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*Application Note 61*

# Mobile Phone Testing Using an *i*Tuner

*Abstract* -**Mobile phone testing is accomplished using Focus Microwaves' Computer-Controlled Microwave iTuner[1] in conjunction with a Radio Communications Tester (RCT). LabView[TM] based custom software has been written to measure transmit power at the antenna port under various antenna impedance conditions in Transmit Mode (TX), and Sensitivity by measuring BER under different antenna impedance conditions in Receive Mode (RX).**

## Introduction

Mobile phone testing has become an important topic for all handset manufacturers worldwide. Handsets must guarantee a certain performance under all possible "real-life" phone conditions including antenna breakage, and user conditions including using a cellular phone in a tunnel or elevator. These real-life conditions are recreated in a laboratory environment by altering the antenna impedance of the mobile phone. By varying the impedance in a controlled manner using an *i*Tuner, we are able to accurately test and characterize a multitude of parameters including transmit power and sensitivity. This is applicable for all modulation schemes including GSM, CDMA and so on.

## System Setup

*Fig. 1* represents the hardware setup used for mobile phone testing. A RCT establishes a call link between the mobile phone and RCT itself through a Focus Microwaves iCCMT-808-TC [2] Computer Controlled Microwave Tuner. The tuner is used to set different VSWRs and phases for the fundamental frequencies covering specific channels within the European and American GSM bands. The RCT is used as both communication controller and analyzer which can set the mobile phone operating mode and evaluate the performance of the communication by measure a series related parameters such as transmit power and sensitivity. This setup simulates a real-life phone call condition in a laboratory environment.

## Output Power Testing In Transmit Mode (TX)

It is important for a mobile phone to maintain a certain level of output power under real-life conditions while transmitting. This test is achieved by using the RCT to set the mobile phone into TX mode on a specific channel. The RCT commands the mobile phone to transmit at a certain power and then reads the power delivered to the instrument. Custom software de-embeds the losses of the tuner and interfaces thereby recording the actual output power at the antenna port under mismatched conditions. This is repeated for a given set of VSWR magnitudes and phases, various battery voltages, and various TX channels (frequencies). *Fig. 2* shows the results of varying VSWR

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[1] Application Note 57: *i*Tuners for Production Testing
[2] iCCMT-808-TC covers frequencies from 800 MHz to 8 GHz

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between 1-5 and varying phase in 30 degree increments with a targeted output power Pout=30.5 dBm. *Fig. 3* shows the same data represented in terms of Transmit Power contours as a function of VSWR magnitude and phase.
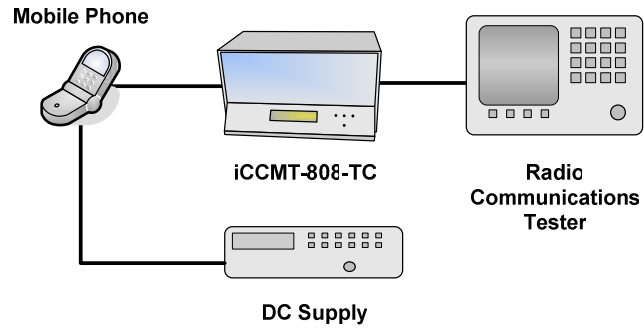


