

AN11293

BGA3012 - 5 MHz to 300 MHz 12 dB reverse amplifier application

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Application note

Document information

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| Keywords | BGA3012, Evaluation board, CATV, Drop amplifier |
| Abstract | This application note describes the schematic and layout requirements for using the BGA3012 as a CATV reverse amplifier. |



Revision history

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1. Introduction

The BGA3012 customer evaluation board enables the user to evaluate the performance of the wideband CATV MMIC amplifier BGA3012.

The BGA3012 performance information is available in the BGA3012 datasheet.

This application note describes the evaluation board schematic and layout requirements for using the BGA3012 as a CATV reverse amplifier between 5 MHz and 300 MHz. The BGA3012 is fabricated in the BiCMOS process and packaged in a lead-free 3-pin SOT89 package. The BGA3012 is surface-mounted on an evaluation board with element matching and DC decoupling circuitry. The amplifier MMIC comprises a two stage amplifier with internal bias network and operates over a frequency range of 5 MHz to 1006 MHz with a supply voltage between 5 V and 8 V.

2. System features

- 12 dB gain
- Internally biased
- Flat gain between 5 MHz and 300 MHz
- Noise figure of 3.3 dB
- High linearity with an $IP3_o$ of 40 dBm and $IP2_o$ of 60 dBm
- 75 Ω input and output impedance
- Unconditionally stable
- Excellent input and output return loss

3. Customer evaluation kit contents

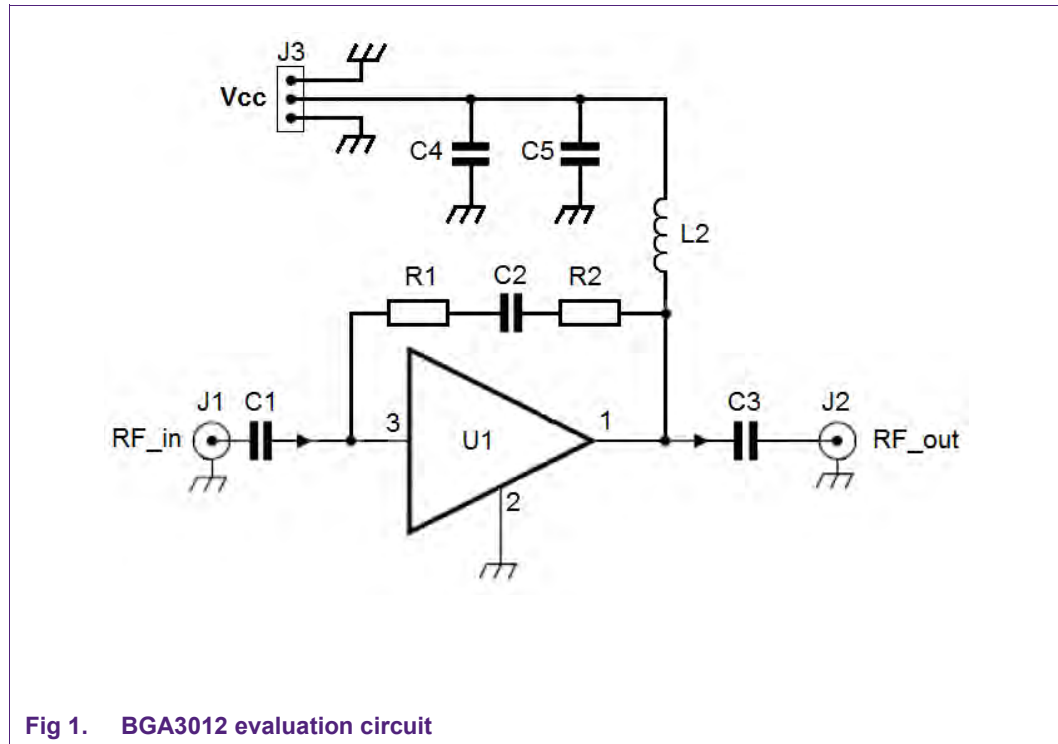
The evaluation kit contains the following items:

- ESD safe casing
- BGA3012 evaluation board
- BGA3012 SOT89 samples

4. Application Information

For evaluation purposes an evaluation board is available. The evaluation circuit can be seen in figure 1 and the corresponding PCB is shown in figure 2. Table 1 shows the bill of materials.

