Universal Radio Communication Tester R&S®CMU 200

Adjustment of polar modulators in production

Polar modulation is being used to an increasing extent to keep costs, size and power consumption of 2.5G mobile radio terminals to a minimum. However, power amplifiers in polar modulators are operated to improve efficiency in the nonlinear characteristic area. This leads to distortions and thus to an unwanted increase in modulation errors and adjacent-channel leakage. You can tackle this problem by means of signal predistortion with customized AM/AM and AM/φM characteristics; however, this requires the output stage characteristics to be determined quickly and effectively in production.

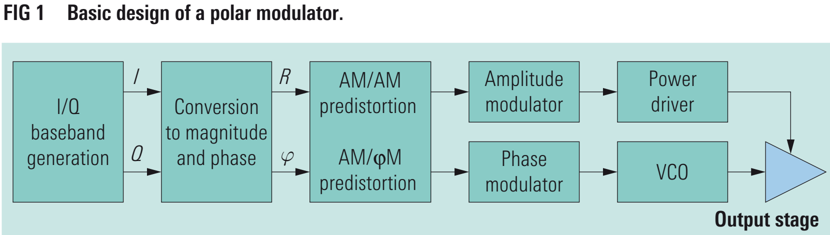
Principle of the polar modulator

FIG 1 shows the basic design of a polar modulator. After the I/Q baseband is generated, the signal is converted to polar coordinate format with magnitude and phase. In the case of modulation modes with constant envelopes (e. g. GMSK in GSM), the phase path is connected directly with the phase modulator and the VCO. During simultaneous amplitude modulation (e. g. 8PSK in EDGE), the AM path directly modulates the output stage. To compensate distortions, which occur due to output stage operation in the nonlinear characteristic area, predistortion is performed. In the ideal case, you can achieve a linear signal chain and thus a sufficiently narrow modulation spectrum.

Determining the output stage characteristic

Even low nonlinearities of the output stage increase adjacent channel leakage. To prevent this, you must have exact knowledge of the output stage characteristic so that correct predistortion is possible. Since the AM/AM and AM/φM characteristics generally scatter strongly in series production, you have to measure the characteristic of each output stage separately – and as quickly and reliably as possible.

FIG 1 Basic design of a polar modulator.



I/Q versus slot measurement

The Universal Radio Communication Tester R&S®CMU 200 with Firmware Option R&S®CMU-K48 allows you to determine the AM/AM and AM/φM characteristic of a power output stage. The test signal necessary for this is generated directly in the baseband of the chipset to be tested. FIG 2 shows the test setup and signal flow. The signal generated in the DUT passes through the entire signal chain and is analyzed in the R&S®CMU 200. The controller performs the final comparison of the nominal test signal with the actual test signal and the calculation of the characteristic.

Signal form and processing in the R&S®CMU 200

FIG 3 shows an example of the amplitude and phase of the staircase signal at the input and output of the output stage. To perform an exact phase measurement in addition to the amplitude measurement, the R&S®CMU 200 coherently synchronizes to the transmitted carrier. To do this, the mobile radio tester estimates the frequency at all level stages and subsequently corrects the test signal by the average value of the estimated frequency offsets. In the ideal case, the blue phase characteristic is the result, which exhibits only the AM/φM influence. By complex averaging you can then determine a complex I/Q value pair for any measurement interval (Sn). These results can then be compared with the nominal values in the controller and further processed to obtain the actual AM/AM and AM/φM predistortion characteristic.

Phase drift compensation

Since the local oscillators of the R&S®CMU 200 and the DUT are not coupled, an irregular drift occurs in the phase characteristic. During normal recording lengths of >50 ms, the test result would be unusable, since the phase shifts to one direction or the other as the test period increases. Further measures are necessary to distinguish this drift from the one caused by the AM/φM characteristic.

The solution to this problem is a special waveform that allows compensation of the drift. FIG 4 shows such a signal characteristic after it has been processed in the R&S®CMU 200 (for the sake of clarity, in two colors, black and yellow). The amplitude characteristic is selected in such a manner that a reference measurement step (black) follows each measurement step (yellow). The measurement steps pass through all desired signal amplitudes at which reference points are to be recorded for the AM/AM and AM/φM characteristic. Between the measurement steps, the reference measurement steps are at a constant level. Accordingly, the associated phases include only the phase drift but no AM/φM contribution. Assuming that the phase drift between two adjacent stages is negligible, you can compensate the phase drift error by calculating the difference between measurement and reference phases. The phase characteristic (orange) caused by the AM/φM characteristic is the result.

