Rohde & Schwarz® products: SMU200A

Generating Polar Modulation with R&S® SMU200A

Application Note

Polar modulation is a method where digital modulation is realized as a combination of phase and amplitude modulation, rather than using an I/Q modulator. This technique becomes increasingly important in mobile communication. This application note shows how to generate polar modulation with an R&S® SMU200A Vector Signal Generator.

ROHDE&SCHWARZ

Subject to change – Dr. R. Desquiotz 11/2004 – 1GP58_0E

Contents

The following abbreviations are used in this application note for R&S test equipment:

- The R&S SMU200A Vector Signal Generator is referred to as SMU

1 Polar Modulation

Polar modulation is a method where digital modulation is realized as a combination of phase and amplitude modulation, rather than using an I/Q modulator. This technique becomes increasingly important in mobile communication, especially when existing GSM devices and modules have to be upgraded to EDGE. In GSM modulators, the phase modulator is already there, and the amplitude modulation can be realized by controlling the gain of the power amplifier. This allows to implement EDGE without major changes of the RF circuits.

Figure 1.1 shows in principle how polar modulation is set up. The modulating baseband signal is generated as time-variant amplitude and phase r(t) and φ(t). The latter drives a phase modulator to generate a phase modulated RF signal that is fed into a power amplifier. The amplitude modulation is done by controlling the bias voltage or the power supply of the amplifier.

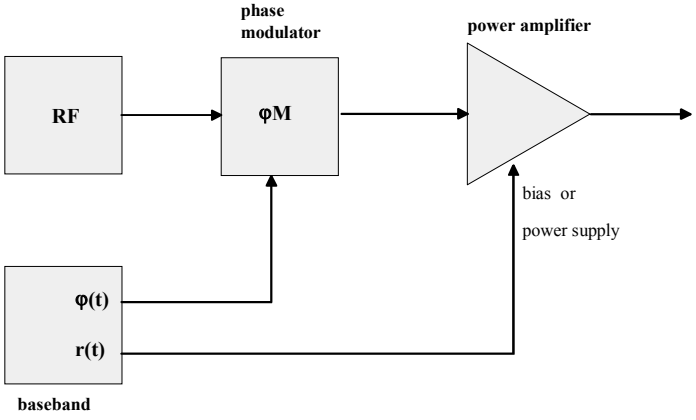


Figure 1.1: The principle of polar modulation.

2 Generating Polar Modulation with SMU

Modern signal generators for digital modulation systems commonly use the I/Q modulator principle. Therefore, it is not straightforward to generate polar modulation with such an instrument, as the signal generator has to provide a phase modulated RF signal and the corresponding amplitude modulation as a separate LF signal.

However, the SMU with its two-path concept can do it without difficulty.

2.1 Required SMU configuration

The required minimum SMU configuration is as follows.

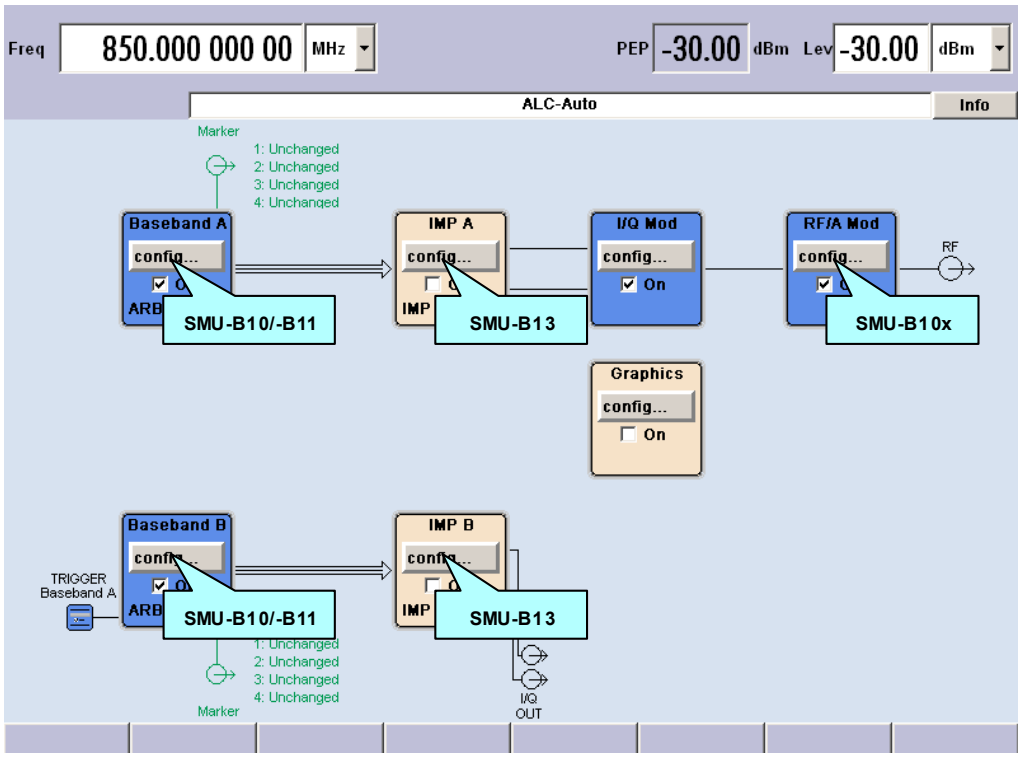


Figure 2.1: SMU configuration for polar modulation.