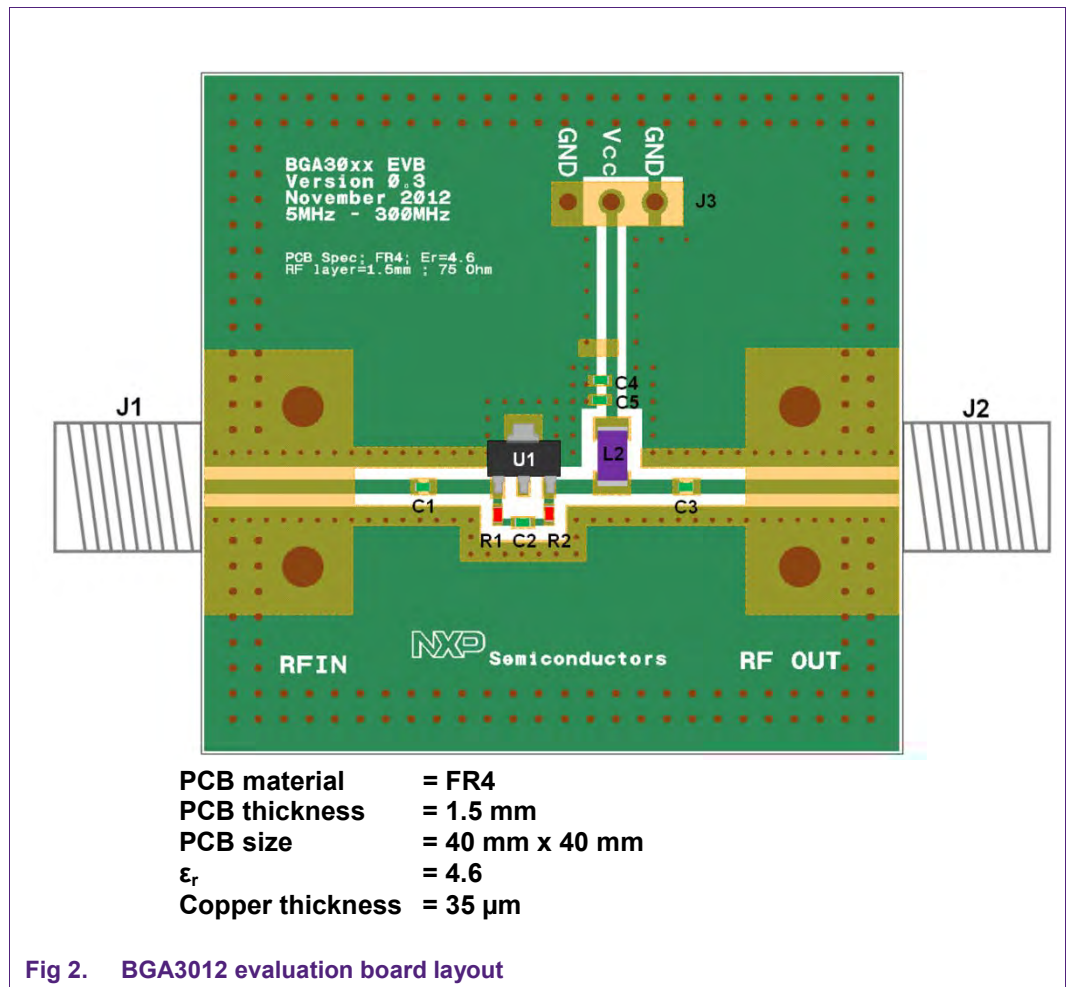
4.1 Evaluation board circuit



The power supply is applied on the center pin of connector J3 and is applied to the MMIC via choke L2 which provides RF blocking to the supply line. Capacitors C4 and C5 are supply decoupling capacitors.

At the F-connector J1 the RF input signal is applied where capacitor C1 provides DC-blocking. Resistors R1 and R2 are used as feedback resistors to set the gain and slope. Two resistors are used to lower the influence of the parasitic capacitance from the circuit board. Capacitor C2 provides DC-blocking between the input and output of the MMIC. Capacitor C3 provides DC-blocking before the RF signal is available at F-connector J2.

