AXIOS^mAX
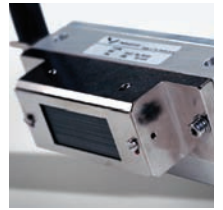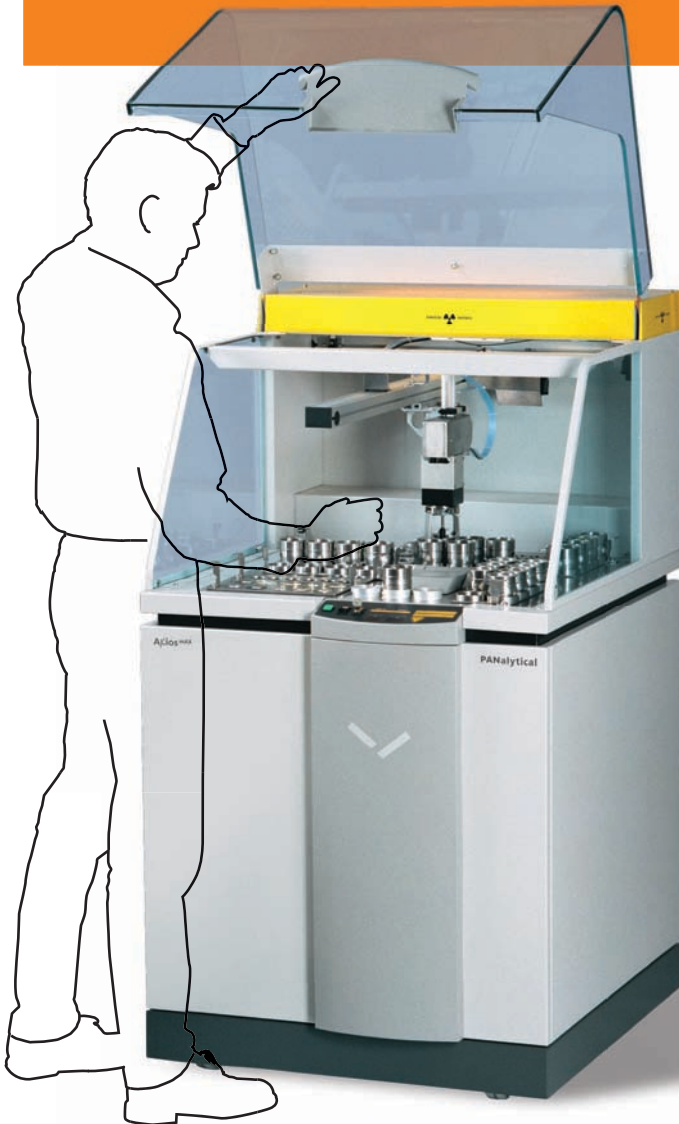
Designed to perform

Axios^mAX wavelength dispersive XRF spectrometers bring real customer benefits through technological innovation. Advanced, yet easy to use, Axios^mAX systems are tailored solutions that reflect and meet the needs of industry by delivering real analytical advantages.

The Analytical X-ray Company

OUTSTANDING PERFORMANCE

The Axios^{mAX} is engineered for excellence in terms of analytical and operational performance. Technological innovation combined with decades of experience has produced the Axios^{mAX} - a true asset to all who require accurate and dependable XRF analysis.

Analytical precision
Precision in XRF is determined by a number of factors, from the physics of counting X-rays, to the accuracy (reproducibility) of mechanical movements and the stability of the system's electronics and internal temperature.

The counting statistical error plays an important role in determining the precision of a measurement. As the count rate or sensitivity of the instrument increases, this error becomes smaller and precision improves - one of the reasons PANalytical innovates to maximize the sensitivity of Axios^{mAX} systems.

Axios^{mAX} systems are themselves precision-made to exacting tolerances, capable of highly accurate movements of components in the optical path and of the sample loading mechanics. The Axios^{mAX} goniometer with Direct Optical Position Sensing (DOPS) technology is arguably the most accurate and reproducible goniometer currently available.

