Thermo Scientific S Series Atomic Absorption Spectrometers

Specifications.

S Series Spectrometer Specification

Models

S2 Spectrometer
- AA Spectrometer with standard or wide range photomultiplier.
- 6 Lamp Automatic Carousel.
- Semi-Automatic Gas System.

S4 Spectrometer
- AA Spectrometer with standard or wide range photomultiplier.
- 6 Lamp Automatic Carousel.
- Fully Automatic Gas System.

Light Source

Single or multi-element hollow cathode lamps.
Uncoded and Data Coded hollow cathode lamps.
6 independent lamp supplies, each providing 0 to 20mA.

Wavelength Range

180nm to 900nm with wide range photomultiplier.
185nm to 760nm with standard photomultiplier.

Data/Control Systems

Spectrometer
- Motorola 68340 microprocessor.
- 512kB Flash PROM.
- 256kB RAM.
- 4 general purpose RS232C ports.
- Dedicated vapour port.

Data Station
- Typically Pentium PC (see below).

Local Control
- Motorola 68340 microprocessor.
- 512kB Flash PROM.
- 512kB RAM.

Optics

Configuration
- Double Beam Stockdale optical system.

Monochromator
- Ebert configuration with nominal 0.2, 0.5 and 1.0nm spectral bandwidths.
- Half height slit settings available.
- Reciprocal linear dispersion 1.5 to 2.0 nm/mm.
- Focal length 270mm.

Grating
- 1800l/mm.

Absorbance Range
- -0.150A to 3.000A (including background signal).

Background Correction
- Quadline (continuum source) is standard on all spectrometers.
- Background signals <2A corrected to <2%.
- Total signal up to 3A.

Gas Control

Fuel Flow Range
- Air/Acetylene - 0.8 to 2.3 l/min.
- Nitrous Oxide/Acetylene - 3.6 to 5.1 l/min.

Power

100 to 240V (±10%) at 50 or 60Hz.

Power consumption

300VA.

Dimensions (mm)

576W x 510H x 589D.

Weight

Approximately 33kg.

Description

Automatic Atomic Absorption Spectrometer system, with full multi-element capability, controlled with either a stand-alone (Local Control) module or a Data Station running SOLAAR software under Windows. Flame absorption/emission systems are extendible to Graphite Furnace, Vapour or Mercury Cold Vapour absorption modes by ordering appropriate accessory atomiser.

Optical system

All systems are supplied with Stockdale double beam optics giving maximum signal-to-noise ratio during signal measurement. All mirrors are silica coated, and the optics are sealed against dust ingress. The self-calibrating Ebert monochromator provides automatic wavelength and bandpass set-up. The high energy QuadLine background correction system corrects for up to 2A of background with <2% error, and is fitted as standard to all instruments. S Series spectrometers are fitted with a 6 position data-coded, auto aligning lamp carousel, with 6 independent power supplies modulated at 200/240Hz. With the carousel, automatic analyses of up to 16 elements in a single method are possible. The standard range photomultiplier covers the wavelength range from 185nm to 760nm, with a wide range option covering 180nm to 900nm. GFTV is an option on all systems.

Flame System

All AA flames are supported by the Universal 50mm titanium burner with chamfered slot design giving high solids handling, excellent flame stability and low carbon build-up. The burner height is automatically adjustable, and controls are provided for the burner rotation and transverse position. An optional 100mm burner for air/acetylene flames is also available. Automatic flame ignition is provided by a high tension electric spark. Flame systems are controlled by either a fully automatic gas control system (S4) or a semi-automatic gas control system (S2). The S4 automatic gas control system uses programmable array state logic and binary flow switching

Specifications (continued).

technology for reliability. Oxidant gas changeover, and fuel and oxidant flow rates are software controlled and interlocked to prevent operation with incorrect burners and gas flows. With the S2 semi-automatic gas system, the fuel flow rate is controlled by a precision needle valve and rotameter display. Oxidant changeover is software controlled, and the burner interlock ensures burner/flame compatibility. On both systems, a flame sensor, responding to all flame types including hydrogen fuelled flames, ensures safe gas handling if the flame goes out. All active gas lines are fitted with flame arrestors and blow back valves, with pressure sensors to provide automatic safe shutdown if the line pressure falls below the safe limits. Both gas control systems shut down safely if the power fails. The totally enclosed, draught proof "kitchen" area has a safety door containing a heat and UV absorbing window.

