| Input power | Pin 6 | $P_{in}$ | | | 12 | dBm |
| Gain control voltage *) | Pin 8 | $V_{CTL}$ | 0 | | 2 | V |
| Duty cycle for operation | | | | | 100 | % |
| Junction temperature | | $T_j$ | | | + 150 | °C |
| Storage temperature | | $T_{stg}$ | – 40 | | +150 | °C |

## Operation Range

All voltages are referred to GND

| Parameters | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Supply voltage $V_{CC}$ *)<br>1 W application | $V_{CC1}$, $V_{CC2}$<br>$V_{CC3}$, $V_{CC,\,CTL}$ | 1.8 | 2.4 | 3.0 | V |
| Supply voltage $V_{CC}$ *)<br>2 W application | $V_{CC1}$, $V_{CC2}$<br>$V_{CC3}$, $V_{CC,\,CTL}$ | 2.6 | 3.2 | 3.6 | V |
| Ambient temperature | $T_{amb}$ | – 25 | | + 85 | °C |
| Input frequency | $f_{in}$ | | 900 | | MHz |

Note: *)
The gain control voltage should be always 0.2 V below the supply voltage. RF should be applied before ramp-up.

## Electrical Characteristics for 1 Watt Application

$V_{CC} = V_{CC1}$, ... , $V_{CC3}$, $V_{CC, CTL}$ = + 2.4 V, $V_{CTL}$ = 1.7 V, $T_{amb}$ = + 25°C, 50-Ω input and 50-Ω external output match

| Parameters | Test Conditions / Pins | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power supply** | | | | | | |
| Supply voltage | | $V_{CC}$ | 1.8 | 2.4 | 3.0 | V |
| Current consumption: active mode | $P_{out}$ = 30 dBm, PAE = 47% | I | | 0.9 | | A |
| Current consumption (leakage current) in power-down mode | $V_{CTL}$ ≤ 0.2 V | I | | | 10 | µA |
| **RF input** | | | | | | |
| Frequency range | | $f_{in}$ | 880 | 900 | 935 | MHz |
| Input impedance *) | | $Z_i$ | | 50 | | Ω |
| Input power | | $P_{in}$ | | 5 | 12 | dBm |
| Input VSWR *) | $P_{in}$ = 0 to 12 dBm, $P_{out}$ = 30 dBm | | | | 2 : 1 | |
| **RF output** | | | | | | |
| Output impedance *) | | $Z_o$ | | 50 | | Ω |
| Output power: normal conditions | Pin = 5 dBm, $R_L = R_G$ = 50 Ω<br>$V_{CC}$ = 2.4 V, $T_{amb}$ = +25°C<br>$V_{CC}$ = 1.8 V, $T_{amb}$ = +25°C | <br>$P_{out}$<br>$P_{out}$ | | <br>30<br>27 | | <br>dBm<br>dBm |
| Minimum output power | $V_{CTL}$ = 0.3 V | | | – 20 | | dBm |
| Power-added efficiency | $V_{CC}$ = 2.4 V, $P_{out}$ = 27 dBm<br>$V_{CC}$ = 2.4 V, $P_{out}$ = 30 dBm | PAE<br>PAE | | 40<br>47 | | %<br>% |
| Stability | Temp = –25 to + 85 °C, no spurious >= –60 dBc | VSWR | | | 10 : 1 | |
| Load mismatch (stable, no damage) | $P_{out}$ = 30 dBm, all phases | VSWR | | | 10 : 1 | |
| Second harmonic distortion | | 2fo | | | –35 | dBc |
| Third harmonic distortion | | 3fo | | | –35 | dBc |
| Noise power<br>f = 925 to 935 MHz<br>f ≥ 935 MHz | <br>$P_{out}$ = 30 dBm,<br>RBW = 100 kHz | | | <br>–73<br>–85 | <br>–70<br>–82 | <br>dBm<br>dBm |
| Rise and fall time | | | | | 0.5 | µs |
| Isolation between input and output | $P_{in}$ = 0 to 10 dBm, $V_{CTL}$ ≤ 0.2 V (power down) | | 50 | | | dB |
| **Power control** | | | | | | |
| Control curve | Pout ≥ 25 dBm | | | | 150 | dB/V |
| Power control range | $V_{CTL}$ = 0.3 to 2.0 V | | 50 | | | dB |
| Control voltage range | | $V_{CTL}$ | 0.3 | | 2.0 | V |
| Control current | $P_{in}$ = 0 to 10 dBm, $V_{CTL}$ = 0 to 2.0 V | $I_{CTL}$ | | | 200 | µA |

Note: *) with external matching (see application circuit)

