

## NPN RF silicon transistor

### Features

- High efficiency
- Common emitter configuration
- Broadband performances  $P_{OUT} = 29$  dBm with 14 dB gain @ 900 MHz
- Plastic package
- Linear and non linear operation
- Supplied in tape and reel
- In compliance with the 2002/95/EC european directive

### Description

The START499D provide the market with a Si state-of-art RF process. Manufactured with ST 3<sup>rd</sup> generation bipolar process, it offers the highest power, gain and efficiency in SOT-89 for given breakdown voltage (BVCEo). START499D is suitable for a wide range of application up to 1 GHz.

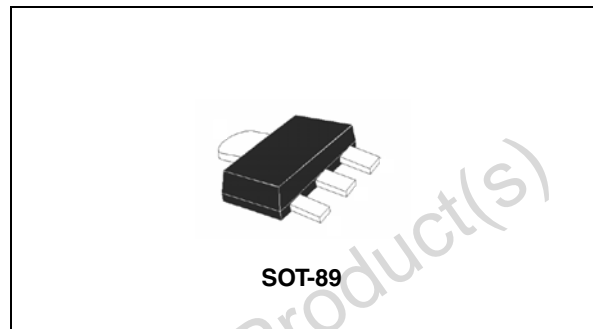


Figure 1. Pin connection

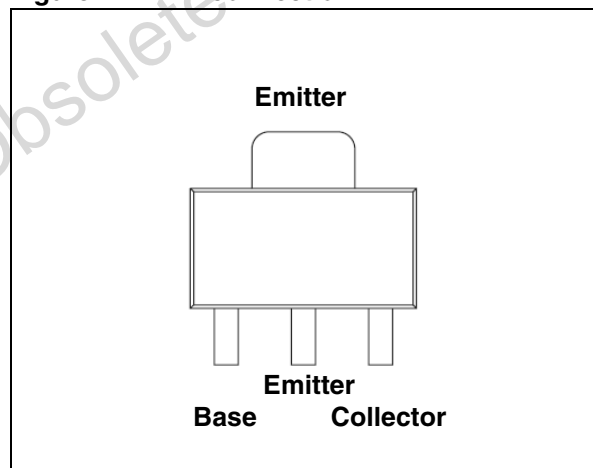


Table 1. Device summary

| Order code | Marking | Package | Packaging     |
|------------|---------|---------|---------------|
| START499D  | D499    | SOT-89  | Tape and reel |

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# 1 Electrical data

## 1.1 Maximum ratings

**Table 2. Absolute maximum ratings** ( $T_{CASE} = +25\text{ °C}$ )

| Symbol     | Parameter                           | Value       | Unit |
|------------|-------------------------------------|-------------|------|
| $V_{CEO}$  | Collector - emitter voltage         | 4.5         | V    |
| $V_{EBO}$  | Emitter - base voltage              | 1.5         | V    |
| $I_C$      | Collector current                   | 1.0         | A    |
| $P_{DISS}$ | Power dissipation                   | 1.7         | W    |
| $T_J$      | Max. operating junction temperature | 150         | °C   |
| $T_{STG}$  | Storage temperature                 | -65 to +150 | °C   |

## 1.2 Thermal data

**Table 3. Thermal data**

| Symbol     | Parameter                          | Value | Unit |
|------------|------------------------------------|-------|------|
| $R_{thJC}$ | Junction - case thermal resistance | 75    | °C/W |

## 2 Electrical characteristics

### 2.1 Static

Table 4. Static  $T_{CASE} = +25\text{ }^{\circ}\text{C}$

| Symbol     | Test conditions                             | Min. | Typ. | Max. | Unit          |
|------------|---|------|------|------|---------------|
| $I_{CBO}$  | $V_{CB} = 15\text{ V}$                      |      |      | 5    | $\mu\text{A}$ |
| $I_{EBO}$  | $V_{EB} = 1.2\text{ V}$                     |      |      | 250  | $\mu\text{A}$ |
| $BV_{CES}$ | $I_C = 200\text{ }\mu\text{A}$              | 15   | 20   |      | V             |
| $h_{FE}$   | $V_{CE} = 3\text{ V}$ $I_C = 0.16\text{ A}$ |      | 150  |      |               |

### 2.2 Dynamic

Table 5. Dynamic

| Symbol        | Test conditions  | Min. | Typ. | Max. | Unit |
|---------------|--|------|------|------|------|
| $P_{OUT}$     | $V_{CC} = 3.6\text{ V}$ , $I_{CQ} = 30\text{ mA}$ , $P_{IN} = 15\text{ dBm}$ , $f = 900\text{ MHz}$                      | 28   | 29   |      | dBm  |
| $G_P$         |  | 13   | 14   |      | dB   |
| $h_D$         |  | 55   | 65   |      | %    |
| Load mismatch | $V_{CC} = 3.6\text{ V}$ , $I_{CQ} = 30\text{ mA}$ , $P_{OUT} = 28\text{ dBm}$ , $f = 900\text{ MHz}$<br>All phase angles | 3:1  |      |      | VSWR |

