Creating RF Test Instruments With Programmable USB Modules

USB-powered mix-and-match memory-stick-sized RF measurement devices include power meters, vector modulators, and synthesized signal generators capable of low-phase-noise performance.

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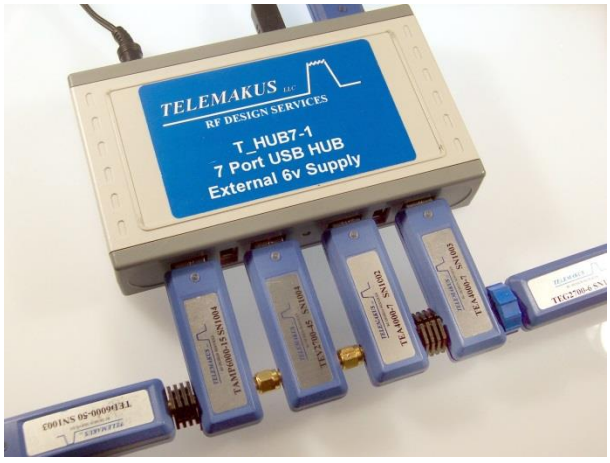
Creating a custom automated test system for RF signals up to 18 GHz usually requires costly instruments controlled from a PC. Computer-controlled test equipment once required racks of instruments connected to a control computer via GPIB. But GPIB has all but disappeared in new equipment and USB is quickly making test systems with laptop control readily available, that are affordable and that fit in a briefcase for field work. No longer do you need to have a customized rackmount system specially designed for you. You can build what you need with reusable USB RF building blocks.Telemakus is one of several companies now offering high-frequency measurement and signal generation functions through 18 GHz that take advantage of a laptop or personal computer (PC) for its processing and display capabilities.

Telemakus RF modules put the subsections of complex bench instruments into USB-powered and USB-controlled modules that can be interconnected to create just the components needed for specific testing situations, reducing equipment cost outlay dramatically. A growing number of RF test functionalities are now possible simply by connecting novel USB-connected RF devices to a personal computer. Automated measurement systems can be created by attaching specific Universal Serial Bus (USB) dongles to a personal computer and controlling them with Telemakus' free GUI software provided. Among the functionalities available now are frequency synthesizers, vector modulators, phase shifters, RF switches, amplifiers, and root-mean-square (RMS) power meters.

Telemakus' USB2.0 modules work with any Windows PC, and as many as 127 USB devices can be connected through a USB hub. Each of these versatile USB test modules contains built-in memory and a microprocessor to store program and calibration data, and they leverage the PC's display and processing capabilities to clearly indicate and interpret RF and microwave measurements. All of the USB instruments are supported and controlled by simple graphical user interface (GUI) software that enables setting of controls and entering data points for measurements. This makes for an extremely portable RF test solution that can be slipped into the pocket of the laptop PC's bag, ready for field work at a moment's notice.



For instance, to create a customized test system, a synthesized signal generator can be combined with a 7 bit, 0.25dB attenuator to control output power, and connected to a power amplifier for connection with a device under test; a USB-connected Power Sensor can measure the output signal, and all these modules and their outputs can be monitored and controlled using the user-friendly graphical software package provided, rivaling the functionality of a very expensive scalar network analyzer. Tremendous cost savings can be obtained this way, not to mention the extreme portability of the solution for field work. These innovative modules leverage the enormous power and capabilities of the PC. Each module has its own flash memory and microprocessor, so the calibration parameters for each device are stored internally.

The TEV2700-45 RF Vector Modulator is ideal for vector signal measurements, beam-forming, and amplitude and/or phase-correction applications. It accepts inputs to +23 dBm from 1800 to 2700 MHz and provides at least a 360 degree phase control range with 12bit resolution and 45-dB dynamic range. Input signals are fed in via an SMA male connector, with outputs are also available on an SMA female connector. Signals are subjected to less than 6dB insertion loss as part of the modulation process, with 9dB typical return loss. Each vector modulator is factory-calibrated at three frequencies,