**Fig. 1**  Mobile Phone Testing System Setup
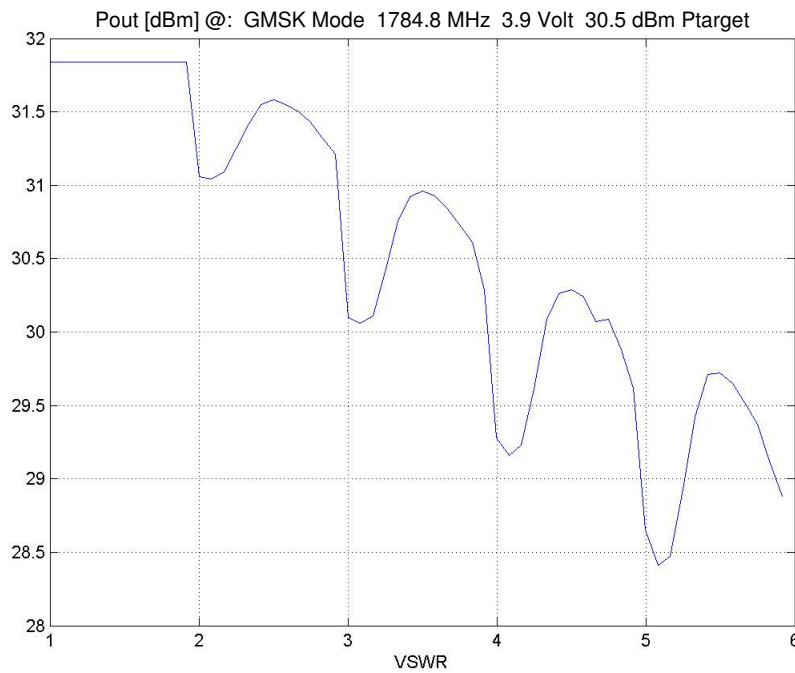


**Fig. 2**  Transmit power as a function of VSWR magnitude (major axis)
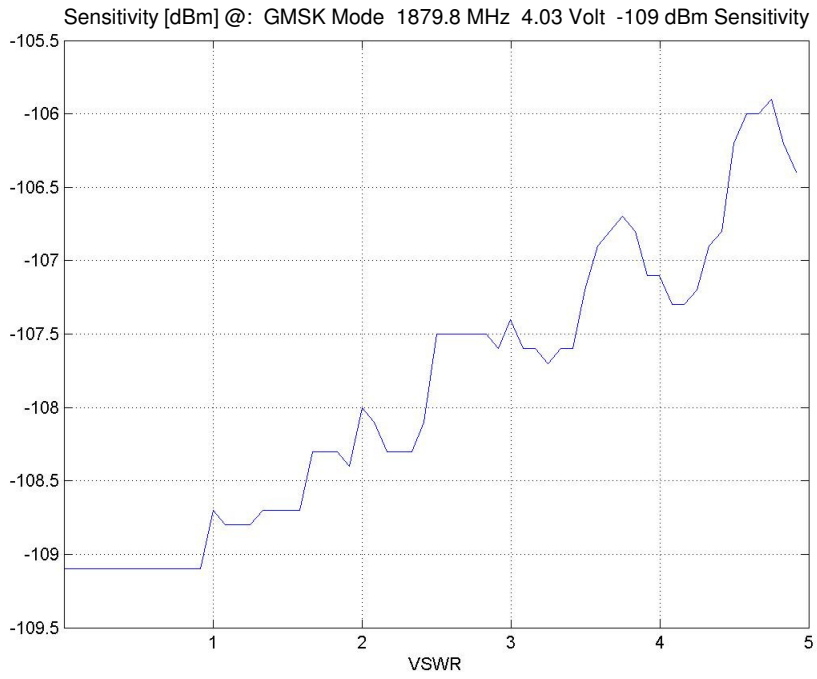and phase (between axis ticks)

Pout [dBm] @:  GMSK Mode  1784.8 MHz  3.9 Volt  30.5 dBm Ptarget
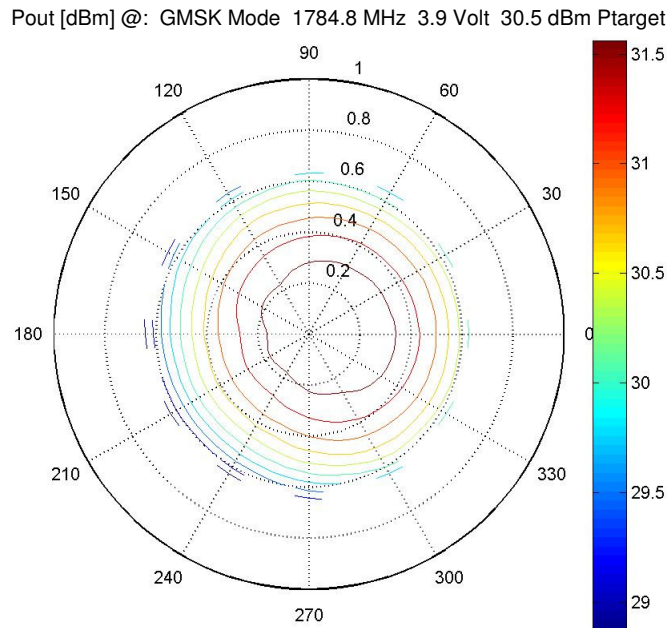
**Fig. 3** Transmit Power contours as a function of antenna impedance

## Sensitivity Testing in Receive Mode (RX)

While measuring transmit characteristics of mobile phone is relatively simple, measuring receive characteristics is more difficult. The sensitivity of a receiver is paramount, and acceptable levels of sensitivity are determined for each frequency of operation. Sensitivity of a mobile phone is defined as the received power level of the receiver while the Bit Error Rate (BER) of the receiver reaches a certain level. Sensitivity is measured through BER: the RCT sends a bit pattern to the mobile phone which is then echoed to the RCT. The RCT compares the original bit pattern with the received bit pattern, counted the errors bits and calculated BER. A predefined acceptable BER is chosen, in our case BER=2%, and the power transmitted from the RCT is adjusted until $BER_{recorded}$ = $BER_{predefined}$.  This is repeated for a given set of VSWR magnitudes and phases, various battery voltages, and various RX channels (frequencies).  *Fig. 4* shows the results of varying VSWR between 1 and 5 and varying phase in 30 degree increments with a targeted sensitivity of -109 dBm.  *Fig. 5* shows the same data represented in terms of sensitivity contours as a function of VSWR magnitude and phase.

