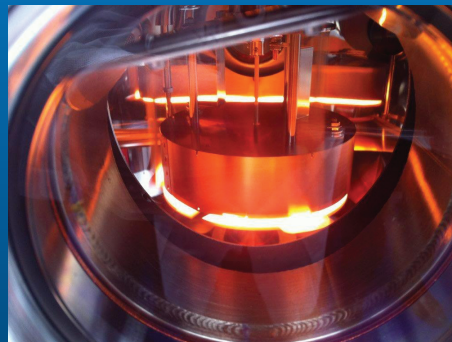




EpiCentre

The Deposition Stage



EpiCentre The Deposition Stage

Introduction

The EpiCentre range of deposition stages employs cutting edge design and engineering to give high temperature substrate heating and manipulation under true UHV conditions.

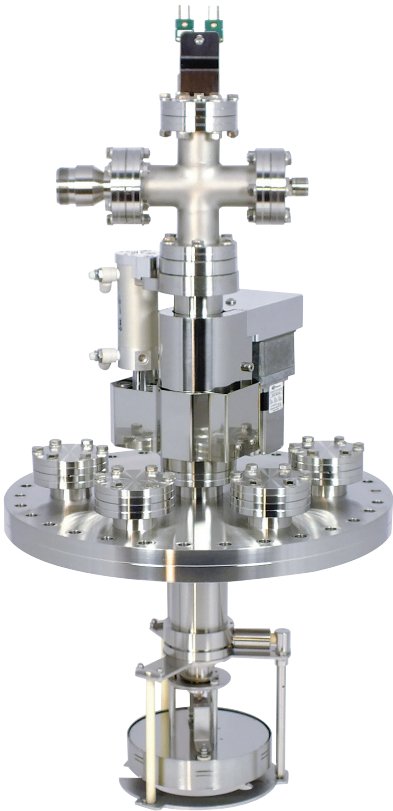
EpiCentres have been designed for deposition applications such as MBE (Molecular Beam Epitaxy), sputtering and CVD (Chemical Vapour Deposition). Substrate annealing, degassing and other high temperature material modifications can also be performed.

EpiCentres can be mounted in any orientation to suit customer chamber designs and application configurations.

The EpiCentre range has been used by pioneering research laboratories around the world for many years. End user references are available for a variety of applications and substrate sizes. The range comprises three model types: EC-I, EC-R and GLAD summarised on the opposite page.



Range Overview



EC-I Series

An 'in-line' design presenting the substrate **parallel to the mounting flange**. The EC-I series provides substrate heating with a number of proven modular options offering substrate rotation, electrical biasing and axial translations to set the substrate height and cradle lift/lower to facilitate substrate transfer. The modular approach allows end users to select features including the substrate size, amount of axial translation required, the size and type of mounting flange, shutter options, motorisation and the operating height.



EC-R Series

A 'right-angle' design presenting the substrate **at 90° to the mounting flange**. The EC-R provides substrate rotation, heating and electrical biasing. The two axes of rotation provide continuous azimuthal rotation and +/- 180° tilt for substrate orientation. The stage may be mounted in any orientation. The EC-R can also be configured specifically as a retrofit instrument for MBE systems such as the VG Semicon V80H.



GLAD Series

An in-line 'glancing-angle' design presenting the substrate **at a variable glancing angle to the mounting flange**. The GLAD (GLancing Angle Deposition) stage is creating great interest in the field of three-dimensional engineered nano-structures. The GLAD stage is suitable for use with all the usual directional deposition sources, e.g.

- Thermal Evaporation
- Pulsed Laser Deposition
- Magnetron Sputtering



Key Advantages

EpiCentre range

Compact, high reliability design

MAGIDRIVE Rotary Feedthroughs

The EpiCentre uses magnetically coupled drives in high duty cycle areas for substrate and polar (tilt) rotation. Eliminating the use of edge-welded bellows, o-ring seals and ferromagnetic components improves reliability and removes possible sources of contamination.

Hollow variants of MagiDrives allow coaxial stacking for true independence of polar and azimuthal rotation without the need for costly head positioning gears.



MAGILIFT Linear/Rotary Stage

The core manipulation of our EC-I stage is provided by our unique, compact, magnetically coupled MagiLift drive which provides:

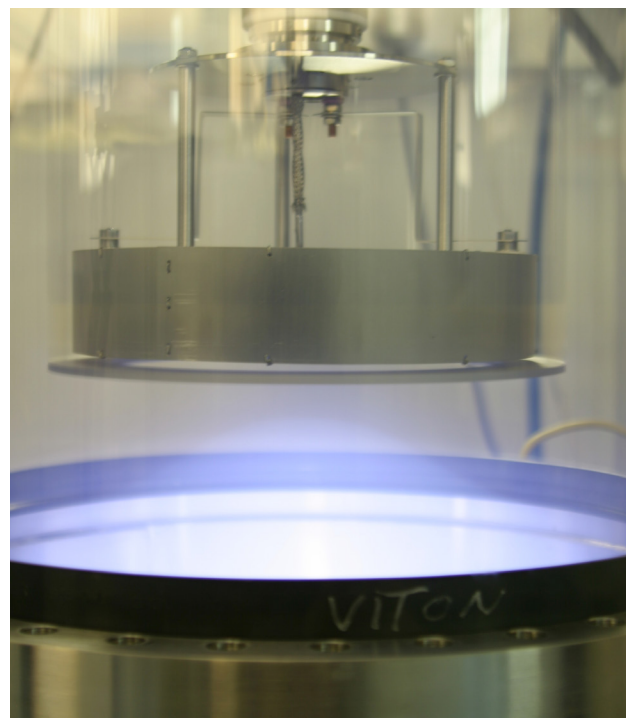
- Continuous substrate rotation
- 25mm substrate lift/lower
- Home sensing of inner shaft with 0.1° resolution