The inert fluoroplastic spray chamber contains an adjustable impact bead, flow spoiler and low memory hydrophilic disc chamber front end, and has built in over pressure relief and automatic empty drain protection. The standard spray chamber configuration is suitable for all flame and sample types. The inert nebuliser with a Pt/Ir capillary and PTFE nose cone, is standard, and is factory optimised.

Graphite Furnace Systems
The GFS97 Integrated Graphite Furnace and Furnace Autosampler can be fitted without removing the spray chamber or disconnecting the gas lines.

Graphite Furnace TeleVision (GFTV)
Optional on all S Series Spectrometers, the GFTV accessory provides high definition images of events inside the Graphite Furnace cuvette, allowing monitoring of the sample injection, dry and ash phases of the furnace program. A CCD camera mounted in the instrument produces live video for display on the Data Stations screen through the GFTV Software and Interface Kit, or on an external monitor. The external monitor should be monochrome, PAL compatible with a minimum screen resolution of 400 lines, and a coaxial video cable with BNC plug for connection to the spectrometer.

Electronics
Spectrometer electronics are based on the Motorola 68340 microprocessor, with the system firmware residing in Flash PROM. Firmware can be downloaded to the Flash PROM from an external PC without removing any covers. Interfacing to the Data Station, autosamplers, furnace and associated accessories is via RS232C at 9600 baud. The vapour systems are interfaced via a dedicated 8 pin socket.

Local Control
For stand-alone operation, the Local Control Interface offers simplified flame, furnace and vapour facilities. The microprocessor controlled interface is robust and reliable, occupies no bench space and requires no external computer. The Local Control keypad features a minimum key configuration for ease-of-use, and the ¼ VGA display panel provides real time display of calibration and signal graphics, as well as parameters and results. Results and parameters are stored in Flash PROM.

Data Station Control
The spectrometer system and accessories are controlled via a Data Station running the SOLAAR AA Software Package under the Microsoft Windows 98, Me, NT v4, 2000 or XP operating systems. The Data Station is a Personal Computer, with a typical configuration of:

800MHz Pentium processor or equivalent.
128MB RAM.
CD ROM Drive.
Fixed Disk Drive with at least 500Mbyte free space
SVGA Colour Monitor.
9 way Serial Port, with type 16550 buffered RS232 interface chip, .
Parallel Port.
Windows 98, Me, NTv4, 2000 or XP.

Additional requirements for GFTV:

Free USB port or free PCI expansion slot.
Video adapter that supports Direct Draw.

Specifications (continued).

SOLAAR Software

Local Control Software

The SOLAAR Local Control Software runs on the Local Control Module, and will control both S Series and M Series spectrometers. The software is aware of the type of spectrometer that it is controlling, and will only provide relevant parameters and options for each instrument type and configuration. The Local Control Software supports all AA Series Accessories, although in some cases provides a more limited range of facilities than does the Data Station software.

Local Control Software offers linear, curved and standard additions calibration algorithms with blank solution and up to 5 standards. Live display of calibration and furnace peak graphics are available and can be copied to an Epson compatible dot matrix printer. Up to 20 parameter sets can be saved in non-volatile memory (NVM), and Multi-element analysis capability is available. Automatic sampling with all flame and furnace autosamplers, and full editable alphanumeric sample details are provided. Parameters, results and graphics can be printed directly to a suitable printer. Results are stored in NVM, and can be reviewed and printed at any time. They will be over-written only when a new analysis is started.

Data Station Software

The SOLAAR Data Station Software runs on the AA Series Data Station, and will control both S Series and M Series spectrometers. The software is aware of the type of spectrometer that it is controlling, and will only provide relevant parameters and options for each instrument type and configuration. The Data Station Software supports all the facilities provided by all the AA Series Accessories.

The software features a range of Wizard based procedures and a tabbed Methods dialogue to make setting up even complex analyses fast and easy. All raw data, results and parameters are stored in a single database for easy retrieval. True Windows multi-tasking is available, so that SOLAAR can be iconised while running an analysis, allowing concurrent use of other applications. Methods can be created, edited and saved, and earlier results can be reviewed, edited and printed, while an analysis is underway.

