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Automatic and adaptive precorrection of digital TV transmitters

Rohde & Schwarz has developed an automatic precorrection function for digital TV transmitters. Since the digital Exciter R&S SV 700/ R&S SV 702 (FIG 1) [*] is modular in design, even transmitter systems already in use can be retrofitted with this module.

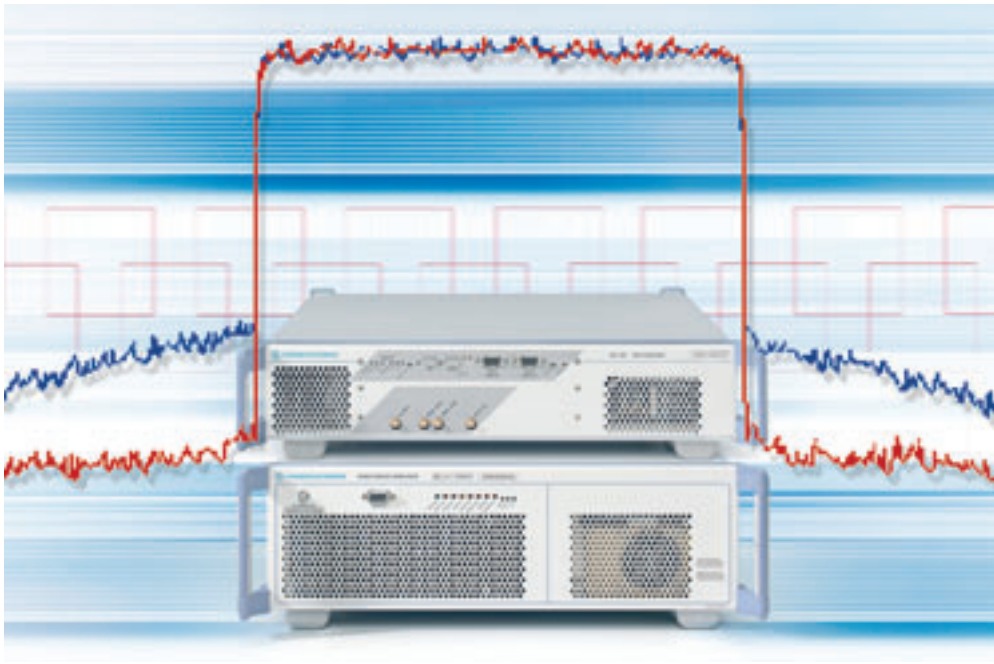
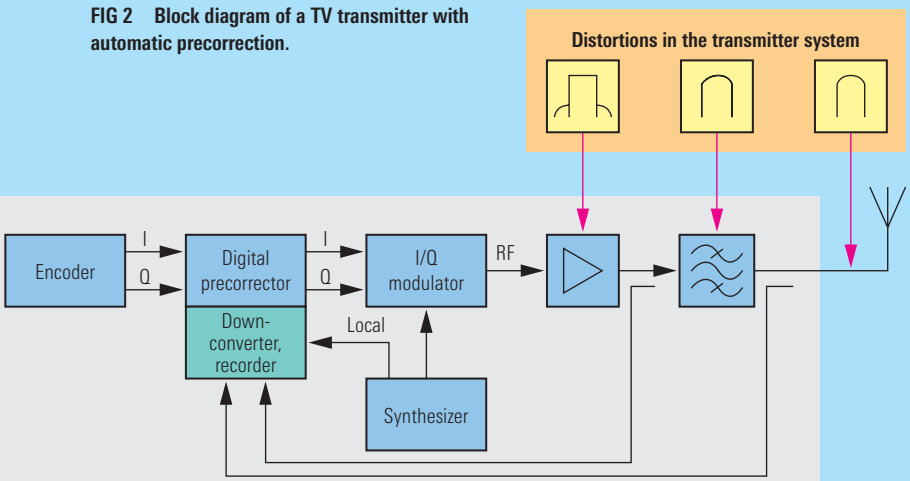


FIG 1 Space-saving digital TV transmitter: The Exciter R&S SV 702 (top) can be retrofitted with the new module for automatic precorrection.

Automatic precorrection for optimum signal quality

An increasing number of TV transmitter systems with digital transmission are being implemented worldwide. While the unambiguous waveform available in analog TV transmitters lends itself to systematic manual precorrection, information on the signal characteristic cannot be obtained in digital systems with commonly used measuring equipment. The sole criterion for manual precorrection is the shoulder distance of the signal spectrum. The new automatic precorrection function from Rohde & Schwarz determines the required parameters from the active signal without requiring much effort and time from the user, thus ensuring optimum signal quality at the transmitter output.

FIG 2 Block diagram of a TV transmitter with automatic precorrection.



