CRESSALL

INDUSTRIAL POWER RESISTORS

Neutral Earthing

Dynamic Braking

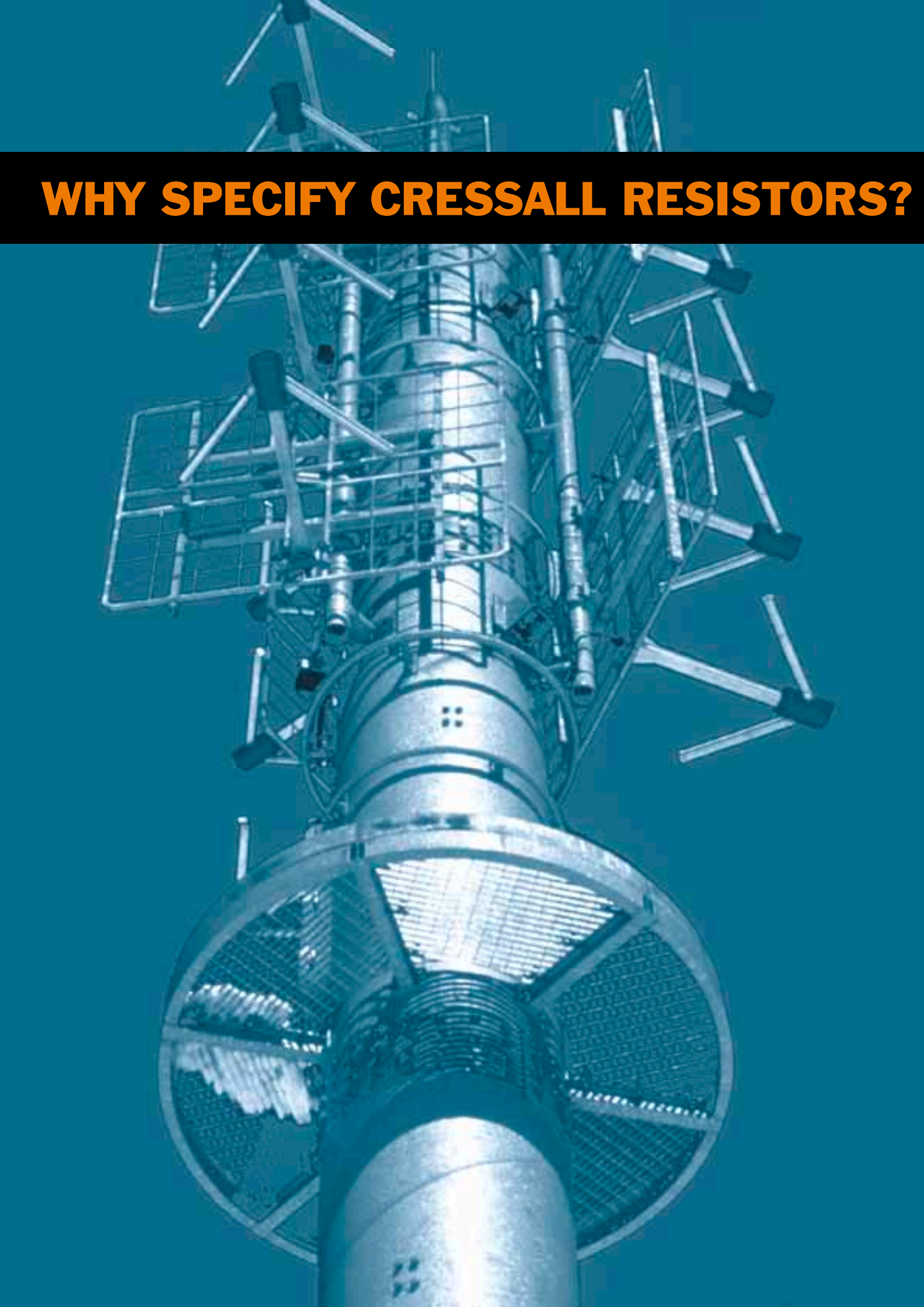
Harmonic Filters

Portable Load Units

Load Banks

Motor Control

WHY SPECIFY CRESSALL RESISTORS?



