HOMER Autotuner ISM 2.45 GHz, R-26 Waveguide

Basic Description

The HOMER-Series STHT 2.45-GHz Autotuner integrates HOMER Analyzer (automatic impedance and power measurement system) and HOMER Mototuner (a three-stub motorized tuner) in one compact unit. Based on R-26 (WR-340) waveguide, the system works under the full-power operating conditions of magnetron-based microwave generators. The Analyzer part measures both magnitude and phase of reflection coefficient as well as incident, reflected and absorbed power and frequency. The Mototuner consists of three stepping-motor-driven tuning stubs spaced in mutual distances of nominally one quarter of guide wavelength. The Tuner uses data measured by Analyzer 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 can be:

- Used autonomously without external controller;
- Controlled from a personal computer via RS232 or CAN Bus interface;
- Integrated in a LabVIEW environment;
- Integrated in a DeviceNet system.

Air- and water-cooled options are available. The purpose of water cooling is enabling work in dusty or hot-air environment (not because of excessive internal heat generation).

Also available is matching for non-zero reflection coefficient magnitude (mismatch tuning).

Fast tuner option can decrease tuning time up to ten times compared with the standard version.

Air-cooled HOMER Autotuner STHT V1.5.

Water-cooled HOMER Autotuner STHT V1.4.

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Principle of Operation

The Analyzer 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 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 measurement-based frequency-dependent equivalent circuit for finding stub positions needed for matching in terms of the complex reflection coefficient delivered from HOMER Analyzer. Thanks to the predictive algorithm, time-consuming trial-and-error optimization schemes are avoided, enabling fast and accurate matching of even grossly mismatched loads.

Modes of Sampling

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

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

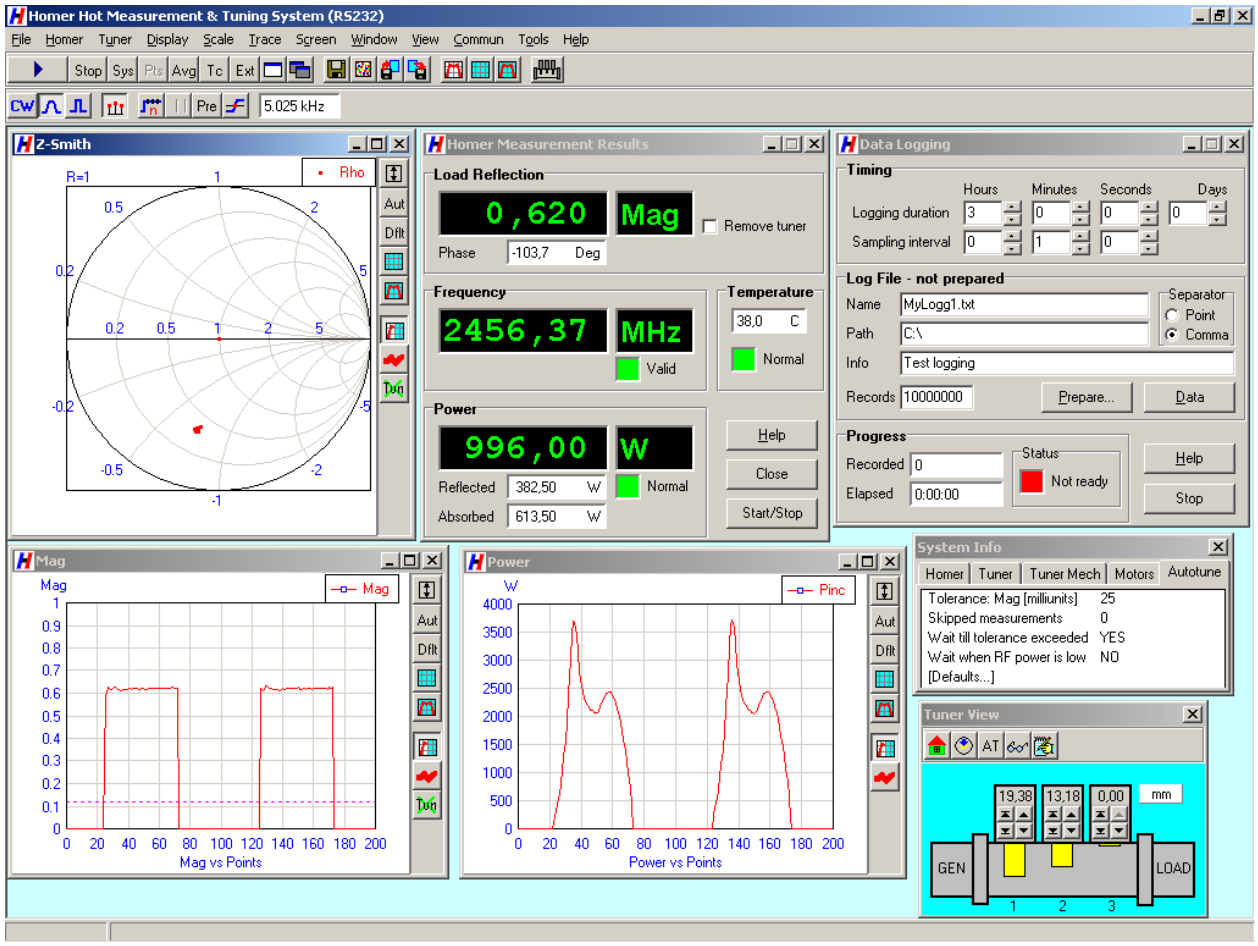
Pulsed mode (optional) is intended primarily for sampling fast square-pulse-modulated microwave signals with pulse widths down to 100 µs.