SOLAAR software enables full 16 element Methods to be performed automatically. The flexible and comprehensive tabbed Methods dialogue box guides the user through setting up complex, multi-element analyses. Data coded HCLs are fully supported, and facilities are provided to record lamp usage. Up to 10 calibration standards and a blank can be used, with segmented curve, linear or quadratic least squares fit calibration algorithms. Normal, standard addition and standard curve calibration methods are supported, with full graphical display and print out of the calibration curve. Full alpha-numeric sample details including sample mass and dilution correction can be entered for each sample, or imported via text files.

Comprehensive furnace signal graphics are provided, and automated ash-atomise plots produce graphical data for furnace program optimisation, and will even suggest optimum values. For flame systems, fully automatic fuel gas flow and burner height optimisation with graphical presentation are provided.

Extensive on line, fully context sensitive, Help facilities are available. Carefully structured "books" allow easy browsing and searching as well as direct access to any Help topic. Trouble-shooting and diagnostics sections describe simple experiments to first locate the problem then to rectify it. A full "Cookbook" with default parameters for all elements, common interferences, and the means of overcoming them is included.

SOLAAR software provides comprehensive printer support through the Windows operating system. Report formatting enables customisation of the sample details, results, summaries, methods, system parameters and graphical displays that are to be included in the Report, and all Reports, as well as individual results, are time and date stamped. Flexible and comprehensive Results database filters select and display the required data, which can be exported to other applications for further processing. Fully undoable results editing is available and is automatically audit trailed. Password protection and the Audit Trail maintain the validity of the data for accreditation purposes.

Integrated Auto QC software provides comprehensive Quality Control protocols automation with checking, testing and re-analysis options, SPC graphical results display, report generation and data filing. QC Blanks, QC Checks, QC Duplicates and two forms of QC Spikes are all included, each with user definable test criteria and failure actions. Full QC reporting, including pass/fail results and time and date stamps is provided on the Results display, and hard copy reporting of all QC protocols, parameters, results and actions is available. QC data is linked to the results to which it applies, and can be exported with the results.

SOLAAR software is available in English, USA English, French, German, Russian, Spanish, Japanese, Chinese and Polish languages.

An additional software package, SOLAAR***security,*** is available, which adds to the SOLAAR Data Station software the tools, functions and facilities required to comply with the Food and Drugs Administration 21 CFR Part 11 Rule “Electronic Records, Electronic Signatures” .

Specifications (continued).

Accessory Specifications

221XL Flame Autosampler

Standard Items

Random access x-y autosampler mechanism.
Rack 21 (60 position).
PTFE probe.
RS232C adaptor.

Necessary Additional Items

AA Wash Accessory.
Polypropylene or glass sample/standard tubes for Rack 21.

Power

110V, 120V, 220V, 240V at 50 or 60Hz.

Power consumption

50VA.

Description

Random access flame and vapour autosampler with 60 (Rack 21), 44 (Rack 22) or 14 (Rack 24) sample capacities. Smaller sample capacities imply larger available volume per sample.

222XL Flame Autosampler

Standard Items

Random access x-y autosampler mechanism.
Rack 24 (14 position).
PTFE probe.
RS232C adaptor.

Necessary Additional Items

AA Wash Accessory.
Polypropylene or glass sample/standard tubes for Rack 24.
4 of Rack 24 (14 positions), Rack 22 (44 positions) or Rack 21 (60 positions) with appropriate polypropylene or glass sample/standard tubes.

Power

110V, 120V, 220V, 240V at 50 or 60Hz.

Power consumption

50VA.

Description

Random access, large capacity flame and vapour autosampler with 70 to 254 sample capacity, dependent on rack configuration. Smaller sample capacities imply larger available volume per sample. First rack (14 position) is used for blank and standards.

ASX-510/520 Flame Autosampler

Standard Items

Random access x-y autosampler mechanism.
Standards rack (10 position).
4 sample racks (60 position each).
10 standard and 240 sample polypropylene sample tubes.
0.5mm ID and 0.8mm ID PTFE sample probes.
Pumped wash facility.
RS232C adaptor.

Necessary Additional Items

None.

Power

100V - 240V at 50 or 60Hz.

Power consumption

50VA.