THE WORLD'S FOREMOST RESISTOR MANUFACTURER, CRESSALL RESISTORS OFFER AN UNRIVALLED COMBINATION OF EXPERIENCE AND THE WIDEST RANGE OF RESISTOR TECHNOLOGIES.

Cressall Resistors have almost 100 years experience of producing power resistors for use in the electro-technical market. With design and manufacturing facilities at two locations in the UK, Cressall can supply both standard and custom-designed resistor solutions for any application from a few watts up to several megawatts and for operation at any voltage.

With more than 100 employees at facilities in Leicester and Dereham, Norfolk, our qualified engineers will advise you on the most suitable and competitive design for your requirements.

A quality management system approved to ISO9001 combined with the continuous development of our products and the people that provide them ensure that the service we offer is second to none.

With sister companies and distributors around the world Cressall can provide global customer service.

Details of our sister companies and distributors can be found on our website www.cressall.com.

WHY SPECIFY CRESSALL RESISTORS?

Cressall reliability

Cressall products are well-proven in the most arduous and demanding environments such as found in steel works, chemical plants and oil rigs.

Versatile technology

The broad range of Cressall resistor elements provides the versatility required to offer solutions for any application.

Resistors can be specified for any combination of resistance value, temperature rise, duty cycle, current and voltage rating.

Product development and innovation

Cressall's range of resistor elements are subject to a process of continuous research, development and product innovation.

Recent developments include:

- Merger of TPR Resistors business with Cressall Resistors
- Opening of a transit and special projects office in Dereham, Norfolk
- Launch of a range of water-cooled braking resistors for marine use
- Portable load bank range extended with 6kW and 100kW AC units
- Next-day despatch service for standard braking resistors

Fast response

Whatever your resistor requirements our team of qualified engineers and production staff will offer a fast, cost-effective solution and deliver a service that is second to none.

This commitment extends through every stage of the process, from initial enquiry to after-sales support.

Quality control

Cressall Resistors has produced products under a quality control system, approved to ISO9001.

Cressall neutral earthing resistors (NERs) are employed in AC distribution networks to limit the current that would flow through the neutral point of a transformer or generator in the event of an earth fault.

The rating of an NER is chosen to meet the requirements of the system protection scheme; this will include consideration of maximum acceptable fault current, earth potential levels, and preventing damage caused by the fault.

Resistors rated 77kV, 400A for 15 seconds supplied by Cressall are being used in domestic Japanese substations.

CRESSALL NERS HAVE NUMEROUS BENEFITS:

Choice

An extensive range of metal resistor elements allows selection of the most efficient and cost effective solution for any required duty. Cressall can manufacture NERs for any system voltage and initial current with rated times from a few seconds to continuous.

Stability and predictability

The resistance value is set at the manufacturing stage and remains constant throughout the life of the NER. Unlike liquid resistors, changes in resistance value due to the fluctuations in ambient temperature are negligible. This means that protection levels can be accurately pre-determined.

In contrast to an earthing reactor, a Cressall NER does not induce phase changes or resonances into the fault current and does not require matching to the associated transformer.

Rapid cooling and short time ratings

Modern protection systems typically clear faults in less than a second. However, the time rating of an NER usually needs to cater for the possibility of several successive faults.

Cressall resistors cool down much faster than liquid resistors after operation. To cater for successive faults liquid resistors have longer time ratings, typically 30 seconds, as opposed to 10 seconds for metallic resistors.

Ease of installation

Cressall NERs are compact and do not require site calibration or auxiliary power supplies.

Low operating costs

Fixed resistance values mean that maintenance is limited to periodic inspection and cleaning. Anti-frost and anti-condensation heaters are not generally required.

