

# STHT Automatic Impedance Analyzer and Matching System

## Basic Description

The *STHT* 2.45-GHz Automatic Impedance Analyzer and Matching System integrates *HOMER*<sup>™</sup> impedance analyzer and a three-stub tuner in one compact unit, working under the full-power operating conditions of magnetron-based microwave generators. *The HOMER* part measures both magnitude and phase of reflection coefficient as well as incident, reflected and absorbed power and frequency. The tuner part consists of three stepping-motor-driven capacitive stubs spaced in mutual distances of nominally one quarter of guide wavelength. The tuner uses data measured by *HOMER* for fast automatic impedance matching of time-varying loads, e.g. in semiconductor/FDP fabrication and other industrial applications, including plasma. The system is designed for CW, high-ripple ("Rectified") and pulsed operation modes. *STHT* comes with its own software and documentation. It can work autonomously without any external controller or be controlled from a personal computer via RS232 or CAN interface.



## Principle of Operation

The *HOMER* part of *STHT* is based on the six-port reflectometer (SPR) principle. SPR is capable of measuring complex reflection coefficient of a load as well as the incident, reflected and absorbed powers. A frequency counter is also integrated with the system. The conceptual simplicity of SPR facilitates its stable and temperature-independent operation of over long periods of time. (It is recommended that a factory-made recalibration be performed once a year.) Reflectometers of this type are especially suitable for industrial applications

where on-line monitoring and control under full working power is required.

The tuner uses an accurate experiment-based frequency-dependent equivalent circuit for finding stub positions needed for matching in terms of the complex reflection coefficient delivered from *HOMER*. Time-consuming trial-and-error optimization schemes are thus avoided, enabling fast and accurate matching of even grossly mismatched loads.

## Modes of Operation

*STHT* supports three modes of operation, named CW, Rectified, and Pulsed.

CW mode is applicable to unmodulated microwave signals with output power ripple not exceeding 15% of peak value.

**Rectified** mode is designed for slowly pulsing microwave signals (up to 400 Hz repetition rate). Such signals are typical for magnetrons powered by low-cost power supplies which incorporate simple half-wave or full-wave rectifiers.

**Pulsed** mode option is intended for sampling fast pulse-modulated microwave signals with pulse widths down to 100 ns and repetition period up to 100 ms.

Rectified and Pulsed modes provide both instantaneous and average values of reflection coefficient and power. Impedance matching is based on the average value of complex reflection coefficient.

## Windows Control, Visualization and Data Logging Software

Although designed as a stand-alone system, the control, visualization and data logging software significantly expands the the system capabilities. The basic features include:

Microsoft Windows® environment

Accurate measurement of complex reflection coefficient and its displaying in various formats, including

- Magnitude
- Phase angle
- Return Loss
- VSWR
- Polar Display
- Smith Charts (Z and Y)
- Rieke-Type Chart

Measurement of incident, reflected, and absorbed power and its displaying in various formats, including watts, decibels, percentage of incident power

Numerical readout of signal frequency, load reflection coefficient and power in various formats

Arbitrary shifting of the measurement plane  
Saving measured data as tables (text files) or pictures (BMP, GIF, JPG)  
Periodic data logging of all or some of the measured quantities