## Electrical Characteristics for 2 Watt Application

$V_{CC} = V_{CC1}$, ... , $V_{CC3}$, $V_{CC,\,CTL}$ = + 3.2 V, $V_{CTL}$ = 1.9 V, $T_{amb}$ = + 25°C, 50-Ω input and 50-Ω external output match

| Parameters | Test Conditions / Pins | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Power supply** | | | | | | |
| Supply voltage | | $V_{CC}$ | 2.6 | 3.2 | 3.6 | V |
| Current consumption: active mode | $P_{out}$ = 33 dBm, PAE = 47% | I | | 1.33 | | A |
| Current consumption (leakage current) in power-down mode | $V_{CTL}$ ≤ 0.2 V | I | | | 10 | µA |
| **RF input** | | | | | | |
| Frequency range | | $f_{in}$ | 880 | 900 | 935 | MHz |
| Input impedance *) | | $Z_i$ | | 50 | | Ω |
| Input power | | $P_{in}$ | | 5 | 12 | dBm |
| Input VSWR *) | $P_{in}$ = 0 to 12 dBm, $P_{out}$ = 30 dBm | | | | 2 : 1 | |
| **RF output** | | | | | | |
| Output impedance *) | | $Z_o$ | | 50 | | Ω |
| Output power: normal conditions | Pin = 5 dBm, $R_L = R_G$ = 50 Ω<br>$V_{CC}$ = 3.2 V, $T_{amb}$ = +25°C<br>$V_{CC}$ = 2.2 V, $T_{amb}$ = +25°C | $P_{out}$<br>$P_{out}$ | | 33<br>30 | | dBm<br>dBm |
| Minimum output power | $V_{CTL}$ = 0.3 V | | | – 20 | | dBm |
| Power-added efficiency | $V_{CC}$ = 3.2 V, $P_{out}$ = 27 dBm | PAE | | 47 | | % |
| Stability | Temp = –25 to + 85 °C, no spurious >= –60 dBc | VSWR | | | 10 : 1 | |
| Load mismatch (stable, no damage) | $P_{out}$ = 33 dBm, all phases | VSWR | | | 10 : 1 | |
| Second harmonic distortion | | 2fo | | | –35 | dBc |
| Third harmonic distortion | | 3fo | | | –35 | dBc |
| Noise power<br>f = 925 to 935 MHz<br>f ≥ 935 MHz | $P_{out}$ = 33 dBm, RBW = 100 kHz | | | –73<br>–85 | –70<br>–82 | dBm<br>dBm |
| Rise and fall time | | | | | 0.5 | µs |
| Isolation between input and output | $P_{in}$ = 0 to 10 dBm, $V_{CTL}$ ≤ 0.2 V (power down) | | 50 | | | dB |
| **Power control** | | | | | | |
| Control curve | Pout ≥ 25 dBm | | | | 150 | dB/V |
| Power control range | $V_{CTL}$ = 0.3 to 2.0 V | | 50 | | | dB |
| Control voltage range | | $V_{CTL}$ | 0.3 | | 2.0 | V |
| Control current | $P_{in}$ = 0 to 10 dBm, $V_{CTL}$ = 0 to 2.0 V | $I_{CTL}$ | | | 200 | µA |

Note: *) with external matching (see application circuit)

