BFQ790 as driver amplifier for GSM900 cellular repeater applications

RF medium-power transistor

About this document

Scope and purpose

This application note provides application circuit design examples with Infineon's radio frequency (RF) medium-power silicon germanium (SiGe) transistor BFQ790 as RF driver amplifier for GSM900 cellular repeater applications. In this document the BFQ790 driver amplifier schematic, PCB layouts and measurement results are shown.

Intended audience

This document is intended for engineers who need to design RF medium power driver amplifier for GSM900 cellular repeater applications.

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1 Introduction

1.1 Driver amplifier for GSM900 cellular repeaters

Sometimes, the cell phone connection to the cellular network may be limited due to the distance to base stations, or due to signal attenuation as a result of the construction materials of a building or vehicle. In such instances, a cellular repeater is a possible solution to extend the cellular signal coverage. It re-transmits a band of carriers from the nearest cellular base station into the area or environment to be served.

The GSM900 is one of the most popular telecommunication standards around the world, operating in the frequency band 8 (925 to 960 MHz for downlink and 880 to 915 MHz for uplink). A block diagram example of the GSM900 repeater is shown in Figure 1. The active components of the repeater are RF amplifiers for both the uplink and downlink signal amplification. The uplink and downlink amplifier chains should provide sufficient signal gain and output power level. The power amplifier (PA), which is the final stage of the signal amplifier chain, requires a certain input signal power level to fully exploit the PA output power and efficiency. The input signal power level required from the PA usually cannot be delivered by the low noise amplifier (LNA) directly. The driver amplifier, also known as a gain block, amplifies the signal from the LNA to the PA in a linear way. The driver amplifier generally operates in linear Class-A mode to enable high linearity and high gain, thereby keeping spurious signals low.

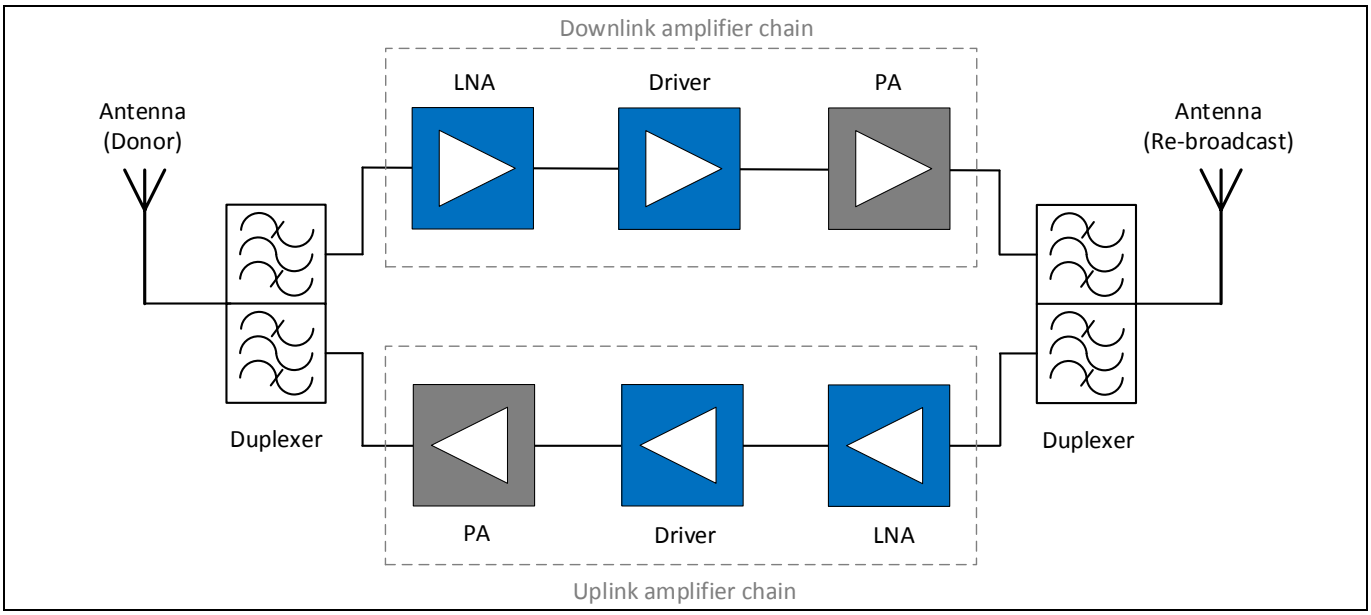

Figure 1 Block diagram example of a cellular repeater

1.2 Infineon driver amplifier family

The BFQ790 is a general-purpose medium-power transistor based on Infineon's cost-effective SiGe technology, which can be produced in high volumes, and is designed for wireless infrastructure applications. These applications include mobile base station transceivers, cellular repeaters, the industrial-scientific-medical (ISM) radio band amplifiers and test equipments. Their operating frequency range can be as high as 3.6 GHz, and the application circuit can be optimized for specific frequency bands with the adoption of external matching components.

The BFQ790 is a single-stage, high-linearity driver amplifier with an output 1 dB compression point of 27 dBm (500 mW), and is available in a halogen-free industry-standard SOT89 package. The high thermal conductivity of the silicon substrate and the low thermal resistance of the package add up to a thermal resistance of only

25 K/W, which leads to moderate junction temperatures even at high dissipated power values. The proper die attachment with good thermal contact is 100 percent tested, so that there is minimal variation of thermal properties. The collector design allows safe operation with 5 V supply voltage, and protects it from thermal runaway secondary breakdown, which makes it rugged when exposed to mis-match at the output. The special design of the emitter-base diode makes it robust and allows for high maximum RF input power.

For further information about the BFQ790, please refer to the datasheet and applications.

2 Driver amplifier BFQ790 for GSM900 cellular repeater applications

2.1 Performance overview

The following table shows the RF driver amplifier performance with RF medium-power transistor BFQ790 for GSM900 cellular repeater applications.