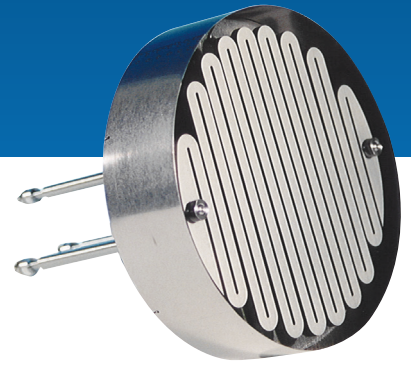
Eliminating unnecessary bellows and dynamic seals from the EpiCentre design ensures true UHV performance, increases reliability and reduces down-time.

Substrate biasing with ultra-stable plasma

EpiCentre stages can be provided with the facility to apply an electrical bias to control substrate deposition characteristics and to generate a plasma for substrate sputter cleaning prior to deposition. Bias can be applied during continuous heating and rotation at up to 1kV DC and/or up to 300 W RF power. Dark space shielding is provided as standard to prevent parasitic plasma formation around the electrical path and other susceptible areas.



Our propriety substrate biasing technology provides unrivalled ultra-stable performance, typically with zero maintenance and long operational life.



High uniformity, high temperature substrate heating

Until recently, Pyrolytic Graphite Coated Graphite (PgG) heaters have been used in the majority of deposition stages and are still the mainstay in the field providing robust performance in UHV applications. However, graphite heaters oxidise and are consumed when run in the presence of high partial pressures of O_2 at high temperature. For sputtering applications that involve high partial pressures of O_2 , other technologies are also available. UHV Design now offer a choice of either Solid Silicon Carbide (sSiC) or Silicon Carbide coated Graphite (SiCg) heater elements which deliver excellent temperature uniformity.

Both options have been fully characterised in terms of typical lifespan against partial pressure of O_2 and temperature, and guidance is available from UHV Design on the best option for your application.

EpiCentre heater modules have a self-supporting element, refractory metal enclosure and are capable of producing substrate temperatures up to 1200°C. By virtue of the exceptionally high ratio of heated to open heater area, the elements run at considerably lower temperatures than conventional metal wire heaters. Multiple layer heat shielding is also provided to reduce unwanted heating of surroundings.



SiCg heater element



sSiC heater element

Temperature Uniformity

UHV Design's heater modules provide outstanding temperature uniformity without the need for dual zone heaters.

Typical substrate temperature uniformity achieved using our heater modules is shown on the right.

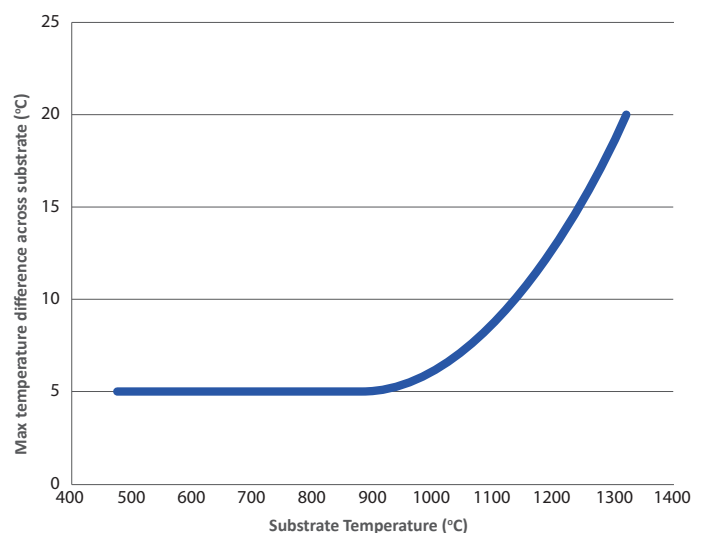
SiC coated elements

SiCg elements are similar to PgG elements being primarily composed of graphite but have a coating of Silicon Carbide (SiC). This provides improved durability when using oxidising atmospheres in comparison to PgG. However, as SiC is an insulator, gaps are required in the coating to allow connections to be made to the underlying graphite. The heater is therefore still somewhat vulnerable to oxidation at these locations in the longer term.

Solid SiC heaters

Solid SiC heaters are manufactured from a conducting solid SiC material in the β phase and are more robust in all respects. They are durable under mechanical or electrical shocking and when exposed to reactive gases including oxidising atmospheres at high temperature. They are also optimised to give the very best in temperature uniformity.

By virtue of the large radiating surface to gap ratio, all these elements run at considerably lower temperatures than more commonly used metal wire heaters. This extends the operational life of the heating element.



In-line Deposition Stages

Substrate parallel to plane of mounting flange

EC-I Series

- Substrate heating to 1200°C
- Continuous substrate rotation up to 60rpm
- Substrate lift/lower for transfer
- DC/RF substrate biasing
- Homing for automatic transfer alignment
- Adjustable deposition height
- SEMI standard 2" to 200mm diameter substrate handling
- SiCg or sSiC heater technology
- True UHV performance

The EC-I series is the latest model in the very successful range of EpiCentre stages, providing state-of-the-art performance for various growth and deposition techniques including MBE, sputtering and CVD. It represents the latest advance in modular 'in-line' deposition instruments which offer continuous substrate heating, rotation, biasing, and facilities for substrate transfer, while maintaining true UHV compatibility.

