AN11220

BGA3012 - 1 GHz 12 dB gain wideband amplifier MMIC

Rev. 2 — 8 January 2013 Application note

Document information

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

Revision history

Rev	Date	Description
1	20121012	First publication
2	20130108	Updated with improved application circuit and test data

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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 drop amplifier between 40 MHz and 1003 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 1003 MHz with a supply voltage between 5 V and 8 V.

2. System features

- 12 dB gain
- Internally biased
- Flat gain between 40 MHz and 1003 MHz
- Noise figure of 3.2 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

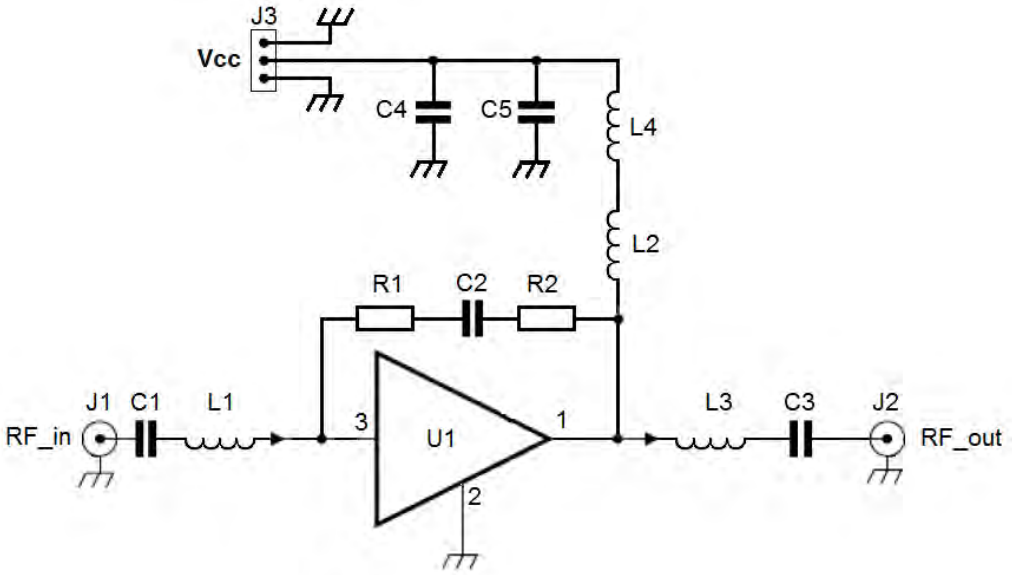
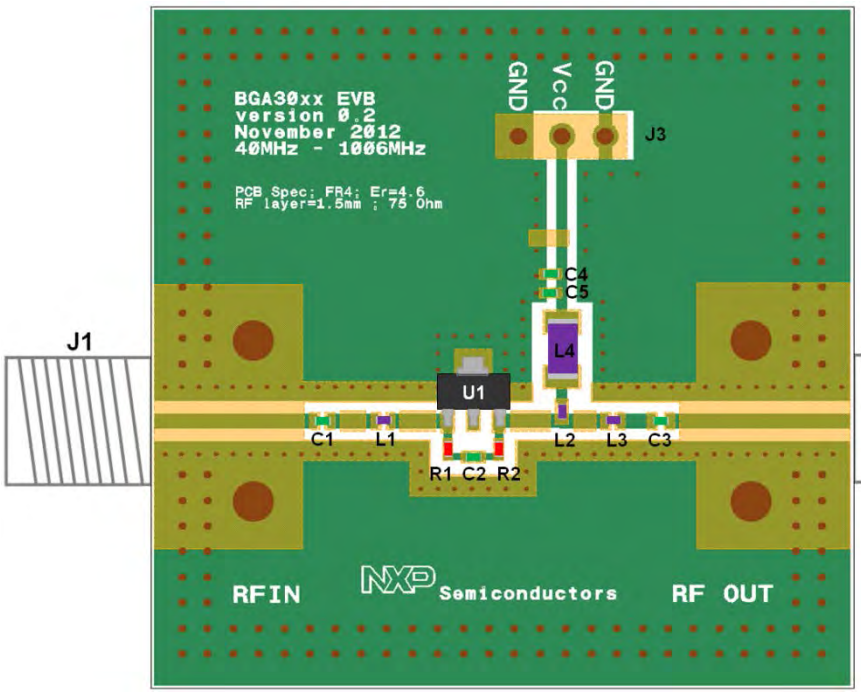