Speed of analysis
In modern laboratories speed of analysis is often critical, particularly in process control. In applications where only short measurement times are required the total instrument overhead time is an important parameter. This is the time the system is busy but not measuring. Simultaneous, high-speed setting of measurement conditions, for example high-speed slewing of the goniometer and isowatt power setting, minimize instrument overhead time in all Axios^{mAX} systems. In addition, continuous and direct loading options greatly speed up sample handling.

Maximizing uptime through stability
In conventional high-power XRF spectrometers, X-ray tube aging is the largest contributor to instrument drift. When the intensity of the tube output decreases, calibration maintenance is necessary to retain analytical accuracy. In addition, a gradual increase in measurement time is required to maintain precision.

All Axios^{mAX} configurations include an SST-mAX X-ray tube. This tube features ZETA Technology, which fully eliminates tube aging and ensures stable tube output during the lifetime of the tube. Therefore Axios^{mAX} requires dramatically less calibration maintenance compared to conventional high-power XRF spectrometers. Using SST-mAX with ZETA Technology, uptime is maximized and short measurement times are maintained.

Instrument sensitivity
When it comes to high precision, speed and low detection limits, sensitivity is all-important. In Axios^{mAX} systems the close coupling of the X-ray tube with the sample and the wide optics of the goniometer result in very high sensitivities for elements right across the periodic table.
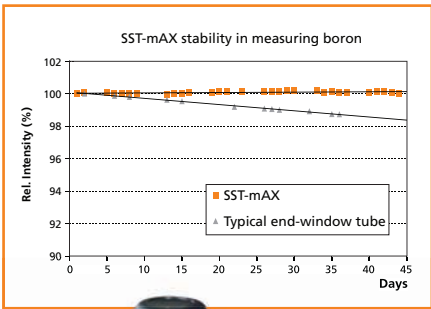
Depending on the application, sensitivities and limits of detection can be further enhanced by refining the configuration with:

- X-ray tube power options (kW)
- Different X-ray tube anodes (for optimized excitation)
- Duplex detector
- Curved analyzing crystals
- High-reflectivity analyzing crystals (e.g. PX7 for B analysis)
- Dedicated Hi-Per channels for specific elements

SST-mAX: groundbreaking technology

The SST-mAX tube, present in every Axios^{mAX} system, allows for superior sensitivity and uptime. The high emission current of up to 160 mA combined with the tube design which allows ultra-close coupling with the sample allow for the highest possible sensitivity. The cathode design completely eliminates filament burnout. The lifetime of the tube is typically 2-4 times longer than other high-power end window tubes. In addition the tube features the unique ZETA Technology, which removes tube aging.

SST-mAX stability in measuring boron

ZETA Technology

ZETA Technology fully eliminates tube aging and ensures stable tube output during the lifetime of the tube. Therefore, the Axios^{mAX} requires dramatically less calibration maintenance when compared to conventional high-power XRF spectrometers.

SST-mAX^{50}: turning superior light element analysis into a lasting benefit

SST-mAX^{50} features an ultra-thin tube window, which combined with ZETA Technology and CHI-BLUE coating technology provides unique advantages. The ultra-thin window ensures superior sensitivity for elements from Be to Cl, while the ZETA Technology ensures that this sensitivity is maintained during the tube's lifetime. The CHI-BLUE coating ensures robustness of the tube.

CHI-BLUE: reliability and durability

The CHI-BLUE coating provides durability to the X-ray tube, by protecting the tube window from corrosion caused by sample spillage. In addition, it guarantees vacuum tightness of the tube window, ensuring reliable tube operation. Protection devices compromizing sensitivity are therefore not required.

Power

Axios^{mAX} systems are available in three power options: 2.4, 3.0 and 4.0 kW. Whereas the 2.4 kW system has sufficient performance for routine analysis of major and minor elements, the 4.0 kW option gives the highest sensitivity for trace element analysis and a higher speed of analysis.

Tube anode material

Axios^{mAX} configurations include a Rh-anode SST-mAX. To improve sensitivity for specific element ranges, it is possible to equip the Axios^{mAX} with Cr-anode X-ray tubes. Other anode materials are available on request.

