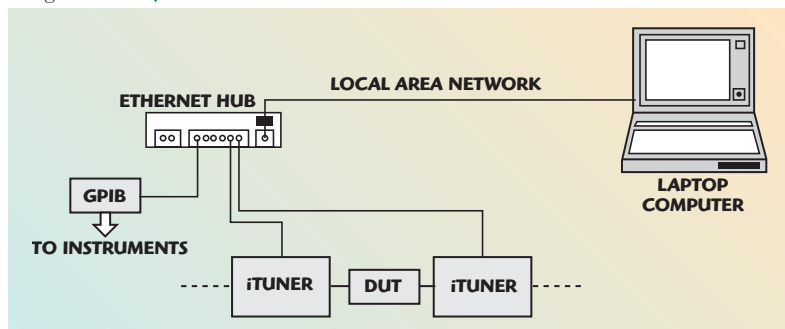# AN INTELLIGENT MICROWAVE TUNER

The latest line of Focus Microwaves' tuners features a completely redesigned control electronics based on a powerful real-time microprocessor that is capable of controlling up to six motors simultaneously. The iTuners are programmed via a TCP/IP interface, thus no dedicated external hardware is required and any computer with a network card may be used for control.

The iTuner is based on the company's proven microwave tuner product line, but offers a TCP/IP interface with an individual IP address, and autonomous control of up to six axes without interaction from an external computer. The unit features upgradeable firmware stored in on-board flash memory, additional on-board memory to store configuration and calibration data, and can be remotely controlled over a standard LAN network.

The iTuner is fully self-contained and can be connected to any computer in a LAN network. Since each tuner has its own programmable IP address, there is no limitation on the number of tuners. The internal 256 kB flash memory stores the firmware and can be upgraded in the field. **Figure 1** shows a typical remote-controlled test setup using iTuners and a laptop computer.

The unit's firmware is written in ANSI C language and serves to provide communication with the controlling computer over both TCP/IP and RS232 interfaces. The firmware parses, dispatches and acknowledges incoming commands, and replies to query commands from the controller. It also simultaneously controls up to six motors with precise timing.

CONTROLLER DETAILS

A Rabbit Semiconductor 3000 processor, operating at 30 MHz clock speed, is used as the controller card core. This processor was selected because of its low cost and royalty free TCP/IP application code. The processor has an extensive array of on-chip peripherals, including six serial ports, 56 parallel I/O pins, clueless memory interfacing to RAM and flash memory,

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Fig. 1 Remote control setup using iTuners. ▼

and in-circuit programming. 128 kB of RAM and 256 kB of flash memory have been allocated to the processor.

The stepper motors are controlled via dedicated control ICs directly connected to the processor I/O ports. These chips provide up to 1.5 A of current per winding to the uni-polar stepper motors used in the tuners. The acceleration/deceleration profile of the stepper motors has been optimized to reduce vibration, which is important when performing on-wafer device characterization.

A non-volatile 4k EEPROM is used to store operation parameters, such as model, serial number and IP address. A removable data flash card (up to 64 MB) is used to store tuner calibration data. The entire controller card area measures less than 10 cm by 7 cm and is compatible with all the existing tuner housings currently in production at Focus. The new controller design consists of a single PCB that fits inside the existing tuner housing and includes all of the interface, control and power electronics to control up to six axes autonomously.

The tuner is connected via a standard TCP/IP interface to the controlling computer. The TCP/IP interface was chosen because most of today's computers come equipped with a network card. Remote control of the tuner is supported by using a LAN, and since each tuner has its own programmable IP address, multiple tuners can be controlled by using a standard low cost hub. These features give the new product line a technical and cost advantage over other tuners on the market and enables new features, here-to-for unavailable due to hardware limitations.

Thermal problems, due to the high supply currents required by the stepper motors, have been solved by adding metallized thermal pads on the PCB. In addition, the design has been optimized for low EMI, in order to minimize the impact on the microwave performance of the tuner.

PRODUCT COMPATIBILITY

The iTuner concept is to be applied to all of the company's microwave tuners, including the pre-matched and harmonic product lines, covering the frequency range from 200 MHz to 110 GHz. The iTuner products are fully supported by software programs for calibration, source/load pull and noise parameter measurements.

COMMAND LANGUAGE

The iTuner is controlled by sending ASCII commands over the TCP/IP interface. Typical commands include:
• Initialize the tuner
• Move the tuning slug(s) to user-defined positions
• Recall calibration data (two-port S-parameter)
• Define test fixture S-parameters, thus allowing reference plane shifting to the DUT
• Tune to user-defined Gamma, in either the tuner or DUT reference plane
• Query of current position
• Query of current Gamma, both in the tuner and DUT reference planes
• Setting of IP address
• Query of tuner operation parameters (limits, speed, serial no., etc.)

In addition to the iTuner, only a computer with a network card is required to build a fully calibrated tuner system. Any modern computer operating system, including Windows 98/NT/ME/2000/XP, UNIX and LINUX, supports TCP/IP sockets. Windows users can use the "HYPER-TERMINAL" application to communicate with the tuner. Popular test software packages, such as Labview or Agilent VEE, all support TCP/IP sockets.

CONCLUSION

A versatile new control feature has now been added to the Focus line of microwave tuners enabling them to be controlled and operated from any computer with a TCP/IP interface and LAN capability. The iTuner incorporates a microprocessor and resident flash memory to store firmware, operation and measurement data, and implement a remote control capability. Up to six axes are simultaneously controlled via remote instructions from a modern computer system, and multiple iTuners can be controlled by a single computer terminal via a standard LAN.

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