Fig 1. BGA3012 evaluation circuit

The power supply is applied on the center pin of connector J3 and is applied to the MMIC via chokes L4 and L2 which provides RF blocking to the supply line. Choke L4 is put in series with choke L2 to improve the performance at frequencies below 100 MHz. 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, followed by L1 for input matching (Z = 75 Ω). 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. Inductor L3 provides the output matching (Z = 75 Ω) at the MMICs output followed by C3 for DC-blocking before the RF signal is available at F-connector J2.

4.2 Evaluation board layout



PCB material	**= FR4**
PCB thickness	**= 1.5 mm**
PCB size	**= 40 mm x 40 mm**
ε_r	**= 4.6**
Copper thickness	**= 35 µm**

Fig 2. BGA3012 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.

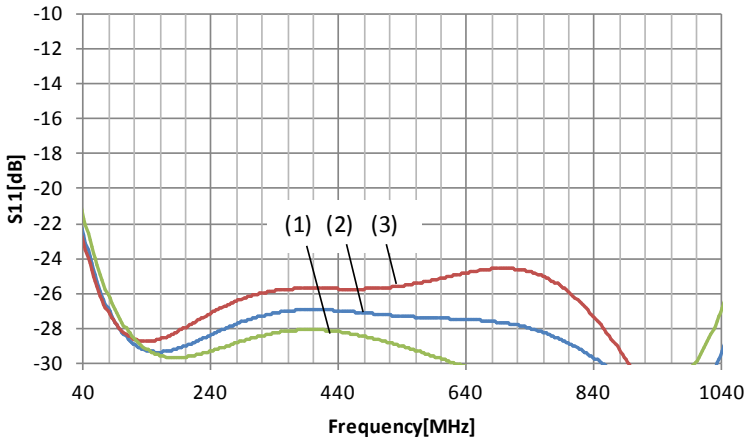
4.3 Bill of materials

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
L1, L3	3.9 nH	2	Murata	LQG15HS3N9S02D	Digikey	490-2617-1-ND
L2	Choke	1	Murata	BLM15HD182SN1D	Digikey	490-5196-1-ND
L4	880nH	1	Murata	LQH31HNR88K03L	Digikey	LQH31HNR88K03L-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

