



ULTRA HIGH DYNAMIC RANGE, SHUTDOWN

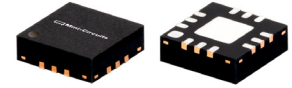
# Monolithic Amplifier

## TSS-23LN+

50Ω 30 MHz to 2 GHz

### THE BIG DEAL

- High IP3, 36.4 dBm typ. at 1GHz
- Gain, 21.5 dB typ. at 1 GHz
- Low noise figure, 1.2 dB at 1 GHz
- Low voltage, 5V and 3V
- Shutdown feature



Generic photo used for illustration purposes only

CASE STYLE: DQ1225

#### +RoHS Compliant

The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

### APPLICATIONS

- Base station infrastructure
- CATV
- Cellular

### PRODUCT OVERVIEW

TSS-23LN+ (RoHS compliant) is an advanced wideband amplifier with shutdown feature. It is fabricated using E-PHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure. In addition, the TSS-23LN+ has good input and output return loss over a broad frequency range. TSS-23LN+ is enclosed in a 3mm x 3mm, 12-lead MCLP package and has very good thermal performance.

### KEY FEATURES

| Feature  | Advantages   |
|--|--|
| Broad Band: 30MHz to 2GHz  | Broadband covering primary wireless communications bands: VHF, UHF, Cellular   |
| Extremely High IP3<br>39.8 dBm typical at 30 MHz<br>36.4 dBm typical at 1GHz | The TSS-23LN+ matches industry leading IP3 performance relative to device size and power consumption. The combination of the design and E-PHEMT Structure provides enhanced linearity over a broad frequency range as evidence in the IP3 being approximately 11-17 dB above the P1dB point. This feature makes this amplifier ideal for use in: <ul style="list-style-type: none"> <li>• Driver amplifiers for complex waveform up converter paths</li> <li>• Drivers in linearized transmit systems</li> <li>• Secondary amplifiers in ultra-High Dynamic range receivers</li> </ul> |
| Shutdown feature   | Allow users to turn on and off the amplifier with pulsed signals while keeping the power supply at constant voltage to minimize DC power consumption   |
| Low Noise Figure<br>1.2 dB at 1 GHz  | Enables lower system noise figure performance and along with High OIP3 provides high dynamic range   |
| Low Supply Voltage   | TSS-23LN+ supports low supply voltage operation which indicate low power consumption.  |

REV. A  
ECO-011809  
TSS-23LN+  
GY/RS/CP  
220211





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# Monolithic Amplifier

TSS-23LN+

Mini-Circuits

## ELECTRICAL SPECIFICATIONS<sup>1</sup> AT 25°C & 50Ω, UNLESS NOTED OTHERWISE

| Parameter  | Condition (MHz) | Amplifier-ON |       |      | Amplifier-OFF | Amplifier-ON | Amplifier-OFF | Units   |
|--|-----------------|--------------|-------|------|---------------|--------------|---------------|---------|
|  |                 | VDD = 5V     |       |      | VDD = 5V      | VDD = 3V     | VDD = 3V      |         |
|  |                 | Min.         | Typ.  | Max. | Typ.          | Typ.         | Typ.          |         |
| Frequency Range  |                 | 30           |       | 2000 | 30-2000       | 30-2000      | 30-2000       | MHz     |
| Noise Figure   | 30              |              | 1.2   |      |               | 1.1          |               | dB      |
|  | 500             |              | 1.2   |      |               | 1.2          |               |         |
|  | 1000            |              | 1.2   |      |               | 1.2          |               |         |
|  | 1500            |              | 1.3   |      |               | 1.4          |               |         |
|  | 2000            |              | 1.4   |      |               | 1.5          |               |         |
| Gain   | 30              | 20.7         | 23.1  | 25.3 | -21           | 22.4         | -21           | dB      |
|  | 500             | —            | 22.2  | —    | -21           | 21.4         | -21           |         |
|  | 1000            | 19.2         | 21.5  | 23.4 | -23           | 20.2         | -24           |         |
|  | 1500            | —            | 20.7  | —    | -26           | 19.1         | -26           |         |
|  | 2000            | 17.6         | 19.9  | 21.6 | -28           | 18           | -27           |         |
| Reversed Isolation                                     | 30-2000         |              | 27    |      | 26            | 27           | 25            | dB      |
| Input Return Loss                                      | 30              |              | 12    |      | 12            | 12           | 12            | dB      |
|  | 500             |              | 12    |      | 12            | 11           | 12            |         |
|  | 1000            |              | 10    |      | 12            | 8            | 12            |         |
|  | 1500            |              | 10    |      | 15            | 8            | 15            |         |
|  | 2000            |              | 11    |      | 19            | 8            | 19            |         |
| Output Return Loss                                     | 30              |              | 15    |      | 2             | 17           | 2             | dB      |
|  | 500             |              | 15    |      | 2             | 19           | 2             |         |
|  | 1000            |              | 16    |      | 2             | 18           | 2             |         |
|  | 1500            |              | 12    |      | 2             | 11           | 2             |         |
|  | 2000            |              | 10    |      | 2             | 9            | 2             |         |
| Output Power @1dB compression AMP-ON                   | 30              |              | 22.8  |      |               | 17.1         |               | dBm     |
|  | 500             |              | 23.8  |      |               | 18.9         |               |         |
|  | 1000            |              | 24.1  |      |               | 19           |               |         |
|  | 1500            |              | 23.5  |      |               | 18.8         |               |         |
|  | 2000            |              | 22.8  |      |               | 18.1         |               |         |
| Output IP3 (Pout = 0dBm/Tone)                          | 30              | —            | 39.8  |      |               | 34.1         |               | dBm     |
|  | 500             | —            | 38.0  |      |               | 33.7         |               |         |
|  | 1000            | —            | 36.4  |      |               | 31.8         |               |         |
|  | 1500            | 33           | 35.5  |      |               | 31.1         |               |         |
|  | 2000            | —            | 34.0  |      |               | 30.3         |               |         |
| Device Operating Voltage (VDD)                         |                 | 4.75         | 5     | 5.25 | 5             | 3            | 3             | V       |
| Device Operating Current (ID)                          |                 |              | 139   | 163  | 5             | 74           | 3             | mA      |
| Control Voltage (VG)                                   |                 |              | 0     |      | 5             | 0            | 5             | V       |
| DC Current (ID) Variation Vs. Temperature <sup>2</sup> |                 |              | -13   |      |               | 27           |               | uA/degC |
| DC Current (ID) Variation Vs. Voltage                  |                 |              | 0.034 |      |               | 0.033        |               | mA/mV   |
| Thermal Resistance                                     |                 |              | 23.3  |      |               | 23.3         |               | degC/W  |