Table 1 Summary of measurement results of the BFQ790 driver amplifier for GSM900 repeater applications

Parameter	Symbol	Value		Unit	Notes
Bias voltage	V_{CC}	5.0		V	
Bias current	I_{CC}	230		mA	
Frequency range	f	880 to 915	925 to 960	MHz	
Gain	G	21.2[1)]	21.5[2)]	dB	1) Measured at 897.5 MHz 2) Measured at 942.5 MHz
Input return loss	RL_{in}	>11		dB	
Output return loss	RL_{out}	>10		dB	
Reverse isolation	ISO_{rev}	>31.8		dB	
Output 1 dB compression point	OP_{1dB}	26.5[3)]	26.6[4)]	dBm	3) Measured at 897.5 MHz 4) Measured at 942.5 MHz
Output third-order intercept point	OIP_3	39.3[5)]	39.4[6)]	dBm	5) Output power: 14 dBm per tone, f_1=897 MHz, f_2=898 MHz. 6) Output power: 14 dBm per tone, f_1=942 MHz, f_2=943 MHz.
Stability	K	>1			Measured from 10 MHz upto 6 GHz

2.2 Schematic

The following figure shows the schematic of the BFQ790 driver amplifier for GSM900 repeater applications. In the schematic, resistors R1 and R2 set up the transistor base biasing, while R2 together with the inductor L2 provides a negative feedback path for better matching. Inductors L3, L4 and the capacitor C3 match the transistor to the output port for output power and linearity. Capacitors C4 and C5 serve as the RF bypass. The circuit input matching is achieved by the network of L1 and C2. The capacitor C1 blocks the DC component to the RF input port.

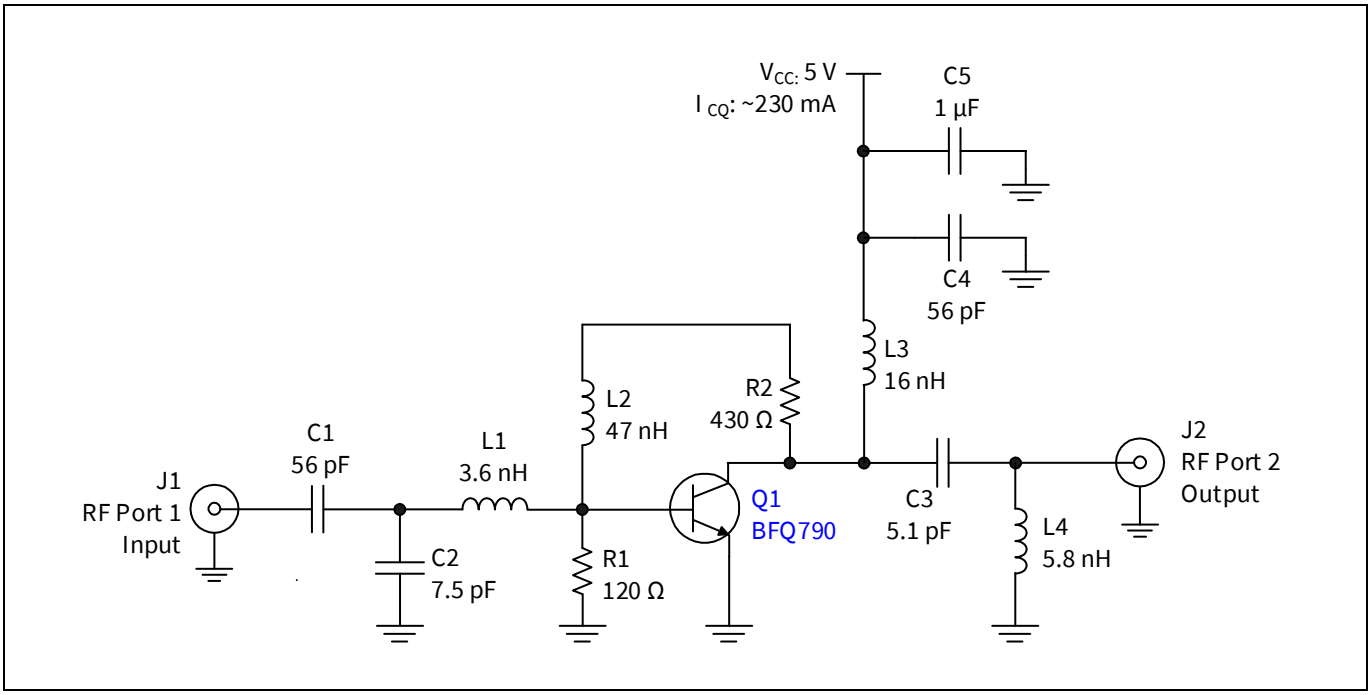

Figure 2 The BFQ790 driver amplifier schematic for GSM900 repeater applications

2.3 Bill of Materials (BOM)

Table 2 BOM of the BFQ790 driver amplifier for GSM900 repeater applications

Symbol	Value	Unit	Package	Manufacturer	Comment
Q1	BFQ790		SOT89	Infineon	SiGe medium-power transistor
C1	56	pF	0402	Various	DC block
C2	7.5	pF	0402	Murata GJM	Input matching
C3	5.1	pF	0402	Murata GJM	Output matching and DC block
C4	56	pF	0402	Various	RF bypass
C5	1	µF	0402	Various	RF bypass
R1	120	Ω	0402	Various	DC bias
R2	430	Ω	0402	Various	DC bias and feedback
L1	3.6	nH	0402	Murata LQW	Input matching
L2	47	nH	0402	Murata LQW	Feedback
L3	16	nH	0402	Murata LQW	Output matching DC current handling higher than 270 mA
L4	5.8	nH	0402	Murata LQW	Output matching

2.4 Evaluation board and layout information

The evaluation board of the BFQ790 driver amplifier for GSM900 repeater applications:

- PCB material: FR4
- PCB marking: M18061502

A photo of the evaluation board and the PCB stack information are shown in the following figures.