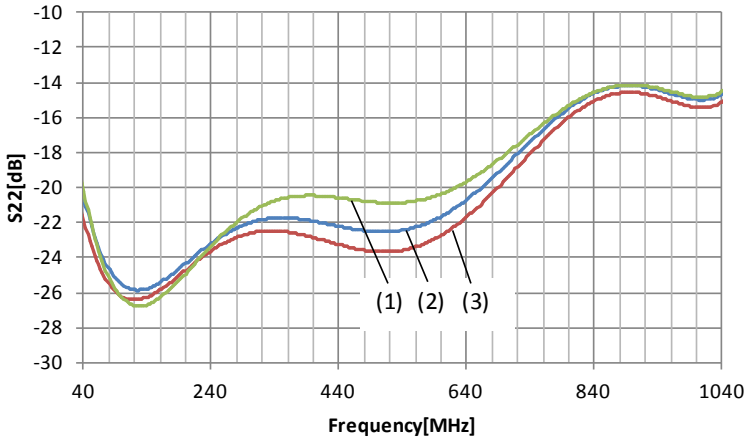
5. Measurement results at Vcc = 8 V

5.1 S-Parameters



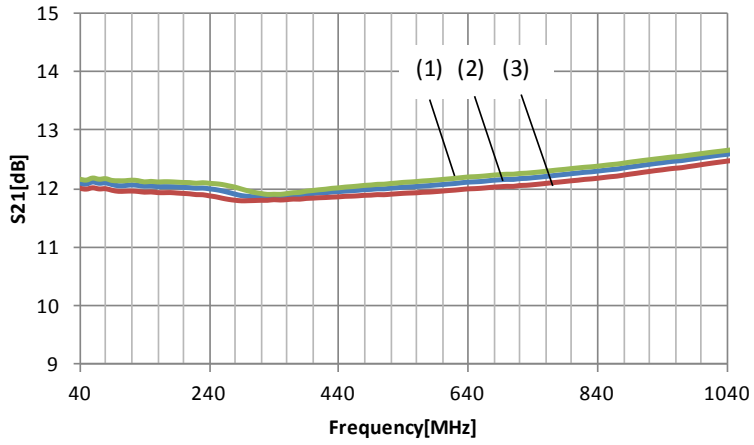
(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

Fig 3. Input matching (S11); Vcc = 8 V



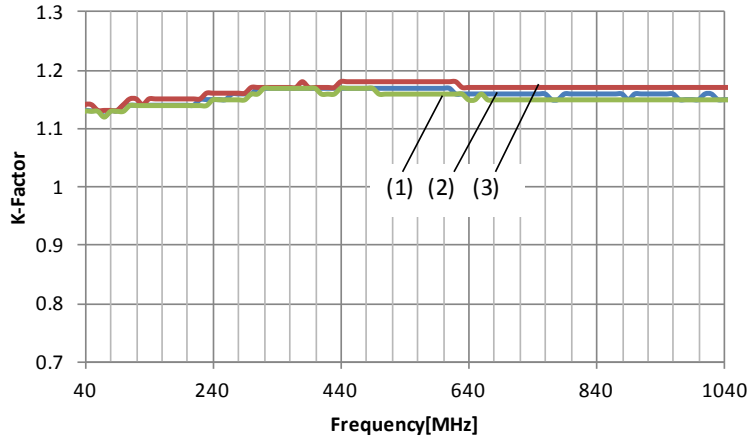
(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