4.2 Evaluation board layout



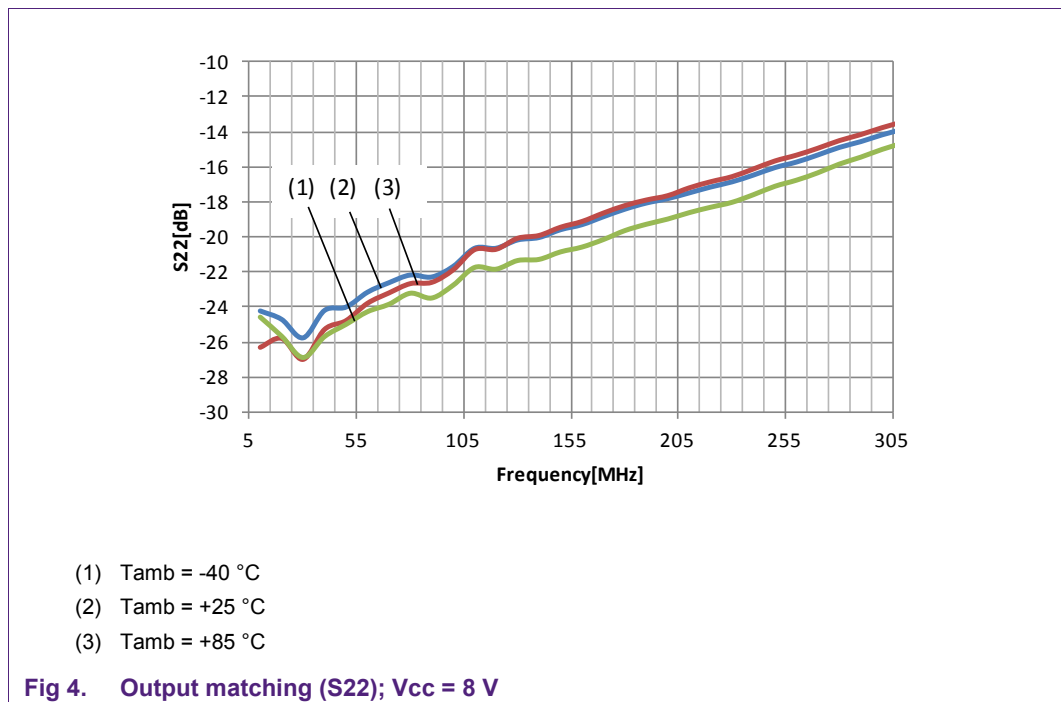
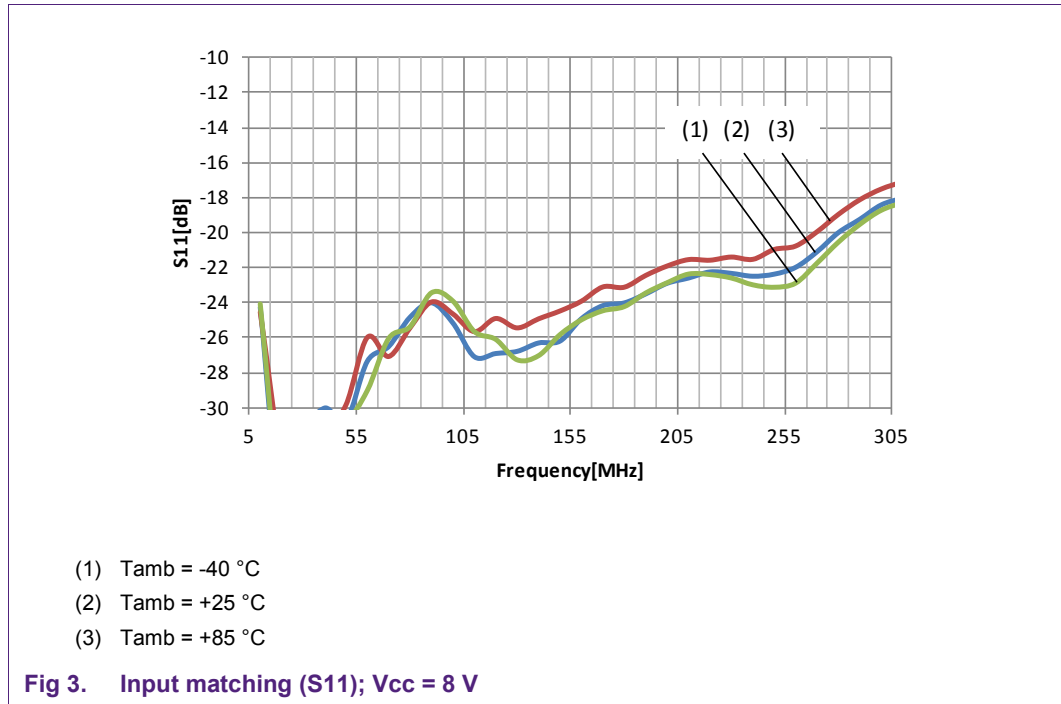
For optimum distortion performance it is important to have enough ground vias underneath and around the MMICs ground pins. This lowers the inductance to the ground plane. The evaluation board is made with two layer FR4 material.