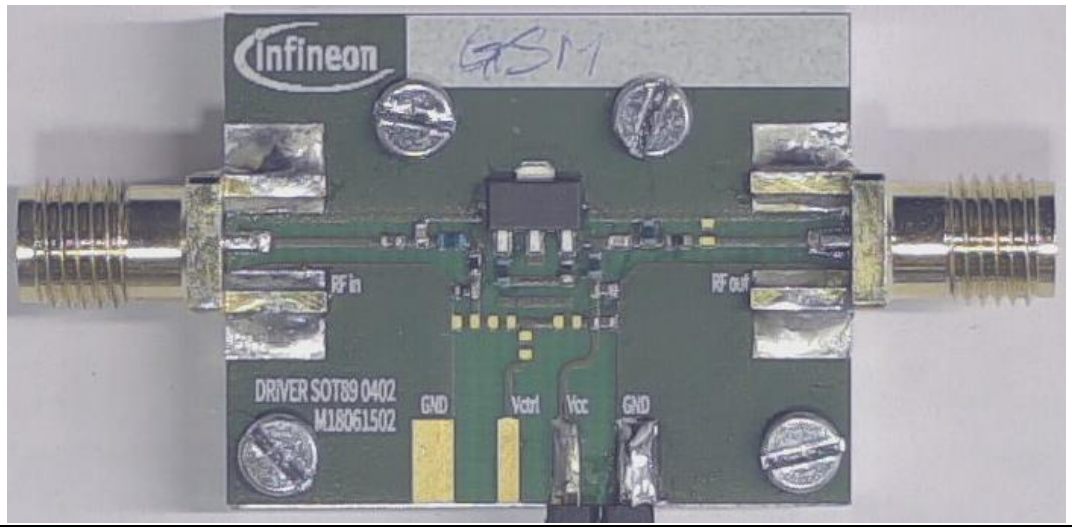

Figure 3 Photo of BFQ790 driver amplifier for GSM900 repeater applications

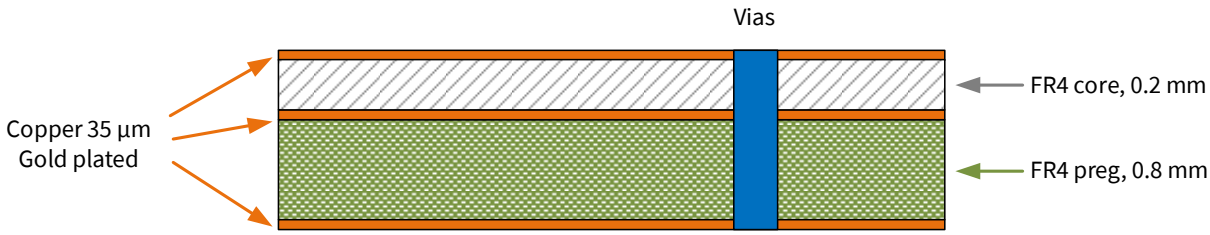

Figure 4 PCB stack information for the evaluation board M18061502

3 Measurement results of the BFQ790 driver amplifier for GSM900 repeater applications

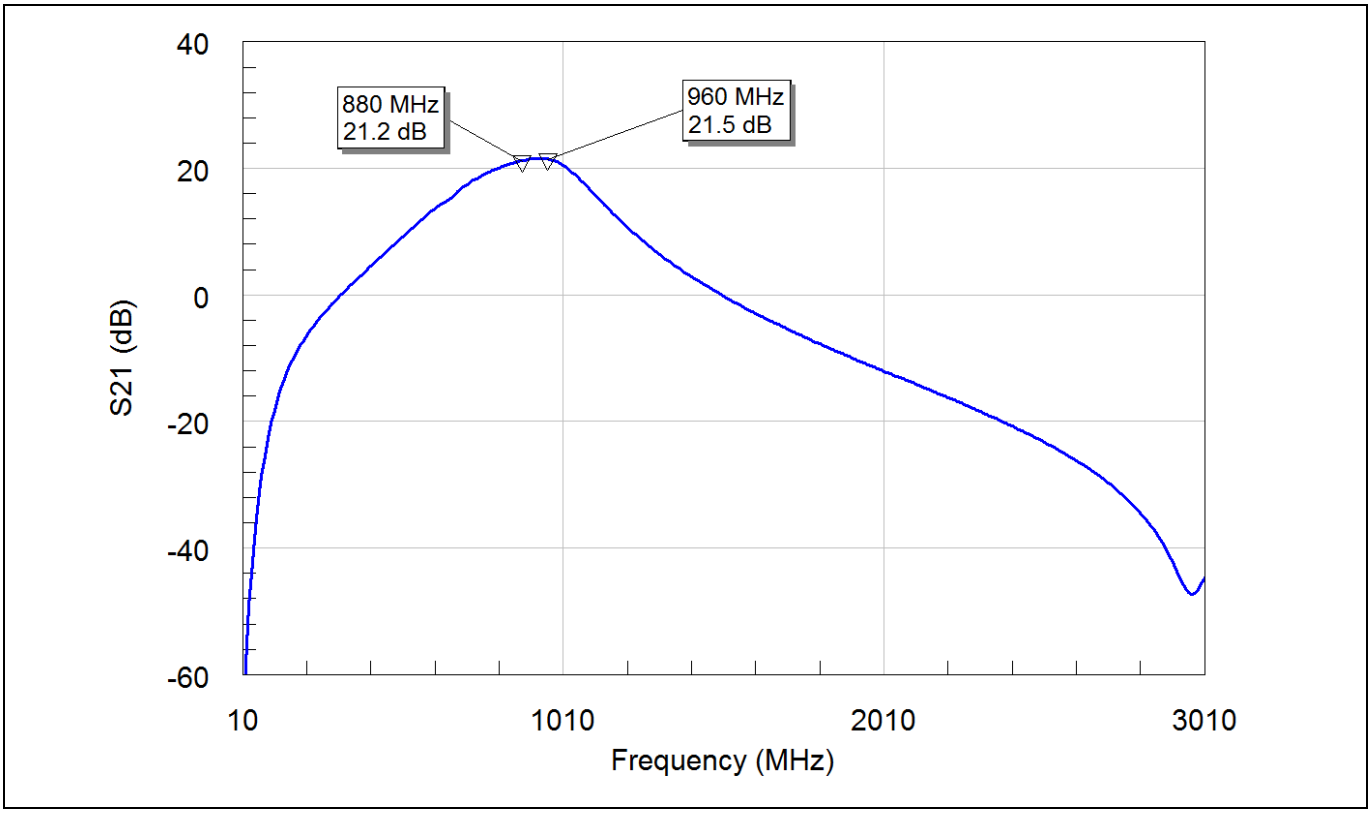

Figure 5 Small signal gain of the BFQ790 driver amplifier for GSM900 repeater applications