Design of a transmitter system with automatic precorrection

FIG 2 shows the basic design of a TV transmitter with automatic precorrection. After the signal is processed in the

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encoder and precorrector, it is modulated directly to RF in the I/Q modulator. The first test point, which is used to detect nonlinear signal errors, is installed after the amplifier. The channel filter that follows eliminates spurious emissions from the signal, and the signal is then forwarded to the antenna via a second test point. The second test point detects linear signal errors.

Nonlinear and linear distortion

Because of their nonlinear characteristic, power amplifiers produce inband and out-of-band interferences, known as shoulders (see "Distortions in the transmitter system" in FIG 2). These nonlinear distortions are practically constant for the entire lifespan of the solid-state transmitters of the R&S NX6000 / R&S NX7000 families. However, some types of output stages (e.g. with tubes such as the inductive output tube (IOT)) are prone to aging which leads to a change of the distortions. In this case, adjusting the precorrection is recommended.

The channel filter after the amplifier eliminates interferences outside the channel used. The steep filter edges produce linear distortions (amplitude frequency response and group delay) in the passband and at the channel boundaries. These errors can also change as a result of a change in the filter characterisitic due to environmental influences. Adaptive adjusting of the linear precorrection may thus be necessary to ensure high signal quality for the transmitter system.

Linear distortions that are not detected by the automatic control function and therefore require additional manual compensation can occur in RF antenna feeders or in other inserted components such as channel combiners.

Precorrector design

The new precorrector can compensate for these distortions and supports both automatic and adaptive precorrection. The digital design makes the preset characteristics stable and reproducible at any time. Since the module is mechanically compatible with the conventional precorrector, exciters already in use can also be retrofitted without any problem.

FIG 3 shows the design of the new automatic precorrector. The digital baseband signal first passes through the linear frequency response precorrector. This precorrector corrects all linear distortions that occur in and after the channel filter by using an efficient digital finite impulse response (FIR) filter. It is followed by the nonlinear precorrector, which corrects instantaneous amplitude and phase distortions that occur in the output stage.

The signal returned from the test points is made available at the RF input of the precorrector via a selection switch, where it is demodulated, digitized and recorded together with the undistorted baseband signal. The digital signal processor (DSP) calculates the signal distortions from the recorded signal curves, derives the characteristics and sets them. Memory swap areas allow a new characteristic to be activated without switching off the output signal or the precorrection.

Operating modes and control of the precorrector

The precorrector supports the manual, automatic and adaptive operating modes. All three are separately available for linear and nonlinear precorrection. They are set and controlled via a convenient PC user interface with graphical display of the linear and nonlinear characteristics (FIG 4).

In the manual mode, the characteristics are entered via the graphical user interface and sent to the precorrector. In the automatic mode, adjustment is started at the press of a button. The automatic control function first performs a measurement. The settings are then calculated and loaded in the precorrector.

In the adaptive mode, signal quality is continuously checked at the output. Tolerances for the characteristics can be set via the graphical user interface. If tolerances are exceeded, the correction characteristics are adjusted without transmission being interrupted. The display shows the automatically or adaptively activated characteristics. These modes also provide manual means for setting linear distortions not detected by the automatic control function.

Condensed data for automatic precorrection

Frequency ranges	170 MHz to 240 MHz 470 MHz to 860 MHz
TV standards	DVB-T ETS 300 744 ATSC / 8VSB
Frequency response precorrection	±2 dB
Group delay precorrection	500 ns (optionally 1.5 µs)
Nonlinear precorrection	3 dB amplitude 45° phase
Operating modes	Manual, automatic, adaptive

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Applications

Automatic precorrection offers substantial advantages for operating digital TV transmitter systems. When transmitters are placed into service or undergo maintenance, the optimum operating state can be set quickly and reliably by pressing a button. Thus, switching to a different transmission frequency or changing the output power, both of which require an adjustment in precorrection, can be performed in a matter of minutes.

A typical application for **adaptive precorrection** is ATSC transmitters, which are operated in the adjacent channel of an analog TV transmitter. This involves the use of extremely steep channel combiners or sharp-tuned filters, which cause group delay differences of greater than 1.5 µs in the useful channel. In addition, environmental influences can alter the characteristic of these components. Since the ATSC signal is very sensitive to group delay errors of only a few nanoseconds, the continuous monitoring and correction provided by adaptive precorrection ensures optimum signal quality.

