

## PBL 403 09

# 3.6 V Differential Power Amplifier for DECT Telecommunications system

### Description.

The PBL 403 09 is a differential two stage silicon MMIC power amplifier intended for use in handheld cordless terminals in the 1900 MHz band. It can deliver more than 27 dBm at 1900 MHz into a balanced  $50\ \Omega$  load using a single 3.6 V supply. The circuit has a logic input to control transmit on/off and can be operated up to 100 % duty cycle with minimum performance degradation. The circuit is housed in a specially designed QSOP16 (150 mil body ) package and the implementation requires only few external components.

25 GHz  $f_t$  state-of-the-art deep trench isolated double-poly silicon bipolar process with additional features for improved wireless performance has been used. On-chip capacitors and inductors are used for the integrated internal matching network. Special front-side metallized substrate contacts provide excellent ground paths from active devices to the highly doped semiconductor substrate and package ground.

### Key features.

- 27 dBm output power
- 25 dB small signal gain
- 50 % Power Added Efficiency
- Simple logic on/off power control
- Battery charging conditions to 5.0 V
- ESD protected
- Excellent ruggedness
- On-chip input and interstage matching
- Differential input matched to  $50\ \Omega$
- Easy implementation with a simple output matching network
- Proven RF Silicon Technology Reliability
- Low overall solution cost

### Applications.

- DECT

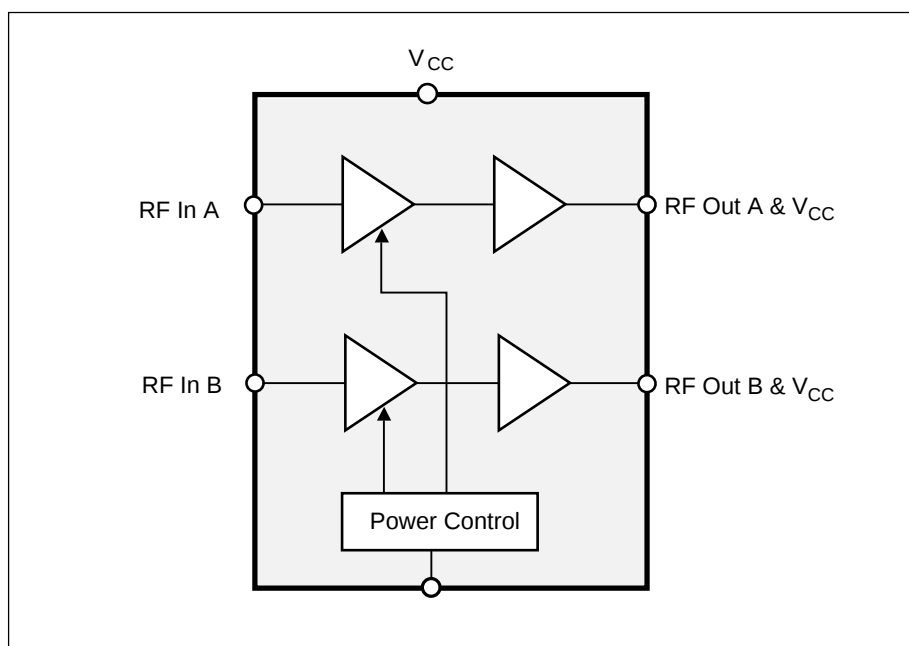


Figure 1. Block diagram.

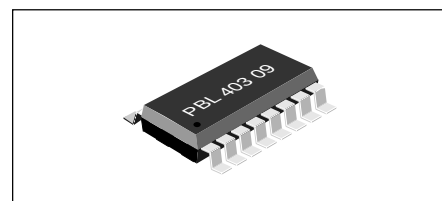


Figure 2. Package outlook.