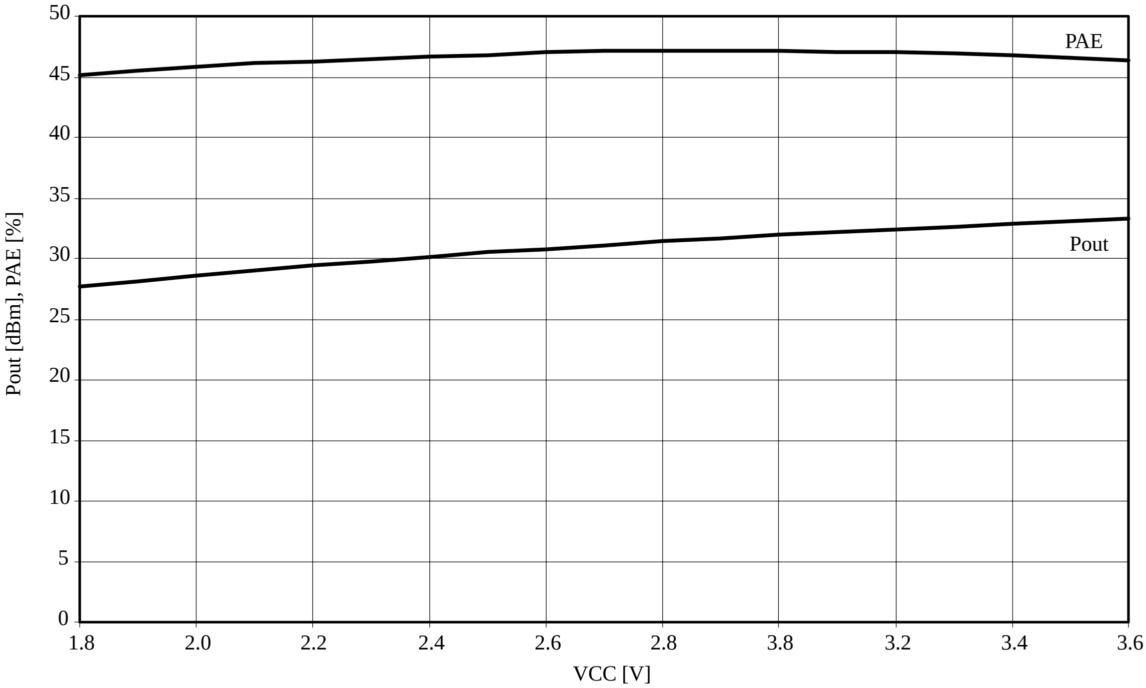



Figure 3. Pout and PAE versus VCC (1 W application)

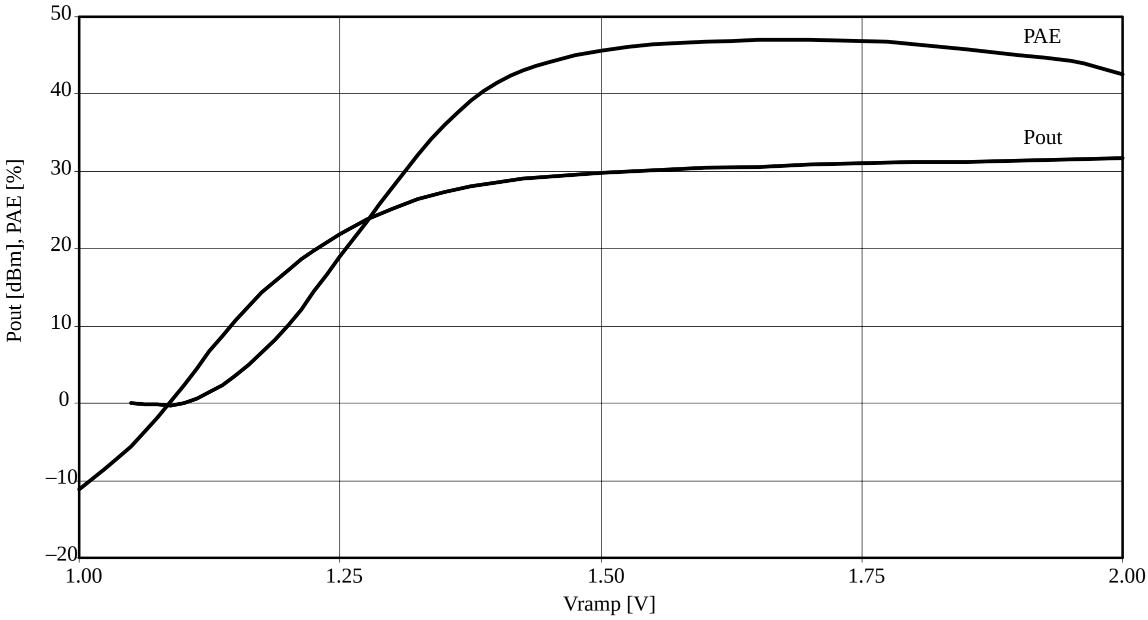



Figure 4. Pout and PAE versus Vramp (1 W application)