Fig 4. Output matching (S22); Vcc = 8 V



(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

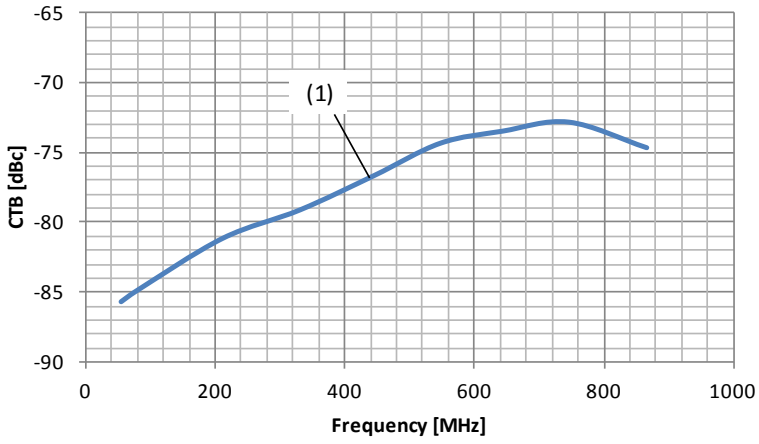
Fig 5. Gain (S21); Vcc = 8 V



(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

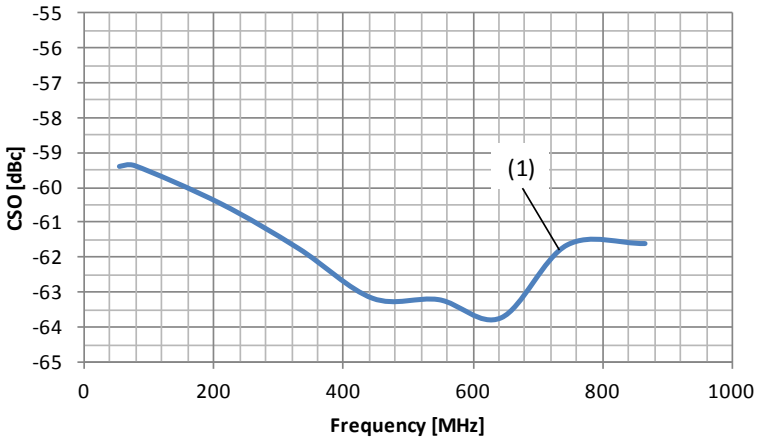
Fig 6. K-factor; Vcc = 8 V

5.2 Distortion



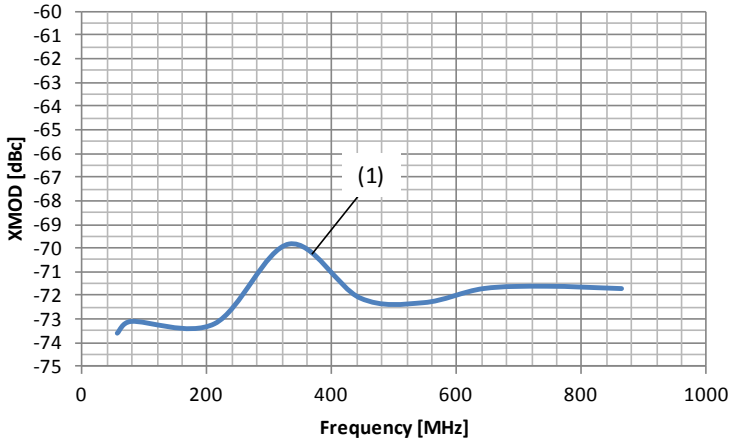
(1) Tamb = +25 °C
132 channels NTSC , Vo = 30 dBmV

Fig 7. Composite triple beat (CTB); Vcc = 8 V



(1) Tamb = +25 °C
132 channels NTSC , Vo = 30 dBmV

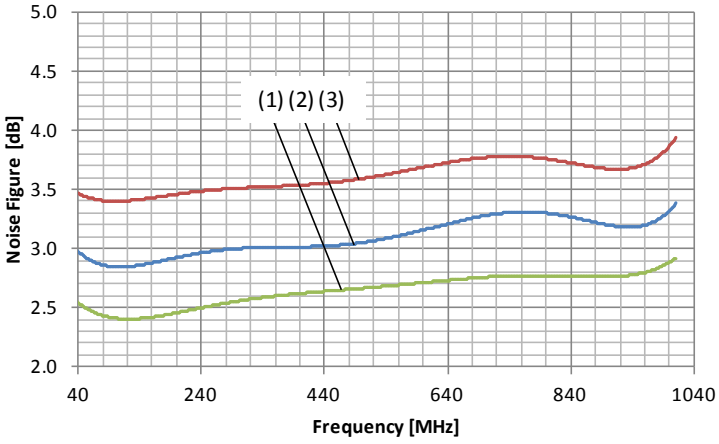
Fig 8. Composite second order (CSO); Vcc = 8 V