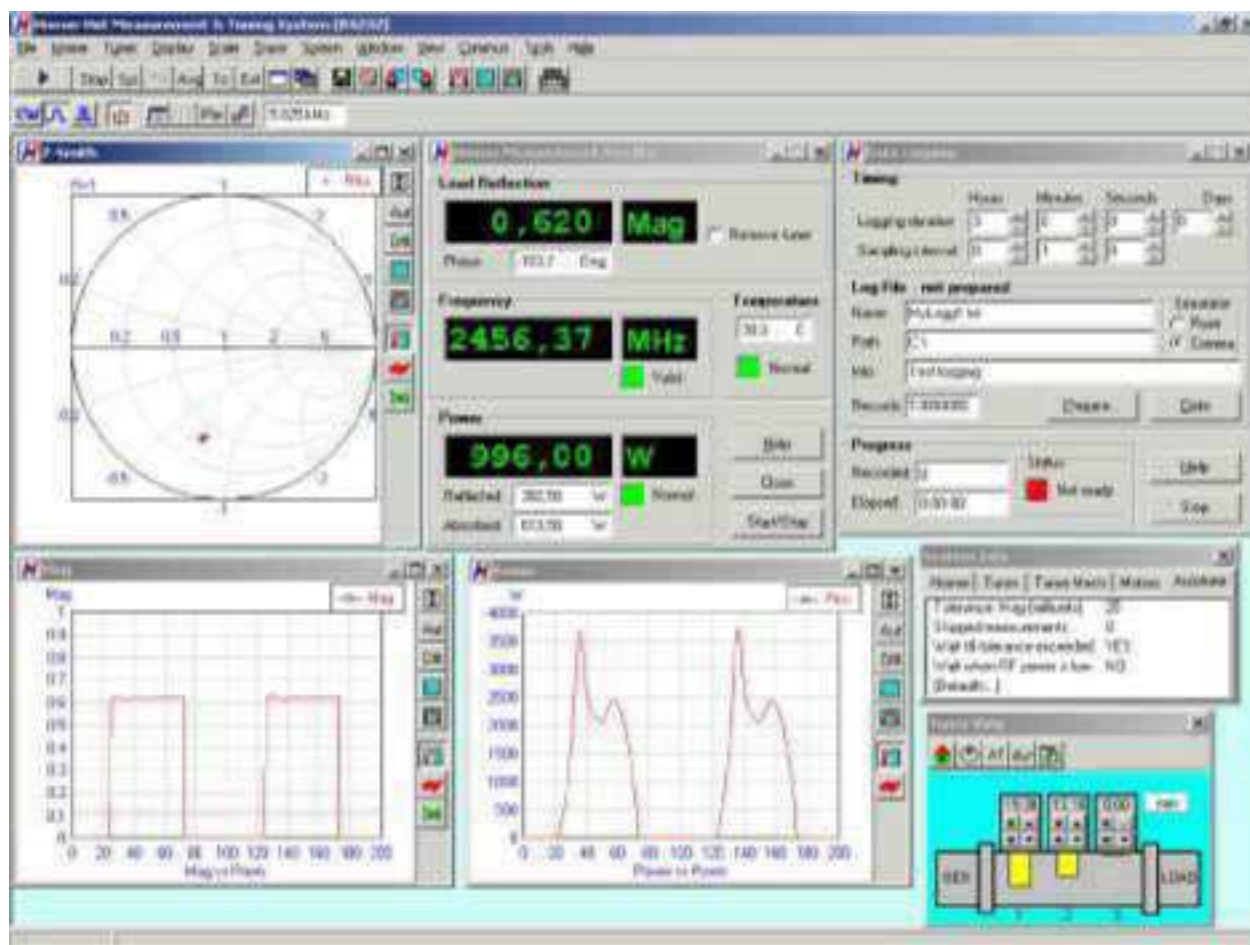
Multiple windows enabling simultaneous observation of various quantities in different formats

Wide selection of appearances of displayed curves

Storing and retrieving of complete system settings matched to particular tasks

Graphical interface for tuner control (manual stub movement, step-by-step/continuous auto-tuning)

Prescribed scenario of tuning stub movements  
Extensive on-line help



## Specifications

<b>Electrical</b>	
Waveguide type	<b>R-26 (WR-340 IEC, WG-9A)</b>
Flange type	<b>IEC</b>
Frequency range	2425 to 2475 MHz
Maximum working power <sup>1)</sup>	30 kW
Minimum working power	1 W
Dynamic range of working power	<b>20 dB</b>
Reflection coefficient measurement error (uncertainty circle radius)	<b>0.05</b>
Incident power measurement error (matched load)	±5 %
Power supply voltage	24 10% DC
Power consumption (all stubs moving)	<b>45 W</b>
Power consumption (stubs resting)	<b>30 W</b>
Interface	<b>RS232, CAN</b>
Modes of operation	CW, Rectified, Pulsed
Max ripple in CW mode	15 % of peak value
Max repetition rate of signal envelope in Rectified mode <sup>3)</sup>	<b>400 Hz</b>
Min pulse width in Pulsed mode	<b>100 µs</b>
Max pulse repetition period Pulsed in mode	100 ms
<b>Tuner</b>	
Tuning range <sup>4)</sup>	VSWR<10:1
Tuning accuracy (reflected-to-incident power ratio)	1 %
Time to achieve match	0.5 to 6 seconds (depending on the load mismatch)
<b>Mechanical</b>	
Mass	6 kg
Length	260 mm (10.24 in)
Width	138 mm (5.43 in)
Height	226 mm (8.90 in)
<b>Environmental</b>	
Operating temperature range	+5 to +55 Celsius
Storage temperature range	-10 to +125 Celsius

- 1) Actual maximum operating power is fixed according to customer's demand (must not exceed 30 kW). The actual minimum operating power is 20 dB (=dynamic range) below the actual maximum operating power or 1 W, whichever is greater.
- 2) In Rectified and Pulsed modes, maximum power means peak power (not its mean value).
- 3) Signal envelope repetition rate  $f_e$  is determined by power line frequency  $f_p$  and the rectification method. Examples:  
Half-wave-rectified signal  $f_e=f_p$ , full-wave-rectified signal  $f_e=2f_p$ , 3-phase ripple period  $f_e=3f_p$ .
- 4) Generally, the match will be improved for loads outside of the tuning range (e.g. VSWR=30 drops below 5).

## Configurations

**Basic Configuration**

STHT

RS232 or CAN Bus interface (one, according to customer's demand)

CW and Rectified mode of operation

Help for Homer (electronic handbook)

**Options**

Windows Software

Additional interface (CAN Bus or RS232)

Pulsed mode of operation