Application Note

Option 8 Signal Generator RF Profiles and Complex Sweep for EMC and ATE Applications

The Option 8 facilities on 2030 and 2040 series signal generators can simplify manual operation and reduce software development time in ATE systems. The complex sweep facilities can be used to speed up EMC Immunity tests.

Power Level Accuracy

Signal generators are used for testing many electronic circuits and systems by simulating the signals seen by the unit under test in actual use. One of the most fundamental requirements of a signal generator is that is must be capable of delivering an accurate signal level to the device under test under all operating conditions.

Signal generator manufacturers expend considerable design and production effort to provide the best traceable RF accuracy at the generator's output port. Typically the calibration systems used will correct for the internal attenuator characteristics and the frequency response of detectors and internal connectors. Modern signal generators, such as the IFR 2030, 2040 and 2050 Series, compensate for these effects entirely in firmware in order to improve the accuracy and long term stability of the carrier power.

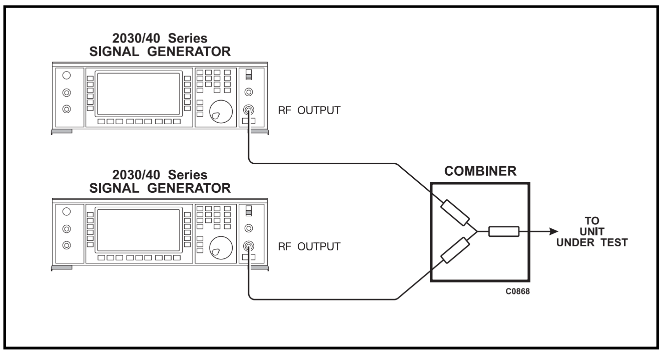
In practice this calibrated signal level is measured directly on the output connector of the generator but the device under test is almost certainly tested by routing the signal through amplifiers, cables, switches, signal splitters or other interface devices. As a result the signal can be significantly altered before it reaches the device under test.

In principal it should be possible to use the same firmware routines that provide internal correction of the signal generator's RF output to calibrate at a remote point. In practice, the internal calibration routines are unlikely to provide a satisfactory solution since they effectively have a good prior knowledge of the general characteristics of the generator architecture and are therefore designed with this model as a basis for the correction routines. When a generator is used as part of a test system the circumstances can be very different and it is unlikely that these routines are sufficiently tolerant of the test systems frequency response characteristics to be of much assistance.

The IFR 2030, 2040 and 2050 series are available with Option 8, which provides very flexible RF level control facilities to overcome the problem of correcting for the test system response. The firmware provides two additional facilities to allow for the characteristics of the test system. In addition Option 8 provides new RF frequency sweep modes which can generate more complex sweep waveforms which can speed up the measurement of RF devices and reduce test system software design costs.

RF Offset

The RF Offset facility allows the displayed RF level on the front panel of the signal generator to be offset from the actual RF output level. If the signal generator is used with external amplifiers, attenuators or combiners which have a nominal defined loss or gain, an offset value can be entered which changes the displayed RF level without changing the actual RF level of the generator.



For example, if the test system uses a resistive signal combiner with 6 dB loss to combine two signals in the system and the signal generator output is set to -10 dBm then entering an offset value of -6 dB will result in the signal generator displaying the RF level of -16 dBm, which is the nominal level at the output of the splitter.

The RF Offset facility allows the entry of offset values between -40 dB and +80 dB so it can be used to correct for attenuators or amplifiers in the system. The display level on the generator can allow voltages of up to 9.99 kV (1.996 Megawatts in 50 W) to be displayed which is adequate for most electronic systems! When an RF Offset is enabled, the offset value is clearly displayed on the LCD panel to remind the user that the offset facility is in use.

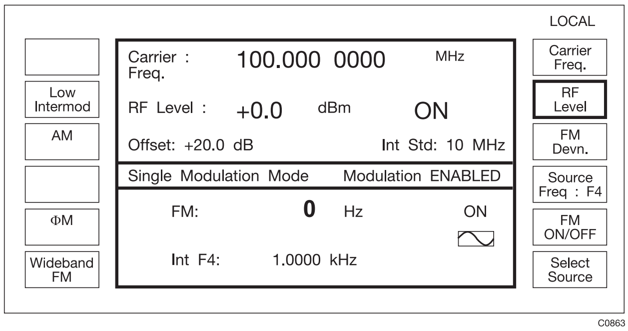


Figure 1 - Signal Generator display with RF offsets enabled

In practice the gain or loss of the connection system is unlikely to precisely equal the nominal characteristics and is likely to exhibit some frequency dependence. The RF Profile facility allows this frequency dependence to be accounted for.