### 3 Impedance

Figure 2. Current conventions

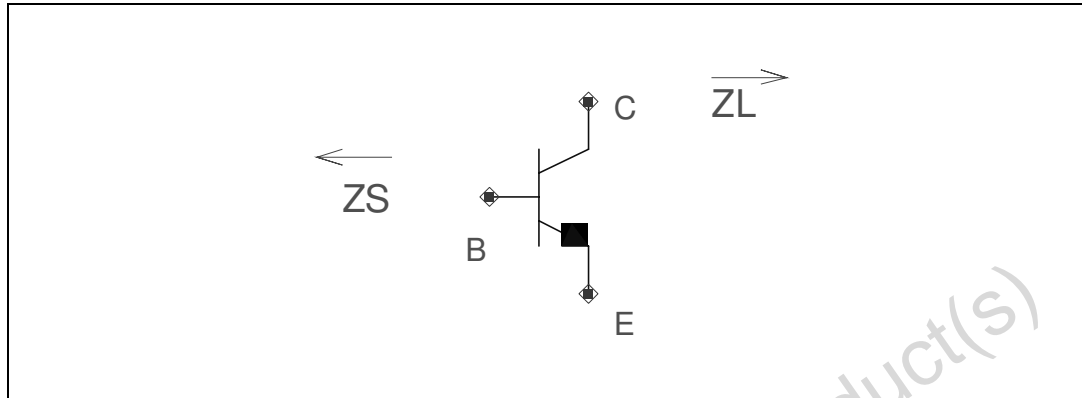


Table 6. Impedance data

| Frequency (MHz) | $Z_{BS} (\Omega)$ | $Z_{CL} (\Omega)$ |
|-----------------|-------------------|-------------------|
| 800             | 16.58 - j4.04     | 17.95 - j5.49     |
| 820             | 15.81 - j3.81     | 16.28 - j5.11     |
| 840             | 15.04 - j3.53     | 14.77 - j4.67     |
| 860             | 14.31 - j3.21     | 13.44 - j4.15     |
| 880             | 13.61 - j2.83     | 12.25 - j3.54     |
| 900             | 12.93 - j2.44     | 11.19 - j2.90     |
| 920             | 12.27 - j2.01     | 10.24 - j2.22     |
| 940             | 11.66 - j1.53     | 9.40 - j1.52      |
| 960             | 11.06 - j1.04     | 8.65 - j0.81      |
| 980             | 10.52 - j0.54     | 7.99 - j0.11      |
| 1000            | 9.98 + j0.02      | 7.38 + j0.62      |