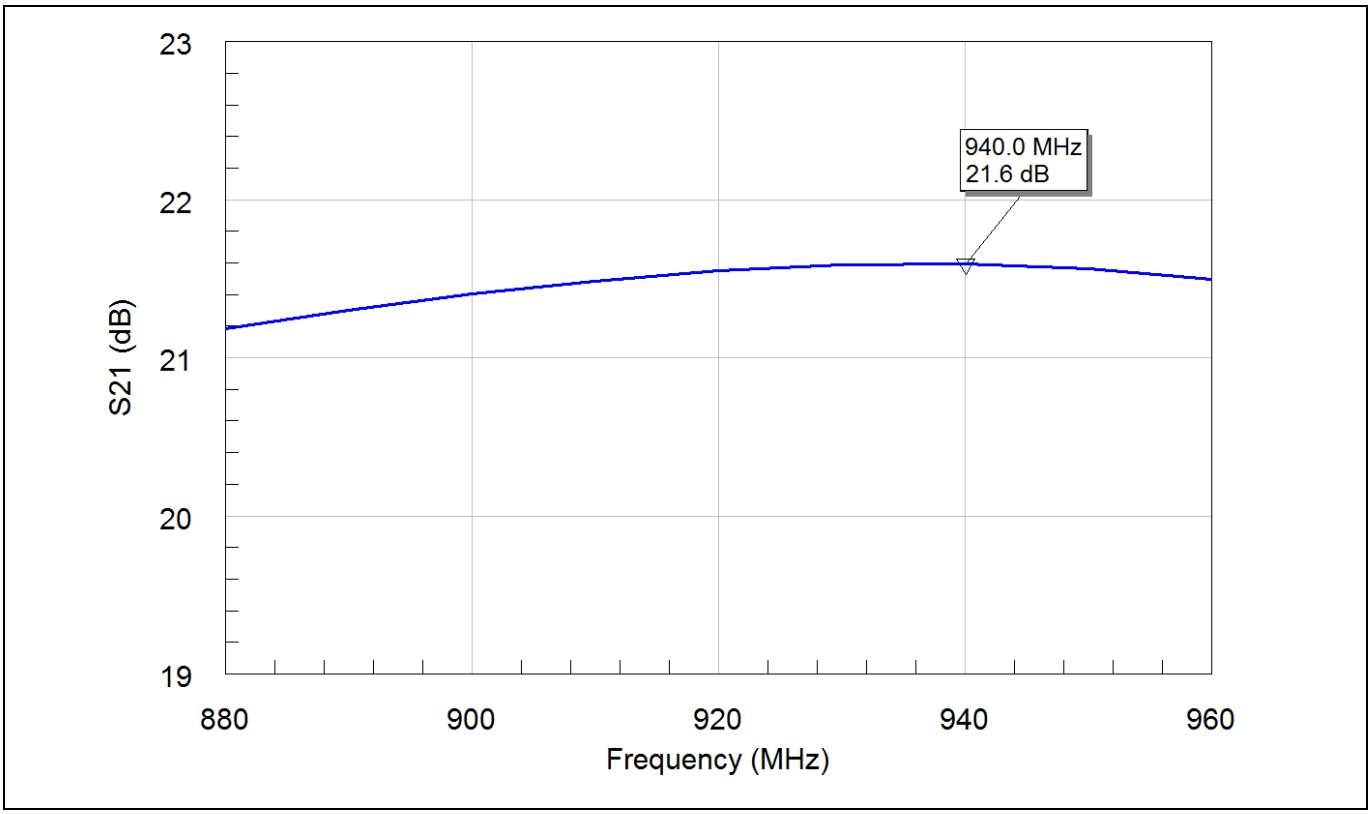

Figure 6 Small signal gain of the BFQ790 driver amplifier for GSM900 repeater applications (detail view)

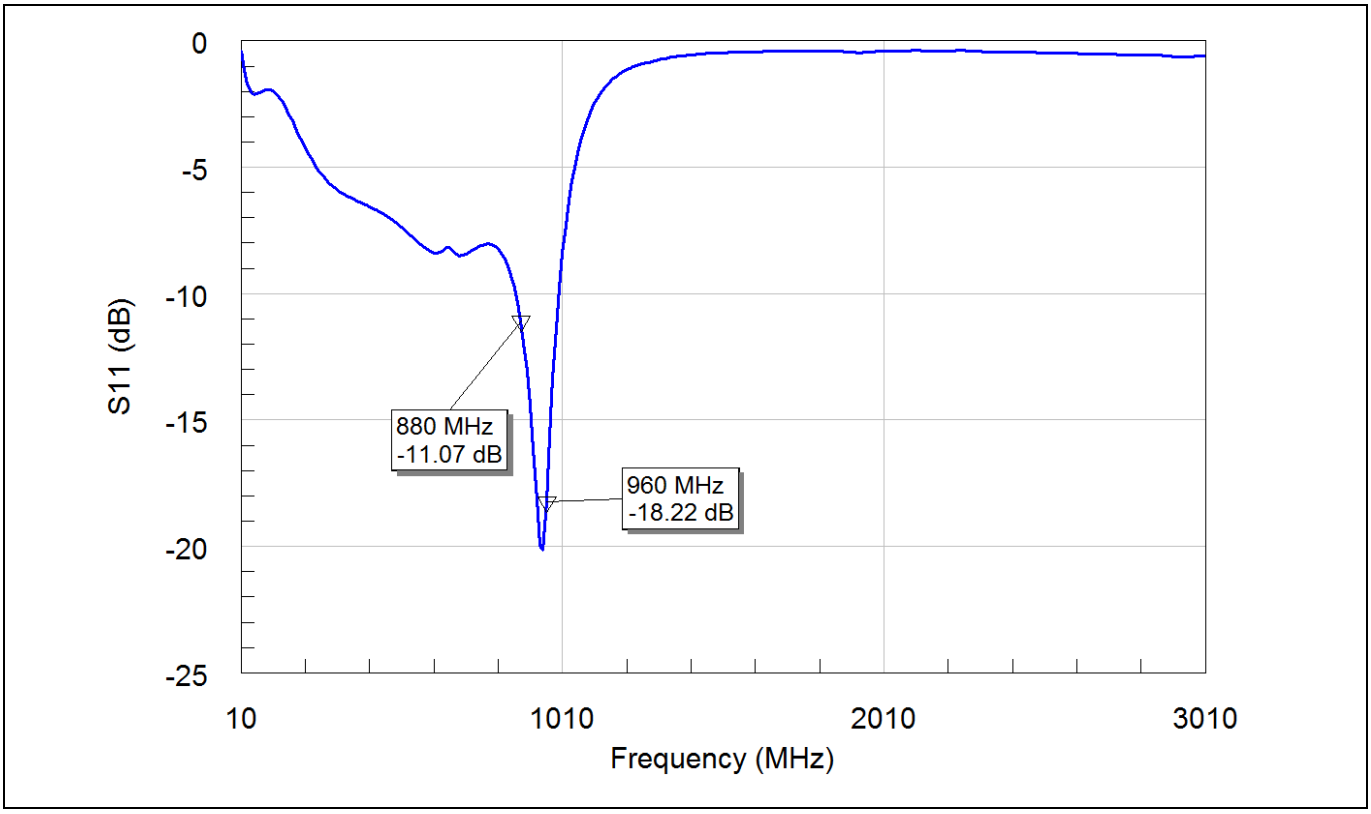

Figure 7 Input return loss of the BFQ790 driver amplifier for GSM900 repeater applications