## Maximum Ratings

| Parameter                     | Symbol           | Min. | Max. | Unit |
|-------------------------------|------------------|------|------|------|
| Supply voltage, continuous    | V <sub>CC</sub>  | -    | 5.2  | V    |
| All inputs (zener protection) |                  |      | 6.5  | V    |
| Operating case temperature    | T <sub>op</sub>  | -25  | +80  | °C   |
| Storage temperature range     | T <sub>Stg</sub> | -30  | +100 | °C   |

## Electrical Characteristics at room temperature

Unless otherwise stated the values below are valid for V<sub>CC</sub> = 3.6 V, P<sub>in</sub> = 4 dBm, Z<sub>L</sub> = 50 Ω and f = 1900 MHz, pulsed mode t = 417 μs, duty cycle 1/24. All data as measured in the recommended typical application circuit.

| Parameter                                     | Condition                                                                              | Symbol          | Min.                        | Typ.  | Max.                  | Unit |
|-----------------------------------------------|----------------------------------------------------------------------------------------|-----------------|-----------------------------|-------|-----------------------|------|
| Frequency range                               |                                                                                        | f               | 1880                        |       | 1930                  | MHz  |
| Power output                                  | PA - ON = low                                                                          | P               | 27                          | 29    | -                     | dBm  |
| Power Added Efficiency                        | P <sub>in</sub> = 10 dBm                                                               | PAE             | 45                          | 50    | -                     | %    |
| Power Added Efficiency                        | P <sub>in</sub> = 4 dBm                                                                | PAE             | 35                          | 43    | -                     | %    |
| Small signal Gain                             | P <sub>in</sub> = -10 dBm                                                              | G               |                             | 25.5  | -                     | dB   |
| Isolation                                     | PA - ON = high, P <sub>in</sub> = 4 dBm                                                |                 |                             | -35   | -30                   | dB   |
| 2 <sup>nd</sup> and 3 <sup>rd</sup> harmonics | PA - ON = low, P <sub>in</sub> < 4 dBm                                                 |                 |                             | -35   |                       | dBc  |
| Input VSWR                                    |                                                                                        |                 |                             | 1.6:1 | 3:1                   |      |
| Load Mismatch                                 | P <sub>in</sub> = 4-10 dBm, V <sub>CC</sub> = 5.2 V,<br>Load VSWR = 6:1 all phases     |                 | no damage for 10 sec.       |       |                       |      |
| Stability and spurious                        | P <sub>in</sub> = 4-10 dBm, V <sub>CC</sub> = 3.0-5.2 V,<br>Load VSWR = 5:1 all phases |                 | All spurious below - 36 dBm |       |                       |      |
| Supply current                                | No input signal present,<br>PA - ON = low                                              | I <sub>DC</sub> |                             | 135   |                       | mA   |
| Supply current                                | P <sub>in</sub> = 4 dBm                                                                | I <sub>DC</sub> |                             | 550   |                       | mA   |
| Supply current                                | PA - ON = high                                                                         | I <sub>DC</sub> |                             | 1     | 10                    | μA   |
| Rise time                                     | P <sub>out</sub> to 1dB from final value.<br>Measure time from switch to low.          | t <sub>r</sub>  |                             |       | 1                     | μA   |
| Fall time                                     | P <sub>out</sub> to less than -20 dB measured<br>from PA - ON pulse switched to high   | t <sub>f</sub>  |                             |       | 2                     | μs   |
| PA - ON = low                                 |                                                                                        |                 | -0.5                        |       | 0.5                   | V    |
| PA - ON = high                                |                                                                                        |                 | V <sub>CC</sub> - 0.5       |       | V <sub>CC</sub> + 0.5 | V    |
| I ( PA - ON ) low                             |                                                                                        |                 |                             | 110   | 130                   | μA   |