(1) Tamb = +25 °C
132 channels NTSC , Vo = 30 dBmV

Fig 9. Cross modulation (XMOD); Vcc = 8 V

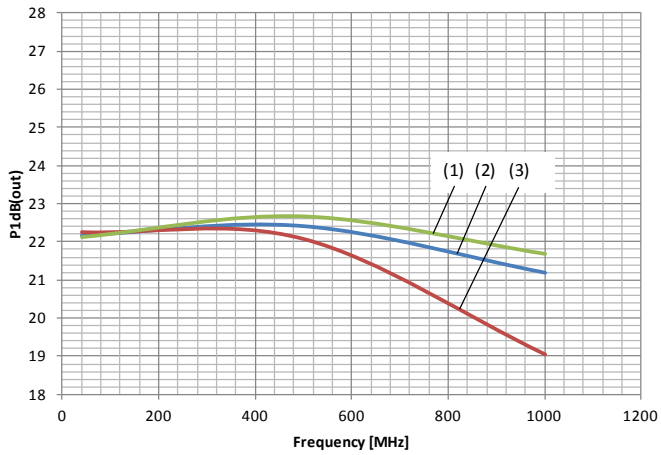
5.3 Noise figure



(1) Tamb = -30 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

Fig 10. Noise figure (NF); Vcc = 8 V

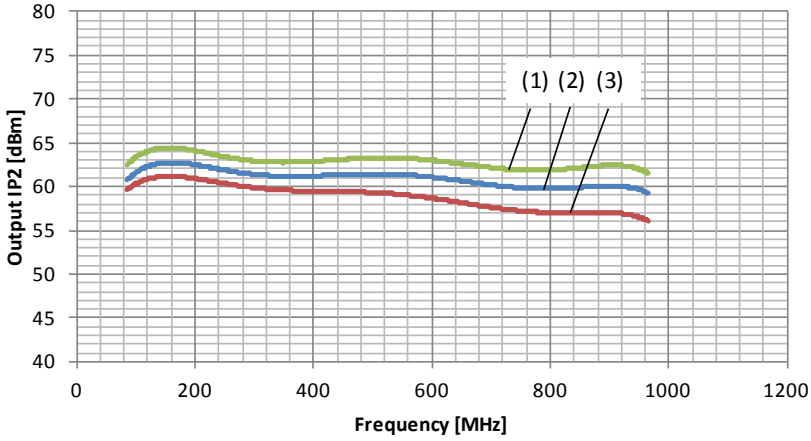
5.4 Output P1dB



(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

Fig 11. Output P1dB; Vcc = 8 V

5.5 Output IP2

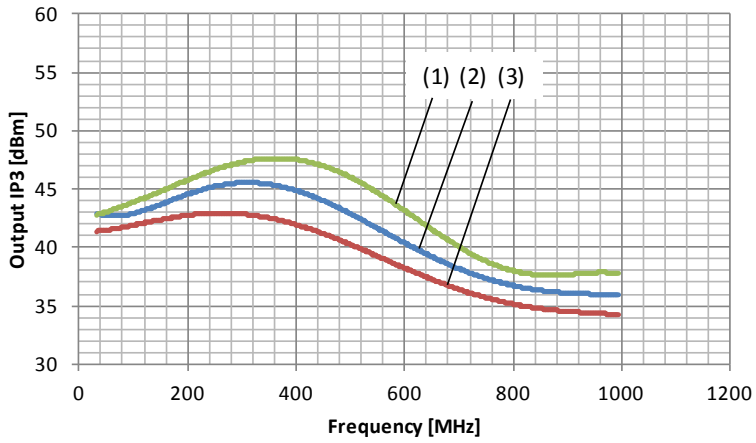


(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

f2 = f1 ± 6 MHz , input power = -20 dBm

Fig 12. Output IP2; Vcc = 8 V

5.6 Output IP3



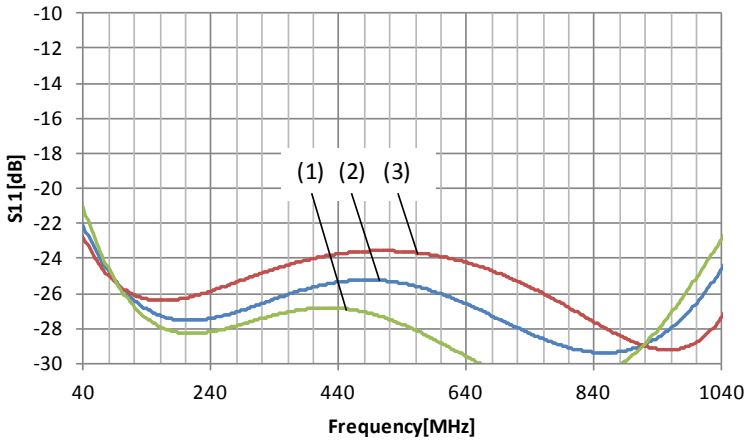
(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