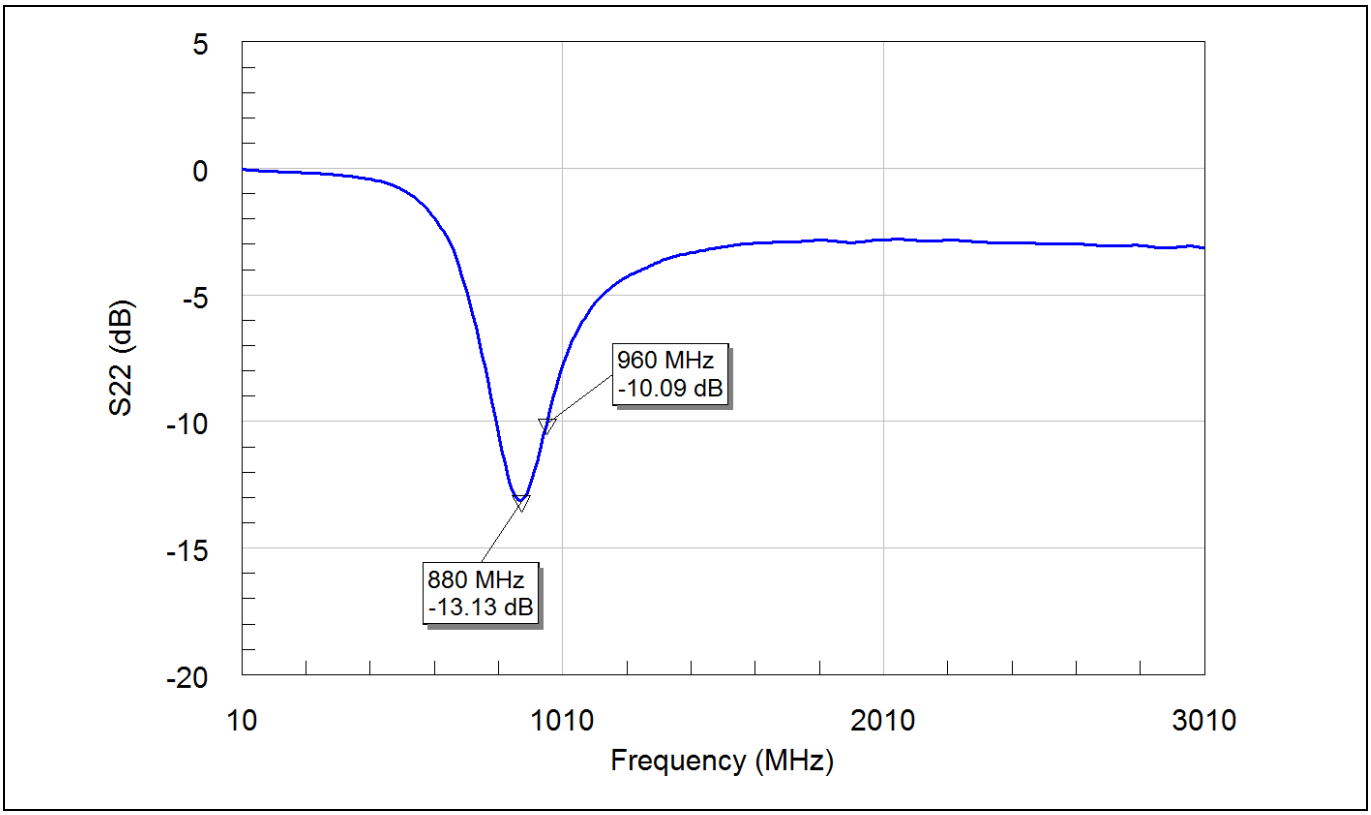

Figure 8 Output return loss of the BFQ790 driver amplifier for GSM900 repeater applications

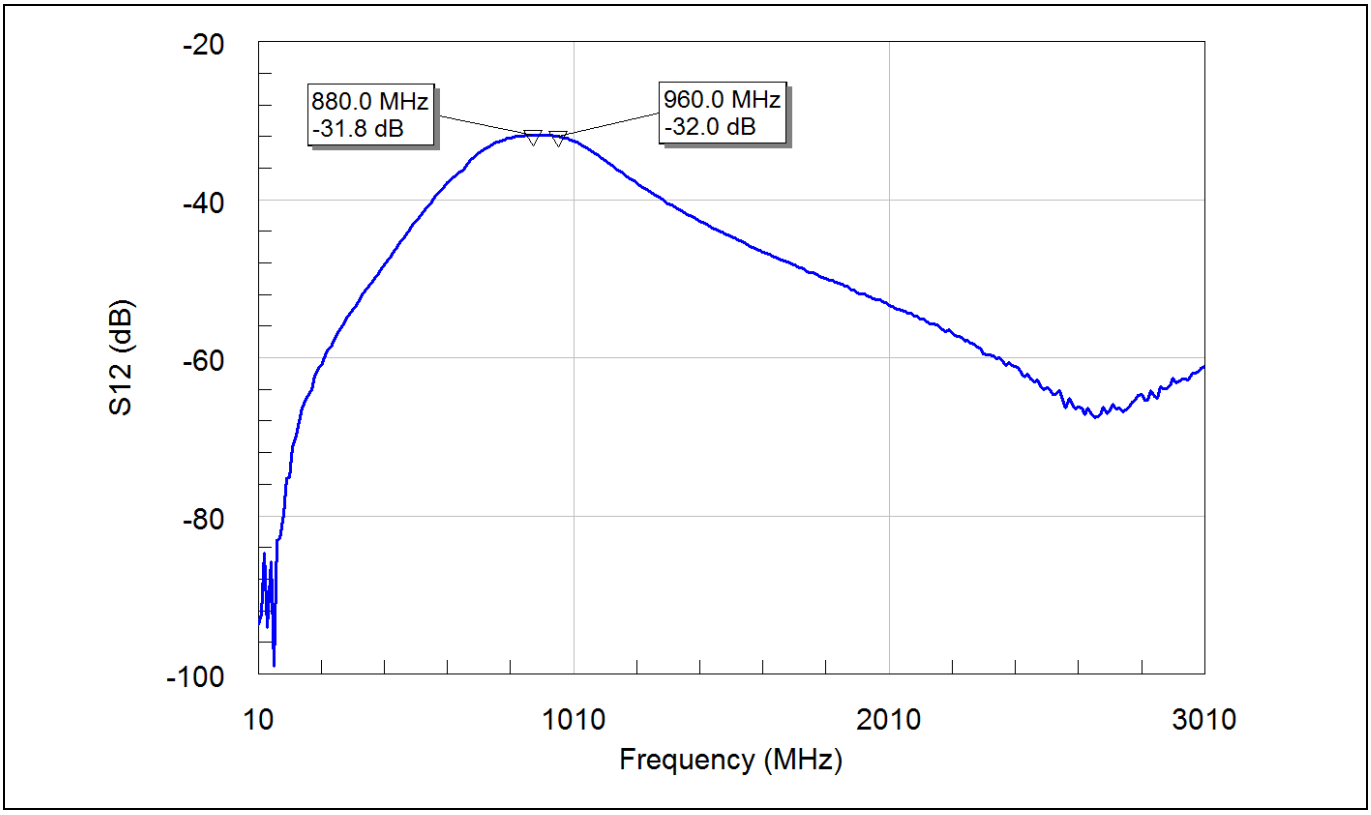

Figure 9 Reverse isolation of the BFQ790 driver amplifier for GSM900 repeater applications