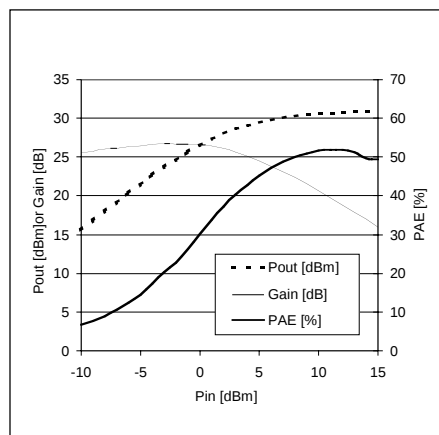


Figure 3. P<sub>out</sub>, Gain and PAE vs. P<sub>in</sub>  
V<sub>CC</sub> = 3.6 V

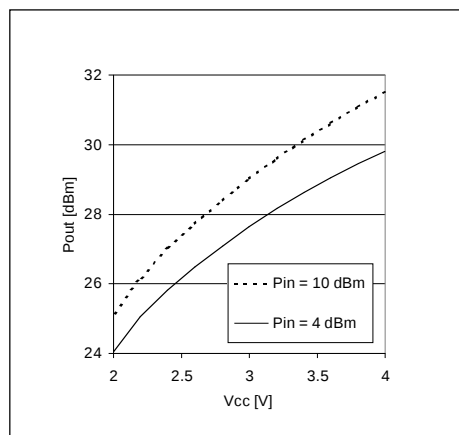


Figure 4. P<sub>out</sub> vs. V<sub>CC</sub> for P<sub>in</sub> = 4 dBm  
and 10 dBm