f2 = f1 ± 6 MHz , input power = -20 dBm

Fig 13. Output IP3; Vcc = 8 V

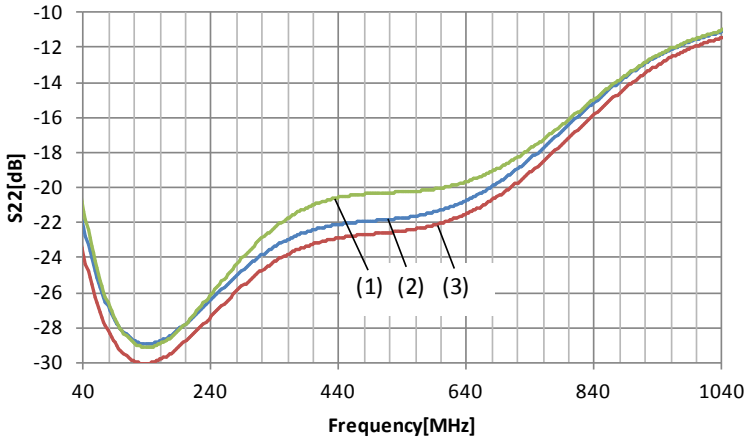
6. Measurement results at Vcc = 5 V

6.1 S-Parameters



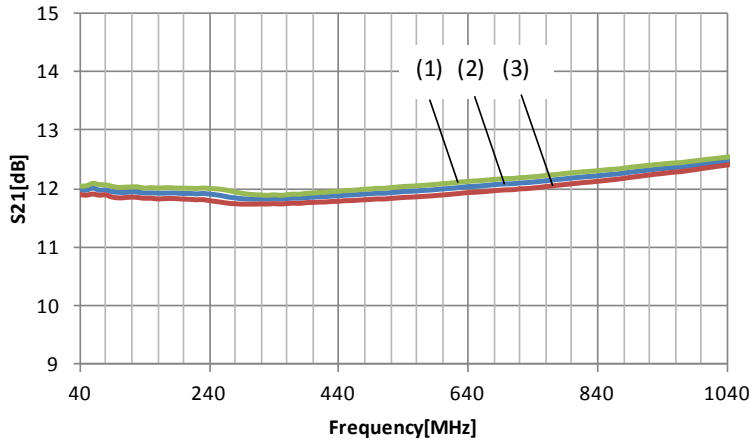
(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

Fig 14. Input matching (S11); Vcc = 5 V



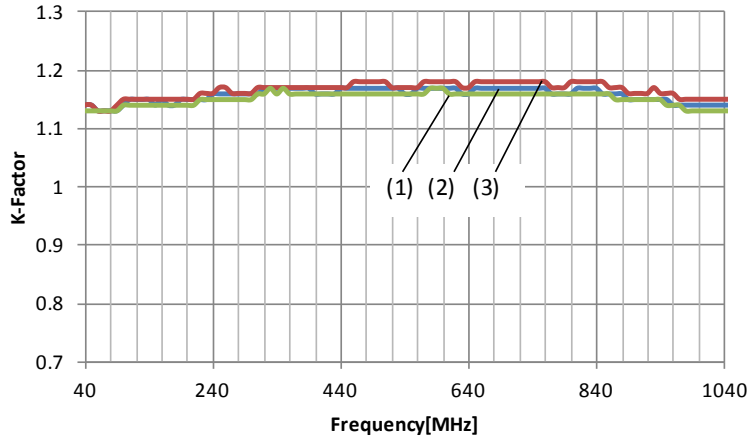
(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