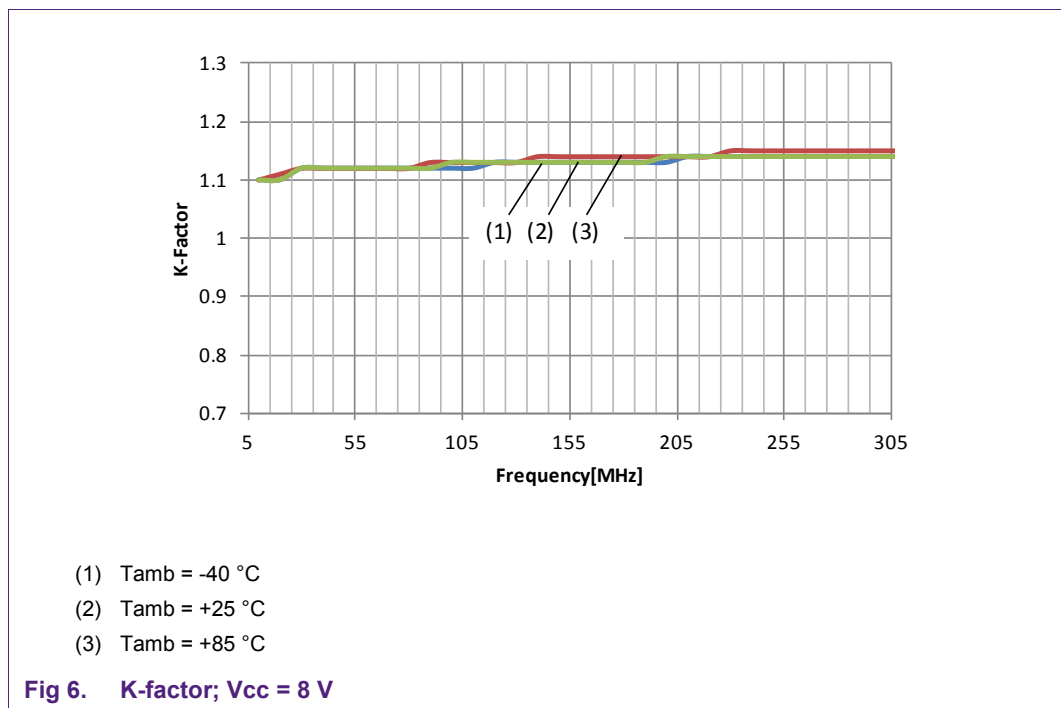
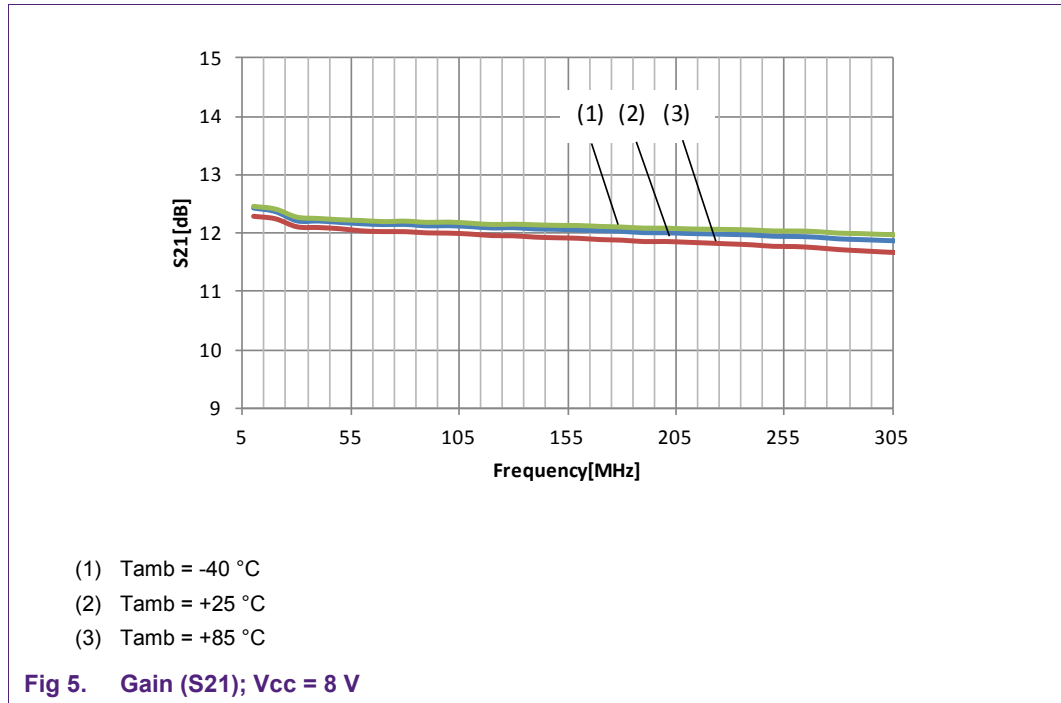
4.3 Bill of materials

Table 1. Evaluation board BoM

| Circuit Reference | Description | Qty | Mfr | Manufacturer number | Supplier | Supplier part number |
|-------------------|-------------------------|-----|--------|---------------------|----------|----------------------|
| U1 | BGA3012 | 1 | NXP | BGA3012 | NXP | BGA3012 |
| C1, C2, C3, C4 | 10 nF | 4 | Murata | GRM155R71E103KA01D | Digikey | 490-1312-1-ND |
| C5 | 100 pF | 1 | Murata | GRM1555C1H101JZ01D | Digikey | 490-3458-1-ND |
| L2 | 22uH | 1 | Murata | LQH31CN220K03L | Digikey | LQH31CN220K03L-ND |
| R1 | 300 Ω | 1 | Yageo | RC0402FR-07300RL | Digikey | 311-300LRCT-ND |
| R2 | 100 Ω | 1 | Yageo | RC0402FR-07100RL | Digikey | 311-100LRCT-ND |
| J1, J2 | 75 Ω F-connector | 2 | Bomar | 861V509ER6 | Mouser | 678-861V509ER6 |
| J3 | Header 3 | 1 | Molex | 90121-0763 | Digikey | WM8109-ND |