# 4 Typical performance

Figure 3. DC output characteristics

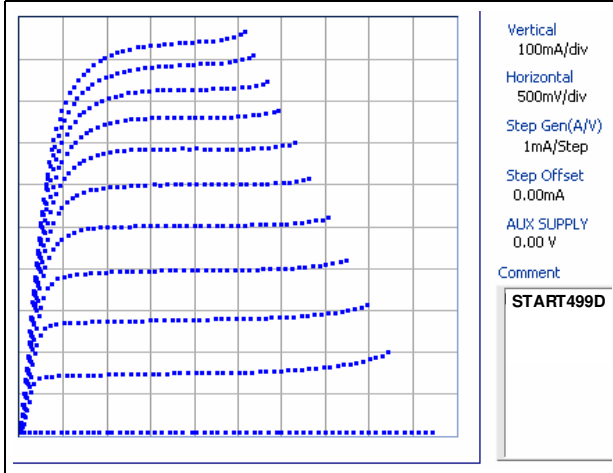


Figure 4. BVEBO

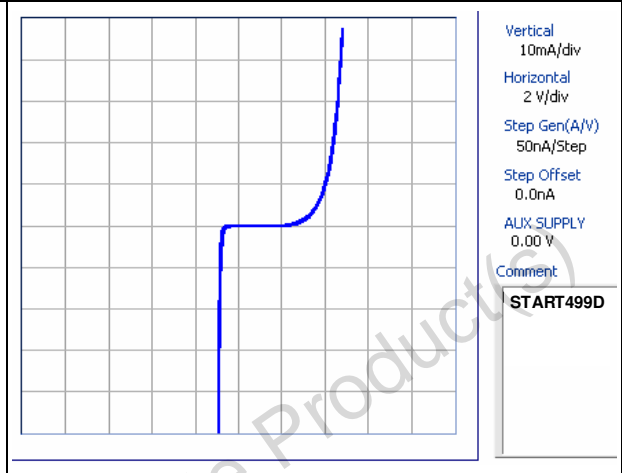


Figure 5. BVCES

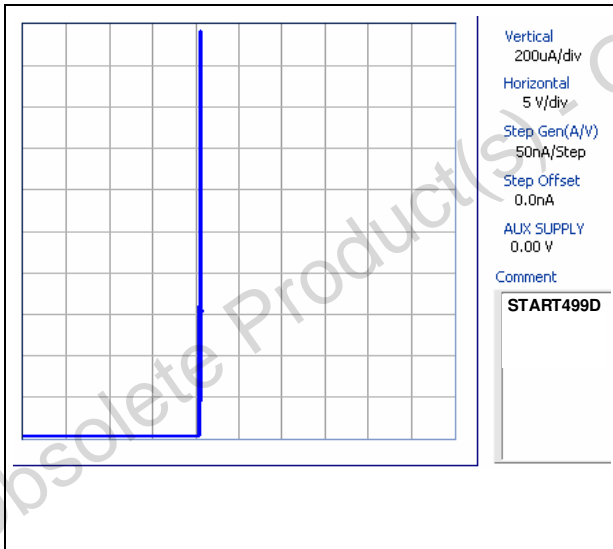


Figure 6. Gain vs frequency

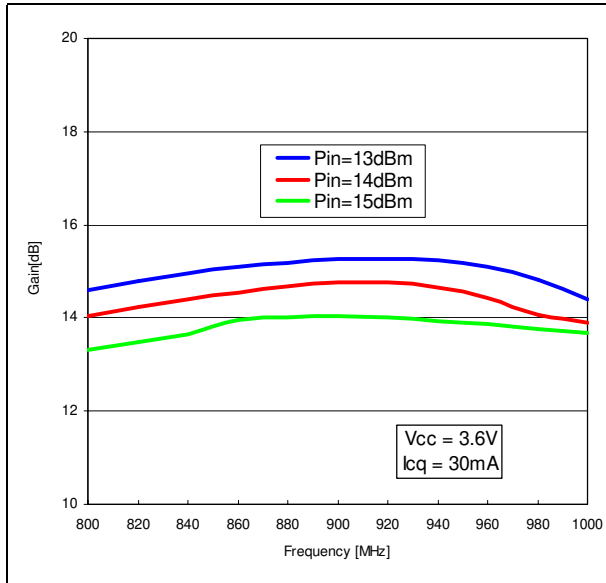


Figure 7. Efficiency vs frequency

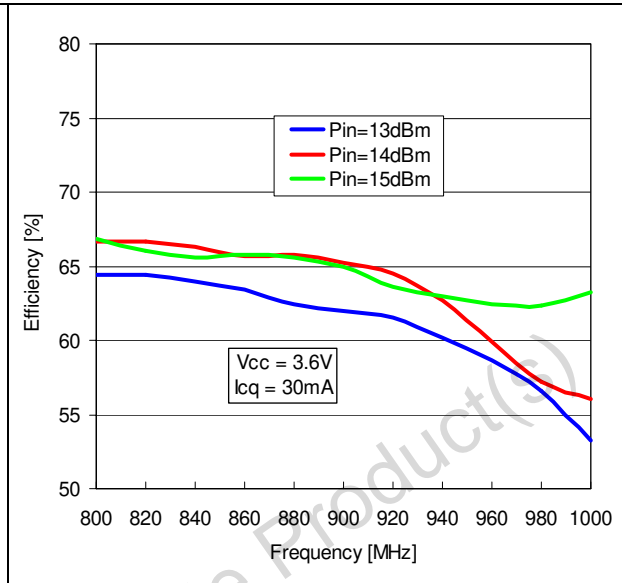


Figure 8. Gain and efficiency vs frequency

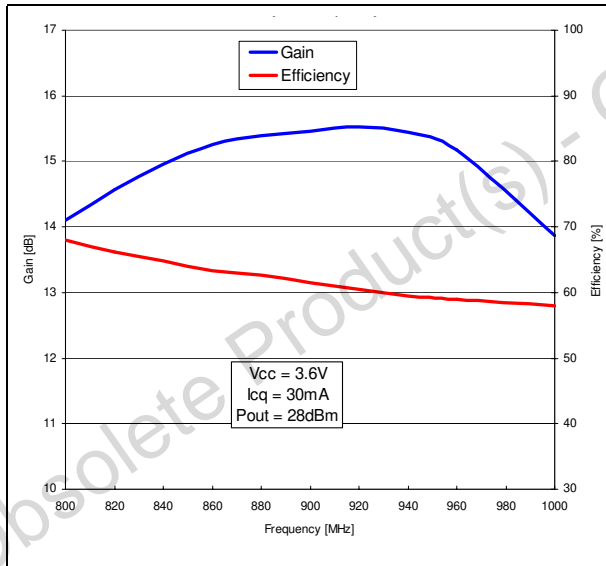


Figure 9. Harmonics vs frequency

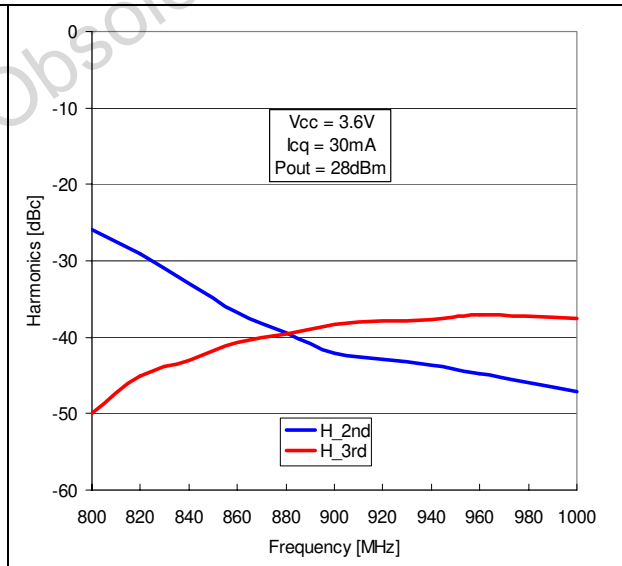