Fig 15. Output matching (S22); Vcc = 5 V



(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

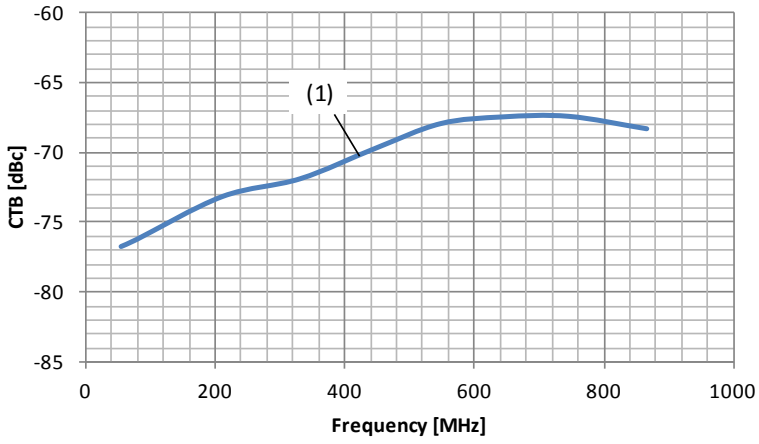
Fig 16. Gain (S21); Vcc = 5 V



(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

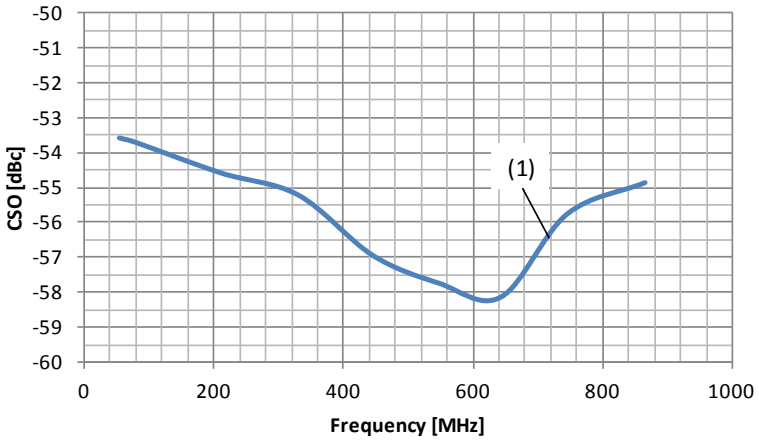
Fig 17. K-factor; Vcc = 5 V

6.2 Distortion



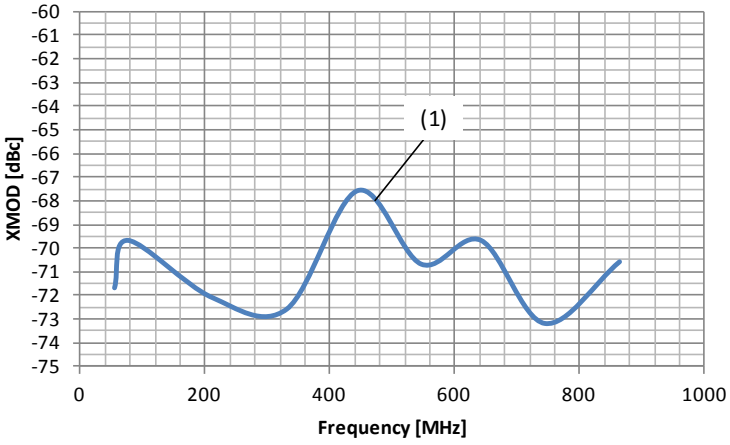
(1) Tamb = +25 °C
132 channels NTSC , Vo = 30 dBmV

Fig 18. Composite triple beat (CTB); Vcc = 5 V



(1) Tamb = +25 °C
132 channels NTSC , Vo = 30 dBmV

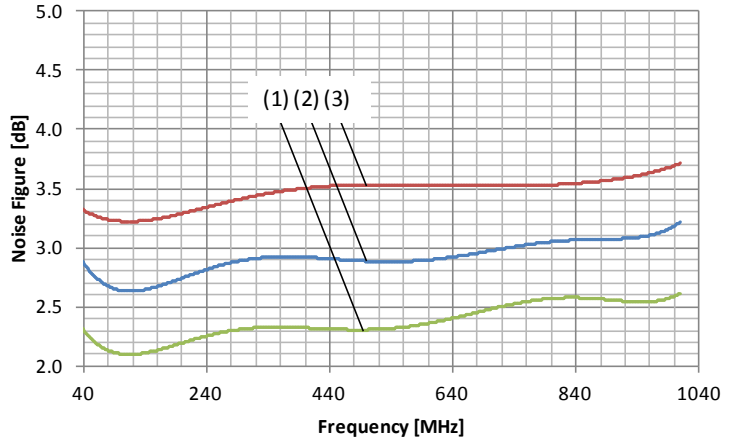
Fig 19. Composite second order (CSO); Vcc = 5 V