Reliability

NERs may only be called upon to operate a few times in their service life, which may be 25 years or more. Cressall NERs have been proven reliable in numerous installations and under severe climatic conditions world-wide.

Construction

Standards

At present the only standard for NERs is ANSI/IEEE Std 32, 1972. Cressall NERs can be designed and tested to comply with this standard, or with individual client specifications.

Resistor elements

For the majority of ratings the most suitable element is the type RP oval edge-wound coil.

RP resistors are manufactured from a continuous stainless steel strip, wound edgewise into oval coils. Each coil is supported by ridged ceramic insulators mounted on a stainless steel centre support, with stainless steel terminals welded at each end. This arrangement allows free expansion and contraction at operating temperatures up to 1100°C without imposing strain on the assembly.

The resistance alloys used are high temperature stainless steels capable of withstanding temperature excursions to 1100°C whilst retaining their strength, unlike 304 or other structural grade stainless steels which are limited to much lower temperatures.

NERs designed for operation to higher temperatures require less active mass, resulting in more compact and economical designs.

Temperature coefficient of resistance

Unlike structural grade stainless steels the temperature coefficient of the material used ensures a resistance increase of less than 3.5% per 100°C rise over the operating temperature range.

Resistor banks

The end insulators of individual resistor elements are clamped and locked on to tie-rods. Any element can be removed without disturbing the remainder.

The tie-rods are supported between galvanised end-plates to form banks. These banks can be mounted on top of each other with intermediate insulators to form a complete self-supporting stack.

Interconnections between coils are copper, using two bolts per joint.

Enclosure protection ratings

The standard enclosure is designed to IP23 to IEC529 (to prevent the ingress of foreign bodies greater than 12mm, and rain falling at any angle up to 60° from the vertical). This rating is suitable for indoor or outdoor use as it allows sufficient cooling and provides more than adequate protection unless the environmental conditions are extreme. Protection ratings above IP23 are rarely needed because Cressall resistor stacks are virtually corrosion proof and immune from progressive pitting and rusting. The operation of the resistor and the ceramic insulators are not affected by exposure to condensation, sand or fine dust, provided that the dust is not unduly conductive.

If higher degrees of protection are specified, these can be provided (up to IP55). It should be realised that the operational penalty of using less well ventilated enclosures is that the external surfaces will become hotter and cooling times will be longer.

Enclosure materials and finish

Enclosures are manufactured as standard from unpainted stainless steel. This ensures better and more economic long term corrosion protection than galvanised or painted mild steel units.