The series includes models to accommodate SEMI standard wafers from 2" to 200mm diameter, and special substrate cradles can be provided to accommodate specific substrate shapes and designs up to 200mm (7.9") diameter.

The EC-I series benefits from the success of UHV Design's unique hollow magnetic coupling technology using the CF38 mounted MagiLift drive. This single compact device provides magnetically coupled rotation and axial motion. The hollow drive technology allows the passing of services through the drive to a stationary wafer heating module in close proximity to the substrate, eliminating the need for vulnerable high current rotational connections. The MagiLift provides continuous rotation of the substrate cradle for better temperature and layer uniformity, plus a pneumatically actuated 25mm lift/lower for substrate transfer. An external magnetic proximity home switch is also provided for position sensing the internal rotor to align the stage to within 0.1° for automated substrate transfer.



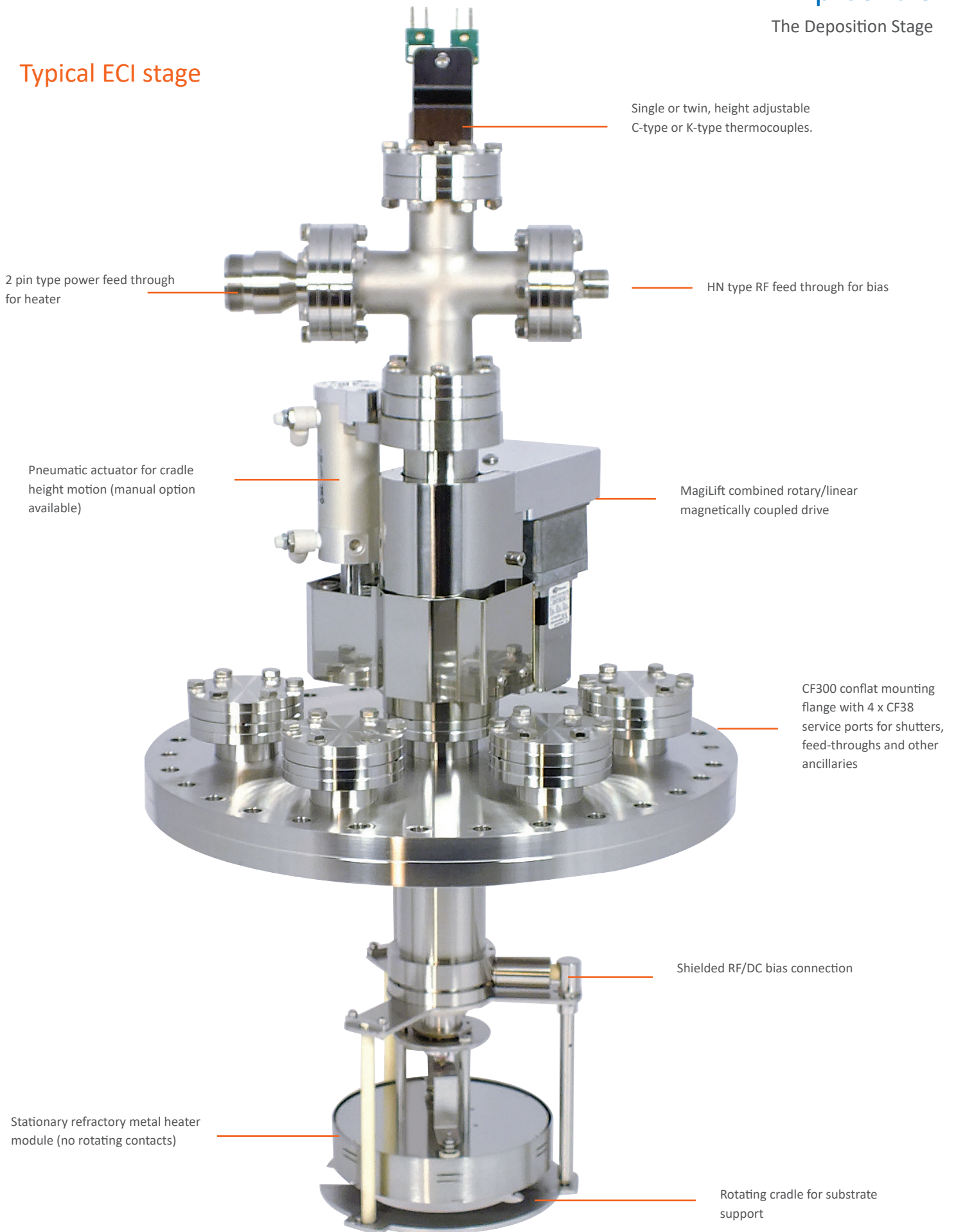
The stationary heater module employs multiple refractory metal Molybdenum heat shields to minimise heat loss, (Inconel and other materials available upon request), and a choice of either SiCg (SiC coated graphite) or sSiC (β phase solid SiC) heater elements, both of which are capable of heating wafers to 1200°C and operating within O_2 rich environments.