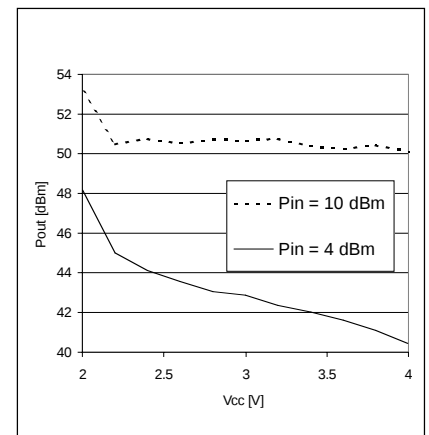


Figure 5. PAE vs. V<sub>CC</sub> for P<sub>in</sub> = 4 dBm  
and 10 dBm

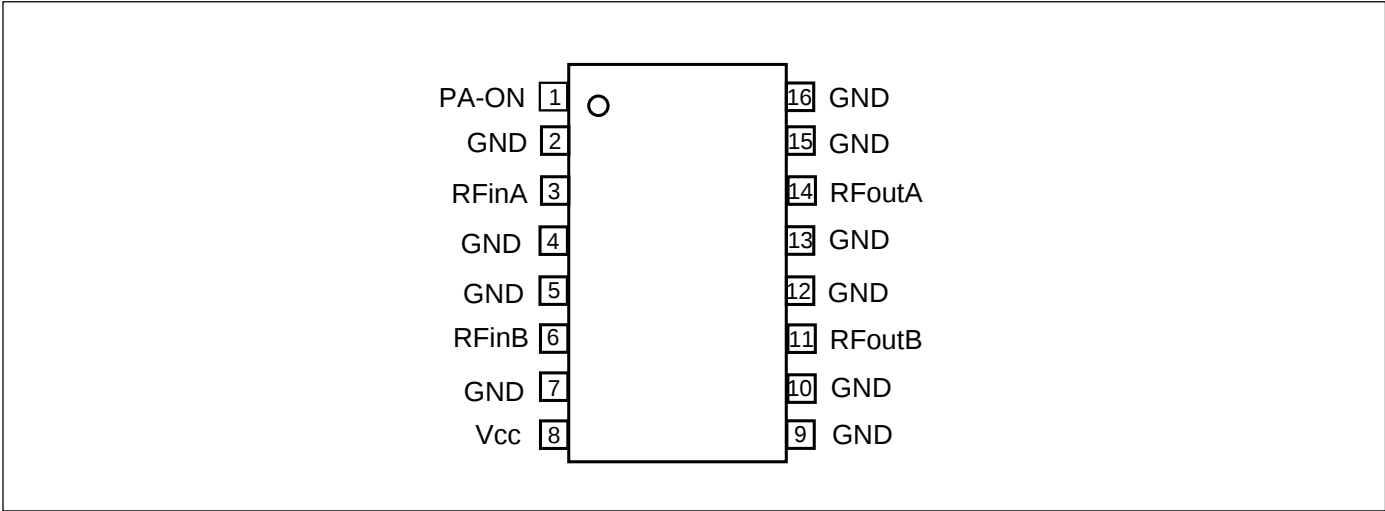


Figure 6. Pin configuration.

Pin Descriptions:

Refer to pin configuration.

| SO | Name  | Function                           | SO | Name   | Function      |
|----|-------|------------------------------------|----|--------|---------------|
| 1  | PA-ON | PA On/Off Control pin (active low) | 9  | GND    | Common ground |
| 2  | GND   | Common ground                      | 10 | GND    | Common ground |
| 3  | RFinA | RF input                           | 11 | RFoutB | RF output     |
| 4  | GND   | Common ground                      | 12 | GND    | Common ground |
| 5  | GND   | Common ground                      | 13 | GND    | Common ground |
| 6  | RFinB | RF input                           | 14 | RFoutA | RF output     |
| 7  | GND   | Common ground                      | 15 | GND    | Common ground |
| 8  | Vcc   | Supply voltage                     | 16 | GND    | Common ground |

Functional description.

PBL403 09 is a differential two stage integrated power amplifier intended for DECT. The circuit is manufactured in a bipolar 5.0 V technology with additional features for improved wireless performance. Input and interstage matching is done completely on-chip, tuned to 1.9 GHz, and only normal supply decoupling plus output matching is necessary. If the device is used in a single ended environment, input and output transformers need to be added to the external circuitry.

PBL403 09 is optimized to work at a supply voltage of 3.6 V, but is able to operate between 2.7 and 5.2 V. At 3.6 V it can deliver up to 31 dBm when driven into compression, while 27 dBm is guaranteed with an input power of 4 dBm. Best Power Added Efficiency (PAE) is obtained close to maximum output power where PAE exceeds 50 %. Small signal gain is 25-26 dB. In a DECT handset with the duty cycle 1/24, the average power dissipation in the circuit is low, normally between 30 to 40 mW. In the base station, the duty cycle can increase and PBL403 09 can be operated at CW with a small penalty in power gain and output power (< 0.5 dB). Operation is controlled through a power-on pin which is active low. When active, the current consumption is typically 135 mA without any input signal present. When not active, current consumption is less than 10 µA.

## Application information.

### DECT SINGLE ENDED POWER AMPLIFIER

When used as a single ended power amplifier, please refer to fig.7 and the test board fig. 8.

The 50  $\Omega$  source impedance is converted to 50  $\Omega$  differential with an LC-CL structure. Two series capacitors AC-couples the signal to the input of PBL403 09. Suitable value of the capacitors is 1 to 5 pF in order to compensate for series inductance of the PCB and package. Input impedance of the PBL403 09 is 50  $\Omega$  differential.

The ideal collector load of the open collector RF output of PBL403 09 is about 11  $\Omega$  per side. A matching and combination network to 50  $\Omega$  single ended case is shown in fig. 7. A shunt capacitor (2.7 pF) transforms each output to 50  $\Omega$ . Both 50  $\Omega$  outputs are AC coupled and then combined with an LC-CL structure to a 50  $\Omega$  single ended output.