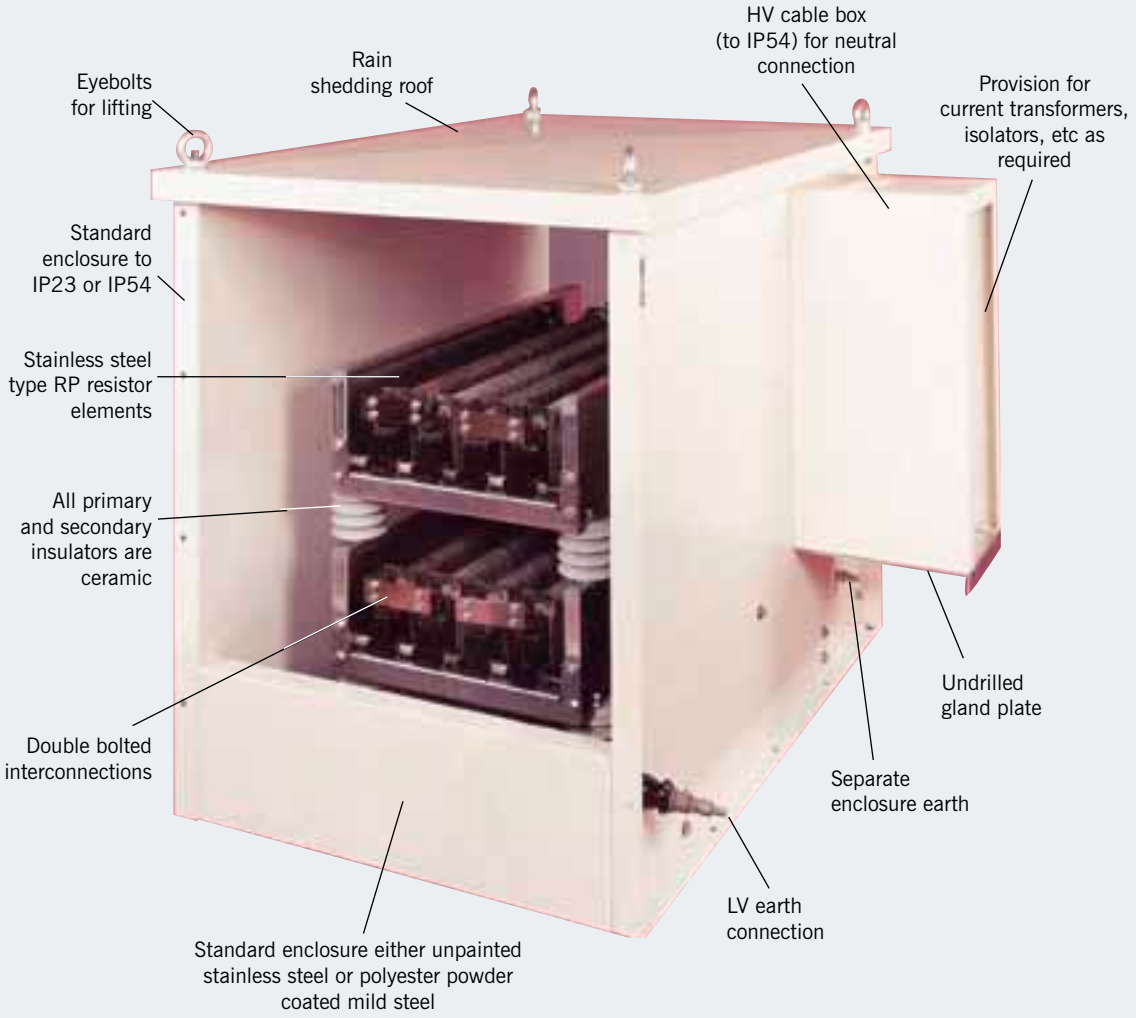
If required other enclosure materials and special finishes can be supplied to comply with users' specifications.

Electrical connections

As standard a HV bushing is mounted on the side of the enclosure. The bushing is housed in an air insulated bottom-entry cable box with a removable undrilled gland plate.

A low voltage bushing is provided for the resistor earth connection. Where required this can also be enclosed in a cable box. Earthing of the enclosure is via two separate stud type terminals, fitted diagonally opposite each other.

As an alternative to the cable boxes, bushings can be mounted on the top cover. However, the enclosure should then be mounted on a plinth or structure to raise the height of the bushing to a suitable distance above ground level to avoid accidental contact. Suitable steel plinths can be supplied.



Other equipment

Where required cable boxes can house current transformers, isolators, vacuum contactors or other ancillary equipment.

Standard tests

As standard, NERs are tested to the requirements of ANSI/IEEE Std 32, 1972.

Routine tests on all units include:

- Dimensional check to relevant drawing
- Resistance measurement at ambient temperature
- One minute power frequency withstand test to levels specified in ANSI/IEEE Std 32, 1972 typically (2.25 x line voltage) +2kV

Temperature rise type tests have been carried out on a range of typical ratings for both 760°C (in accordance with ANSI/IEEE Std 32, 1972) and 1000°C. Copies of these results are available.

NER rated 11kV, 625A for 10 seconds installed in a substation near Heathrow.

Transformer mounted NER rated 11kV, 1000A for 10 seconds.