Figure 10. Input return loss vs frequency

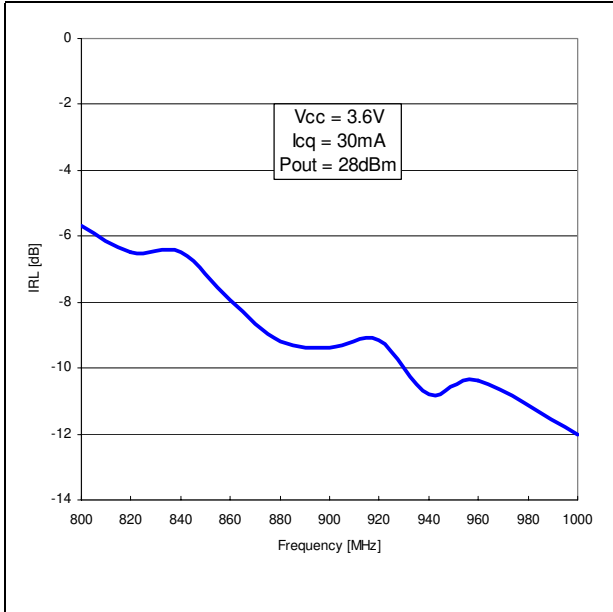


Figure 11. Gain vs output power

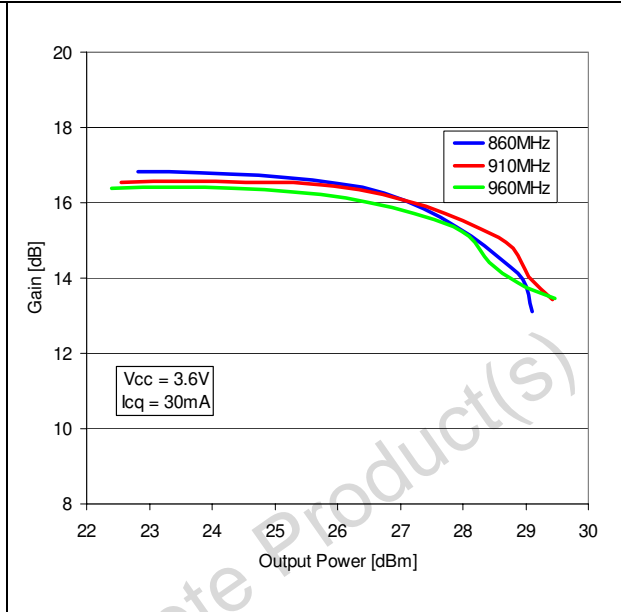


Figure 12. Efficiency vs output power

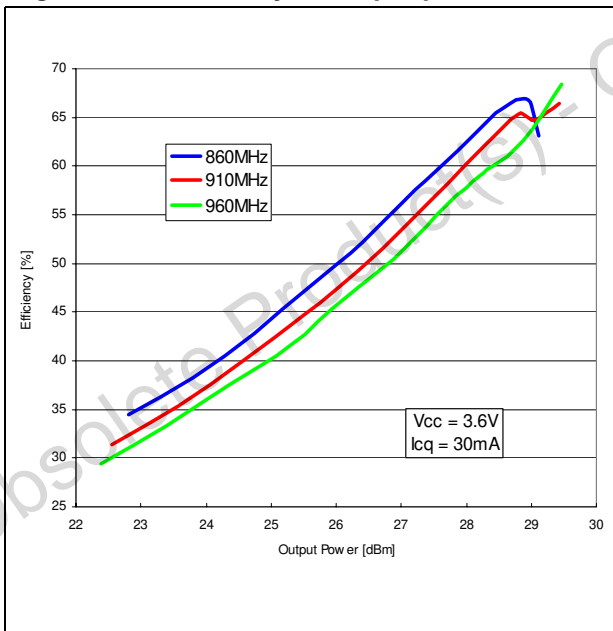


Figure 13. Gain vs output power

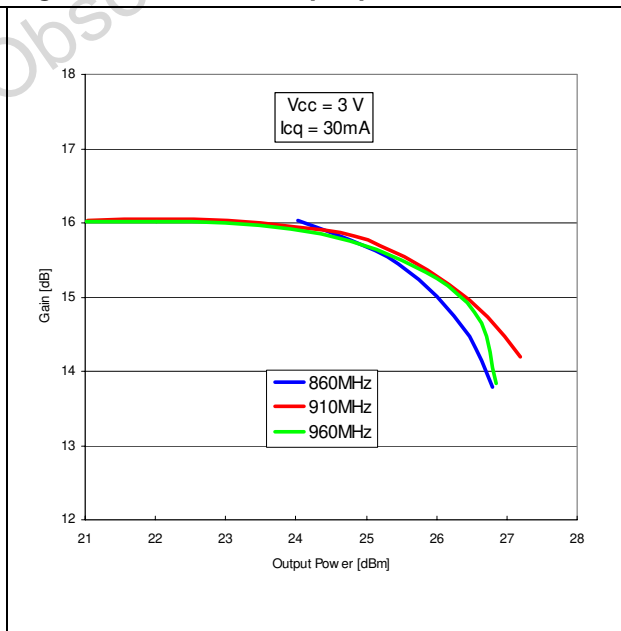




Figure 14. Efficiency vs output power

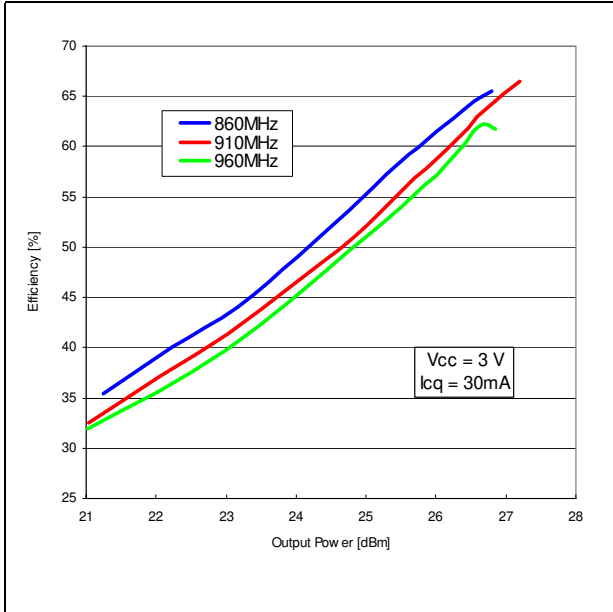


Figure 15. Gain vs output power

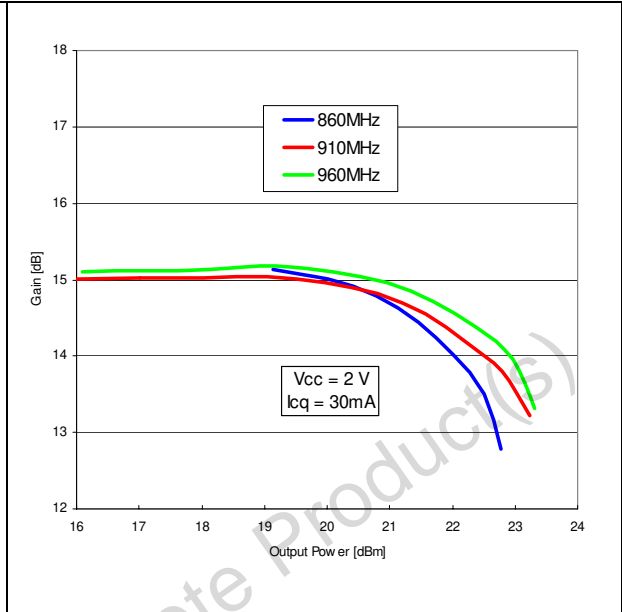
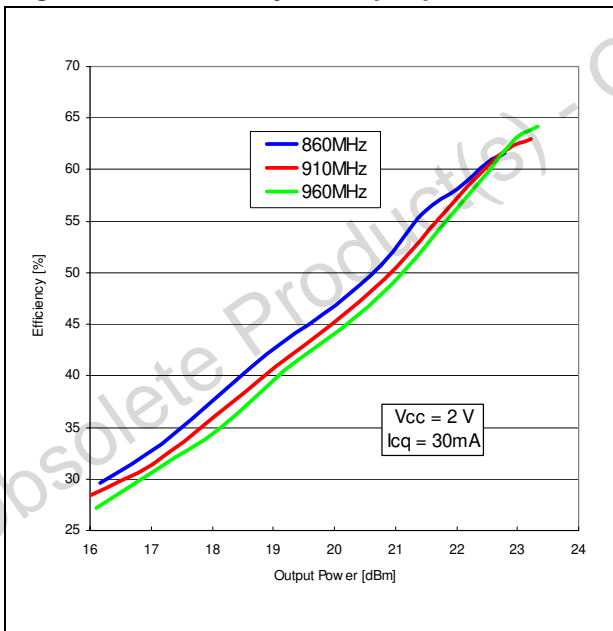