Description

Random access, large capacity flame and vapour autosampler with 84 to 360 maximum sample capacity, dependent on rack configuration. Optional racks for 21, 24, 40, 60 or 90 samples. Smaller sample capacities imply larger available volume per sample

ASX-260 Flame Autosampler

Standard Items

Random access x-y autosampler mechanism.
Standards rack (10 position).
2 sample racks (60 position each).
10 standard and 240 sample polypropylene sample tubes.
0.5mm ID and 0.8mm ID PTFE sample probes.
Pumped wash facility.
RS232C adaptor.

Necessary Additional Items

None.

Power

100V - 240V at 50 or 60Hz.

Power consumption

50VA.

Description

Random access, medium capacity flame and vapour autosampler with 42 to 180 maximum sample capacity, dependent on rack configuration. Optional racks for 21, 24, 40, 60 or 90 samples. Smaller sample capacities imply larger available volume per sample

AA Wash Accessory

Standard Items

Wash well for 221XL/ 222XL autosamplers.
Wash vessel for AS2000/AS25000 autosamplers.

Necessary additional Items

None.

Description

The AA Wash Accessory provides wash facilities for the 221XL, 222XL, AS2000 and AS2500 autosamplers.

ID100 Autodilutor

Standard Items

Specifications (continued).

ID100 Autodilutor.

Necessary Additional Items
None.

Power
110V - 240V at 50 or 60Hz.

Power consumption
85VA.

Description
The ID100 Autodilutor provides rapid, in-line preparation of calibration standards and intelligent or fixed ratio dilution of samples for flame measurements. It is based on a high precision multi-piston pump that is calibrated for life, and does not require any consumable items. It can be used with manual sampling or with any of the flame autosamplers.

GFS97 Integrated Graphite Furnace and Autosampler
Standard Items
Furnace Head.
Power supply.
Furnace Autosampler.
GFS97 Integrated Furnace and Autosampler Mount.
Normal Electrographite cuvettes (10).

Necessary Additional Items
Additional cuvettes as required.

Furnace Head
Contacts
End-loaded graphite.

Containment
All graphite.

Cuvettes
Normal Electrographite.
Extended Lifetime (ELC).
Pyrolytically Coated Electrographite.
Omega Platform Extended Lifetime.

Cuvette Volume
0 - 70µl.

Temperature Control System
Choice of Voltage Control or Optical Temperature Control with a stabilised sensor and fibre optic transmission system.

Gas System
Fixed external flow.
Adjustable internal flow with choice of inert or alternate gas.

Gas Flow Rate
3.5l/min external flow.
0, 100, 200, 300ml/min internal flow.

Gas Pressure
1.03 ± 0.07 bar (15 ± 1psi)

Cooling Water
Mains or Recirculator.
Minimum flow rate 0.7l/min.
Pressure 1.4 - 6.9 bar (20 -100psi).

Cooling Time
20 seconds (fixed).

Interlocks
Water pressure and flow rate.
Inert gas pressure.
Power.
Power supply temperature.
Magnet temperature (GF95Z only).
Furnace open.
Magnet open (GF95Z only).
Cuvette present.

Power
200/220/240V at 50/60 Hz, 30A Single phase.
GF95Z requires additional 200-240V 50/60 Hz single phase supply.

Power consumption
7.2kVA.
GF95Z - additional 1.5kVA

Dimensions (mm)
265W x 390H x 495D.

Weight
GF95 - 50kg, GF95Z - 66kg.

Furnace Head Description
All cuvettes mount directly in an all-graphite containment with end loaded contacts. Cuvettes are self aligning, and can be rapidly exchanged with a single lever movement.

The binary flow controlled internal gas system, with gas stop, offers a choice of the inert gas or an alternate gas, and the fixed external inert gas flow protects the cuvette and purges the optical temperature sensor.

Furnace Control
Control System
From Data Station or Local Control software.

Program Phases
20 time + temperature phases and 20 ramp (5 of each with Local Control).

Phase Temperature Range
Ambient to 3000°C in 1°C increments.

Phase Time
0 to 200.0 seconds in 0.1 second increments.

Ramping Modes
Linear and non-linear.

Specifications (continued).

Ramp Rates
1 to 2000°C/sec in 1°C/sec increments.

Injection Temperature
Programmable up to 200°C when used with the furnace autosampler.

Signal Display
Data Station VDU or Local Control ¼ VGA display.