CRESSALL EARTH FAULT DETECTION SYSTEMS

- **Compact**
- **Designed to be retrofitted**
- **Options for indication, metering, pulsing and auxiliary resistance circuits**

In low voltage three phase distribution networks where continuity of supply is a priority, high resistance earthing reduces the risk of service interruptions caused by an earth fault while maintaining the integrity of the system.

Where their use is permitted, Cressall earth fault detection resistors are ideal for sensing and locating earth faults quickly, minimising plant down time in industrial applications.

The earth fault detection resistor is connected between the neutral point of the distribution network and earth. In the event of an earth fault the resistor will limit the fault current to a few amps (typically 3-5). Control equipment continuously monitors this earth current and provides indication when it exceeds a predetermined level.

Units can be supplied with a range of features:

- Earth fault protection and monitoring
- Pulsed earth fault protection and hand held sensor for easy fault finding
- Double resistor paths with continuous monitoring for fail safe protection

DYNAMIC BRAKING

Cressall is one of the leading suppliers of dynamic braking resistors to OEMs, integrators, users and distributors of AC variable frequency drives.

Cressall DBRs are used to stop motors or to produce a braking torque in the motor during overhauling load conditions. The dynamic braking resistor is connected across the DC bus and can see voltages as high as 1100 volts (Cressall DBRs can be insulated and rated for higher voltages if required).

The resistance value determines the amount of braking torque produced and thus the rate at which the motor will stop, the lower the resistance the higher the braking torque and the quicker the stop. Drive manufacturers will specify a minimum resistance value to ensure that the braking capacity of the drive is not exceeded. As standard Cressall manufacture DBRs with a –0/+10% tolerance to ensure optimum performance (other values can be achieved if required).

When sizing brake resistors, key parameters for consideration are resistance value, braking power and the duration and frequency of the stop.

Braking resistors are used for speed control and braking of passenger lifts.

Construction

Manufactured using electrical grade alloys, resistor elements are either type 'ZC' (coiled strip) 'CC' (coiled coil) or 'SD' (expanded mesh). Units can be supplied as loose elements, open banks or housed in ventilated enclosures.

Type CC coiled coil resistors

- Medium to high resistance value
- Rapid duty cycle
- High overload capacity

Type ZC edgewound strip

- Low to medium resistance value
- High power intermittent duty
- High overload capacity

Type SD expanded mesh

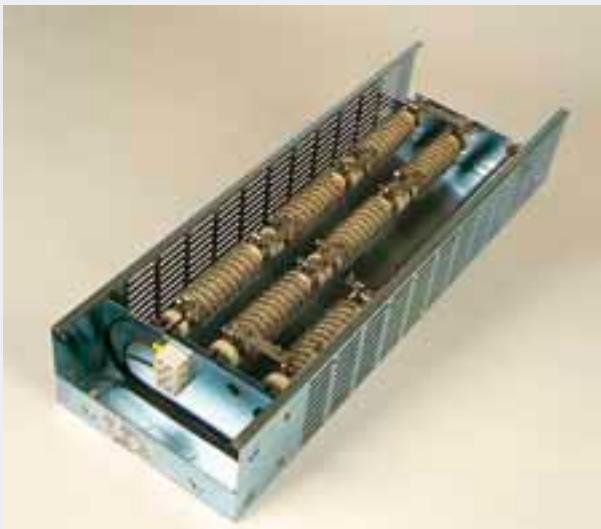
- Low resistance value
- High continuous power
- Rapid duty cycle

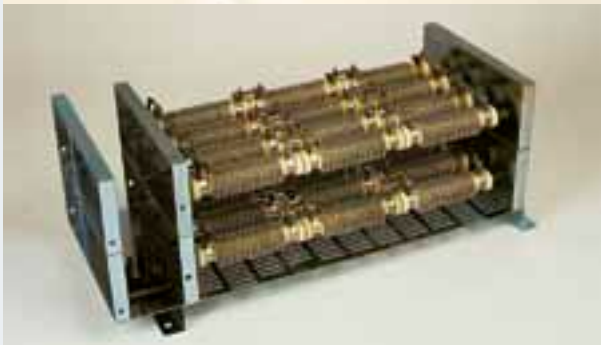
Standard dynamic braking resistors

To meet the requirements of the market Cressall have developed a range of standard DBRs designed to cater for the most common applications. Depending on rating these units can be manufactured from stock components or (for the most popular sizes) supplied direct from stock.