## System Performance Evaluation

To verify the performance of proposed mobile phone testing system, testing results from Focus custom software are compared with the testing results from the mobile phone manufacturer. The comparison results are shown in *Fig. 6* and *Fig. 7*. The solid line curve represents the results from Focus software while the dashed line curve is from mobile phone manufacturer. It can be seen that these two curves are matched very well, which proved the accuracy of proposed mobile phone testing system.
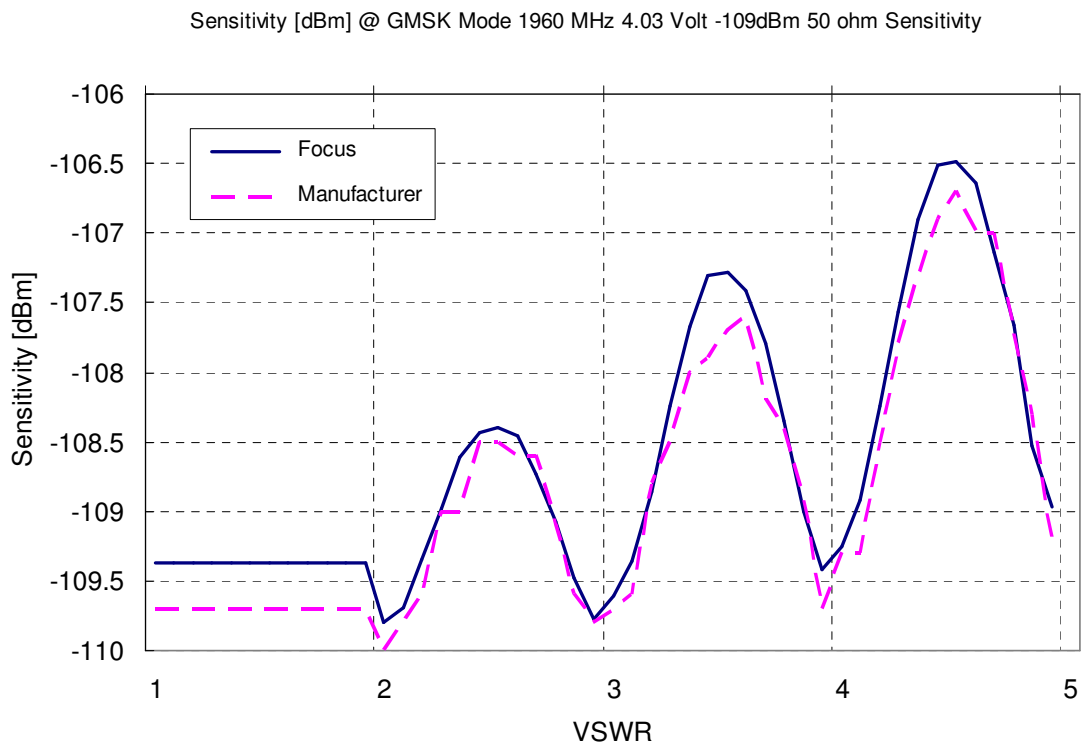
Sensitivity [dBm] @:  GMSK Mode  1879.8 MHz  4.03 Volt  -109 dBm Sensitivity