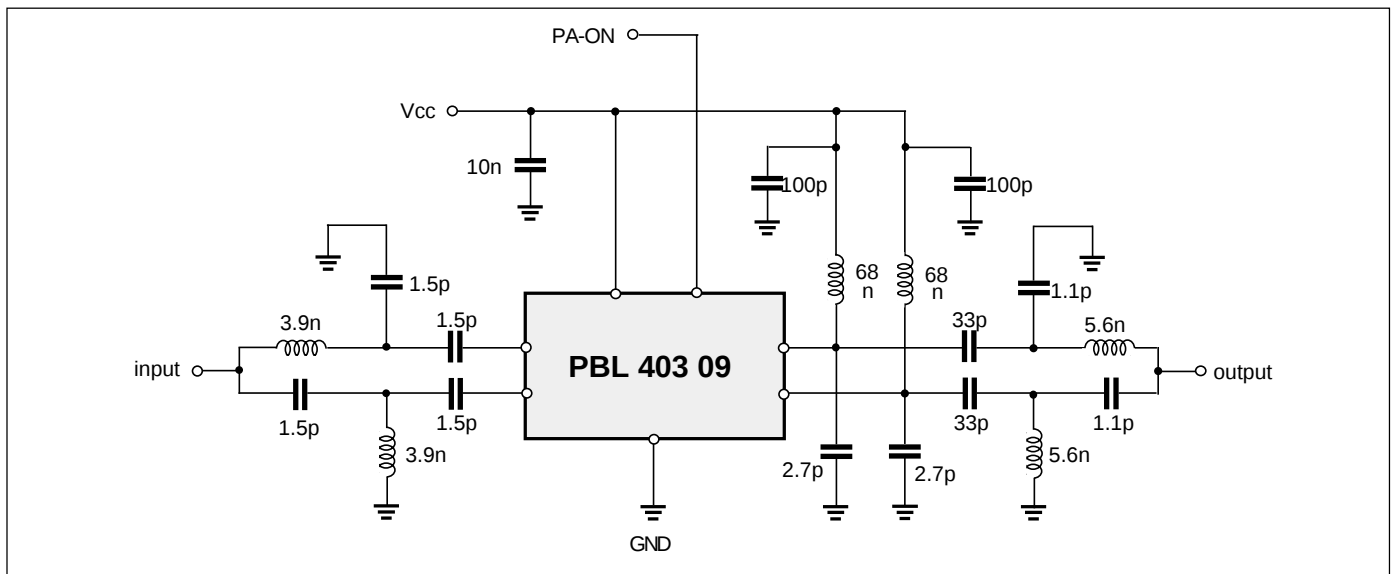


Figure 7. Evaluation setup including networks for unbalanced input/output.