5. Measurement results at Vcc = 8 V





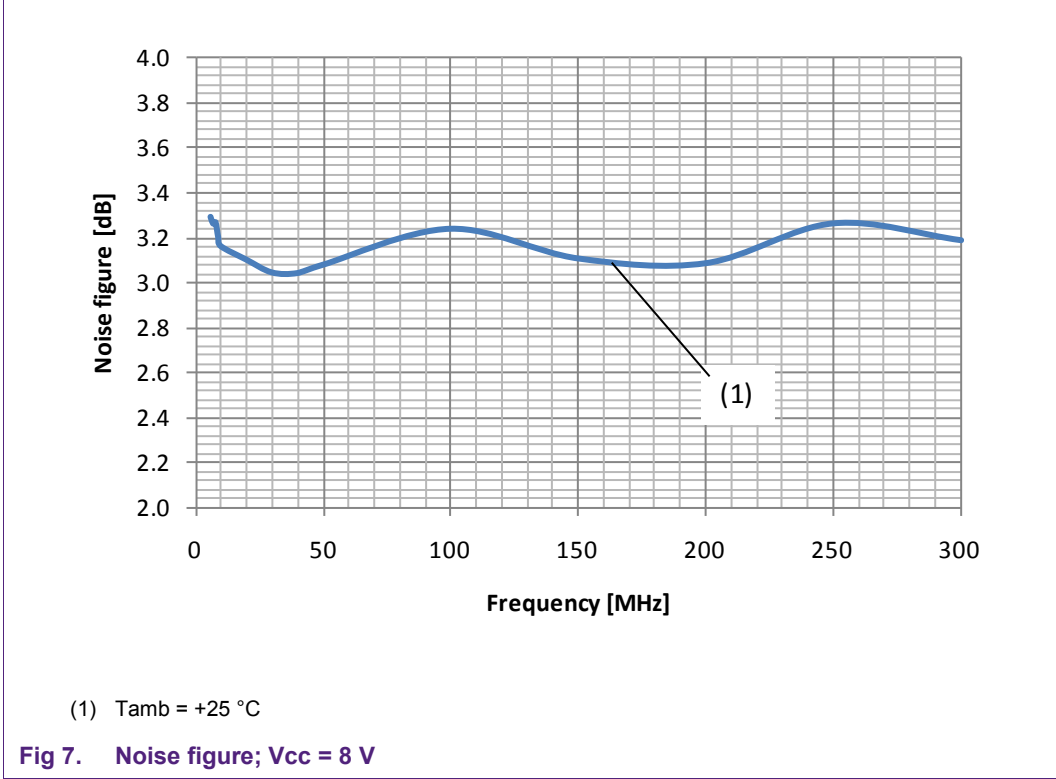