**Fig. 4**  Sensitivity at BER=2% as a function of VSWR magnitude (major axis) and phase (between axis ticks)

Sensitivity [dBm] @:  GMSK Mode  1879.8 MHz  4.03 Volt  -109 dBm Sensitivity
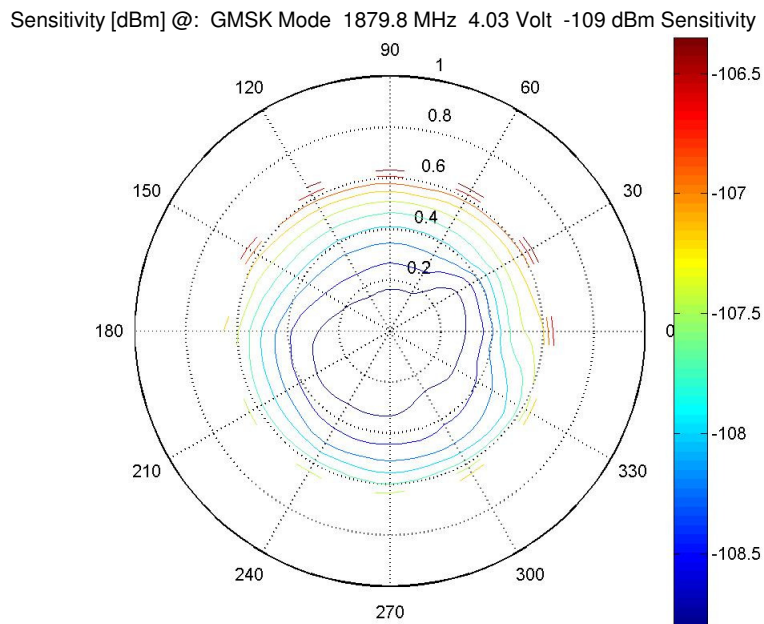
**Fig. 5** Sensitivity at BER=2% contours as a function of antenna impedance
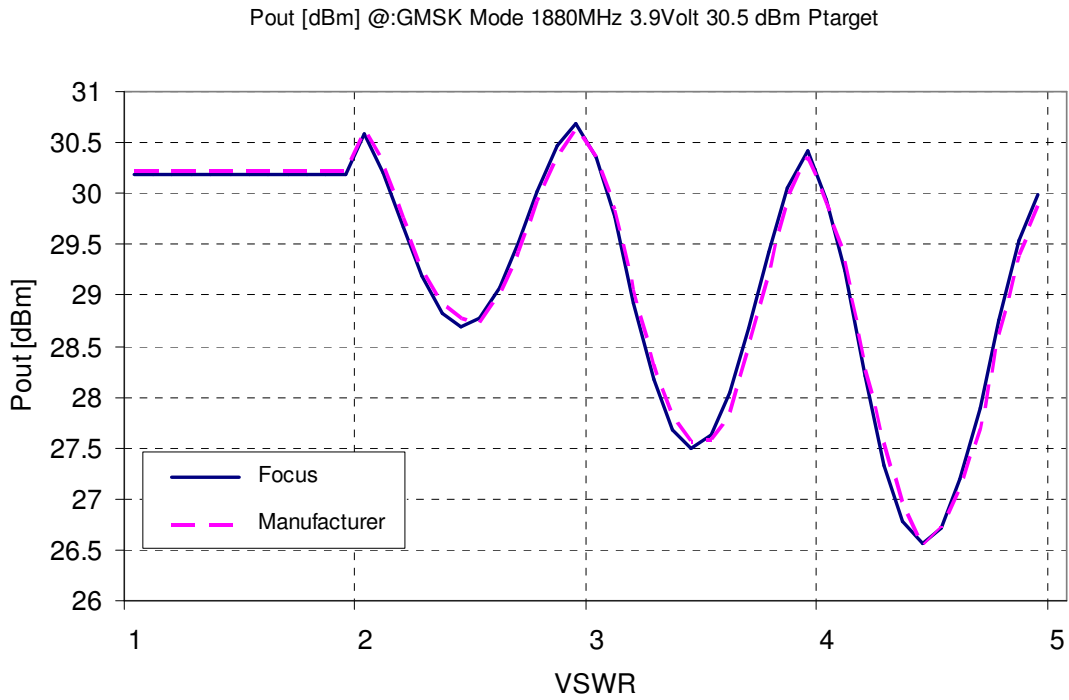
Pout [dBm] @:GMSK Mode 1880MHz 3.9Volt 30.5 dBm Ptarget



**Fig. 6** Transmit power as a function of VSWR magnitude (major axis) and phase (between axis ticks), Focus results vs. manufacturer results

Sensitivity [dBm] @ GMSK Mode 1960 MHz 4.03 Volt -109dBm 50 ohm Sensitivity



**Fig. 7** Sensitivity at BER=2% as a function of VSWR magnitude (major axis) and phase (between axis ticks), Focus results vs. manufacturer results

## Conclusion

Mobile phone testing is a very important topic as cellular communications continue to advance. Focus Microwaves has proposed a simple, user-friendly, modular solution for all modulation schemes covering all frequencies. With only a single iTuner and a RCT, we are able to accurately and efficiently verify the functionality of mobile phones under real-life conditions.