(1) Tamb = +25 °C
132 channels NTSC , Vo = 30 dBmV

Fig 20. Cross modulation (XMOD); Vcc = 5 V

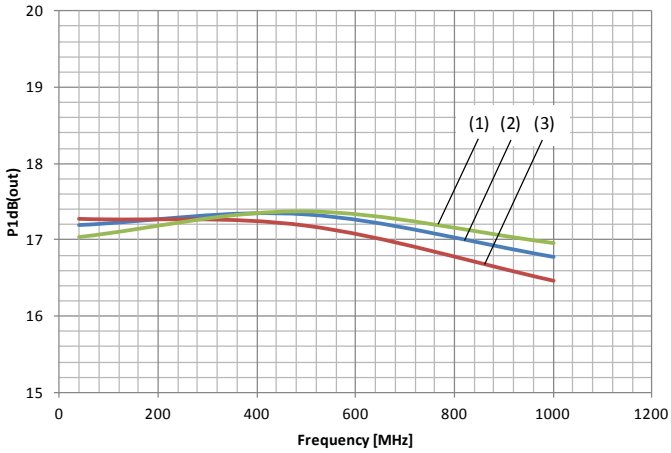
6.3 Noise Figure



(1) Tamb = -30 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

Fig 21. Noise figure (NF); Vcc = 5 V

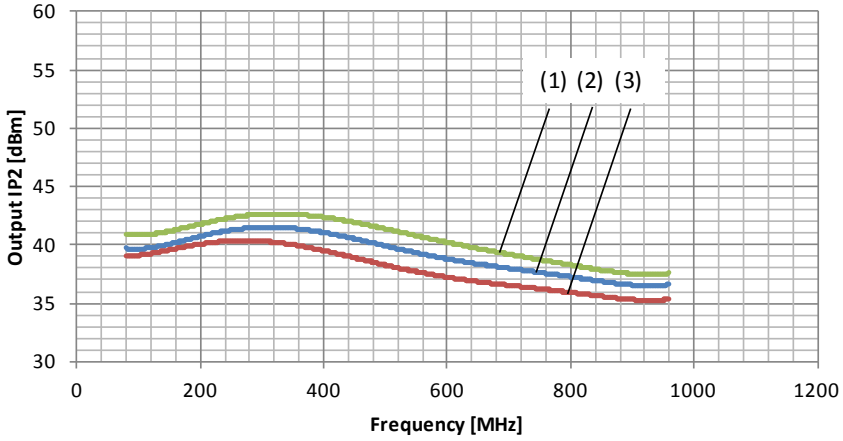
6.4 Output P1dB



(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

Fig 22. Output P1dB; Vcc = 5 V

6.5 Output IP2

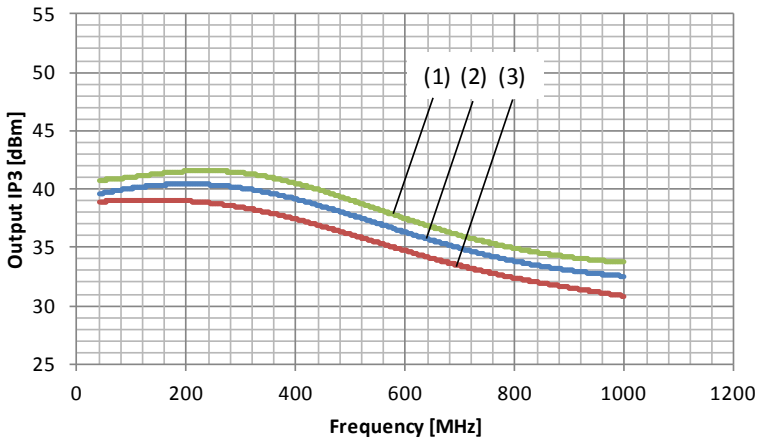


(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

f2 = f1 ± 6 MHz , input power = -20 dBm

Fig 23. Output IP2; Vcc = 5 V

6.6 Output IP3



(1) Tamb = -40 °C
(2) Tamb = +25 °C
(3) Tamb = +85 °C

f2 = f1 ± 6 MHz , input power = -20 dBm

Fig 24. Output IP3; Vcc = 5 V

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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