Figure 16. Efficiency vs output power



## 5 Test circuit, part list and photo

Figure 17. Test circuit schematic

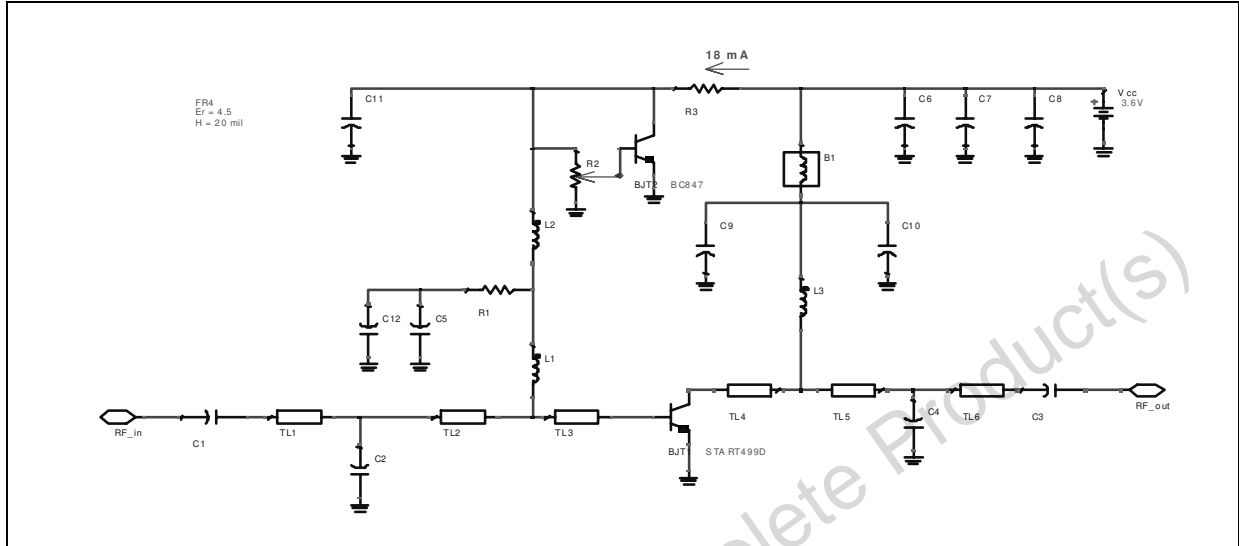


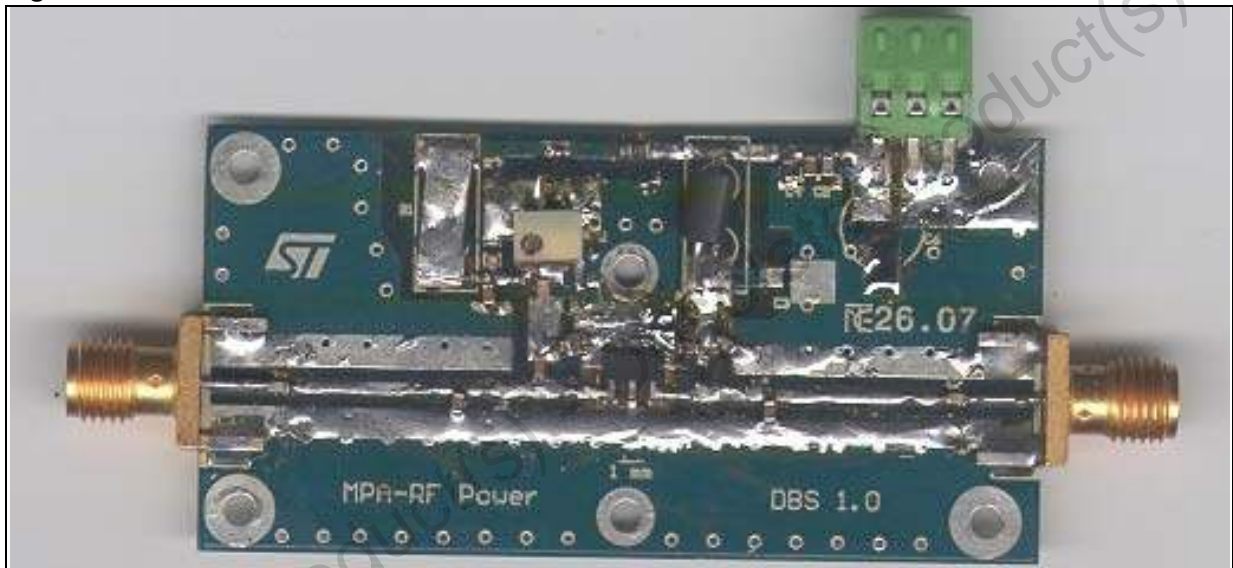
Table 7. Components part list

| Component ID | Description       | Value     | Case size | Manufacturer       | Part code                             |
|--------------|-------------------|-----------|-----------|--------------------|---------------------------------------|
| C1,C3,C5,C9  | Capacitor         | 100 pF    | 1608      | Murata             | GRM1885C1H101JA01                     |
| C2           | Capacitor         | 5.6 pF    | 1608      | Murata             | GRM1885C1HR50CZ01                     |
| C4           | Capacitor         | 6.8 pF    | 1608      | Murata             | GRM1885C1H6R8CZ01                     |
| C6,C10,C11   | Capacitor         | 1 nF      | 1608      | Murata             | GRM1885C1H102JA01                     |
| C7           | Capacitor         | 10 nF     | 1608      | Murata             | GRM188R71H103KA01                     |
| C8           | Capacitor         | 1 uF      | 1608      | Murata             | GRM188R71H105KA01                     |
| L1           | Inductor          | 11 nH     | 1608      | Coilcraft          | 0603CS-11NXGB                         |
| L2           | Inductor          | 100 nH    | 1608      | Coilcraft          | 0603CS-R10XGB                         |
| L3           | Inductor          | 5.4 nH    | 2012      | Coilcraft          | 0906-5JLB                             |
| B1           | Ferrite bead      |           |           | Panasonic          | EXCELDRC35C                           |
| R1           | Resister          | 30 ohm    | 1608      |                    | 1608 chip resister<br>(0.063 W, ±5 %) |
| R3           | Resister          | 180 ohm   | 1608      |                    |                                       |
| R2           | Potentiometer     | 10 KΩ     |           | Bourns electronics | 3214W-1-103E                          |
| TL1          | Transmission line | L=11.9 mm | W=0.9 mm  |                    |                                       |