As standard Cressall DBRs are housed in plated mild steel enclosures affording ingress protection to IP20 or IP21. They include a built-in terminal box, terminal block and high temperature wiring. A normally closed thermal switch is fitted as standard. Units may be wall or roof mounted as required.

- **Most common sizes available from stock**
- **Easily installed**
- **Suitable for all ranges of drives**
- **Suitable for any power or duty cycle**
- **Insulated for operation at 800V**
- **Thermal trip fitted as standard**
- **CE marked**





A DBR used for hoist application undergoes final testing before installation.

Designed for easy panel mounting, DBRs are used in a range of industries such as food processing and lift control.

ES braking resistors

A comprehensive range of compact, IP20 dynamic braking resistors with a choice of accessories that keeps both purchase and installation costs low - all available at short notice.

- **Rated for repetitive duty**
- **Resistance never lower than expected**
- **Robust construction**
- **Low inductance element**
- **High overload capacity**
- **Close tolerance (+5% - 0%)**
- **Noise free**
- **Temperature stable element**

Cressall ES braking resistors are based on HP Coils, spiral wire-wound on ceramic formers.

These elements have a high overload capacity and cool rapidly. The resistance material is a high grade stainless steel with no more than 7% resistance increase over the whole temperature range. Cheaper designs using 304 stainless steel can increase in resistance during the heating cycle by as much as 50%, which results in lower current and less effective braking.

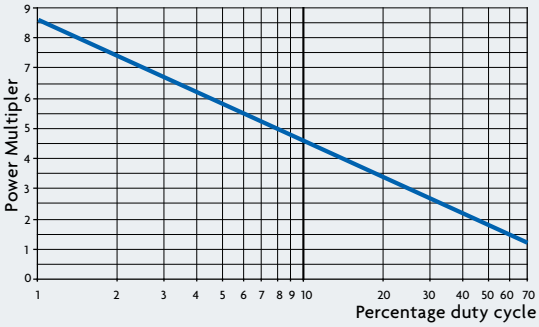
The enclosures are made of galvanized steel. Ingress protection is IP 20.

Options are a thermal switch and/or terminal cover.

Duty cycle and power

The eight standard enclosures have continuous power ratings from 0.6kW to 8kW. These ratings can be exceeded when power is applied for less than 100% of the time. The graph below gives a "power multiplier" based on a 10 second "on time". Multiply the resistor's continuous rating by the "power multiplier" number to calculate power.

Example: 10 seconds on in 100 seconds is defined as a 10% duty cycle. A 10% duty cycle gives a 4.6 times power multiplier. ES1 resistors are rated 1.5kW continuously and so can be rated 6.9kW (4.6 x 1.5kW) for 10 seconds in 100 seconds. If the resistors have a resistance of 100Ω or more, then the power rating is reduced by 20%.



Enclosure	ESH	EST	ES1	EST2	ES2	ES3	ES4	ES8
Continuous power/kW	0.6	1.0	1.5	2.0	3.0	4.5	6.0	8.0
Min Ω	2.5	4.0	6.0	2.0	3.0	2.0	1.5	0.75
Max Ω	180	300	450	600	900	1350	1800	3600

Applications

- **Dynamic braking**
- **Motor control**
- **Variable speed drives**
- **Lifts & elevators**
- **Cranes & winches**
- **Conveyors**
- **Test loads**

Maximum operating voltage:
1000V DC or AC rms

Connections
Power: Screw terminals for up to 10mm² cable (ESH-ES3), M8 stud terminals (ES4-8)

Earth: Self tapper, near screw terminals

Thermal sensor: 6.25mm male blade (faston) connections (receptacles not supplied)

Terminal cover (optional for ESH-ES3)
Two 20mm gland holes with cover grommets provided on end face. The cover overhangs the resistor by 22mm. The open overhang area can be used for cable entry.