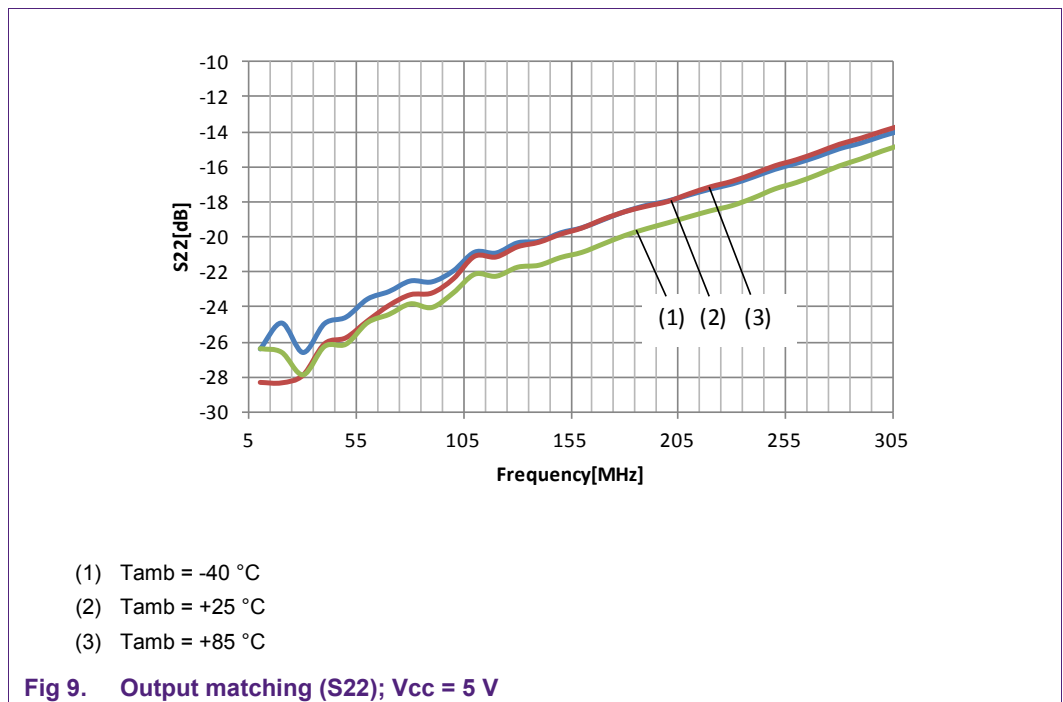
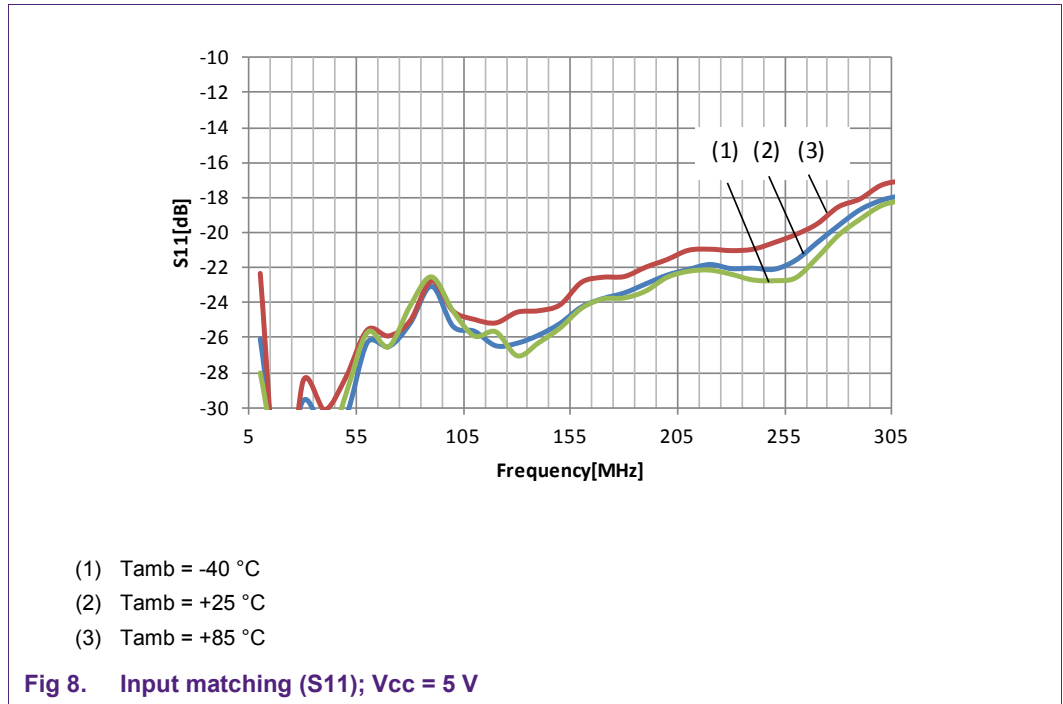
Table 2. Measurement results at Vcc = 8 V