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

HomSoft Windows Control, Visualization and Data Logging Software

Although designed as a stand-alone system, the *HomSoft* control, visualization and data logging software significantly expands 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
  - 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 tailored to particular tasks
- Graphical interface for tuner control (manual stub movement, step-by-step/continuous autotuning)
- Prescribed scenario of tuning stub movements
- DDE server option enables another Windows application to share measurement results
- Extensive on-line help



Example of *HomSoft* graphical user interface.

Specifications

Electrical	
Waveguide type	R-26 (WR-340)[1]
Flange type	IEC
Frequency range	2425 ÷ 2475 MHz
Maximum working power[2] [3]	30 kW
Minimum working power	1 W
Dynamic range of working power	20 dB
Reflection coefficient measurement error (uncertainty circle radius)	0.05
Incident power measurement error (matched load)	±5 %
Power supply voltage	24 V ±10% DC
Peak current consumption (all stubs moving)	2 A (standard motors) 3 A (fast motors)
Current consumption (stubs resting)	1.3 A
Interface	RS232, CAN, DeviceNet
Modes of operation	CW, Rectified, Pulsed
Max ripple in CW mode	15 % of peak value
Max repetition rate of signal envelope in Rectified mode[4]	400 Hz
Min pulse width in Pulsed mode	100 µs
Tuner	
Max tuning stub travel[5]	25 mm
Tuning range[6]	VSWR < 10:1
Tuning accuracy (reflected-to-incident power ratio)	1 %
Full stub insertion travel time	3.2 s (standard) 0.23 s (high speed motors option)
Time to achieve match	Depends on load mismatch, initial stub positions and signal quality[7]
Mechanical	
Mass	6 kg
Length	260 mm (10.24 in)
Width	138 mm (5.43 in)
Height	226 mm (8.90 in)
Surface finish	E-CLPS 4600

(continued…)

1 Stepped precision transitions to either R-22 (WR-430) or R-26 (WR-284) waveguides can be integrated on request.

2 Actual maximum working power is fixed according to customer's demand (must not exceed 30 kW). The actual minimum working power is 20 dB (=dynamic range) below the actual maximum operating power or 1 W, whichever is greater.
Maximum working power is specified for ***matched load*** conditions. For loads with high reflection coefficient magnitude (>0.9), the maximum power is derated to avoid arcing with deeply inserted tuning stubs. Please contact the manufacturer for details.

3 In Rectified and Pulsed modes, maximum power means ***peak*** power (not its mean value).

4 Signal envelope repetition rate (ripple period) 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 $f_e=3f_p$ (half-wave rectification), $f_e=6f_p$ (full-wave rectification).