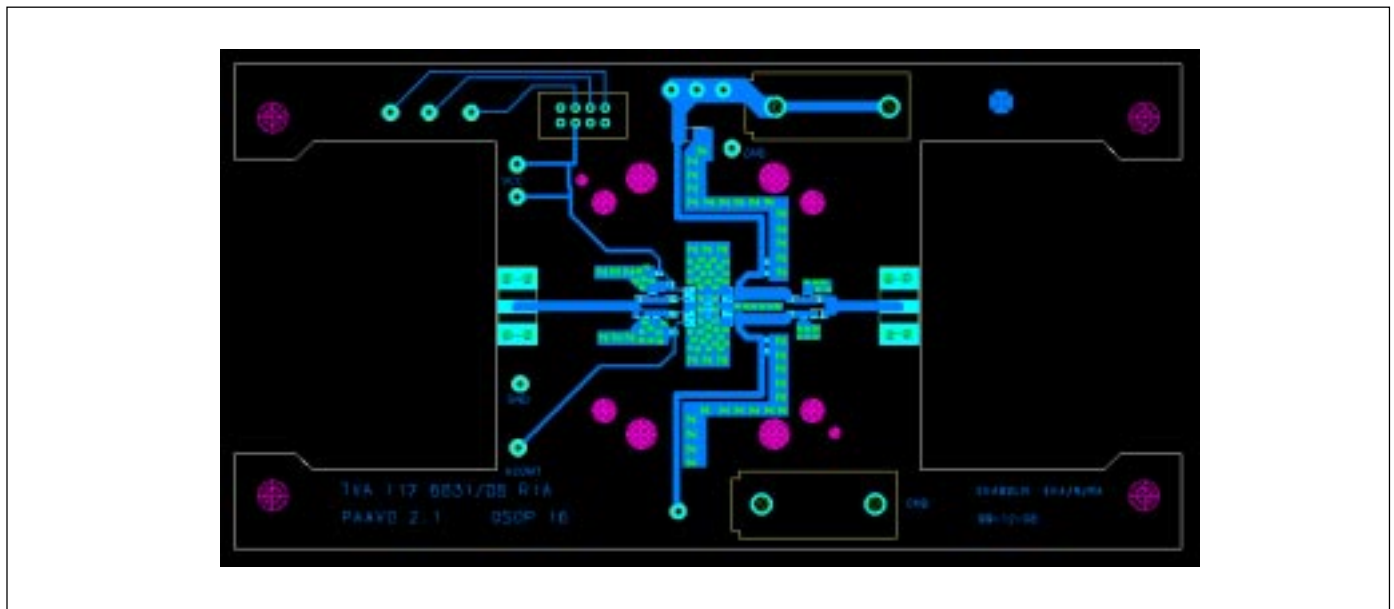


Figure 8. Evaluation testboard.

## DECT RADIO WITH PBL402 15 TRANSCEIVER

PBL403 09 together with the transceiver chip PBL402 15 form the base of the radio platform for DECT systems. The transmission part of the chip PBL402 15 has a differential output which can deliver up to 7 dBm. The output power can be programmed in steps. The outputs are of open-collector type. Suitable network between PBL402 15 and PBL403 09 is therefore shunt inductors from the open-collectors to  $V_{cc}$  and series capacitors to the RF inputs of PBL403 09. Suitable value of the capacitors is 1 to 5 pF in order to compensate for the series inductance of the PCB and package. Input impedance of the PBL403 09 is 50  $\Omega$  differential.

The ideal collector load of the open collector RF output of PBL403 09 is about 11  $\Omega$  per side. A matching and combination network to 50  $\Omega$  single ended case is shown in fig.9. A shunt capacitor (2.7 pF) transforms each output to 50  $\Omega$ . Both 50  $\Omega$  outputs are AC coupled and then combined with an LC-CL structure to a 50  $\Omega$  single ended output.

A power control signal with active low is received from PBL402 15. This signal controls power up/down of the PBL403 09.

Supply decoupling consists of high frequency and low frequency decoupling capacitors. The high frequency decoupling capacitor should be placed close to the  $V_{cc}$  pin.