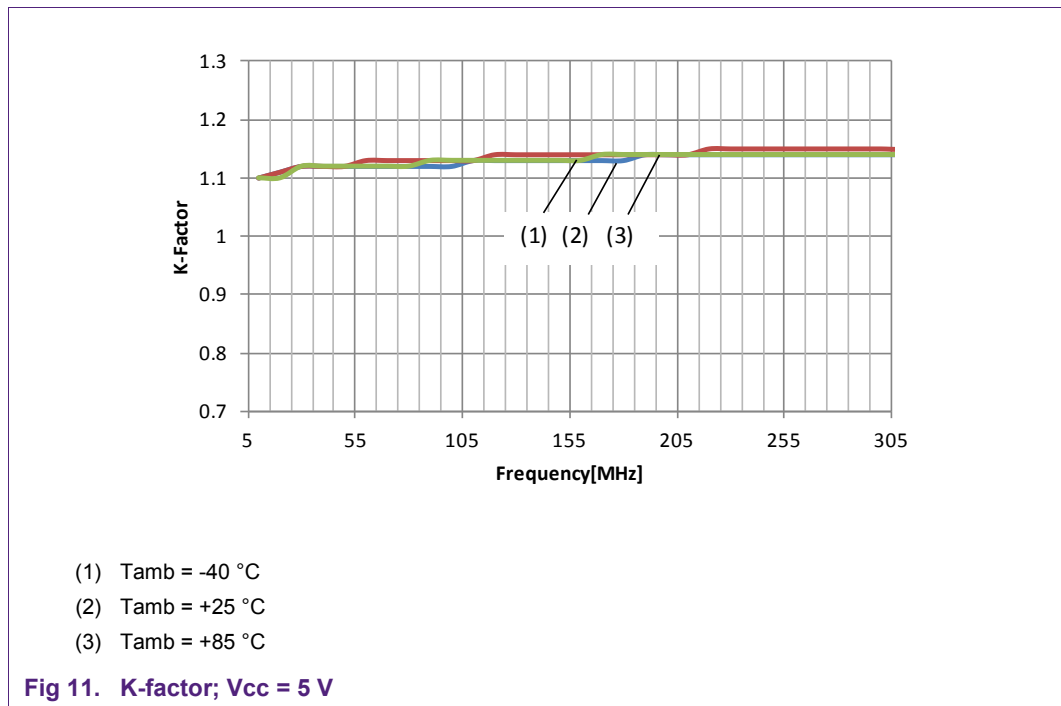
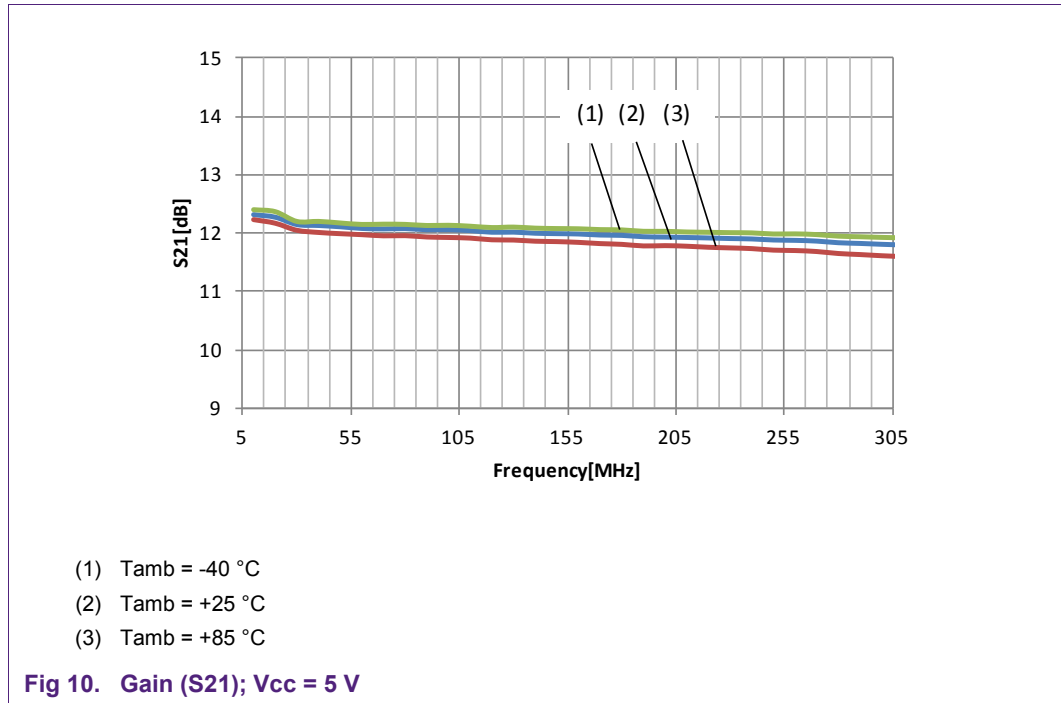
| Symbol | Conditions | -40 °C | +25 °C | +85 °C | Unit | |
|---------------------|------------|--------|--------|--------|------|-----|
| NF | At 10 MHz | 2.8 | 3.1 | 3.1 | dB | |
| | At 300 MHz | 3.0 | 3.2 | 3.4 | dB | |
| P _{L(1dB)} | At 40 MHz | 22.5 | 22.5 | 22.5 | dBm | |
| IP3 _o | At 34 MHz | [1] | 44.5 | 44.0 | 42.5 | dBc |
| | At 74 MHz | [1] | 42.0 | 42.0 | 41.5 | dBc |
| | At 114 MHz | [1] | 42.5 | 42.0 | 41.5 | dBc |
| | At 154 MHz | [1] | 44.0 | 43.0 | 41.5 | dBc |
| | At 194 MHz | [1] | 45.0 | 43.5 | 42.0 | dBc |
| | At 234 MHz | [1] | 46.5 | 44.5 | 42.5 | dBc |
| | At 274 MHz | [1] | 48.0 | 45.0 | 42.5 | dBc |
| IP2 _o | At 86 MHz | [2] | 63.0 | 61.0 | 60.0 | dBc |
| | At 166 MHz | [2] | 65.5 | 64.0 | 62.0 | dBc |
| | At 246 MHz | [2] | 62.5 | 61.0 | 60.0 | dBc |

[1] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 300 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 6$ MHz. Input power $P_i = -20$ dBm.

[2] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 300 MHz. The intermodulation product (IM20 is $|f_2 - f_1|$, with $40 \text{ MHz} < |f_1 - f_2| < 300 \text{ MHz}$. Input power $P_i = -20$ dBm.

