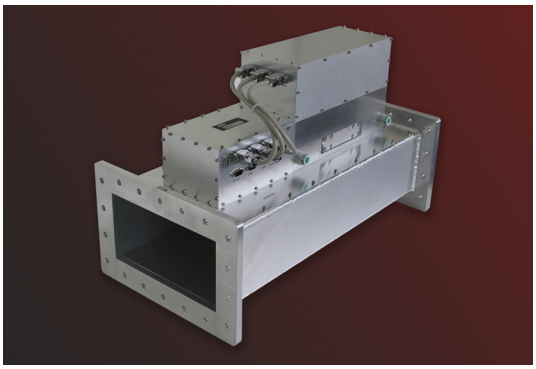
Autotuner ISM 900 MHz, R9 Waveguide

FM-AT-3S/915

Description



The Autotuner **FM-AT-3S/915** with 915 MHz integrates the Analyzer (automatic impedance and power measurement system) and Mototuner (a three-stub motorized tuner) in one compact unit. Based on the R9 (WR975) waveguide, the system works under the full-power operating conditions of magnetron-based microwave generators. The Analyzer part measures both the magnitude and phase of reflection coefficient as well as the incident, reflected and absorbed power, and frequency. The Mototuner consists of three stepping-motor-driven tuning stubs spaced at 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 in all industrial applications, including plasma. The system is designed for CW, high-ripple (Rectified) and Pulsed sampling modes. Also available is matching for non-zero reflection coefficient magnitude (defined mismatch tuning). The peak working power is set at the manufacture time as specified in the customer's order.

The Autotuner **FM-AT-3S/915** can be:

- Used autonomously without an external controller.
- Controlled from a personal computer or another controller via RS232, RS422 or CAN Bus interface.
- Integrated into a LabVIEW environment.

Air-cooled and water-cooled versions are available. The main purpose of water cooling is isolating the internal electronics from dusty or hot-air environment (see the notes below). The high-speed motors version can decrease tuning time compared with the standard version. Basic Units can be provided with waveguide transition at one or both ends, allowing their easy integration in installations with different waveguide sizes (see section Modifications).

Priciple of Operation

The Analyzer part of the Autotuner **FM-AT-3S/915** is based on the six-port reflectometer (SPR) principle. Reflectometers of this type are especially suitable for industrial applications where on-line monitoring and control under full working power is required. SPR is capable of measuring not only the complex reflection coefficient of the load but also 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. The system parameters required for the computations are obtained in the process of factory-made calibration where a collection of impedance standards is connected in place of load. For best performance it is recommended that the recalibration be repeated each two years.
The Mototuner part of the Autotuner **FM-AT-3S/915** uses an accurate measurement-based equivalent circuit for finding stub positions needed for matching loads, characterized by a complex reflection coefficient delivered from the Analyzer part. Thanks to the predictive algorithm employed, time-consuming trial-and-error optimization schemes are avoided, enabling fast and accurate matching of even grossly mismatched loads.

Modes of Sampling

The Autotuner **FM-AT-3S/915** supports three modes of microwave power sampling, named CW, Rectified, and Pulsed.

- CW mode is applicable to unmodulated signals with power ripple not exceeding 15% of the peak value.
- Rectified mode is designed for slowly pulsing signals (up to several kHz repetition rate). Such signals are typical for magnetrons powered by economy 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.

The Rectified and Pulsed modes provide both instantaneous and mean values of the reflection coefficient and the powers. Impedance matching is based on the mean value of the load reflection coefficient.

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General Information

Specifications

Electrical	
Waveguide type	R9 (WR975)
Flange type	IEC
Frequency range	890 – 930 MHz
Available maximum working power [1] [2] [3]	1 - 100 kW
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)	5 A
Current consumption (stubs resting)	2 A
Interface	RS232 or RS422, optionally CAN Bus
Modes of signal sampling	CW, Rectified, Pulsed
Max acceptable ripple in CW mode	15 % of peak value
Max repetition rate of signal envelope in Rectified mode[4]	10 kHz
Min pulse width in Pulsed mode	100 µs
Tuner	
Max tuning stub travel[5]	70 mm
Tuning range	VSWR < 10:1
Tuning accuracy (reflected-to-incident power ratio)	1 %
High speed full stub insertion travel time	0.55 s
Time to achieve match	Depends on load mismatch, initial stub positions and signal quality[6]
Mechanical	
Length	655.3 mm
Width	336.6 mm
Height	371.6 mm
Weight	26.5 kg
Surface finish	E-CLPS 4600
Others	
Cooling water flow rate (minimum)	5 liter/min.
Cooling water temperature[7]	+15 to +25 °C
Pressure drop at min water flow rate	< 50 kPa
Maximum working pressure	500 kPa
Water inlet/outlet connector[8]	SMC KPH12-03
Water hose	SMC TU 1208 Polyurethane
Operating temperature range	+5 to +55 °C
Storage temperature range	-10 to +70 °C
Optimal conditions for long term storage	+5 to +35 °C, humidity < 75%