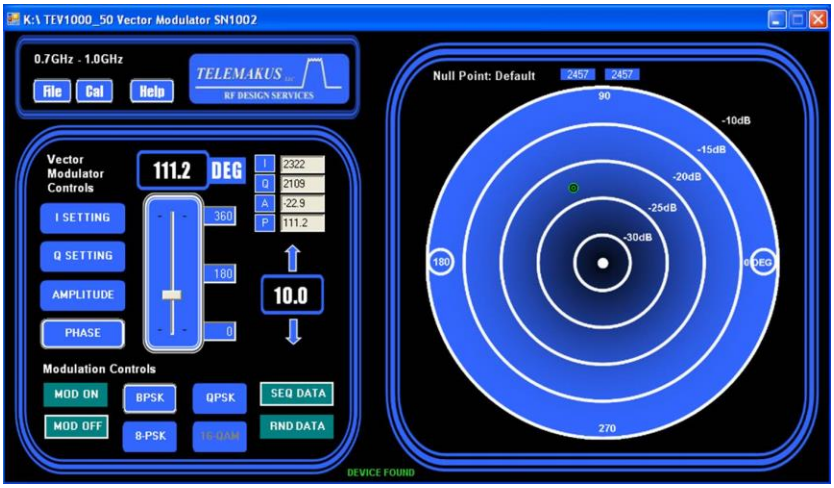
but additional calibration points can be added by the user. An easy-to-use graphical interface facilitates keypad or on-screen slider controls data entry.

Telemakus Frequency Synthesizers are stabilized by an internal 10 MHz crystal reference oscillator with excellent temperature stability. Model TEG250-15 is the lowest-frequency signal source member, tunable from 140 MHz to 250 MHz in steps as small as 1 kHz. It delivers +15dBm low-spurious output power across the whole bandwidth, with better than -118dBc/Hz phase noise. The tiny signal generator features on/off power control and draws 150 mA from the USB's +5VDC. For generating microwave test signals, the TEG10200-1 provides +15dBm from 9.3 to 10.2 GHz, and uses an internal 10 MHz crystal reference oscillator with 2.5ppm frequency stability from -40 to +55degC. It achieves phase noise of -95 dBc/Hz offset 100 kHz from the carrier, with spurious levels of -75 dBc, second harmonics of -20 dBc, and third harmonics of -30 dBc, drawing 250 mA from the USB port. Other signal generators cover frequency ranges of 700 to 1000 MHz (TEG1000-10), 1800 to 2700 MHz (TEG-2700-6), and 2700 to 3500 MHz (TEG3500-8), with phase noise of -105 dBc/Hz phase noise offset 10 kHz from the carrier. A simple visual GUI can control multiple USB frequency synthesizers for multi-tone testing situations. The GUI allows a choice of tuning in steps of 1 kHz, 10 kHz, 100 kHz, and 1 MHz.

USB module RF Amplifiers are available for boosting signals when needed: for instance, TAMP6000-15 provides 15 dB gain from 100 MHz to 6 GHz with +19 dBm typical output power at 2 GHz and 1dB compression.

Several true RMS Power Meters are also available: TED10200-45 has a 45 dB dynamic range from 9.3 to 10.2 GHz, with RF power being measured using a built-in logarithmic detector. An internal temperature sensor ensures accuracy over a wide temperature range, and it can handle inputs to +20 dBm from an SMA male connector with accuracy of 0.5dB to +10dBm. TED6000-50 power meter suits 50 MHz to 6 GHz frequencies, and TED14500-45 is available for 14.0 to 14.5 GHz.

Phase Shifters are a critical component in many RF and Microwave systems. Applications include controlling the relative phase of each element in a phase array antenna in a radar or steerable communications link and for cancelation loops used in high linearity amplifiers. Telemakus offers modules that can control phase by at least 360degrees from 1 GHz up to 18 GHz in different modules, with insertion losses of around -4 dB.



The Telemakus' software API was created to assist users in developing creative and cost effective RF test applications using their USB devices across a wide variety of programming languages and development tools. The .NET-based common programming interface simplifies the task of integrating multiple devices into larger complex systems. A user can quickly design a very robust application by following just a few simple guidelines for managing how and when the USB pipes are opened and closed for each device. Adding a level of USB management to the error handler of the application can further strengthen its robustness. The possibilities of USB-controlled RF test equipment are limited only by the creativity of the developer. Not only can these devices be controlled by a PC, but they can be plugged into and operated from the front panel display of other Windows-based test instruments. The Telemakus API also allows installation of their range of USB-controlled RF products in LabView-based RF test applications.

Conclusion

Using any Windows PC and a USB hub, multiple USB RF modules can be connected and controlled to build up a complex system of RF functions that include switches, attenuators, amplifiers, signal generators, vector modulators, phase shifters, frequency doublers, and power detectors. It is now easy and economical to combine various USB modules together to assemble a custom, reconfigurable and extremely portable RF test system, creating the features of expensive benchtop systems such as network analyzers, and synthesized signal generators at a fraction of their cost, with a resulting system that rivals expensive benchtop equipment with the portability of a laptop PC.