6. Measurement results at Vcc = 5 V





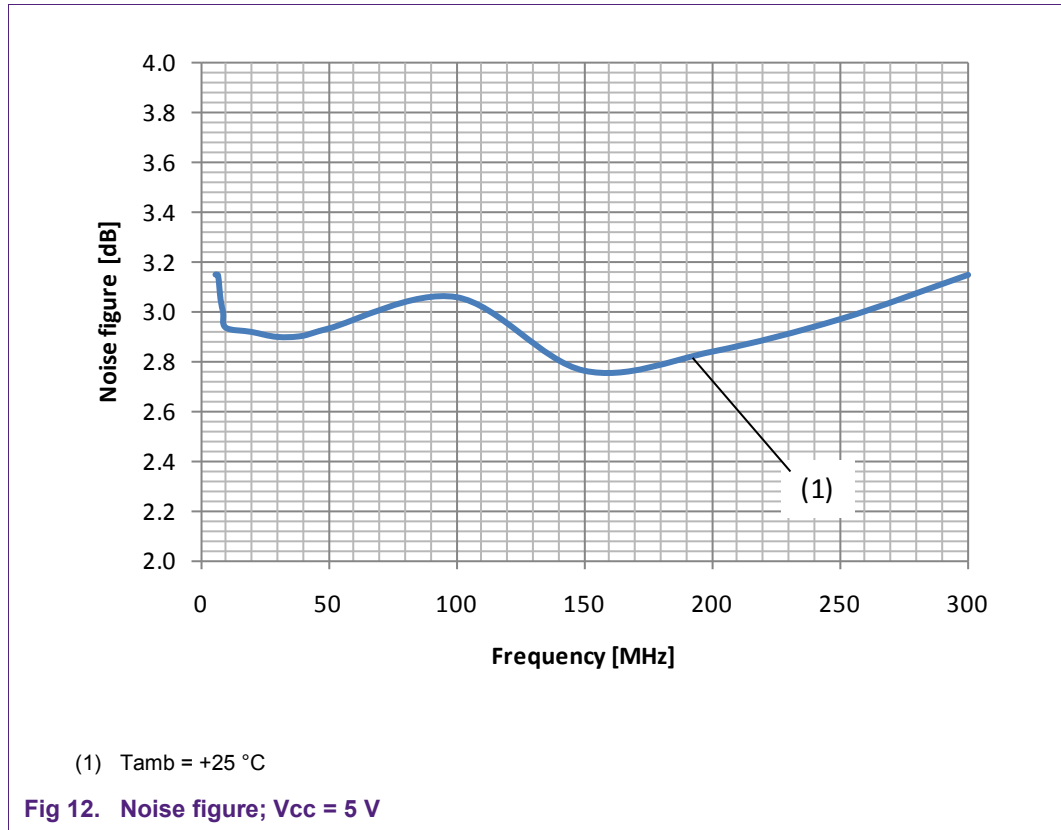


Table 3. Measurement results at Vcc = 5 V

| Symbol | Conditions | -40 °C | +25 °C | +85 °C | Unit | |
|---------------------|------------|--------|--------|--------|------|-----|
| NF | At 10 MHz | 2.7 | 2.9 | 2.9 | dB | |
| | At 300 MHz | 2.8 | 3.1 | 3.1 | dB | |
| P _{L(1dB)} | At 40 MHz | 17.5 | 17.5 | 17.5 | dBm | |
| IP _{3o} | At 34 MHz | [1] | 42.0 | 40.5 | 39.5 | dBc |
| | At 74 MHz | [1] | 40.5 | 38.5 | 38.0 | dBc |
| | At 114 MHz | [1] | 40.0 | 39.0 | 38.5 | dBc |
| | At 154 MHz | [1] | 40.5 | 39.5 | 38.5 | dBc |
| | At 194 MHz | [1] | 41.0 | 39.0 | 38.0 | dBc |
| | At 234 MHz | [1] | 41.0 | 39.5 | 38.0 | dBc |
| | At 274 MHz | [1] | 40.5 | 39.0 | 37.5 | dBc |
| | At 246 MHz | [2] | 58.5 | 56.5 | 55.0 | dBc |
| IP _{2o} | At 166 MHz | [2] | 59.5 | 57.0 | 56.0 | dBc |
| | At 246 MHz | [2] | 58.0 | 56.0 | 54.5 | dBc |

[1] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 300 MHz. The intermodulation product (IM3) is $2 \times f_2 - f_1$, where $f_2 = f_1 \pm 6$ MHz. Input power $P_i = -20$ dBm.

[2] The fundamental frequencies (f_1) and (f_2) lay between 40 MHz and 300 MHz. The intermodulation product (IM20 is $|f_2 - f_1|$, with $40 \text{ MHz} < |f_1 - f_2| < 300 \text{ MHz}$. Input power $P_i = -20$ dBm.

7. Abbreviations

Table 2. Abbreviations

| Acronym | Description |
|----------------|---|
| AC | Alternating Current |
| CATV | Community Antenna TeleVision |
| DC | Direct Current |
| ESD | Electro Static Discharge |
| MMIC | Monolithic Microwave Integrated Circuit |
| NTSC | National Television Standards Committee |
| PCB | Printed Circuit Board |
| RF | Radio Frequency |
| SMD | Surface Mounted Device |

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