Hi-Per channels - for higher sensitivities and quicker analysis

Axios^{mAX} can be fitted with either one or two Hi-Per channels for increased sensitivity for elements from boron to magnesium. Hi-Per channels use curved, multi-layer crystals to focus incoming radiation. This results in a short optical path length, delivering intensities significantly higher than conventional channels.

Simultaneous measurements of Hi-Per and goniometer channels reduces application measurement times.
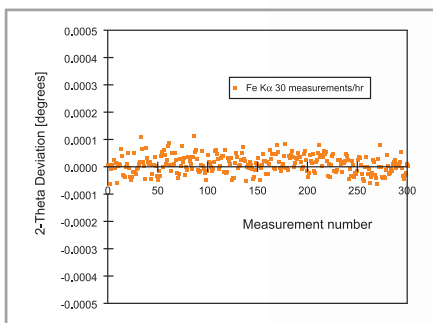
DOPS goniometer

Based on optical-disc technology, our unique Direct Optical Position Sensing (DOPS) provides outstanding accuracy in goniometer movement. Angular positions can be controlled with an absolute accuracy of 0.0025° and reproducibility within a remarkable ±0.0001°. This level of accuracy is achieved by using optical encoders on both sides of the goniometer. This robust system is unaffected by mechanical shocks or vibration and eliminates any effects of wear or backlash.

Multiple detector configurations

Close-coupled scintillation and flow detectors are mounted in parallel for uncompromised detection of heavy and light elements, respectively.

A sealed xenon detector can be fitted behind the flow counter and together they act as a duplex gas detector that significantly increases sensitivity for the transition metals.

Hi-Per Scint

Hi-Per Scint is an optional detector upgrade which boosts the dynamic range from 1.5 Mcps to 3.5 Mcps and lowers the background signal for a selection of elements.
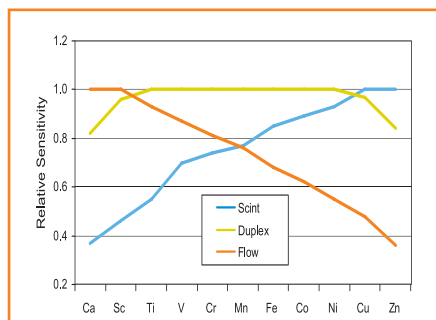
DMCA counting electronics

The Axios^{mAX} Dual Multi Channel Analyzer (DMCA) allows incredibly fast scanning and near perfect dead time correction. This ensures a linear response up to exceptionally high count rate levels, making it possible for calibration lines to be extended over large concentration ranges. In combination with the DOPS goniometer and the highly sensitive optics a complete standardless analysis can be delivered in less than two minutes.
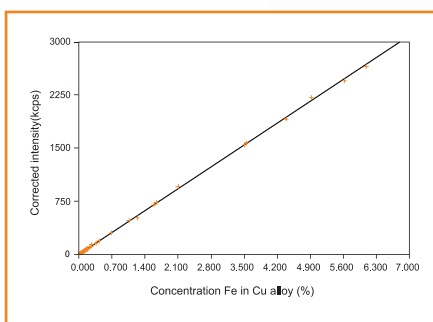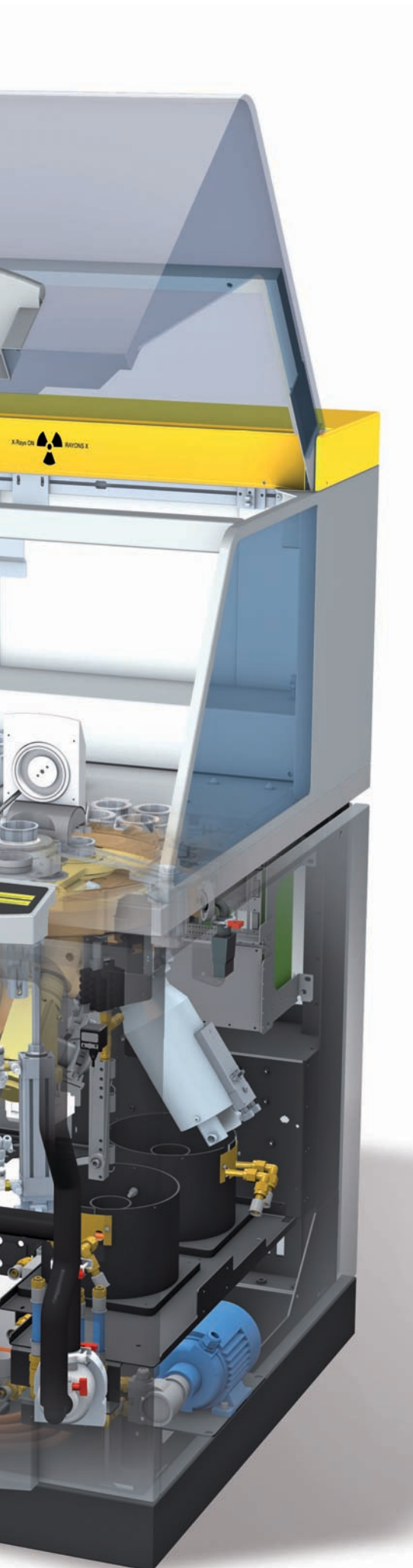
Increased up-time with dust removal device
This device removes loose dust before samples are brought into the measurement position, protecting the components of the optical path against contamination. In combination with the sample loader's airlock mechanism, the dust removal device is also invaluable in the event that poorly prepared samples disintegrate.