RF Profiles

The RF Profile facility allows the generation of a correction table to remove the frequency dependence of the external interconnection system. The system works in a similar way to the internal software correction routines used on the signal generator but has to be far more flexible.

As with the internal correction routines the profiling facility generates a table of correction factors for different carrier frequencies and interpolates linearly between the calibration points. The calibration frequencies, however, are freely user defined and up to 100 points can be entered. The correction table can change the RF level output by up to ±40 dB which is a far greater range than required for internal correction factors but is consistent with the requirement to correct for the characteristics of items such as an antenna mounted in screened rooms where the performance can vary significantly with carrier frequency.

In practice test systems, such as integrated circuit testers, it is likely that more than one signal path is used to route the signal to the device under test. For this reason the RF Profile facility allows the storage of up to 10 different profile tables. Once generated the profiles can be stored in a non volatile memory. With a profile enabled the signal generator clearly displays that a profile is being applied to the output.

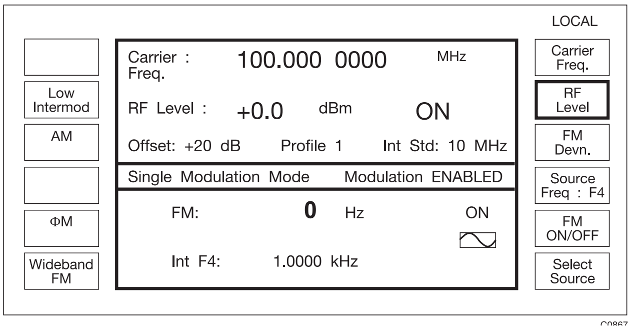


Figure 2 - Signal Generator display with Offsets and profiles enabled

Manual Generation of Profiles

The profiles can be generated manually from the front panel using LCD panel and soft keys to display and edit the points in the profile. The editing facility provides a simple means of first generating the profile by using keyboard entry or the rotary control of the carrier frequency and then adjusting the RF level to obtain the correct level at the unit under test. The editor allows for the deletion of correction points or the insertion of a correction point to improve the characteristics of an existing profile. The editor automatically sorts the correction points into their frequency order to perform the interpolation function so correction points can be entered in any order.

The profile editor is accessed manually by first entering a password to unlock the software. Since the password can be user defined it can be used to protect the profile from being edited by unauthorised users.

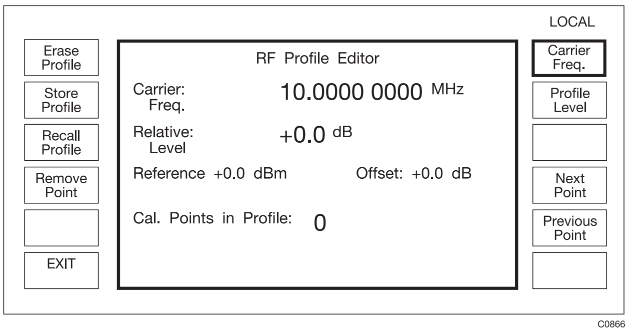


Figure 3 - RF Profile Editor display

Profiles using the GPIB

The profiles can also be created by a controller and loaded into the generator over the GPIB to simplify the generation of the correction table. Many ATE systems already include this facility but having the correction table in the generator offers significant practical advantages.

When the system is being checked to ensure that it is behaving as expected, the signal generator will display the correct RF level at the device under test rather than the signal at the output of the generator. The automatic test results can be simply and quickly checked for accuracy against a manual test which takes into account the system calibration factors for RF level rather than relying on system deriving correction values from the controller for each frequency.

If the ATE system is testing a device and some unexpected results occur, the system can be halted and manually driven to explore the response. This is particularly true of EMC immunity test systems where a device response can be quickly manually explored using the signal generator keyboard and rotary control to characterise the failure margin and display the results clearly and unambiguously.