The electrically isolated substrate cradle can be biased with either DC or RF to facilitate sputter cleaning prior to deposition or for better control of deposition kinetics. 'Faraday Dark Space Shielding' is supplied as standard on all stages. This confines plasma to the substrate cradle region. Our proprietary substrate biasing technology provides unrivalled flicker-free performance, typically with zero maintenance and long operational life. The deposition height adjustment option allows the height of the substrate to be adjusted to optimise the distance from the deposition flux. Deposition shields can also be provided to protect the heater module.

The stages can be mounted in any orientation, although they are most commonly mounted vertically with the wafer facing up or down and parallel to the mounting flange. Other orientations can be accommodated with special wafer holders. Options are also available to configure EpiCentres for higher pressure and corrosive environments.

The series has a full suite of options including a choice of system mounting flanges, manual or pneumatic substrate shutters and thermocouple materials. Insertion length can be tailored to meet your requirements.

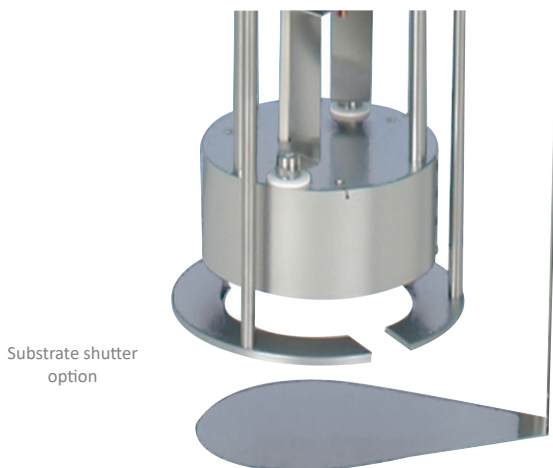
Typical ECI stage



Stage Configuration: EC-I Series

STANDARD CONFIGURATION				
Substrate diameter	2" (50mm)	100mm	150mm	200mm
CF200/10" OD system flange	☐	☐	☐	☐
CF250/12" OD system flange	☐ (s)	☐ (s)	☐	☐
CF300/14" OD system flange	☐ (s)	☐ (s)	☐ (s)	☐
CF350/16.5" OD system flange	☐ (s)	☐ (s)	☐ (s)	☐ (s)
Heater element	Silicon Carbide coated graphite (SiCg) as standard (see options below)			
Substrate rotation	Stepper motorised			
Cradle movement for substrate transfer	25mm pneumatic via MagiLift			
Standard Insertion length (flange face to substrate)	240mm (+25mm for substrate transfer)			
Deposition height adjustment	Not adjustable as standard (see options below)			
Achievable temperature	1200°C (based on Molybdenum heater module heating a standard Silicon wafer)			
STAGE MOTION OPTIONS				
Azimuthal rotation	24 V DC motor or Smart Motor or no motor (gearbox only fitted, customer supplies and fits NEMA 23 frame motor)			
Deposition height adjustment	Z = 50mm (other options available upon request)			
Deposition height actuation	Stepper, 24 V DC motor or Smart Motor or no motor (gearbox only fitted, customer supplies and fits NEMA 23 frame motor)			
ADDITIONAL OPTIONS				
DC & RF bias	DC bias ≤ 1kV, RF ≤ 100W (with 300W option)			
Substrate shutter	Manual, pneumatic or motorised. See system flange options (s)			
Heater element	Solid Silicon Carbide (sSiC)			
Heater module shield	Inconel heat shields for higher O ₂ partial pressures (limited to 1000°C)			
Cradle movement for substrate transfer	Manual hand wheel actuation (standard actuation is pneumatic)			
Thermocouple options - with RF / DC bias	UHV Option: 2 x CF bellows-sealed sheathed Type K or HV option: 2 x O-ring sheathed Type K			
Thermocouple options - with no RF / DC bias	1 x CF (unsheathed) Type K or Type C			
Homing sensor	24V pre-wired DC NPN sensor kit			
Deposition shield cans to protect stage mechanism	Available on request			
Custom insertion length	Available on request			

KEY: ☐ = Substrate size can be accommodated on specified system flange
☐(s) = Substrate shutter option is available on specified system flange
☐ = Not available



Right-angle Deposition Stages

EC-R Series

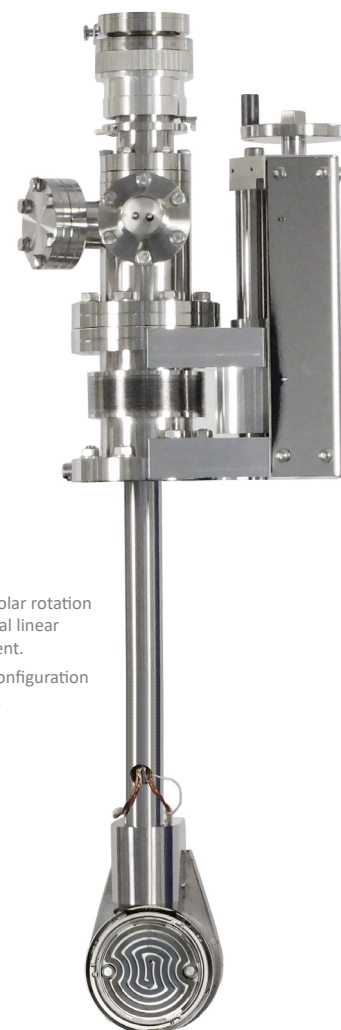
Substrate surface at right angle to mounting flange plane