Turret sample introduction
The sample turret design ensures reliable and repeatable sample presentation in the measurement position. Furthermore, since the loading position is not directly above the X-ray tube, the turret mechanism protects the optical path from accidental contamination by poorly prepared samples.


Curved crystals for improved analytical performance
The use of laterally curved crystals (Ge111, PE002 and InSb) can improve intensity by as much as 50 %. With ordinary flat crystals, the peak shapes become broad and asymmetric at high take-off angles - whereas with curved crystals they remain Gaussian with excellent spectral resolution.
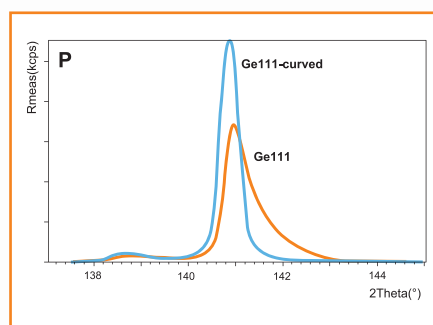
Gas purge unit for liquid analysis
An optional gas purge system can be fitted for the analysis of liquids and loose powders. The type of incoming sample is detected in the loading position. If required, the medium of the optical chamber is automatically switched from vacuum to helium or nitrogen, preventing any instrument damage by accidental operation.
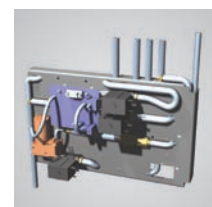
Multi-layers for light element analysis
Several multi-layer crystals are available for Axios^{mAX} enabling high precision light element analysis. A full range of multi-layers is available to measure elements from Be to Mg.

High stability
Axios^{mAX} guarantees outstanding stability because the temperature in the spectrometer cabinet can be controlled to within 0.05 °C by means of the advanced water-cooling circuitry. Similarly, Axios^{mAX} assures a constant gas density when measuring liquids and loose powders in a helium atmosphere thanks to ultra-precise temperature and pressure control. This is crucial for ensuring good reproducibility, especially for the analysis of light elements.

High sample throughput
With the continuous loading option, two positions are available on the sample introduction turret. This enables a second sample to be loaded into the spectrometer while the first is being measured. When this measurement is finished the second sample can be immediately transported to the measurement position. Continuous loading significantly reduces instrument overhead time and saves over half a minute per sample.

Save time with direct loading
Loading time can be further reduced with the direct-loading option for uncupped samples. With this mechanism samples on the changer are loaded directly into a sample cup in the loading position, saving up to 10 seconds overhead time per sample.

Integrated barcode reader
Requirements for traceability make it essential that samples can be tracked through the whole analytical process and that data entry necessary to analyze samples is minimal.

Where manual intervention and handling is required, the possibility for sample misplacement and data entry errors is always present.