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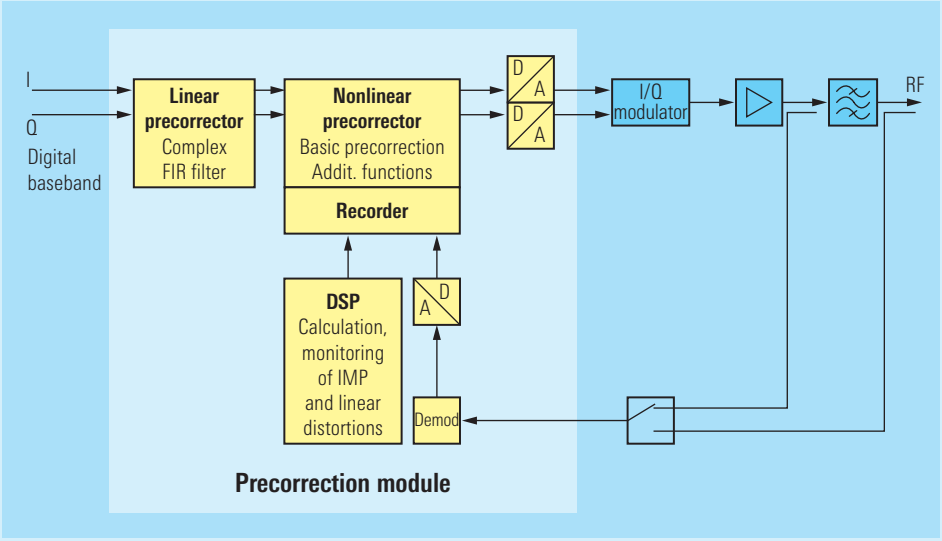
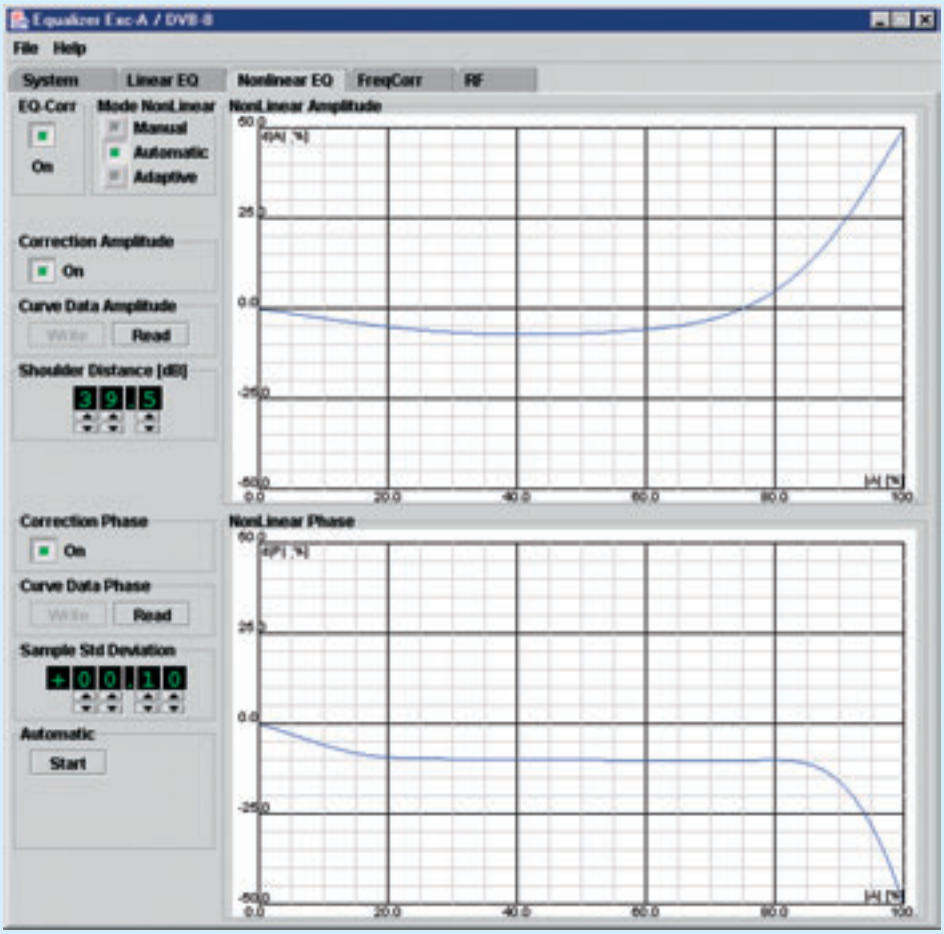


FIG 3 Block diagram of the precorrection module.

FIG 4 Convenient user interface for nonlinear precorrection.



More information on Rohde & Schwarz transmitters at www.rohde-schwarz.com

REFERENCES

[*] DTV Exciter R&S SV702 – Compact exciter for digital terrestrial TV. News from Rohde & Schwarz (2003) No. 177, pp 40–41

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