| TL2          | Transmission line | L=5.0 mm  | W=0.9 mm  |                    |                                       |
| TL3          | Transmission line | L=5.2 mm  | W=0.9 mm  |                    |                                       |

Table 7. Components part list (continued)

| Component ID | Description                             | Value     | Case size | Manufacturer       | Part code |
|--------------|---|-----------|-----------|--------------------|-----------|
| TL4          | Transmission line                       | L=3.5 mm  | W=0.9 mm  |                    |           |
| TL5          | Transmission line                       | L=2.8 mm  | W=0.9 mm  |                    |           |
| TL6          | Transmission line                       | L=12.2 mm | W=0.9 mm  |                    |           |
| BJT2         | BJT                                     |           |           | STMicroelectronics | BC847     |
| BJT1         | BJT                                     |           |           | STMicroelectronics | START499D |
| Board        | FR4 Er=4.5 THk=0.020" 1OZ Cu both sides |           |           |                    |           |

Figure 18. Photo



## 6 Package mechanical data

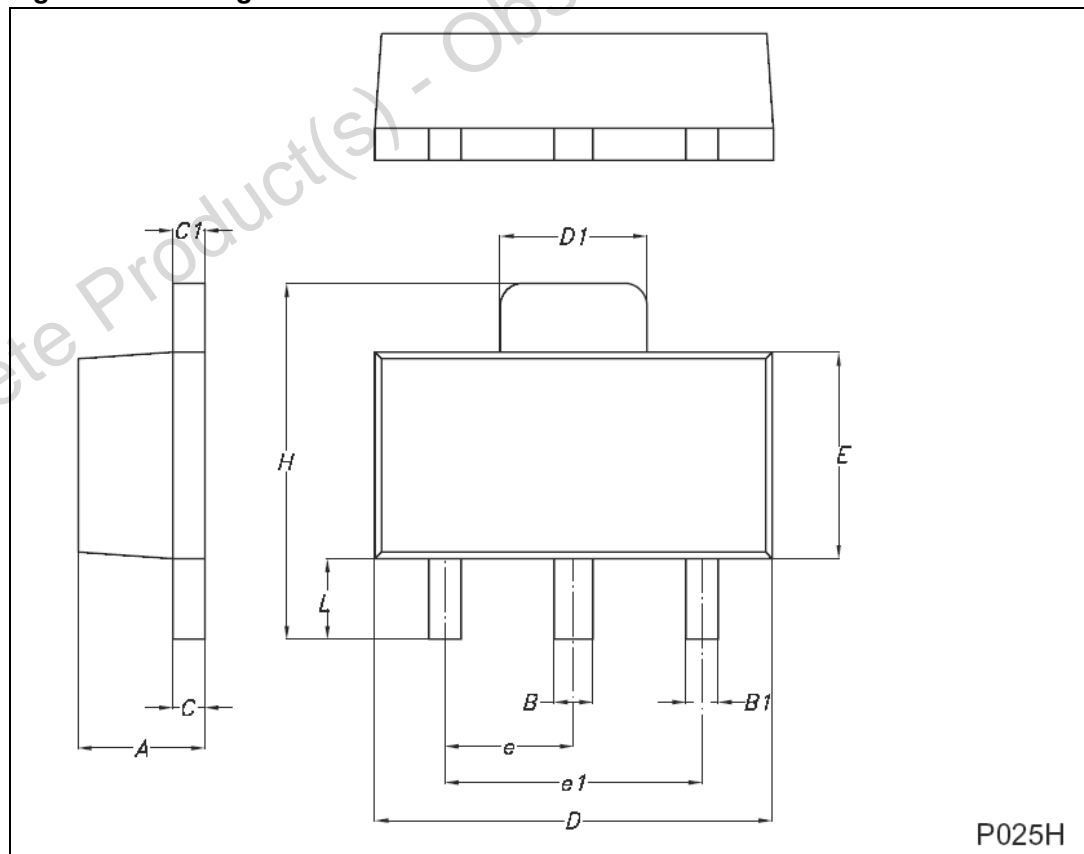
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Table 8. SOT-89 mechanical data

| Dim. | mm.  |     |      | Inch  |     |       |
|------|------|-----|------|-------|-----|-------|
|      | Min  | Typ | Max  | Min   | Typ | Max   |
| A    | 1.4  |     | 1.6  | 55.1  |     | 63.0  |
| B    | 0.44 |     | 0.56 | 17.3  |     | 22.0  |
| B1   | 0.36 |     | 0.48 | 14.2  |     | 18.9  |
| C    | 0.35 |     | 0.44 | 13.8  |     | 17.3  |
| C1   | 0.35 |     | 0.44 | 13.8  |     | 17.3  |
| D    | 4.4  |     | 4.6  | 173.2 |     | 181.1 |
| D1   | 1.62 |     | 1.83 | 63.8  |     | 72.0  |
| E    | 2.40 |     | 2.6  | 94.5  |     | 102.4 |
| e    | 1.42 |     | 1.57 | 55.9  |     | 61.8  |
| e1   | 2.92 |     | 3.07 | 115.0 |     | 120.9 |
| H    | 3.94 |     | 4.25 | 155.1 |     | 167.3 |
| L    | 0.89 |     | 1.2  | 35.0  |     | 47.2  |