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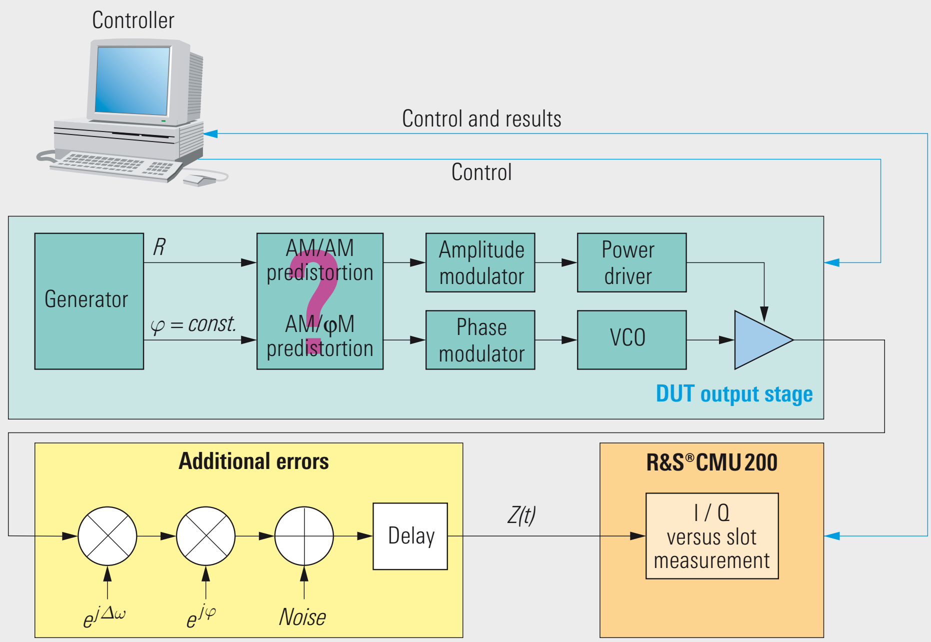

FIG 2 Test setup for determining the AM/φM characteristic of an output stage.

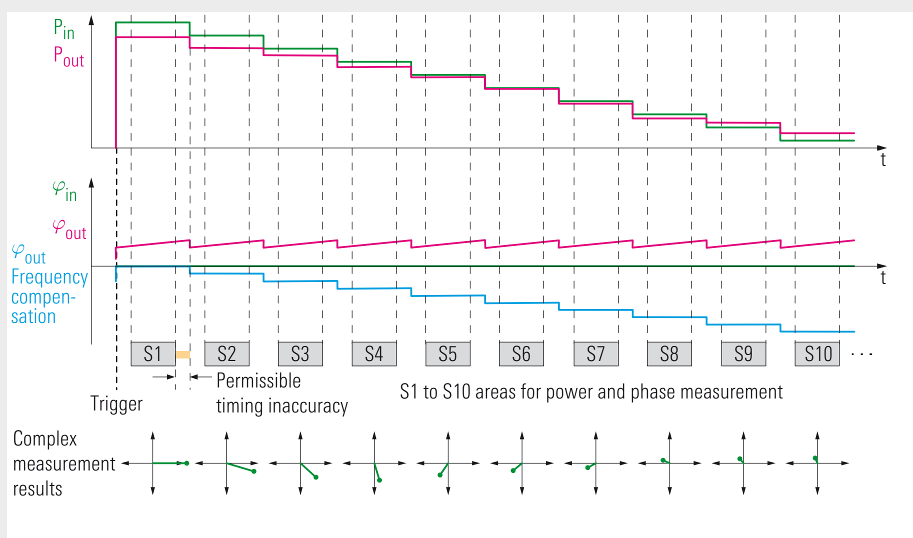

FIG 3 Example of amplitude and phase of the staircase signal at the input and output of the output stage.

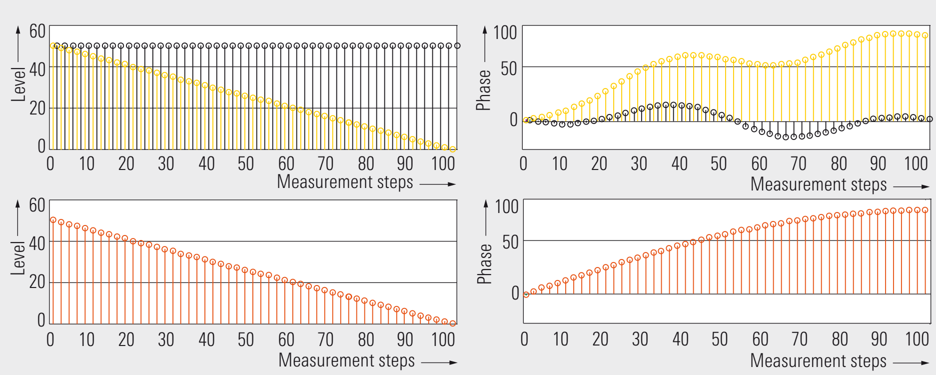

FIG 4 Phase drift compensation with special measurement signals.