Hardware Options		
RF path A		
100 kHz to 2.2/3/4/6 GHz	R&S SMU-B10x	1141.8603.0x
Baseband		
2x Baseband Generator with ARB	R&S SMU-B10 or R&S SMU-B11	1141.7007.02
2x Baseband Main Module	R&S SMU-B13	1141.8003.02

2.2 Setting up polar modulation

Figure 2.2 shows a typical test setup for power amplifiers.

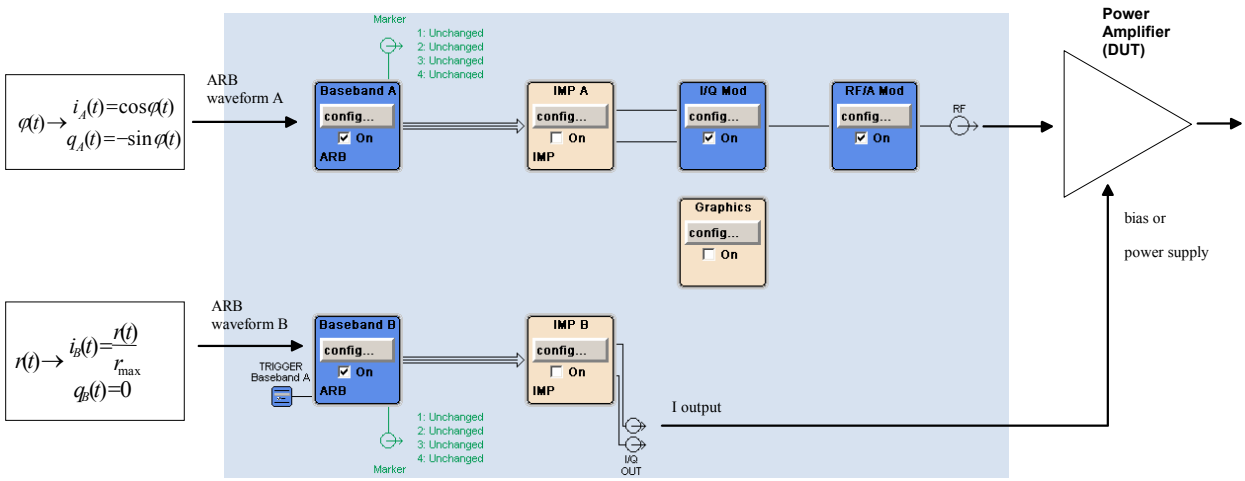


Figure 2.2: Generating polar modulation with an SMU to test a power amplifier.

We use path A of the SMU to generate the phase modulated RF signal. As the SMU uses I/Q modulation, we have to transform the time-variant phase φ(t) into I and Q values according to

$$i_A(t) = \cos\varphi(t)$$
$$q_A(t) = -\sin\varphi(t)$$

These I/Q values have to be stored in a waveform file and transferred to the ARB of baseband A.

The time-variant amplitude r(t) is also transformed into I and Q values

$$i_B(t) = r(t)$$
$$q_B(t) = 0$$

which have to be transferred to the ARB of baseband B. The I/Q outputs must be routed to path B. The amplitude signal is then available at the I output.

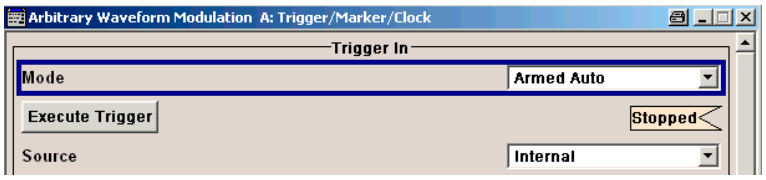
Note: make sure that the A and B waveforms have equal sample rate and equal numbers of samples!

2.3 Trigger settings

To ensure a synchronized start of baseband A and B, respective the two signal components φ(t) and r(t), the following trigger settings have to be made.

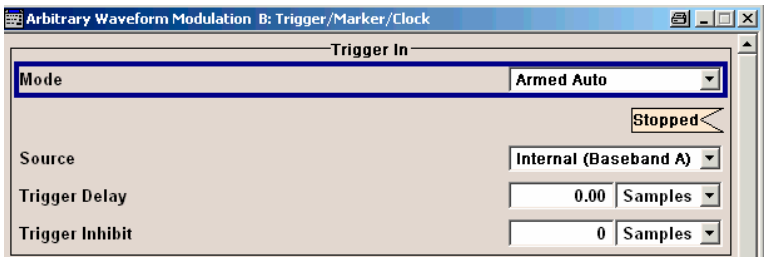
Baseband A:

Mode armed auto, source internal



Baseband B:

Mode armed auto, source internal (baseband A)



Note that the phase modulated part of the signal runs through the SMU RF chain, while the amplitude signal does not. This may cause a slight timing delay between the two parts. Therefore a trigger delay for baseband B might be necessary, depending on the actual signal and test setup.