5 May be reduced for high working powers.

6 Depends on max. stub insertion. Generally, the match will be improved for loads outside of the tuning range.

7 For tuning speed details, see S-TEAM Application Note AN-0901.

Specifications – Continued

Other	
Cooling water flow rate (minimum)[8]	1 liter/minute
Cooling water temperature[9]	+15 to +25 ^{0}C
Pressure drop at min water flow rate	< 5 kPa
Maximum working pressure	500 kPa
Water inlet/outlet connector[10]	Rectus 26SF AW10 MXX
Operating temperature range	+5 to +55 ^{0}C
Storage temperature range	-10 to +125 ^{0}C

[8] For water-cooled version.

[9] Increase minimum cooling water temperature in condensing situation (may occur e.g. when cooling while Homer is switched off).

[10] See e.g. http://www.rectus.de

Configurations

Basic Configuration

- STHT + internal firmware (Server)
- RS232 or RS422 serial interface
- CW and Rectified modes of operation
- Operating handbook (pdf)
- Communication protocol manual (pdf)
- Set of standard cables[11]

Options

1. ***HomSoft*** Windows visualization and control software
2. Pulsed mode of operation
3. High-speed motors
4. Additional Server – CAN Bus
5. Additional Server – DeviceNet
6. Dynamic Data Exchange (DDE) server in *HomSoft* Windows SW[12]
7. LabVIEW Homer virtual instrument library
8. CAN-USB Adapter (to connect PC to CAN Bus or DeviceNet network)
9. Water cooling
10. Defined mismatch tuning[13]
11. Technical support in hours (four hours are complimentary)

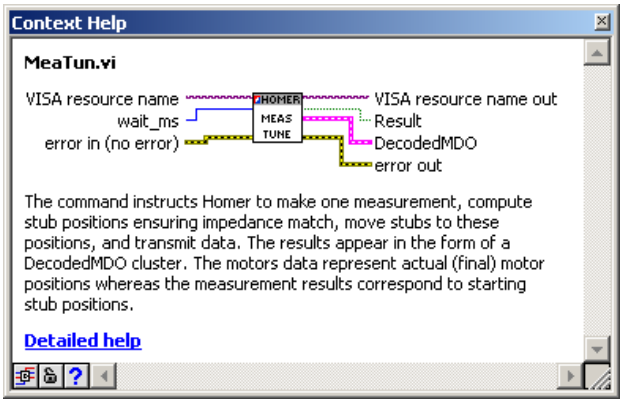
[11] Set of standard cables includes DC power supply cable, RS232/RS422 cable, and, in case of CAN Bus, CAN Bus cable.
[12] *HomSoft* Windows visualization and control SW option required.
[13] Target of tuning is not perfect match but reflection coefficient with defined nonzero magnitude. Phase is arbitrary.

Miscellaneous

DeviceNet. Elements of complex industrial applications (sensors, actuators, controllers) are often interconnected via CAN Bus network where special protocols for smooth collaboration are used. One of the common communication protocols is DeviceNet. HOMER can be equipped with internal program (Server) which enables connection to DeviceNet.

DDE Server. DDE Server is a functionality within the *HomSoft* Windows SW hence it needs the *HomSoft Windows visualization and control software* option, too. The DDE Server enables another (customer's) Windows program to extract measurement results from *HomSoft* program, e.g. to a LabVIEW environment.

LabVIEW Homer Virtual Instruments Library enables HOMER control and monitoring (measurement results retrieval) from within the National Instruments' LabVIEW environment. The library consists of a number of virtual subinstruments and is accompanied by a few useful examples. The library enables users to integrate HOMER into their own applications with much less effort than trying to start from scratch by studying HOMER communication protocol and programming the communication themselves.