Figure 19. Package dimensions

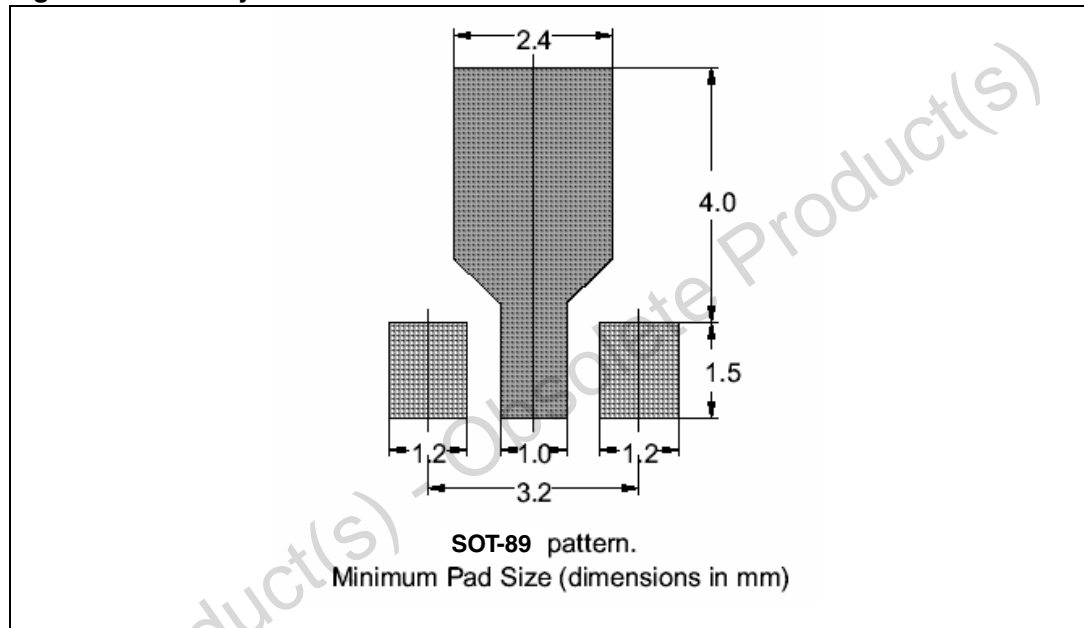


### 6.1 Thermal pad and via design

Thermal vias are required in the PCB layout to effectively conduct heat away from the package. The via pattern has been designed to address thermal, power dissipation and electrical requirements of the device.

The via pattern is based on thru-hole vias with 0.203 mm to 0.330 mm finished hole size on a 0.5 mm to 1.2 mm grid pattern with 0.025 plating on via walls. If micro vias are used in a design, it is suggested that the quantity of vias be increased by a 4:1 ratio to achieve similar results.

Figure 20. Pad layout details



## 6.2 Soldering profile

Figure 21 shows the recommended solder for devices that have Pb-free terminal plating and where a Pb-free solder is used.

Figure 21. Recommended solder profile

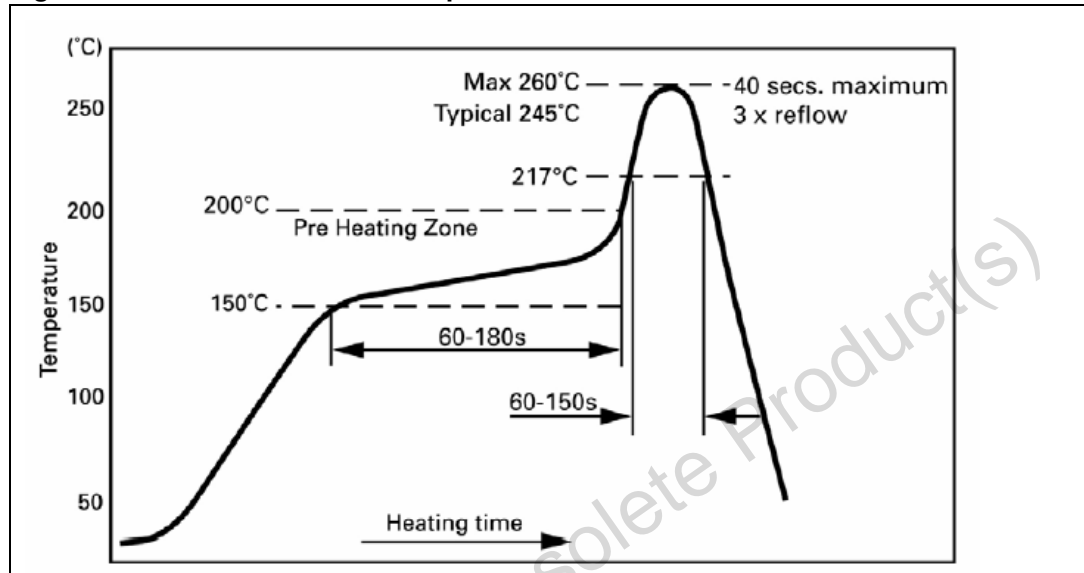


Figure 22 shows the recommended solder for devices with Pb-free terminal plating used with leaded solder, or for devices with leaded terminal plating used with a leaded solder.