- 2" to 6" substrate diameters
- Substrate heating to 1200°C
- Continuous azimuthal rotation up to 60rpm
- Polar rotation (tilt) up to +/- 180°
- DC/RF substrate biasing
- X,Y & Z motion options
- SiCg or sSiC heater technology
- True UHV performance

The EC-R provides substrate rotation, tilt, heating and electrical biasing with the substrate surface supported at right angles to the plane of the mounting flange. The base EC-R configuration provides polar rotation to adjust the angle of incidence with respect to the deposition flux and sample heating. The modular EC-R concept provides the flexibility to select options such as azimuthal rotation to continuously rotate the substrate to maximise temperature and deposition uniformity. X, Y and Z motion can then be added to position the substrate. The concept of this stage was strongly influenced by a complete review of existing right angled deposition stages. By stacking two magnetically-coupled 'MagiDrive' rotary feedthroughs, UHV Design are able to achieve a dual axis, concentric rotation system which eliminates the head positioning gear train typically used in other designs. Furthermore, by incorporating our latest heater module technology into this stage, improvements upon conventional designs have been achieved in ultimate temperature capability, uniformity and heater reliability. Refractory metal deposition shielding is provided as standard to protect the heating module.

The EC-R can also be configured specifically as a retrofit instrument for MBE systems such as the VG Semicon V80H.

A range of sample transfer options are available (see page 14).



EC-R with manual polar rotation (tilt) and manual linear displacement.

See next page for configuration options.



EC-R Series Continued

The EC-R can be configured to suit your application:



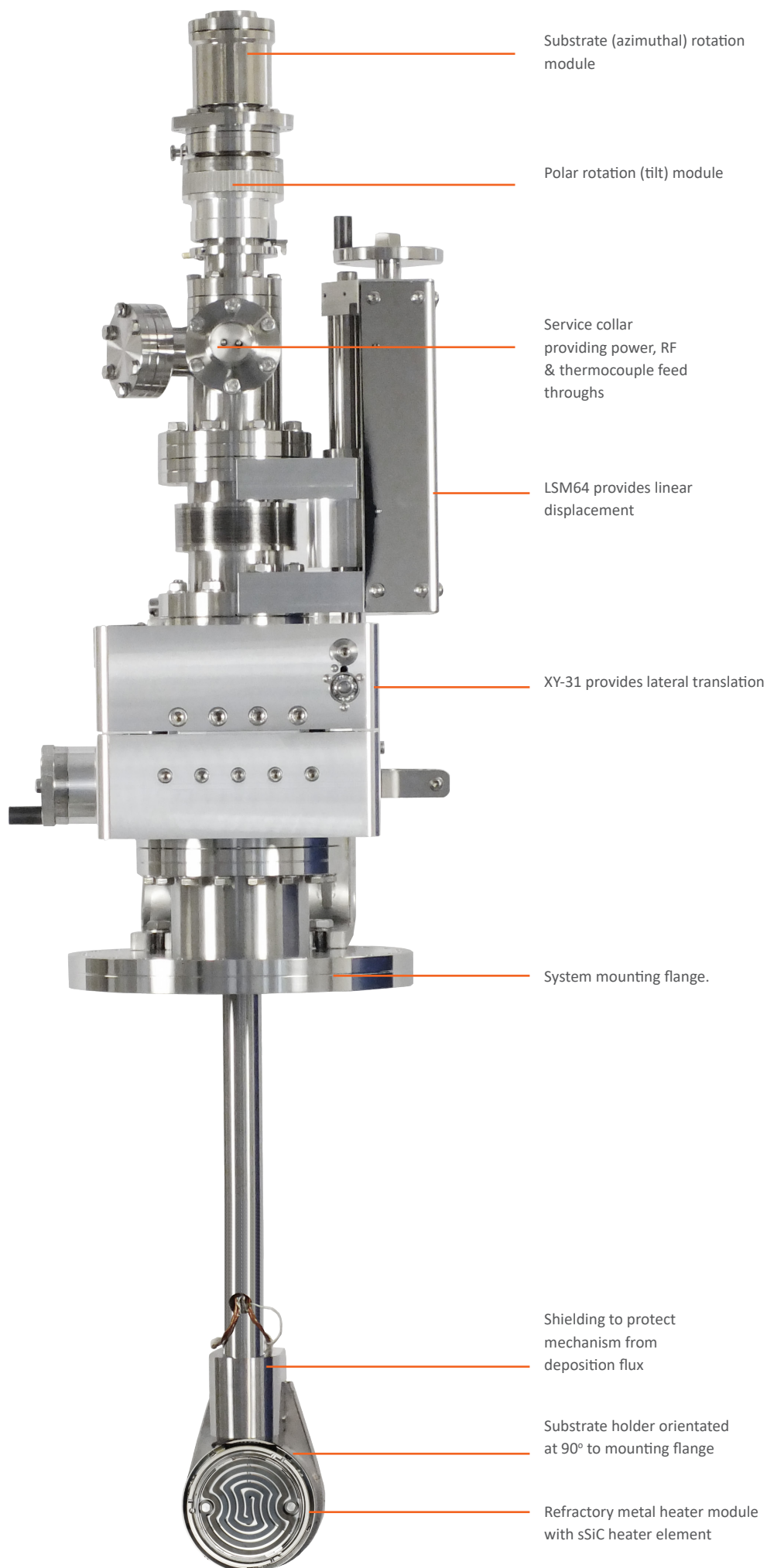
EC-R with manual polar rotation (tilt) and manual linear displacement.