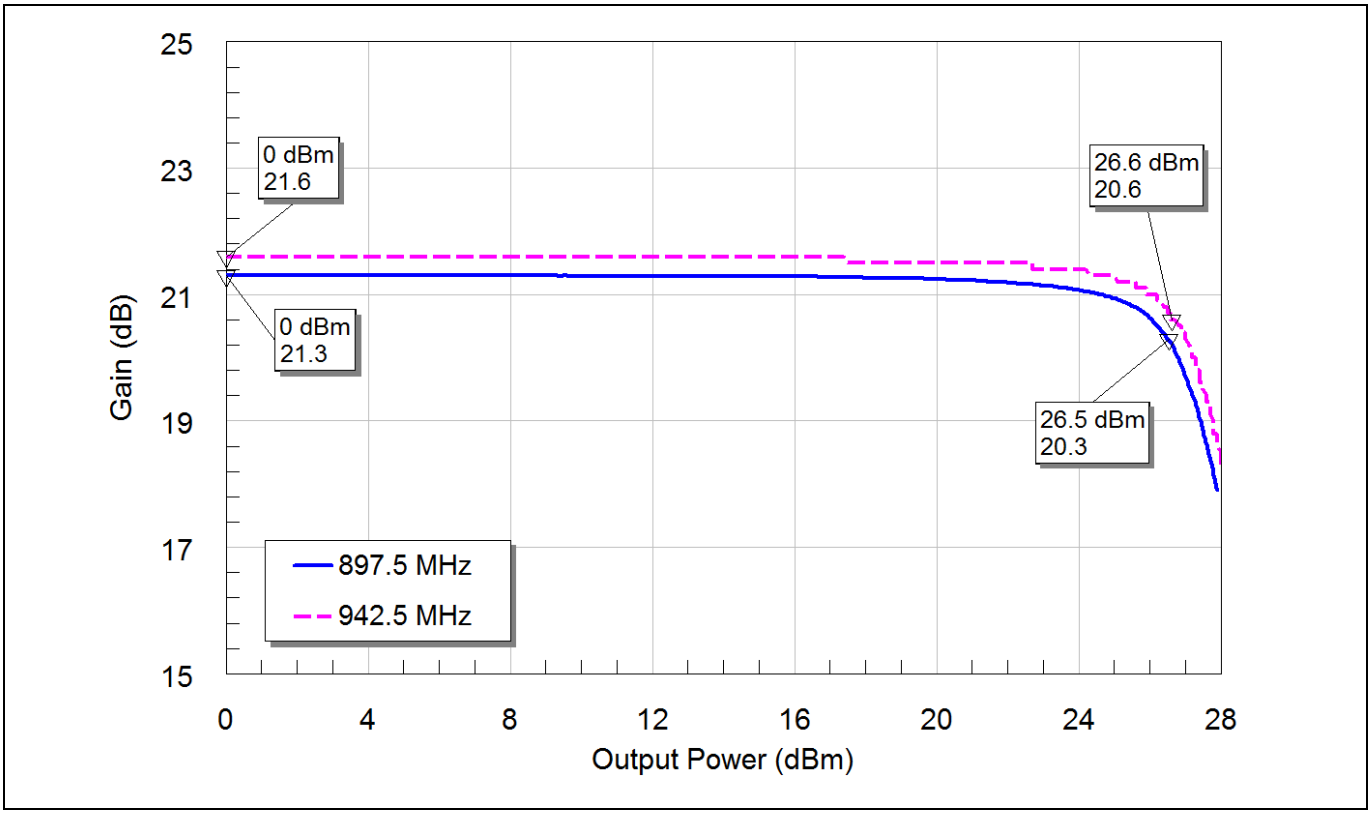

Figure 10 Output 1 dB compression point of the BFQ790 driver amplifier for GSM900 repeater applications