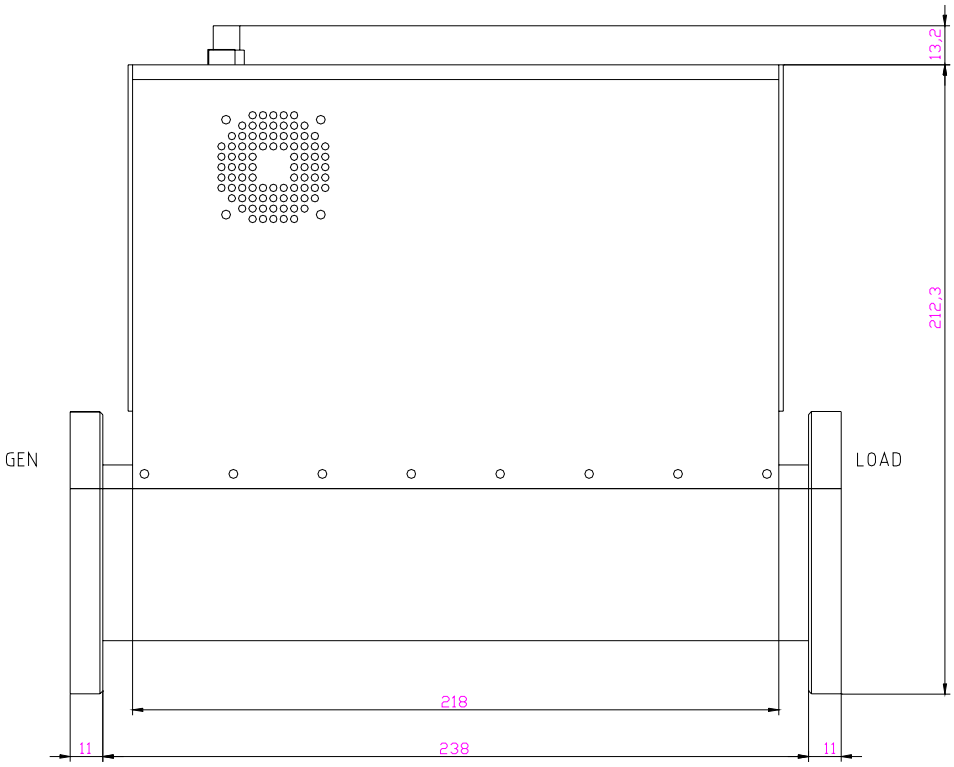
CAN-USB Adapter. To connect your PC with a CAN Bus network (or with the STHT alone), the *Sontheim CAN USB Light Dongle* adapter is needed. You can order it as an option. Another possibility is to buy the dongle yourself from the manufacturer (see http://www.s-i-e.de).

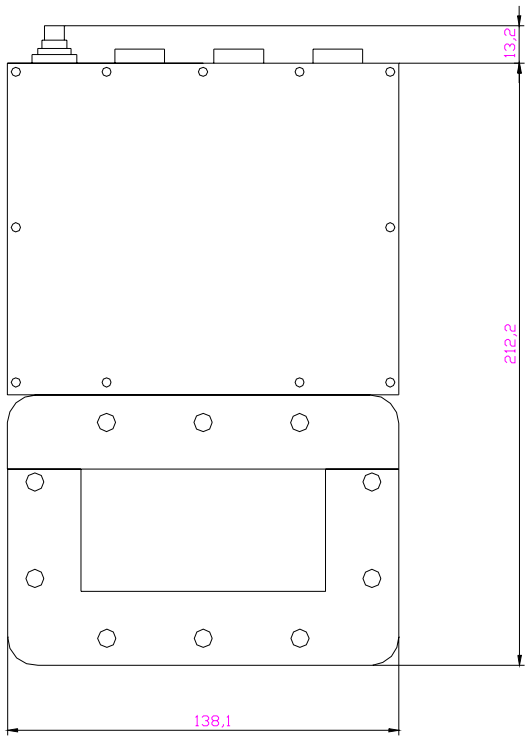
Water Cooling. The purpose of water cooling is not enhancing cooling efficiency but isolating HOMER interior from the ambient air, enabling thus its operation in a dusty or too hot environment. The air is forcibly circulated inside the HOMER electronics compartment, passing through the water-cooler, and cooling the interior. Note that the water cooling as well as air cooling is not intended for removing heat generated outside of the electronics compartment and conducted to it e.g. by waveguide flanges. In the latter case, use water-cooled external flanges.

Defined Mismatch Tuning. Some installations (notably some plasma applicators) may work better when the result of autotuning is not a zero reflection coefficient but a slight mismatch. *Defined Mismatch Tuning* option enables such tuning method, resulting in a reflection coefficient that has a user-specified, nonzero magnitude.

Technical support. Very often users, especially in the initial phase, need counsel about issues that are not the matter of HOMER itself but of their particular application, or about topics that are in detail described in the accompanying documentation. Four hours of such support are provided free of charge; additional support should be ordered.

Basic Dimensions STHT V1.5 (in millimeters)





Basic Dimensions STHT V1.4 (in millimeters)