Complex Sweeps

The ability of a signal generator to provide swept signals in level or frequency can significantly simplify and speed up measurements on a device under test. The 2030, 2040 and 2050 Series signal generators include a fast sweep system which is well suited to plotting frequency response, modulation bandwidth and level compression characteristics. Some applications, however, require more complex sweep functions which usually can only be implemented using an external controller to control the signal generator over the GPIB. This is not a very convenient method of generating the required sweep particularly if the controller has to perform many other tasks in the system or frequent manual intervention to explore a device response is required. This is particularly true of EMC Immunity tests where further information about the device response might give clues as to the origin of a failure.

Option 8 on 2030, 2040 and 2050 Series signal generators provide a complex sweep facility as an additional sweep mode to the normal sweep mode which allows the generation of more complex sweep patterns.

Profiling

An important characteristic of the complex sweep is that an RF Profile can be applied so that the level is calibrated at the input to the device under test rather than at the output connector of the signal generator. Since the correction factors are calculated by the signal generator this substantially reduces ATE control software complexity and results in the signal generator displaying more meaningful RF output levels that can be more easily interpreted during system debugging or in the event of manual intervention.

Segmenting the Sweep

In addition the sweep is defined as consisting of a number of segments and each segment had independently set characteristics. A sweep segment has a start and stop frequency, a frequency step size, a step time and an RF level. The number of steps in a segment is determined by the difference in start and stop frequency and the step size. The step time can be set to between 20 ms and 20 s.

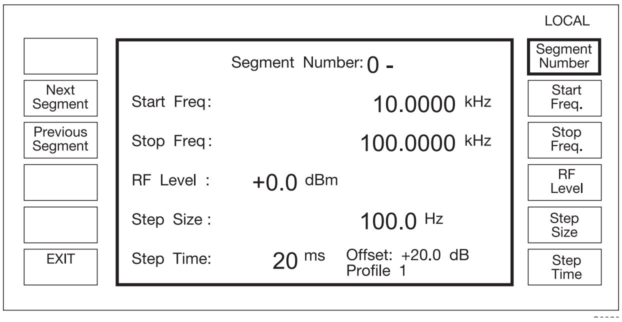
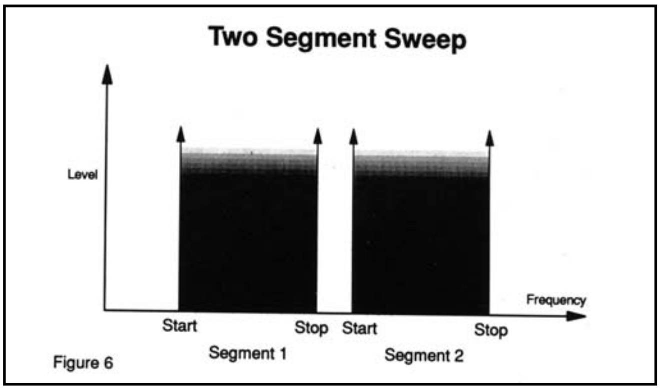


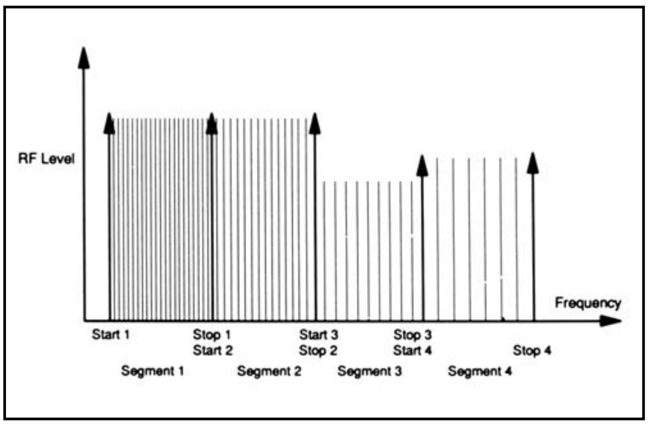
Figure 4 - Creating a Sweep Segment

A sweep can be defined as having from 1 to 10 different segments. If a sweep consists of just one segment it will sweep at a constant RF level from one frequency to another. If 2 or more segments are used more complex sweeps can be generated which are useful for more demanding applications.