EC-R with manual substrate rotation, manual polar rotation (tilt) and manual linear displacement.



EC-R with manual substrate rotation, manual polar rotation (tilt), manual X & Y motion and manual linear displacement.



Stage Configuration: EC-R Series

STANDARD CONFIGURATION			
Substrate diameter	2" (50mm)	100mm	150mm
CF150/8" OD system flange	☐	☐	☐
CF200/10" OD system flange	☐	☐	☐
CF250/12" OD system flange	☐	☐	☐
POLAR ROTATION			
Adjustable position	Manual (1° resolution)		
HEATING			
Heater element	Silicon Carbide coated graphite (SiCg) as standard (see options below)		
Achievable temperature	1200°C (based on heating a Molybdenum sample)		
STAGE MOTION OPTIONS			
POLAR ROTATION			
Stepper motorised	0.025° resolution		
AZIMUTHAL ROTATION			
Manually driven	Manual thimble		
DC motorised	Up to 60rpm (maximum 20rpm recommended with bias)		
Stepper motorised	Up to 60rpm (maximum 20rpm recommended with bias)		
XYZ MOTION OPTIONS	TTX		XYZ
Z AXIS			
Z stroke range offered	50-300mm		50-1000mm
Resolution manual	0.01mm		1mm
Resolution stepper motorised	0.001mm		0.001mm
XY AXIS			
Manual actuation	+/- 15mm (+/-21mm vector)		+/- 19mm (+/-27mm vector)
X-Y resolution manual	0.001mm		0.01mm
Motorised actuation	+/- 14mm (+/-20mm vector)		+/- 18mm (+/-25.5mm vector)
X-Y Resolution stepper motorised	0.0025mm		0.005mm
AXIS ALIGNMENT			
Adjustable position (manual)	+/-2°		N/A
ADDITIONAL OPTIONS			
DC & RF bias	DC bias ≤ 1kV, RF ≤ 40W (including dark space shielding)		
Heater element	Solid Silicon Carbide (sSiC)		
Insertion length (nominally 240mm)	Customer specified		
Motorisation	Stepper or Smart Motor (DC for azimuthal only)		
X,Y and Z encoders	Option		
Azimuthal home position sensor	Option		
Temperature measurement	Type K or Type C thermocouple		
Water cooling of head assembly (NOT substrate) to aid heat dissipation	Option		

KEY: ☐ = Substrate size can be accommodated on specified system flange
 ☐ = Not available



Glancing Angle Deposition Stages **GLAD Series**

Substrate at a variable glancing angle to the mounting flange

Glancing Angle Deposition (GLAD) is creating great interest in areas where structured three-dimensional deposition is required.

Based on UHV Design's highly successful EpiCentre range, the GLAD stage provides an in-line solution (as with the EC-I Series) but with the addition of substrate tilt. Being an in-line stage, a large range of axial (Z) motion can be provided.

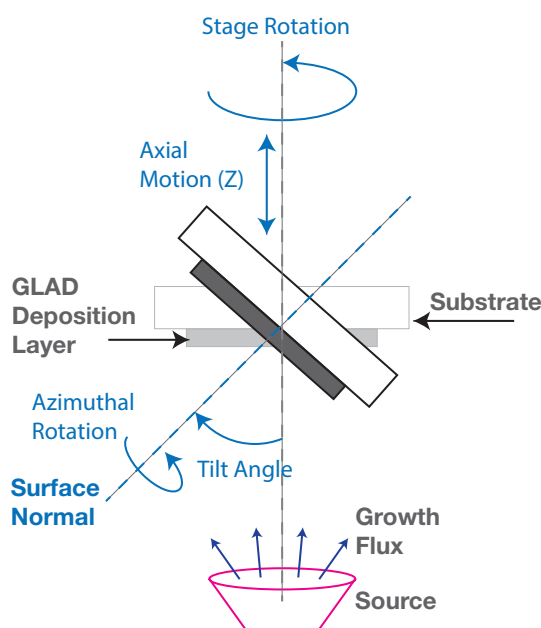
By precisely controlling the polar and azimuthal rotations simultaneously, novel structures can be grown, which have, for example, columnar morphology or a nano-helical structure or are structured via anisotropic shadowing. Such materials have applications in many highly topical fields such as photonics, catalysis, bio-compatible materials and fuel cells.

Being fully UHV compatible, the GLAD stage is eminently suitable for use with all the usual directional deposition sources, including:

- Thermal Evaporation
- Pulsed Laser Deposition
- Magnetron Sputtering

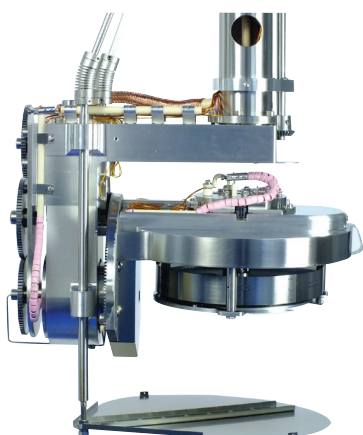
Features

- Continuous azimuthal rotation from 0.1 - 20rpm, but at any tilt angle from zero to +/- 85 degrees.
- Substrate temperature heating to 1200°C, with solid Silicon Carbide technology option to provide durability in O₂ rich environments.
- DC bias ≤ 1 kV for sputter process modification – ultra-stable plasma during azimuthal rotation.
- RF bias to 100W power for substrate cleaning prior to deposition.
- Z-axis travel up to 200mm to accommodate different source geometries.
- Optional rotation of the entire stage/tilt axis orientation to facilitate glancing angle deposition using out-of-plane sources. (Requires the use of a differentially pumped rotary feedthrough that can be fitted as an option.)