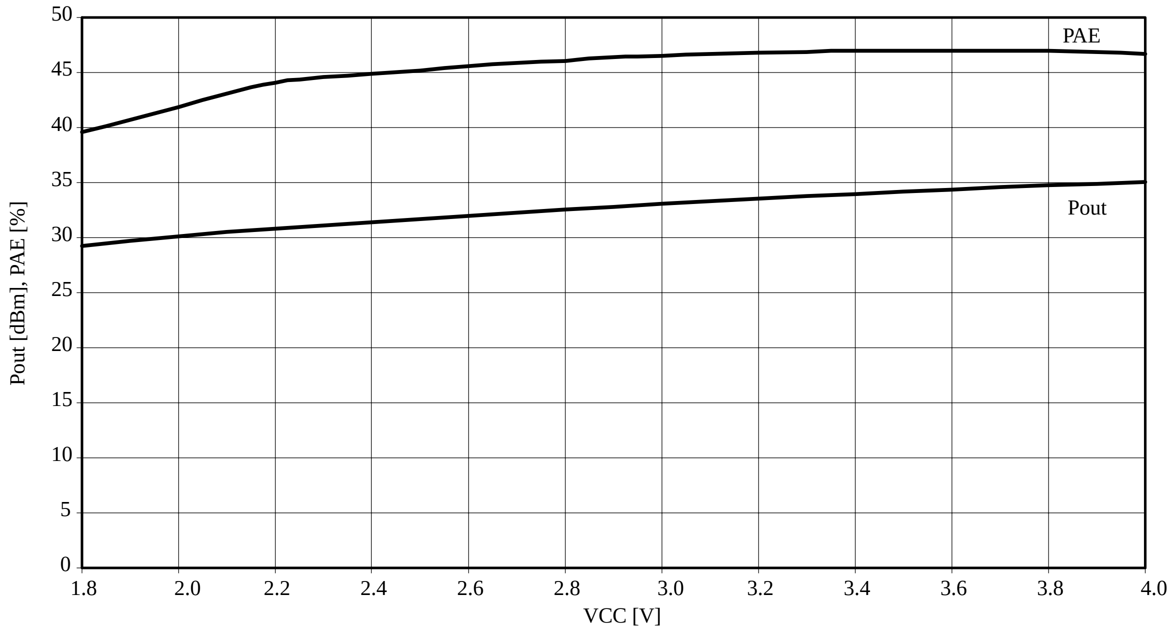



Figure 5. Pout and PAE versus VCC (2 W application)

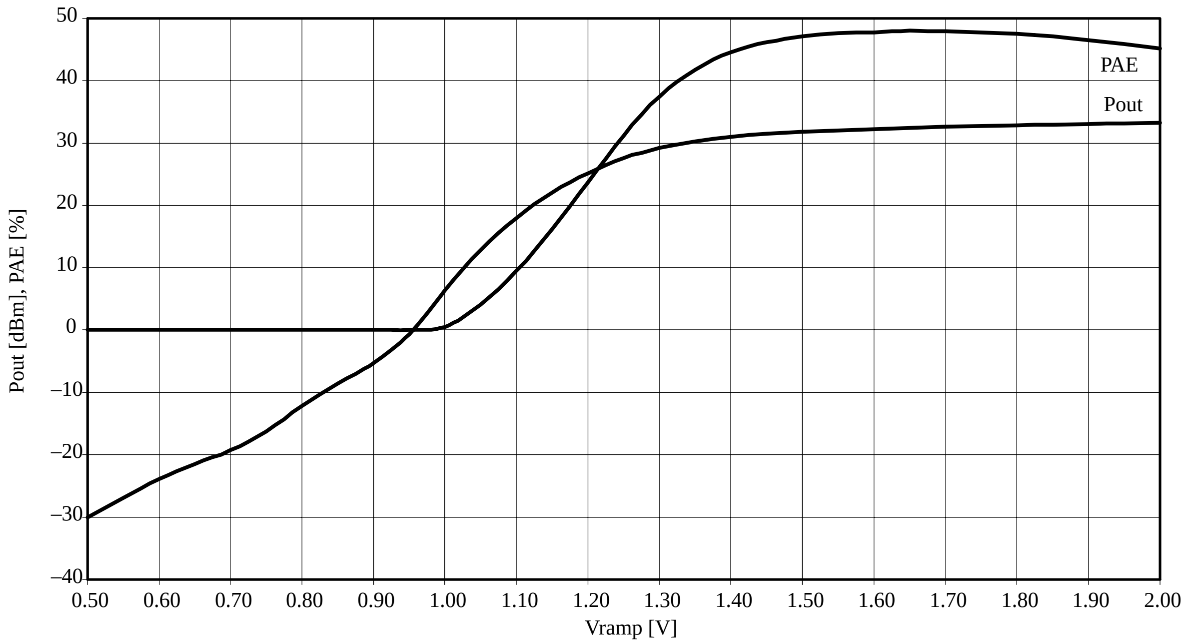
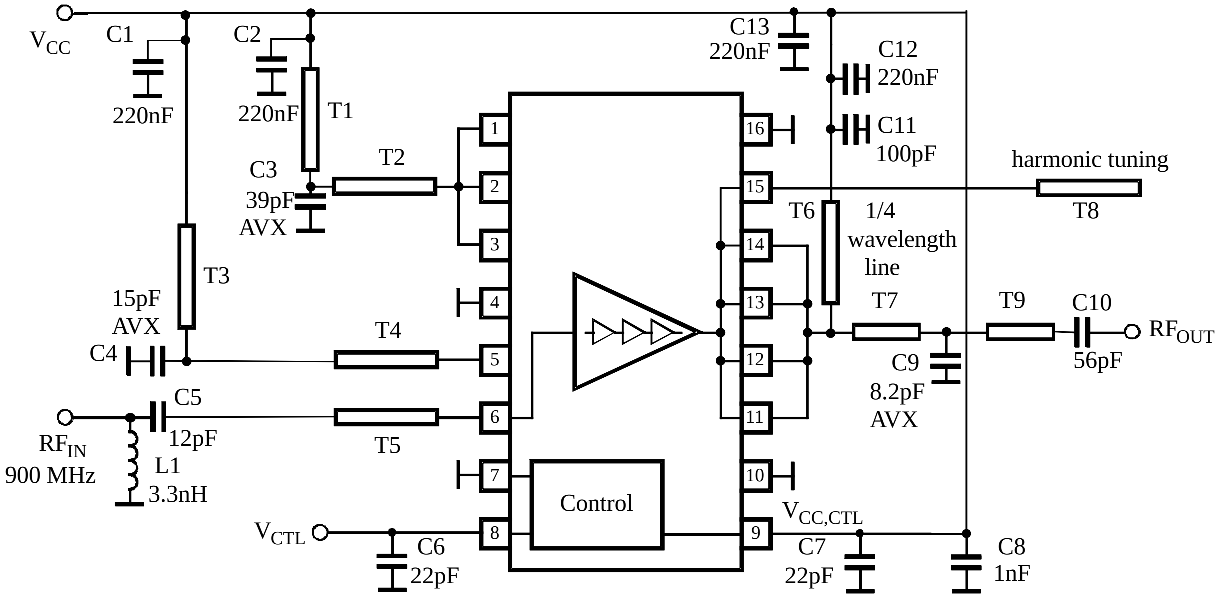