Configurations

Basic Configuration

- Autotuner **FM-AT-3S/900** Basic Unit
- Internal firmware (Server)
- Calibration in 890 – 930 MHz band
- RS232 or RS422 serial interface
- CW and Rectified modes of sampling
- Operating handbook (pdf)
- Communication protocol manual (pdf)
- Set of standard cables[9]

Options

Visualization SoftWare for Windows

Pulsed mode of sampling

Defined mismatch tuning

CAN Bus communication interface (includes CAN Bus cable)

CAN-USB Adapter (to connect a PC to CAN Bus network)

LabVIEW Virtual Instruments Library

Dynamic Data Exchange (DDE) server in Visualization SoftWare[10]

Technical support in hours (four hours are complimentary)

Traco Power Supply TBL 150-124, 24V/6.25A, DIN rail mountable

Electro-Automatik EA-PS-524-11T, 24V/10.5A, input 90-264 V, benchtop

NOTES:

[1] Actual maximum working power is hardware-fixed according to customer's demand (must be within the Specifications limits). Posterior changing of the peak working power requires hardware modification and partial unit recalibration, and therefore must be done at the factory. Minimum working power is 20 dB (= dynamic range) below the actual maximum working power.

[2] The maximum working power is specified for matched load conditions. For loads with high reflection coefficient magnitude (> 0.9), the applied power must be lowered to avoid arcing for 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 frequency) fe is determined by power line frequency fp and rectification method. Examples: One-phase half-wave rectification fe=fp; one-phase full-wave rectification fe=2fp; three-phase half-wave rectification fe=3fp; three-phase full-wave rectification fe=6fp; three-phase Y+Δ half-wave rectification fe=6fp; threephase Y+Δ full-wave rectification fe=12fp.

[5] Generally, the match will be improved for loads outside of the tuning range.

[6] For tuning speed details, please contact us.

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

[8] See e.g. www.smc.eu

[9] Set of standard cables includes DC power supply cable, RS232/RS422 cable, and (in case of CAN Bus) CAN Bus cable.

[10] Visualization SoftWare for Windows required.

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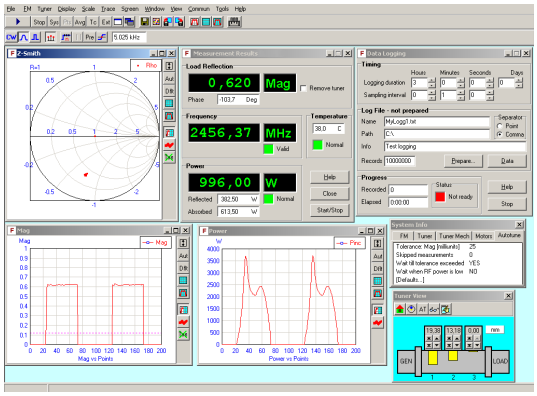
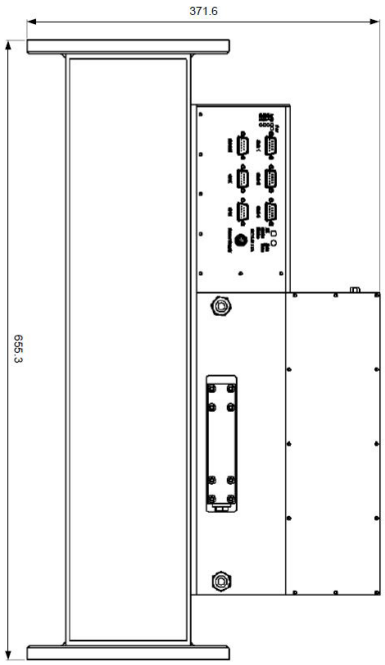
Visualization SoftWare for Windows

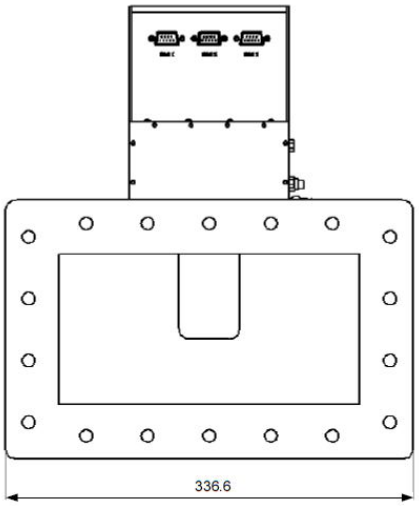


Although the Autotuner **FM-AT-3S/900** can operate as a stand-alone system, the Windows control, visualization and data logging software significantly expands its capabilities. The basic features include:

- 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)
- Oven diagram (Rieke-type chart) – Frequency
- Measurement of incident, reflected, and absorbed powers and their 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 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 enables, among others, automated Rieke diagram measurement.
- DDE Server option enables other Windows applications to share measurement results.
- Extensive on-line help.

Dimensional Drawings





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