Program Storage
Unlimited disk storage with Data Station.
20 parameter sets with Local Control.

Description
Control of the furnace is from the SOLAAR Data Station or Local Control software via the spectrometer. A full handshaking RS232C link is provided to the furnace power supply. Furnace cycles are set up within a rapid fill table allowing up to 20 phases to be programmed for temperature, time, ramp rate, gas type and flow and special functions such as optical temperature control, read phase and non linear ramp. (Limited facilities with Local Control). Individual temperature look-up tables for all cuvette types ensure accurate temperature calibration. A lifetime display enables the cuvette to be changed before failure becomes likely. A pre-programmed cuvette clean cycle is available, culminating in maximum temperature for 5 seconds to ensure complete contamination removal. Comprehensive storage of the furnace program, together with spectrometer and autosampler parameters, is provided. Full furnace and autosampler status can be displayed, together with the results during the analysis (Data Station control only). Complete monitoring of all furnace interlocks is provided.

Furnace Autosampler
Standard Items
Polypropylene Sample cups (1000).
Polypropylene Reagent cups (50).
Spare capillary tips (10).

Necessary Additional Items
None.

Carousel Capacity
60 sample cups, 6 reagent cups.

Cup Types
Polypropylene sample cups.
Fluoroplastic sample cups.
Reduced Volume sample cups.
Polypropylene reagent cups.

Cup Volume (nominal)
Sample cups 2ml.
Reduced Volume cups 1.5ml.
Reagent cups 25ml.

Matrix Modifiers
Up to 6 per Method.

Resamples
1 to 99 per measurement.

Sampling System
100µl syringe (side port).

Sampling Volume
1 to 70µl.

Reproducibility of Injected Volume
Better than 1% (by mass) at volumes equal to and exceeding 10µl.

Accuracy of Injected Volume
±0.5µl.

Inert Gas Pressure
Nominal - 0.34 bar (5psi).
Minimum - 0.20 bar (3psi).
Maximum - 0.68 bar (10psi).

Wash and Waste Container Volume
1 litre each.

Dimensions (mm)
296W x 380H x 320D.

Weight
Approximately 7.3kg.

Furnace Autosampler Description
The attractively styled Autosampler will accommodate up to 60 samples in the large carousel. Carousel changeover allows up to 120 samples per element run. 6 large reagent cups enable up to 6 matrix modifiers to be employed. Using the cup reducing ring, smaller cups can be used to reduce modifier consumption. The sample is collected and dispensed via an inert PTFE capillary with rapidly interchangeable tips. Viscous and Normal modes of injection ensure that samples are handled appropriately and an enhanced wash program eliminates contamination. Fast furnace operation provides concurrent operation of the furnace, spectrometer, and autosampler sample uptake procedures, minimising overall furnace cycle time. The syringe is visible and easily accessible for routine maintenance. A large, 1 litre capacity wash vessel for long, unattended analysis is complemented by an on-board waste vessel, removing the need for inconvenient waste collection on the laboratory floor. All facilities are programmed from the SOLAAR software and sampling facilities such as matrix modification (wet or dry mixing), standards addition, dilution, re-concentration and automatic standards preparations can be rapidly set up. Automatic re-scaling and re-calibration functions are provided. If a sample falls outside the calibration range the system automatically and intelligently calculates the most appropriate dilution factor required to bring the sample back within range. Autosampler loading guides

Specifications (continued).

indicate the optimum carousel layout.

VP100 Continuous Flow Vapour System

Standard Items
- 'T' cell (2).
- Spare pump tubing.

Necessary Additional Items
- None

Absorption Cell
- Open ended, T-shaped silica cell.
- 120mm long.
- 8mm internal diameter.

Cell Heating
- Air/acetylene flame on 50mm Universal burner.
- Electrical heating using EC90.

Carrier/Purge Gas
- Argon or nitrogen.

Gas Inlet Pressure
- 0.35 - 1 bar (5 - 14psi).

Gas Consumption
- Up to 500ml/min.

Reducing Agents
- Sodium borohydride
- Tin (II) chloride may be used for mercury analysis.

Solution Transport
- Variable speed, 4 channel peristaltic pump, using continuous flow principle.

Solution Flow Rates
- Reductant - 3.2ml/min.
- Sample - 7.8 ml/min.