1. Measured on Mini-Circuits Characterization test board TB-TSS-23LN+. See Characterization Test Circuit (Fig. 1)

2. (Current at 105°C – Current at -45°C)/150

## MAXIMUM RATINGS<sup>3</sup>

| Parameter                                       | Ratings  |
|---|--|
| Operating Temperature (ground lead)             | -40°C to 105°C   |
| Storage Temperature                             | -65°C to 150°C   |
| Total Power Dissipation                         | 3.3W   |
| Input Power                                     | 28 dBm (5 minutes max.)<br>10 dBm (continuous) for 0.03-1 GHz<br>13 dBm (continuous) for 1-2 GHz |
| DC Voltage V <sub>DD</sub> <sup>4</sup> (Pad 7) | 10V  |
| DC Voltage V <sub>G</sub> <sup>5</sup> (Pad 1)  | 10V  |

3 Permanent damage may occur if these limits are exceeded.

4 Measured by keeping VG=0V.

5 Measured by keeping Vdd=5V.

## CONTROL VOLTAGE (V<sub>G</sub>) FIG. 1

|               | Min. | Typ. | Max. | Units |
|---------------|------|------|------|-------|
| Amplifier-ON  | —    | 0    | 0.7  | V     |
| Amplifier-OFF | 1.9  | 5    | —    | V     |

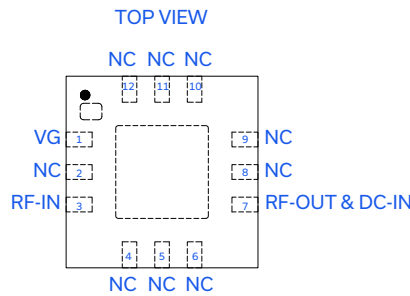
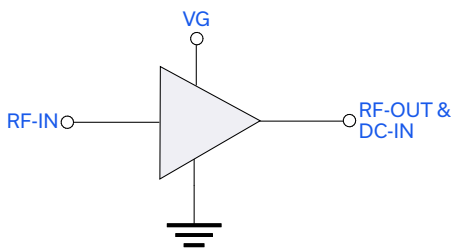




### SWITCHING SPECIFICATIONS

| Parameter                |                                  | Min. | 5V Typ. | 3V Typ. | Units |
|--------------------------|----------------------------------|------|---------|---------|-------|
| Amplifier ON to Shutdown | OFF TIME (50% Control to 10% RF) | —    | 4.8     | 6.2     | μs    |
|                          | FALL TIME (90 to 10% RF)         | —    | 7.4     | 3.6     |       |
| Amplifier Shutdown to ON | ON TIME (50% Control to 90% RF)  | —    | 95.2    | 144.7   | μs    |
|                          | RISE TIME (10% to 90% RF)        | —    | 60.0    | 200.7   |       |
| Control Voltage Leakage  |                                  | —    | 482.9   | 311.0   | mV    |

### SIMPLIFIED SCHEMATIC AND PAD DESCRIPTION



| Function         | Pad Number   | Description                        |
|------------------|--------------|------------------------------------|
| RF-IN            | 3            | RF Input                           |
| RF-OUT and DC-IN | 7            | RF Output and DC Bias              |
| GND              | Paddle       | Connections to ground.             |
| NC               | 2, 4-6, 8-12 | No connection, grounded externally |
| VG               | 1            | Control voltage for shutdown (VG)  |