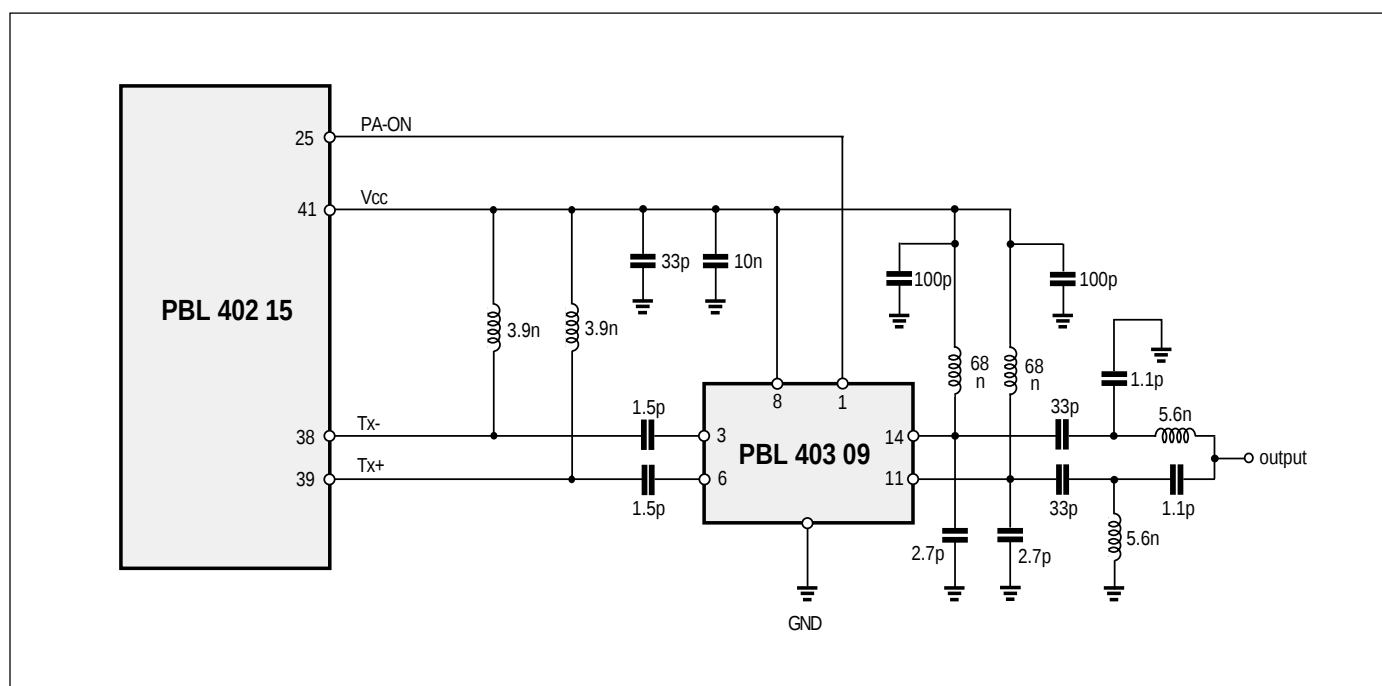
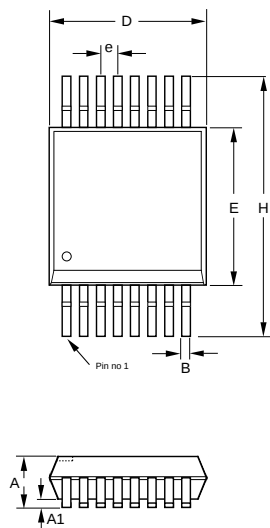
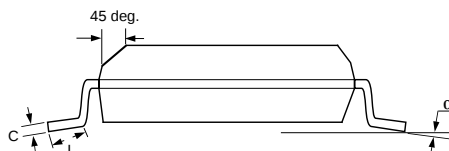


Figure 9. DECT radio with PBL402 015 transceiver and PA.

## Package drawing, QSOP 16



| Dim.                        | millimeters |      | inches          |        |
|-----------------------------|-------------|------|-----------------|--------|
|                             | min.        | max. | min.            | max.   |
| A                           | 1.35        | 1.75 | 0.532           | 0.688  |
| A1                          | 0.10        | 0.25 | 0.004           | 0.0098 |
| B                           | 0.20        | 0.30 | 0.008           | 0.012  |
| C                           | 0.15        | 0.25 | 0.006           | 0.01   |
| D                           | 4.80        | 4.98 | 0.189           | 0.196  |
| E                           | 3.81        | 3.99 | 0.150           | 0.157  |
| e                           | 0.635mm     |      | 0.025 inch ref. |        |
| H                           | 5.70        | 6.20 | 0.228           | 0.244  |
| L                           | 0.40        | 1.27 | 0.016           | 0.050  |
| $\alpha = 0-8 \text{ deg.}$ |             |      |                 |        |
| h                           | 0.22        | 0.49 | 0.009           | 0.019  |



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1522-PBL 403 09 Uen Rev.A  
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August 2000

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## Ordering Information

| Package             | Temp. Range | Part No.   |
|---------------------|-------------|------------|
| 16 pin plastic QSOP | -25 to 80°C | PBL 403 09 |