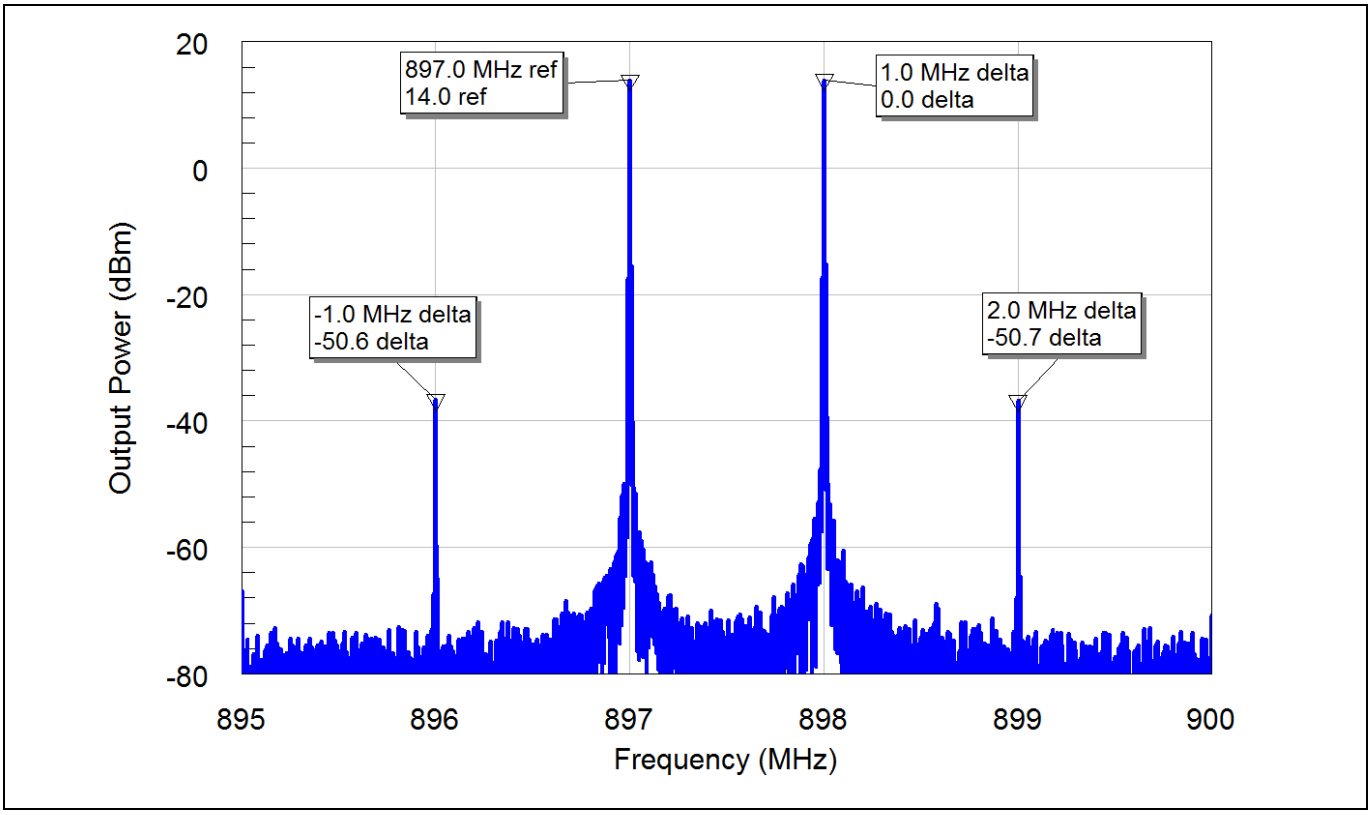

Figure 11 Output third-order intermodulation products at 897.5 MHz of the BFQ790 driver amplifier for GSM900 repeater applications

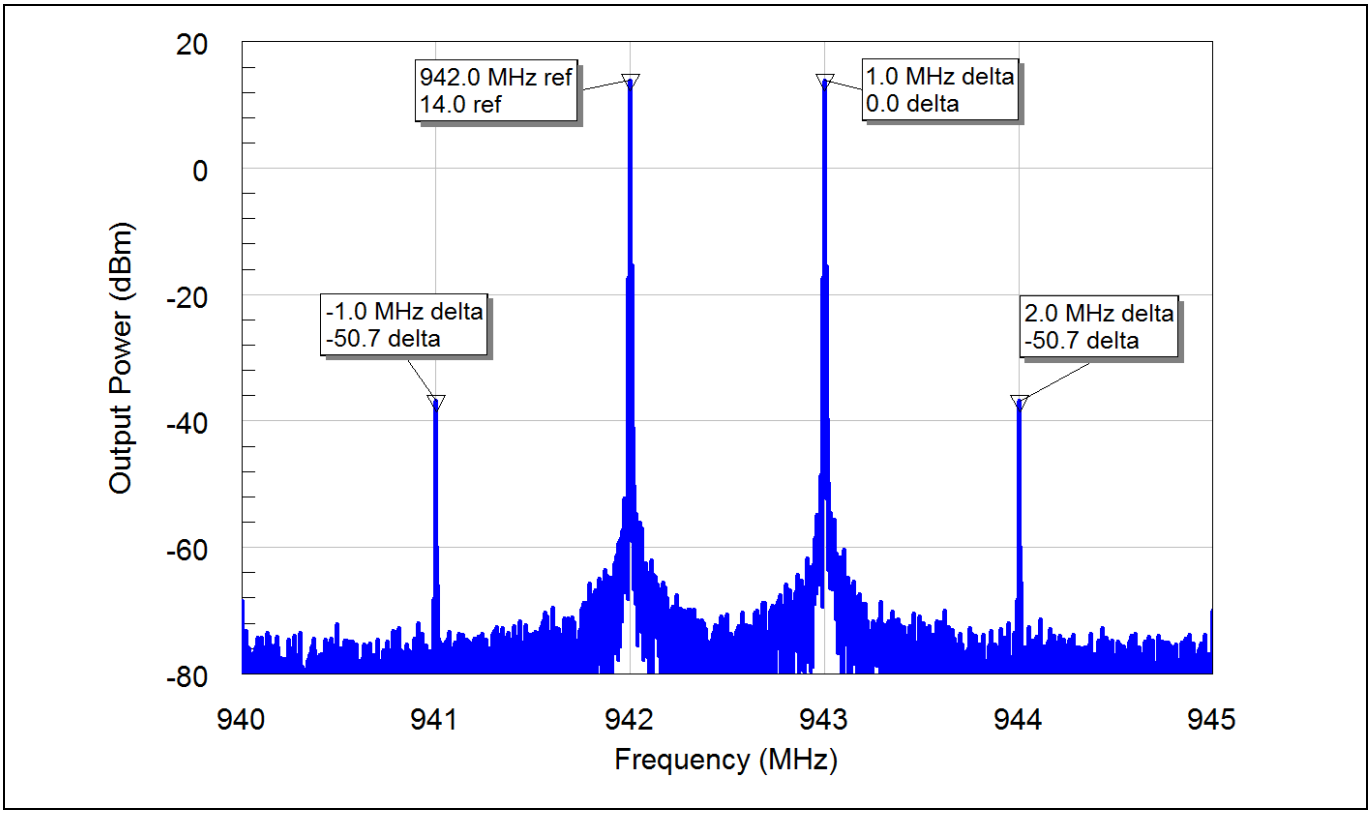

Figure 12 Output third-order intermodulation products at 942.5 MHz of the BFQ790 driver amplifier for GSM900 repeater applications