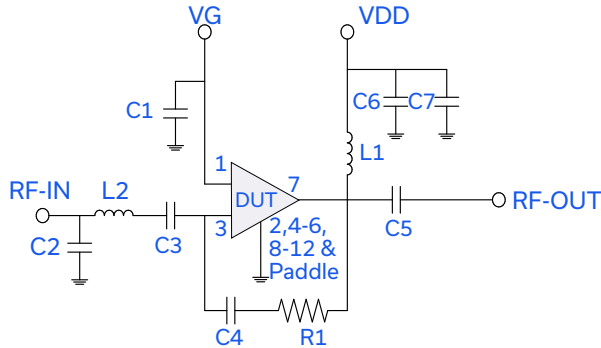


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## CHARACTERIZATION TEST CIRCUIT / RECOMMENDED APPLICATION CIRCUIT



| Component | Size | Value   | Part Number        | Manufacturer |
|-----------|------|---------|--------------------|--------------|
| C1        | 0402 | 0.1uF   | GRM155R71C104KA88D | Murata       |
| C2        | 0402 | 1.5pF   | GRM1555C1H1R5CA1D  | Murata       |
| C3        | 0603 | 2.2uF   | GRM188C71E225KE11D | Murata       |
| C4        | 0402 | 0.1uF   | GRM155R71C104KA88D | Murata       |
| C5        | 0603 | 2.2uF   | GRM188C71E225KE11D | Murata       |
| C6        | 0402 | 1000pF  | GRM1555C1H102JA01D | Murata       |
| C7        | 0805 | 10uF    | GRM21BC71E106KE11L | Murata       |
| L1        | 1210 | 15uH    | LQH32DN150K53L     | Murata       |
| L2        | 0603 | 5.1nH   | 0603CS-5N1XJLU     | Coilcraft    |
| R1        | 0402 | 1.5K0hm | RK73H1ETTP1501F    | Koa          |

Fig 1. Block diagram of Test Circuit used for characterization. (DUT soldered on Mini-Circuits Characterization test board TB-TSS-13LN+) Gain, Return loss, Output power at 1dB compression (P1dB) , output IP3 (OIP3) and noise figure measured using Agilent's N5242A PNA-X microwave network analyzer.

### Conditions:

1. Gain and Return Loss: Pin= -25dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, +0dBm/tone at output.
3. Switching Time  
RF Signal: Pin=-25 dBm, fRF=500 MHz.  
Vdd=3 & 5V DC, VG=Pulse signal at 1 KHz with VHIGH=5V, VLOW=0V, 50% duty cycle.

## PRODUCT MARKING



Marking may contain other features or characters for internal lot control



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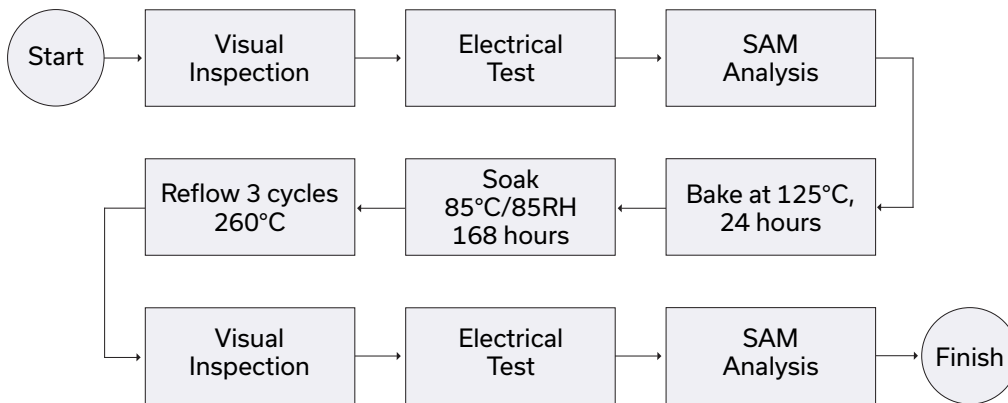
ADDITIONAL DETAILED TECHNICAL INFORMATION IS AVAILABLE ON OUR DASH BOARD. TO ACCESS [CLICK HERE](#)

|  |  |
|--|--|
| Performance Data                                     | Data Table<br>Swept Graphs<br>S-Parameter (S2P Files) Data Set (.zip file) |
| Case Style   | DQ1225<br>Plastic package, exposed paddle lead finish: Matte-Tin           |
| Tape & Reel<br>Standard quantities available on reel | F66<br>7" reels with 20, 50, 100, 200, 500, 1K, or 2K devices              |
| Suggested Layout for PCB Design                      | PL-619   |
| Evaluation Board                                     | TB-TSS-23LN+   |
| Environmental Ratings                                | ENV08T9  |

### ESD RATING

Human Body Model (HBM): Class 1A (Pass 250 V) in accordance with ANSI/ESD STM 5.1 - 2001

### MSL FLOW CHART



- NOTES**
- A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
  - B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
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