Figure 22. Recommended solder profile for leaded devices

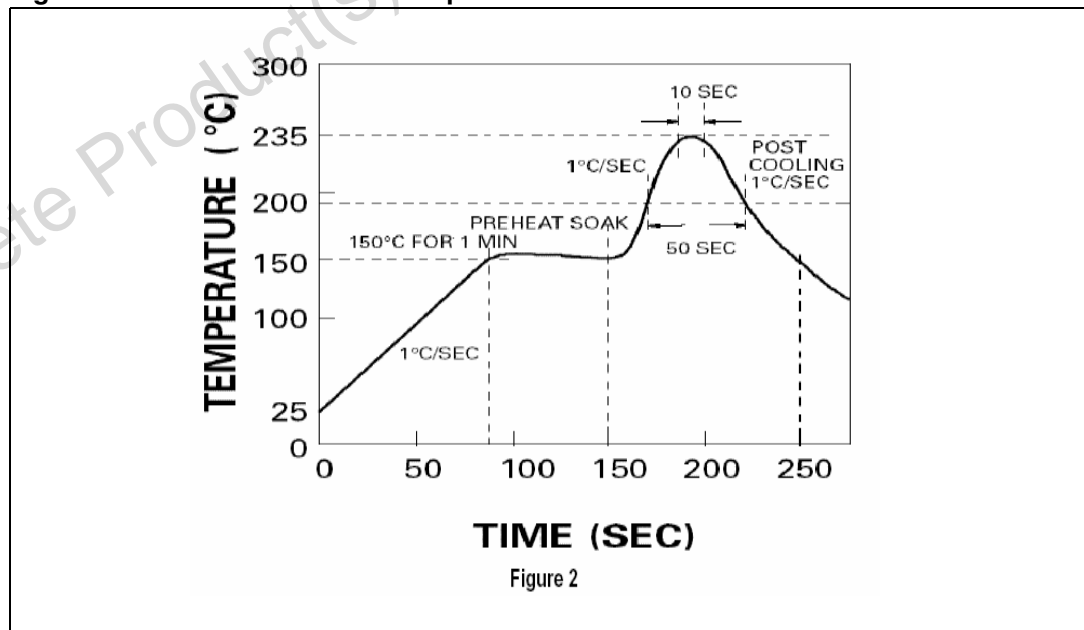
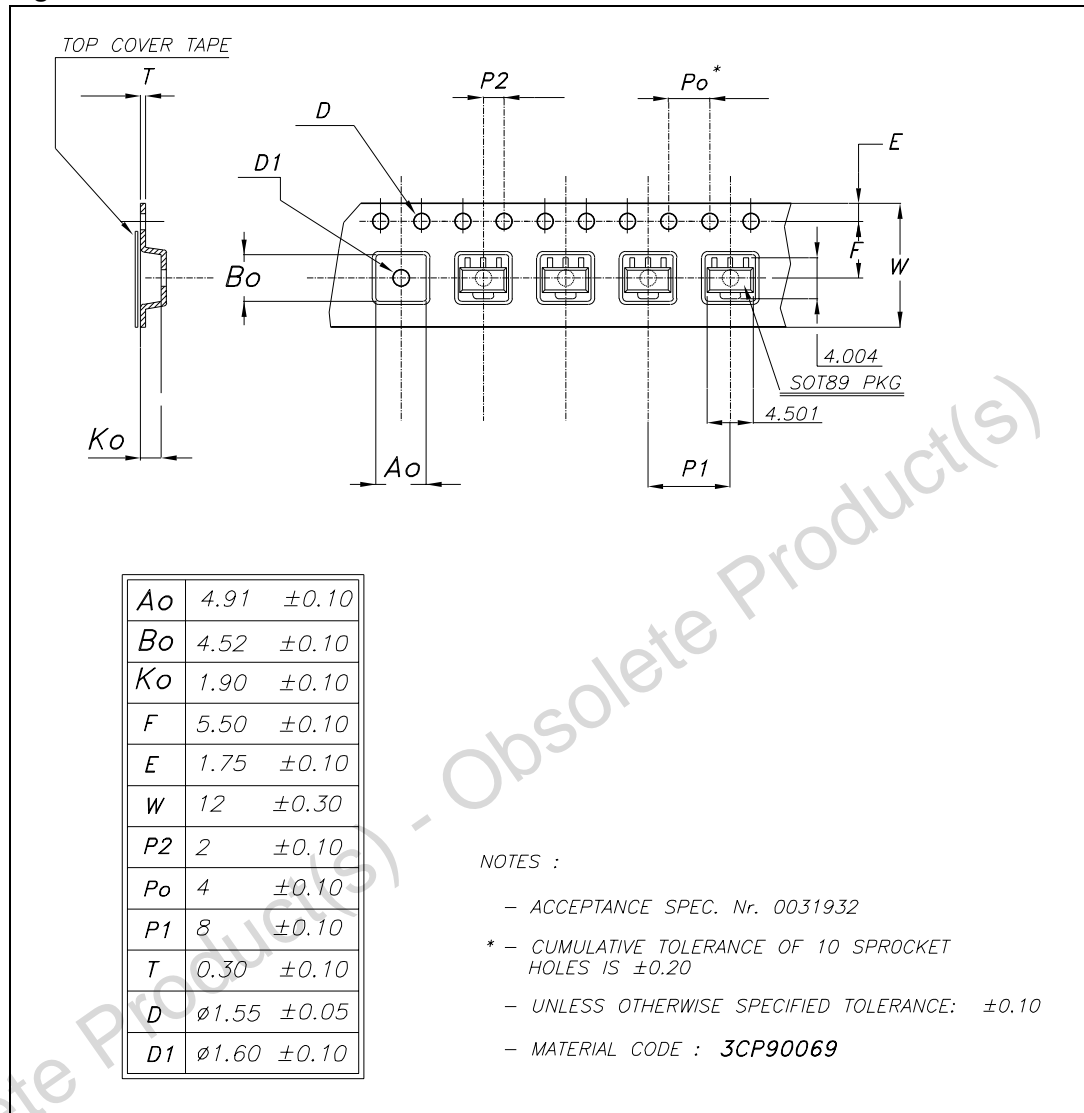


Figure 23. Reel information





## 7 Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 03-Mar-2008 | 1        | Initial release.                                     |
| 15-Jul-2008 | 2        | Updated <a href="#">Table 1 on page 1</a> .          |
| 17-Jul-2008 | 3        | Values update on <a href="#">Table 4 on page 4</a> . |
| 29-Jun-2010 | 4        | Updated <a href="#">Table 8 on page 13</a> .         |

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