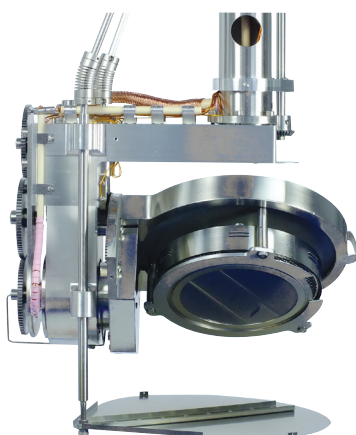


Stage Configuration: GLAD Series

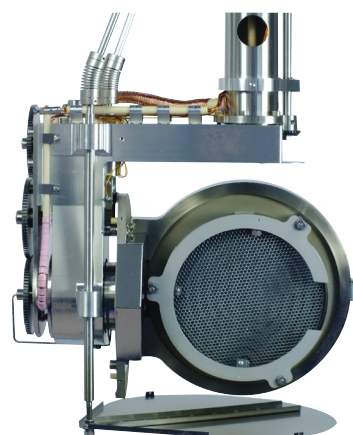
STANDARD CONFIGURATION		
Substrate size	2" (50mm)	4" (100mm)
CF300 / 14" OD system flange	☐	☐
CF350 / 16.5" OD system flange	☐	☐
Heater element	Silicon Carbide coated graphite (SiCg) as standard (see Options below)	
Substrate rotation	Continuous, stepper motorised, 0.1 - 20 rpm	
Substrate tilt	Manual actuation +/- 85°	
Insertion length	240mm flange face to substrate centre	
Deposition height adjustment	None (see options below)	
Thermocouple	1 x Type K	
Achievable temperature	1200°C (based on heating a Molybdenum sample)	
OPTIONS		
DC & RF bias	DC bias ≤ 1kV, RF ≤ 100W (inc. dark space shielding - must use screened thermocouple options)	
Shutter	Manual, pneumatic or stepper motorised	
Heater element	Solid Silicon Carbide (sSiC)	
Thermocouple options	1 x (screened) Type K 1 x (screened) Type C	
Deposition height adjustment	up to 200mm	
Deposition height automation	24 V DC Motor, stepper motor, Smart Motor, no motor* (*gearbox only fitted, customer supplies and fits NEMA 23 frame motor)	
Substrate rotation	24 V DC motor or Smart Motor or no motor* (*gearbox only fitted, customer supplies and fits NEMA 23 frame motor)	
Substrate tilt automation	Stepper motor, Smart Motor, no motor* (*gearbox only fitted, customer supplies and fits NEMA 23 frame motor)	
Homing sensor	Internal magnetic switch	
Custom insertion length	Available on request	
Stage / Tilt axis rotation (via DPRF)	Available on request	
Stage / Tilt axis rotation automation	Available on request	



Normal angle of incidence



Variable angle of incidence via stepper motor control



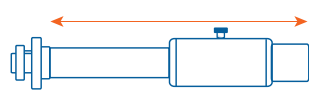
Glancing maximum angle of incidence at +/- 85°

Optional Items

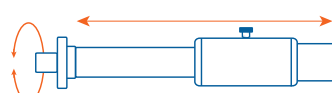
Substrate Transfer Arms

PowerProbe substrate transfer arms enable secure transfer of substrates within UHV as a consequence of their unrivalled magnetic coupling strength. In addition to linear and linear/rotary probes, this extensive range includes the Elevating PowerProbe and the Dual Axis PowerProbe. The Elevating PowerProbe offers a complete solution for linear low load substrate transfer with a range of standard effectors and up to 50mm of lift for hand-off. The Dual Axis PowerProbe is ideal for substrate transfer systems which require a secondary motion to actuate an end effector mechanism such as a gripper.

- Comprehensive range with elevating platforms and substrate gripping probes
- 10 times the thrust and 4 times the torque of conventional magnetically coupled designs
- Bakeable to 250°C without removal of magnets
- Motorised solutions available
- Linear movement up to 1.8m as standard



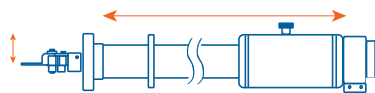
Linear Only PowerProbe



Linear and Rotary PowerProbe



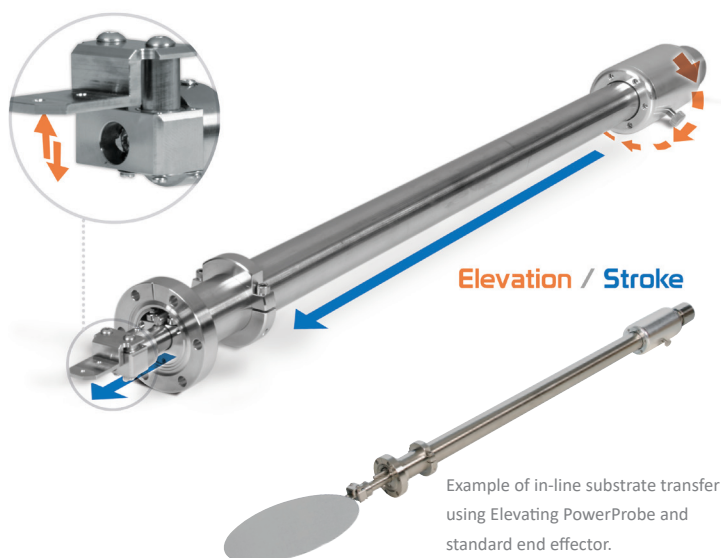
Dual Axis PowerProbe



Elevating Power Probe

Substrate Transfer for In-Line Stages

For in-line sample transfer applications the Elevating PowerProbe can be fitted with a wide range of standard end-effectors to provide a cost-effective, reliable solution for low load substrate hand-off.