Carrier Gas Flow Rates
- Variable 50 - 500mL/min.
- Electronic control via Mass Flow Controller.

Reagent Containers
- Two 1L plastic bottles.

Power
- 220/240V, 50Hz or 110/120V, 60Hz.

Power consumption
- 30VA.

Dimensions (mm)
- 475W x 300H x 200D.

Description

The VP100 Continuous Flow Vapour System performs hydride and mercury vapour measurements with significant sensitivity improvement over normal flame techniques. An air/acetylene flame or an electrically heated cell is used for atomisation, avoiding the need to use hydrogen as the fuel gas. The VP100 unit incorporates the reagent reservoirs, a variable speed 4 channel peristaltic pump, control electronics and gas-liquid separator. A integrated Mass Flow Controller allows the carrier gas flow to be controlled and monitored through the system software, and the continuous flow principle eliminates the need to clean the reaction vessel after each sample. The VP100 operates automatically under Data Station control and can provide full autosampling operation with a suitable autosampler. When used with the EC90 Electrically Heated Atomisation Cell, unattended operation is possible.

EC90 Electrically Heated Atomisation Cell

Standard Items
- EC90 Furnace Head.
- EC90 Furnace Power Supply.
- 2 Silica T Cells.

Necessary Additional Items
- VP90 or FI90 Continuous Flow Vapour System. Accessory Mount.

Control System
- From external power supply.

Temperature Range
- Ambient to 1000°C in 1°C steps.

Power
- 220/240V, 50Hz or 110/120V, 60Hz.

Power consumption
- 700VA.

Dimensions (mm)
- 280W x 140H x 290D (Power supply).

Weight
- Approximately 13kg.

Description

The EC90 is an electrically heated atomisation cell for flameless vapour generation AAS. It provides improved analytical performance, unattended operation and reduced operating costs. The EC90 must be used with the VP90 or FI90 and is suitable for all hydride forming elements.

AA Validator

Major Contents (depends on kit type):
- SOLAAR Validator Logbook
- Ca/Mg Hollow Cathode Lamp
- Ni/Cr/Mn Hollow Cathode Lamp
- Pyrolytically Coated Cuvettes
- Manganese Validation Standard
- Nickel Validation Standard
- Chromium Validation Standard
- Water Blank Validation Standard

Specifications (continued).

Description
Available in three separate kits designed for Flame, Furnace or Flame and Furnace installations, the unique AA Validator provides full system validation for M Series AA systems, including comprehensive qualification plans. Full SOP's and check sheets, together with complete supplier assessment questionnaires, are supplied in the Validator Logbook for recording and demonstrating compliance. All necessary consumables are provided and even method validation guidelines are included.

AA Validator$_{plus}$
Standard Items
Calibrated Validation Unit (CVU).

Power Supply.

RS232 Data Lead.

Necessary Additional Items
Either the Validator Logbook or the appropriate Validator Kit.

Power
110V - 240V at 50 or 60Hz.

Power consumption

10VA

Description
The CVU contains a set of traceable and certified filters. It is fitted in the spectrometer and controlled by the OQ Test software, and tests the spectrometer resolution, wavelength accuracy, photometric accuracy and stability, and D2 background correction efficiency.

The integrated PQ Test software contains a complete set of SOPs and a Wizard to lead the user through the tests needed to validate the instrument analytical performance against the manufacturer's specification.

LH Universal Accessory Mount
Description
Accessory Mount for use in the S Series and left hand M Series Sample Compartments. This is necessary for mounting the EC90 Furnace Head, the Validator$_{plus}$ Calibration Validation Unit, and the Mercury Absorption Cell in these Sample Compartments.

RH Universal Accessory Mount
Description
Accessory Mount for use in the right hand M Series Sample Compartment. This is necessary for mounting the EC90 Furnace Head, the Validator$_{plus}$ Calibration Validation Unit, and the Mercury Absorption Cell in this Sample Compartment.

Si Enhancement
Standard Items
Intelligent Spectrometer Qualification module.
Coded Ca/Mg Hollow cathode lamp
RH Accessory mount

Necessary Additional Items
None

Power
110V - 240V at 50 or 60Hz.

Power consumption
10VA

Description
The iSQ module is mounted in the sample compartment of the S Series instruments. It provides facilities for automatically testing the spectrometer hardware.