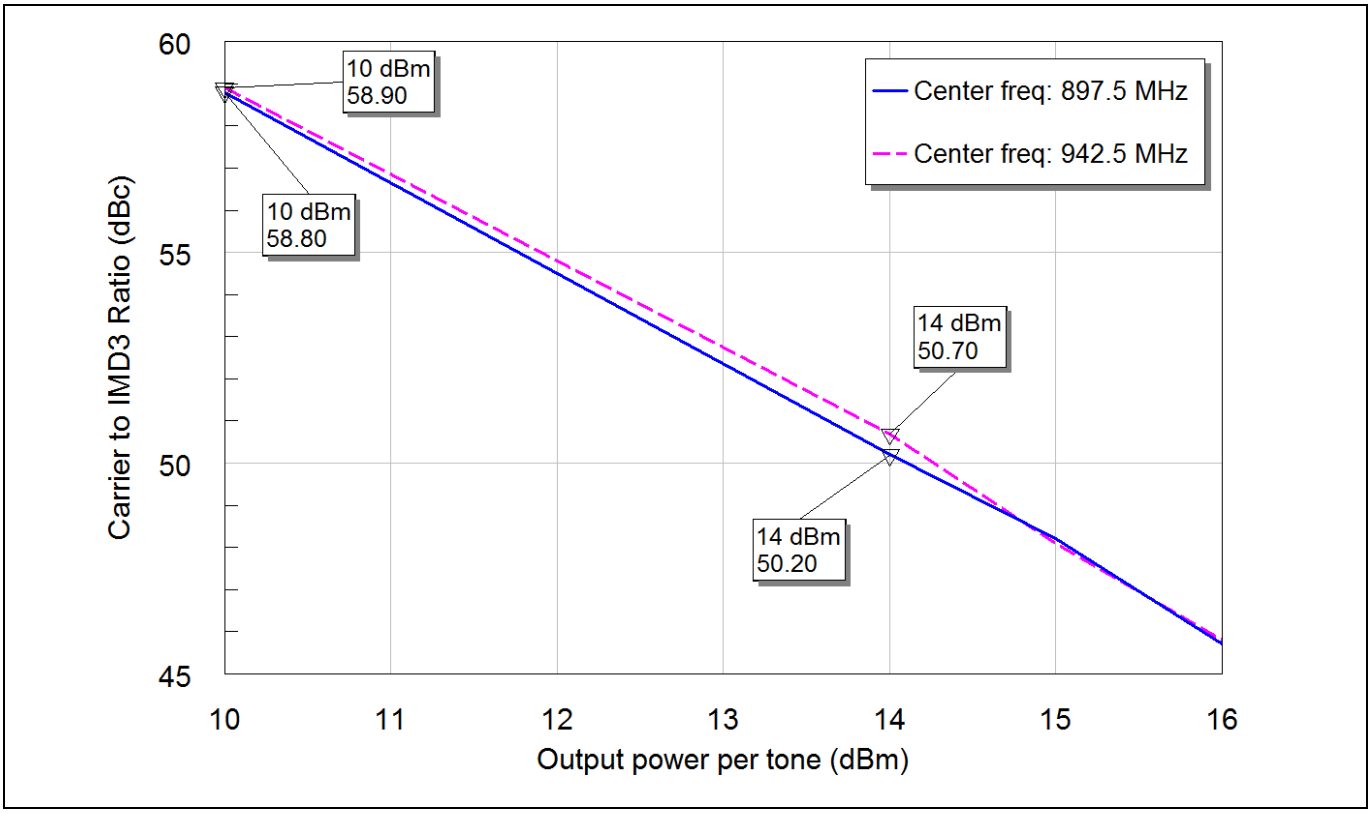

Figure 13 Carrier to third-order intermodulation ratio of the BFQ790 driver amplifier for GSM900 repeater applications

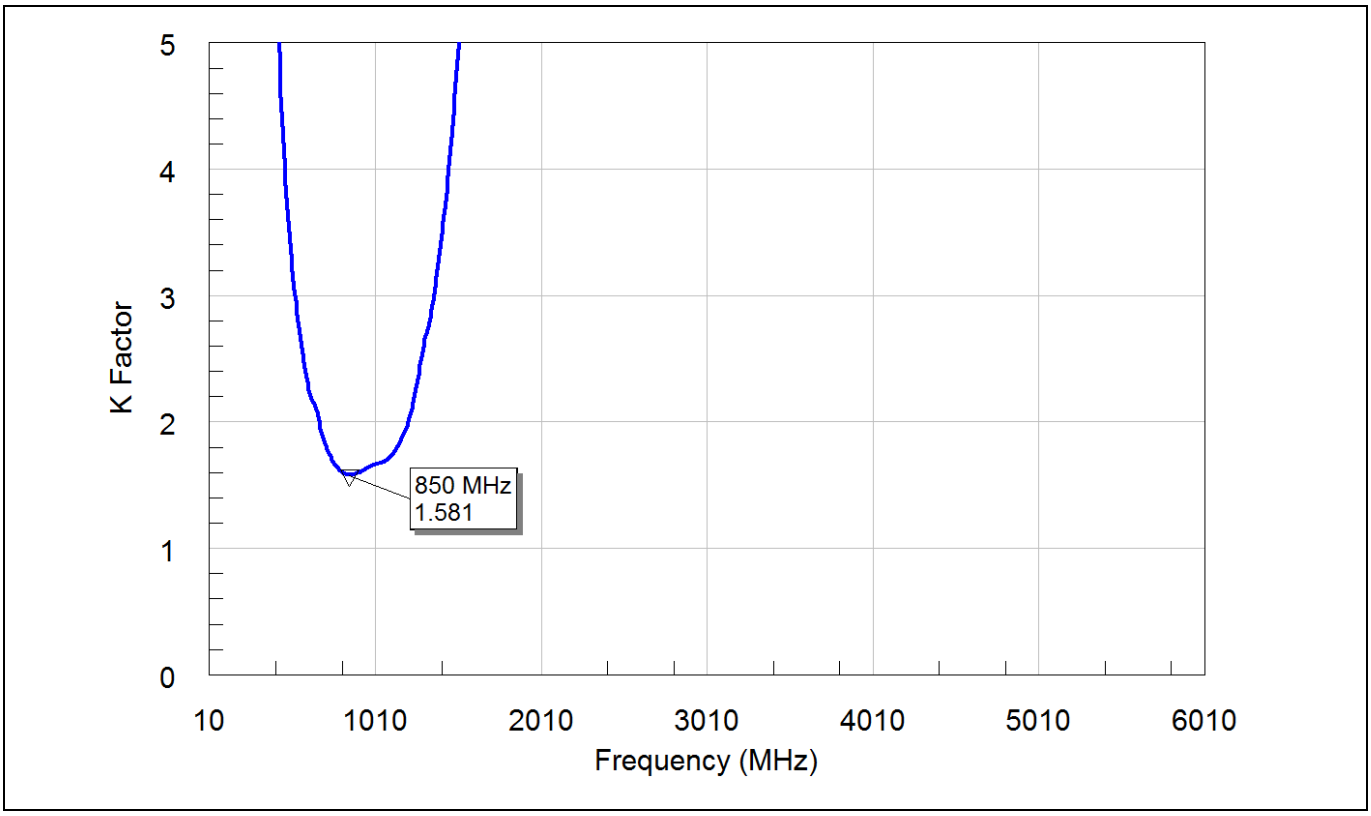

Figure 14 K-factor measurement of the BFQ790 driver amplifier for GSM900 repeater applications

4 Author

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Revision history

Document version	Date of release	Description of changes

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Edition 2018-08-03

Published by

Infineon Technologies AG

81726 Munich, Germany

Do you have a question about this document?

Email: erratum@infineon.com

Document reference
AN_1808_PL32_1808_174416

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