PANalytical's integrated barcode reader scans the barcode during sample loading to determine the sample's identification and the required measuring conditions, thereby eliminating handling errors. The barcode reader can easily be integrated into any software environment, boosting the throughput of your laboratory and significantly reducing operational costs.

Flexibility for different sample sizes
Axios^{mAX} is available with programmable collimator masks that have either 3 or 6 different aperture sizes. This gives the flexibility to measure a wide variety of sample diameters within one measurement batch.

Flexible sample changer configuration
An unprecedented range of sample changing possibilities makes Axios^{mAX} ideal for multiple applications. The sample changer can accommodate up to 8 sample trays and a special SPC/monitor tray. Different trays are available for sample holders, steel rings and uncupped samples with diameters of 25, 32, 41 and 50 mm. Trays for sample holders or steel rings can hold 8 samples, whereas trays for unmounted samples of 25 mm diameter can hold 21. This gives the flexibility of configuring the changer for up to 172 samples. In addition a high-capacity sample

changer is available which can accomodate up to 209 uncupped samples of 32 mm or 140 uncupped samples of 40 mm diameter.

Robust

Axios^{mAX} is designed to work perfectly in dusty and harsh environments. Features ensuring this robustness are:
- Dust removal device
- Recognition of liquid samples in load position and automatic switching to helium
- Air lock with programmable pumping time
- Turret sample introduction
- Sealed spectrometer cabinet

Flexible

Sample handling with Axios^{mAX} is highly flexible. A single batch queue can contain a wide variety of sample types and sizes and high-priority measurements can be added easily to an ongoing batch.

The features making this possible are:
- Integrated sample changer
- Priority sample position with sample detection allowing QuickStart
- Programmable collimator masks (6 – 37 mm)

Automation

Axios^{mAX} is easily integrated in automated laboratory systems. Sample loading access is possible from either side of the instrument with a specifically designed sample inverter or from the rear with a backfeed unit.

Easy and pleasant to work with

The Axios^{mAX} system is extremely quiet because special attention has been paid to reduce the noise level generation by fans, water pumps and generators. Furthermore, it dissipates little heat into the room. Its small footprint and mobility make it easy to maneuver and position in confined laboratory spaces.

Remote support - PANassist

Remote support packages are available to expedite trouble shooting and minimize downtime. The can system can be connected via LAN, DSL or UMTS. Pre-installed software allowing fast and dedicated remote diagnostics is included. In addition, alerting facilities are available which can transmit warning messages in case of events that users have classified as important.

Serviceability

Axios^{mAX} is designed with serviceability in mind. Components on special service racks make regular service tasks easy. For example, exchanging the internal cooling water or topping up the oil level of the

vacuum pump. Furthermore, accessibility from all sides allows unrestricted access for maintenance, speeding up servicing and minimizing downtime.

Quality

Axios^{mAX} is designed, built and tested according to the ISO9001 quality standards. PANalytical is certified according to ISO14001 for environmental management. In this way PANalytical accepts its responsibility to strive for continuous improvement of its performance towards the environment with respect to its processes and products.

Axios^{mAX} technical specifications

Sample handling	
Types	Solid, fused beads, filters, pressed/loose powders and liquids
Handling	All samples are fitted in sample holders during measurement. Liquids and loose powders in disposable (P2) liquid cells, which are fitted in liquid sample holders
Dimensions	51.5 mm Ø x 40 mm height, maximum
Weight	Max. 400 g including sample holder
Sample changer	X-Y changer with priority position for 1 sample (detected) and 2 empty holders with capacity for 8 trays for 8 sample holders and 1 tray for 4 sample holders. Optional: High-capacity changer up to 209 uncupped samples of 32 mm or 140 uncupped samples of 40 mm diameter
Changer trays	for: 8 sample holders, 8 flex positions, 8 steel rings (Ø 51.5 mm), 21 samples (Ø 25 mm), 12 samples (Ø 32 mm), 10 samples (Ø 41 mm), or 4 sample holders (SPC/monitor tray)
Loading	Air lock with programmable pumping time, one or two position turret mechanism, sample-surface down, direct loading of unmounted samples in holder in loading position
Spinner	0.5 rev/s