3 Modifying I/Q Signals for Polar Modulation

To modify existing I/Q signals (files) for polar modulation, we need to generate two waveform files from the original I/Q values. This can be done with the following transformation.

With the well-known relation between (I(t), Q(t)) and (r(t), φ(t))

$$I(t) = r(t) \cdot \cos\varphi(t)$$
$$Q(t) = -r(t) \cdot \sin\varphi(t)$$

and the transformation from section 2.2, we get

$$i_A(t) = \frac{1}{\sqrt{I^2(t) + Q^2(t)}} \cdot I(t)$$
$$q_A(t) = \frac{1}{\sqrt{I^2(t) + Q^2(t)}} \cdot Q(t)$$

and

$$i_B(t) = \sqrt{I^2(t) + Q^2(t)}$$
$$q_B(t) = 0$$

where

$$r(t) = \sqrt{I^2(t) + Q^2(t)}$$

4 Ordering Information

Vector Signal Generator[1]		R&S SMU200A	1141.2005.02
including power cable, Quick Start Guide and CD-ROM (with operating and service manual)			
Options			
RF path A			
100 kHz to 2.2 GHz		R&S SMU-B102	1141.8503.02
100 kHz to 3 GHz		R&S SMU-B103	1141.8603.02
100 kHz to 4 GHz		R&S SMU-B104	1141.8703.02
100 kHz to 6 GHz		R&S SMU-B106	1141.8803.02
Overvoltage Protection		R&S SMU-B30	1159.7444.02
High-Power Output		R&S SMU-B31	1159.8011.02
Overvoltage Protection and High-Power Output		R&S SMU-B32	1160.0256.02
RF path B			
100 kHz to 2.2 GHz		R&S SMU-B202	1141.9400.02
100 kHz to 3 GHz		R&S SMU-B203	1141.9500.02
Overvoltage Protection		R&S SMU-B35	1160.0633.02
High-Power Output		R&S SMU-B36	1160.1000.02
Overvoltage Protection and High-Power Output		R&S SMU-B37	1160.1400.02
Baseband			
Baseband Generator with ARB (64 MSample) and Digital Modulation (realtime)		R&S SMU-B10	1141.7007.02
Baseband Generator with ARB (16 MSample) and Digital Modulation (realtime)		R&S SMU-B11	1159.8411.02
Baseband Main Module		R&S SMU-B13	1141.8003.02
Digital modulation systems			
Digital Standard GSM/EDGE		R&S SMU-K40	1160.7609.02
Digital Standard 3GPP FDD		R&S SMU-K42	1160.7909.02
3GPP enhanced MS/BS tests incl. HSDPA		R&S SMU-K43	1160.9660.02
Digital Standard CDMA2000 incl. 1xEV-DV		R&S SMU-K46	1160.9876.02
Multicarrier CW Signal Generation		R&S SMU-K61	1160.8505.02
Digital modulation systems using R&S WinIQSIM™[2]			
Digital Standard IS-95	(with R&S WinIQSIM™)	R&S SMU-K11	1160.5335.02
Digital Standard CDMA2000	(with R&S WinIQSIM™)	R&S SMU-K12	1160.5658.02
Digital Standard 3GPP TDD	(with R&S WinIQSIM™)	R&S SMU-K13	1160.5906.02
Digital Standard TD-SCDMA	(with R&S WinIQSIM™)	R&S SMU-K14	1160.6202.02
User-Defined OFDM Signals	(with R&S WinIQSIM™ and R&S WinIQOFDM)	R&S SMU-K15	1160.6402.02
Digital Standard 1xEV-DO	(with R&S WinIQSIM™)	R&S SMU-K17	1160.7009.02
Digital Standard IEEE 802.11 (a/b/g)	(with R&S WinIQSIM™)	R&S SMU-K19	1160.8805.02
Digital Standard 3GPP FDD incl. HSDPA	(with R&S WinIQSIM™)	R&S SMU-K20	1160.9460.02
Noise			
Additive White Gaussian Noise (AWGN)		R&S SMU-K62	1159.8511.02
Other options			
BER/BLER Measurement		R&S SMU-K80	1159.8770.02

[1] The base unit can only be ordered with an R&S SMU-B10x frequency option.

[2] R&S WinIQSIM ™ requires an external PC.

Recommended extras		
Hardcopy manuals (in German)		1007.9845.31
Hardcopy manuals (in English, UK)		1007.9845.32
Hardcopy manuals (in English, USA)		1007.9845.39
19" Rack Adapter	R&S ZZA-411	1096.3283.00
Adapter for Telescopic Sliders	R&S ZZA-T45	1109.3774.00
BNC Adapter for AUX I/O connector	R&S SMU-Z5	1160.4545.02
Keyboard with USB Interface (US assignment)	R&S PSL-Z2	1157.6870.03
Mouse with USB interface, optical	R&S PSL-Z10	1157.7060.02
External USB CD-RW Drive	R&S PSP-B6	1134.8201.12

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