Two segments can be defined to have start and stop frequencies which result in the signal sweeping from one frequency to another and then missing a section of the RF spectrum before resuming the sweep at a higher frequency. This can be useful for making selectivity test on a radio where the missing section receivers pass band.

Different segments can be arranged to have a different step sizes so that a sweep can use larger step sizes as the carrier frequency is increased. This is particularly useful when undertaking immunity measurements since the linear progression of frequency is maintained to provide known beat frequencies with harmonics of clocks in the device under test whilst still providing a reasonable simulation of a logarithmic sweep.



The ability to set independent RF levels in each segment also allows the RF level to be changed as the sweep progresses to match the test limits. For immunity tests the entire frequency band can be swept using an RF signal whose frequency, step size, dwell time and RF level varies in accordance with the regulations set by the national authorities

Remote Control

The segmented sweep can be loaded into the signal generator using the GPIB and the controller can then instruct the generator to start a sweep. The fact that the sweep is computed and executed by the signal generator's internal microprocessor reduces that complexity of the system software and saves development time and costs.

The trigger facility can also be used to make the signal generator sweep continuously, sweep the complete complex sweep once or execute a single step in the sweep on each trigger.

Manual Control

Once a sweep has been started under manual control the sweep can be halted at any point and the RF level and carrier frequency varied by keyboard entry or using the rotary control. This is particularly useful for immunity testing since if the device under test produces a response the sweep can be stopped and the response explored. After altering the signal generator's state, the sweep can be restarted and the generator will return to the condition where is was halted before continuing the sweep in order to complete the test.

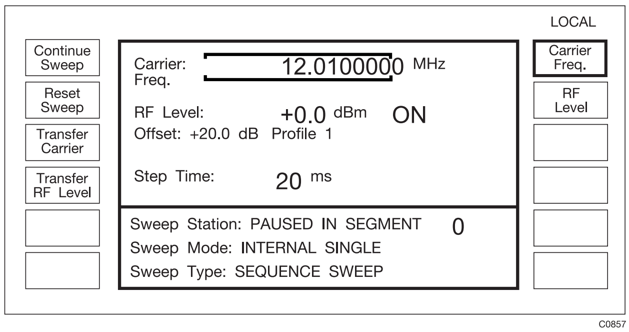


Figure 5 - Signal Generator display with the Sweep passed

Suppressing Attenuator Operations

When the RF level is changing during a sweep either as a result of a new segment having a different RF level or an RF profile being used, the signal generator's attenuator may operate to rest the RF level. Careful attention to the software control and hardware design ensure that positive level transients are not generated which could produce higher field strengths in an immunity test or even damage an external power amplifier.

In suppressing the positive transients, it is inevitable that a negative level transient is produced. When the level recovers, it produces a rapid change of RF output voltage and this can confuse immunity test results on devices prone to rapid changes of level. Software on the 2030, 2040 and 2050 Series signal generators introduced a selectable extended hysterisis facility which extends the electronic control range of the electronic levelling system to cover up to 24dB level range. When in the extended range the signal generator indicates if the ALC is operating out of its normal range of values. The RF level accuracy in this extended range is not as accurate as in the normal operating range.

Square Wave Modulation

Instruments supplied with Option 8 can produce a square wave modulation waveform in addition to the normal sine or triangular signals. Square wave modulation is particularly useful for immunity testing since many forms of radio use Time Domain Duplex (TDD) or Time Domain Multiple Access (TDMA) formats. These systems produce burst of RF signals and their effects on a device can be simulated by applying square wave modulation to the carrier during the frequency sweep. The rise and fall times of the square wave source are shaped so that the resulting square wave modulation has no RF overshoot that could produce erroneous results.

Summary

The features provided by Option 8 offer important advantages in the manual and automatic testing of modern electronic devices. The features shorten the development time of ATE system and reduced the cost of debugging and checking ATE results. Applications for the software vary from manually testing the selectivity of receivers to conducing immunity test in GTEM cells or screened rooms. The profiling facility offers important advantages in improving the accuracy of the system calibration and ensuring that automatic test results can be checked manually to validate the system performance.

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