X-ray tube SST-mAX	
Type	Super Sharp End Window tube featuring ZETA Technology
Anode	Rh standard, Cr optional, other anodes on request
Window	Ultra-high transmission, 50 µm and 75 µm
Window coating	CHI-BLUE coating for x 50 corrosion resistance
Operation	Tube remains powered on during sample loading

HV Generator	
Output	Selectable in steps of 1 kV, 1 mA
kV / mA switching	Isowatt switching
Stability	0.00006 % / 1 % mains variation
Stability mains	± 10 %

Rating	
Axios^{mAX} 2.4 kW	20 - 60 kV, 10 - 100 mA
Axios^{mAX} 3.0 kW	20 - 60 kV, 10 - 125 mA
Axios^{mAX} 4.0 kW	20 - 60 kV, 10 - 160 mA

Goniometer	
Type	θ/2θ decoupled with Direct Optical Position Sensing (DOPS)
Angular accuracy	0.0025° θ and 2θ
Angular reproducibility	0.0001° θ and 2θ
Scanning speed	Up to 10° 2θ /s
Slewing speed	40° 2θ/s
Temp. stabilization	± 0.05°C at 31° cabinet temperature

Optical path	
Channels masks	Single mask (fixed 27, 30 or 37 mm), switchable 3 positions (27, 30, 37 mm) or 6 positions (6, 10, 20, 27, 30, 37 mm)

Optical path (continued)	
Primary collimators	3 max.: 100, 150, 300, 550, 700 or 4000 µm
Primary beamfilters	4 max.: One may be used as beam stop
Crystals	8 max.: LiF420, LiF220, LiF200, Ge111 (flat/curved), PE002 (flat/curved), InSb (flat/curved), TlAP coated, PX1, PX4, PX5, PX6, PX7, PX10
Detectors	Flow, scintillation, sealed Xe in tandem with flow counter as duplex counter (optional), Hi-Per Scint (optional)
Hi-Per channels	Maximum of 2: for B to Mg
Beam path	Vacuum: <10 Pa; He, N_2 optional

Counting electronics	
Type	Dual multi channel analyser with digital signal processor
Maximum count rate	Flow counter: 3000 kcps Scintillation and sealed counter: 1500 kcps Duplex counter: 4500 kcps Hi-Per Scint: 3500 kcps (non-linearity ≤ 1 %)
Pulse shift correction	Automatic, dynamic (selectable)
Dead time correction	Automatic

Automation interfacing	
Inverter Transfer point at side	41.1 cm (16.18 in) from front side, protruding 28.95 cm (11.4 in)
Transfer point heights	85, 88.5, 91.2, 111.2 cm (33.46, 34.84, 35.91, 43.78 in)
Back feed unit Transfer point at side	25.25 cm (9.94 in) from side, protruding 3.5 cm (1.38 in)
Transfer point height	104.8 cm (41.26 in)

Safety standards	
Applicabe regulations	Machine Directive (2006/42/EC) EMC Directive (2009/108/EC) CAN CSA C22.2 1010
X-ray safety	Vollschutz RöV 2002
Electrical	Installation category class II
Protection	Pollution degree 2 Class IP40

Installation	
Dimensions	84 x 98 x 151 cm (33.1 x 38.6 x 59.4 in) (WxDxH)
Floor space (WxD, in use)	134 (25 + 84 + 25) x 223 (25 + 98 + 100) cm² (53 x 88 in²)
Floor space (WxD, maintenance)	Min. 2 x 2 m² (6.6 x 6.6 ft²), i.e. 1 m (39 in) extra on service side
Weight	550 kg
Power consumption	5.5 kW, 7.5 kVA, 33 A (@ 230 V, 50 Hz)
Mains requirements	Single phase, 50-60 Hz, 188-253 V, 38 A max.
Environment temp.	10° to 35° C (50° to 95° F)
Cooling water	12° to 20° C (54° to 68° F), 3.5 to 8 bar, 5 to 11 l/min
Compressed air	4 to 5 bar

Global and near