Figure 6. Pout and PAE versus Vramp (2 W application)

## Application Circuit



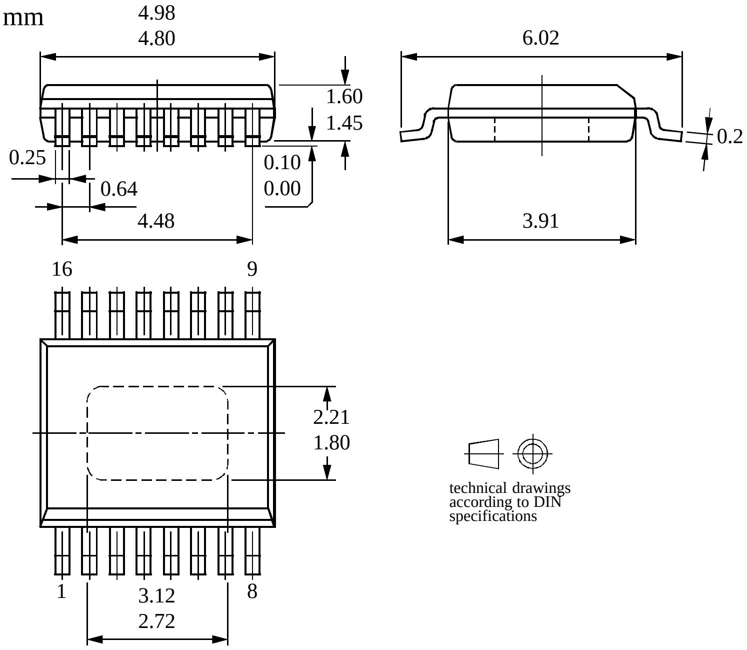

Microstrip line : FR4 ; Epsilon(r) : 4.3 ; metal Cu : 35 um
distance 1. layer – rf ground : 0.5 mm

| | l/mm | | w/mm |
|---|---|---|---|
| T1 | 20.5 | x | 1.0 |
| T2 | 1.3 | x | 1.0 |
| T3 | 14.8 | x | 0.5 |
| T4 | 14.2 | x | 0.5 |
| T5 | 2.5 | x | 1.0 |
| T6 | 43.1 | x | 0.5 |
| T7 | 6.0 | x | 1.25 |
| T8 | 10.0 | x | 0.5 |
| T9 | 4.0 | x | 1.25 |

Figure 7. Application circuit GSM pager (900 MHz)

## Package Information

Package PSSOP16
Dimensions in mm



## Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC Semiconductor GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

**TEMIC Semiconductor GmbH** has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

**TEMIC Semiconductor GmbH** can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.



**Data sheets can also be retrieved from the Internet: http://www.temic–semi.com**

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