Substrate Transfer for Right-Angle Stages

For right-angled substrate transfers our linear and rotary PowerProbe allows a range of end effectors to be used, for example, the bayonet style substrate transfer system. The rotary motion of the shaft is used to rotate the substrate's bayonet fittings to secure and release within the substrate holder.



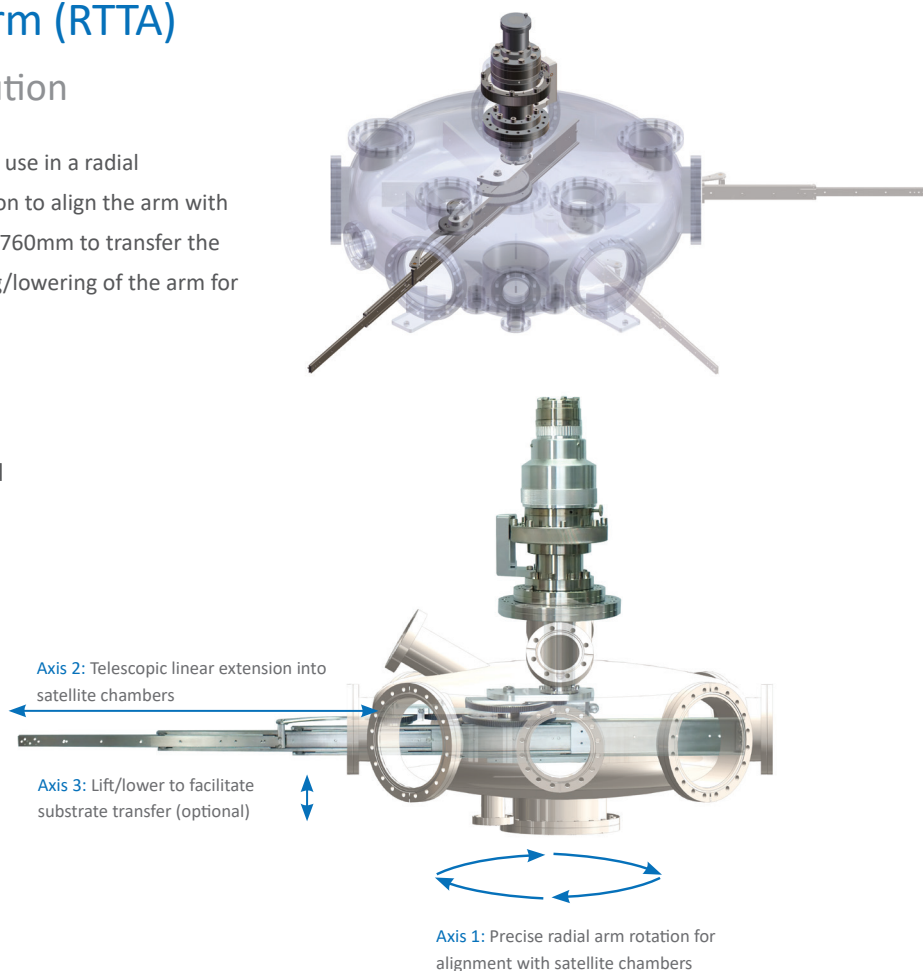
Example of right-angled bayonet style substrate transfer using linear and rotary PowerProbe.

Radial Telescopic Transfer Arm (RTTA)

Radial Distribution Chamber Solution

The unique Radial Telescopic Transfer Arm (RTTA) is for use in a radial distribution chamber. The RTTA provides 360° of rotation to align the arm with the satellite chamber access port, an arm extension of 760mm to transfer the substrate into the satellite chamber and optional lifting/lowering of the arm for substrate hand-off. Contact us for more information.

- 2.5 times more extension than conventional designs for same size chamber diameter
- High stability: <1mm deflection under 10 N load at full arm extension
- Excellent substrate position reproducibility: <0.2mm laterally & axially
- Reduced system footprint giving:
 - Smaller, lower cost chamber
 - Quicker pump down
 - Lower cost pumps
- True UHV performance (no O-rings, dynamic seals or oil)



DC Heater Power Supplies

To complement the range of EpiCentre stages, UHV Design have introduced a new family of DC Heater Power Supplies, providing an easy-to-use solution for substrate heating. The unit offers reliable, low noise and ripple operation, resulting in minimal EM interference when performing RHEED measurements. Contact us for more information.



- 2U 19" rack mounted unit
- Universal voltage 110V/240Vac 50Hz/60Hz
- Type K or C thermocouple
- 7m cables supplied as standard
- Eurotherm[®] temperature controller
- RS232 communication
- Analogue current limit
- Analogue current and voltage output monitor signals



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