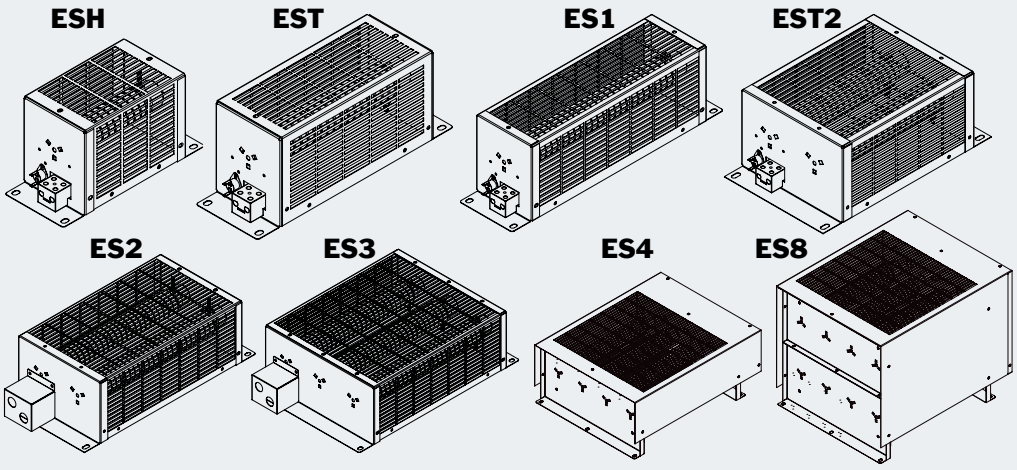
Thermal sensor (optional)
Located near screw terminals

Normally closed contact, opens at ~250˚C, re-closes at ~210˚C

Voltage: 240V AC rms; current: 7A AC rms

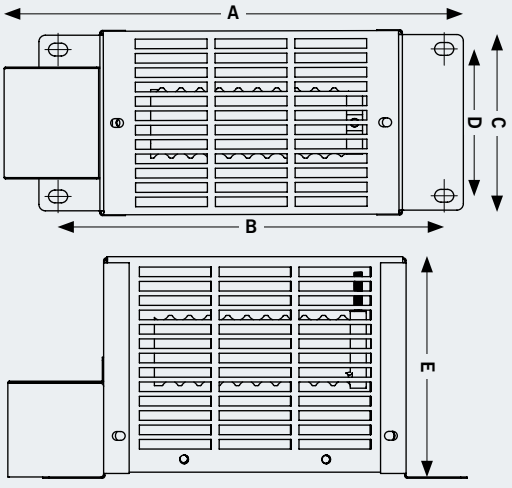
Installation
Units have slotted mounting points suitable for M6 fixings. Mount horizontally with base facing down. Other orientations may result in increased element temperatures.

Warning: *Units must never be mounted with the terminal area or base uppermost.*



Mounting dimensions (mm) and weights

	A	B	C	D	E	kg
ESH	288	236	121	92	141	1.4
EST	367	315	121	92	141	1.8
ES1	467	415	121	92	141	2.2
EST2	367	315	213	185	141	3.0
ES2	467	415	213	185	141	3.8
ES3	467	415	307	278	141	5.4
ES4	500	422	380	352	195	6.6
ES8	500	422	380	352	390	11.5



HARMONIC FILTERS

The ever-increasing use of power electronics has led to a rise in the amount of harmonic voltages on the power supply network. Harmonics can have an adverse impact on many electrical systems and, as such, this makes the aspect of power quality more and more important for both suppliers and users of electrical power.

These harmonic voltages can increase line losses and also have a detrimental effect on other users of the network.

Harmonics can be reduced to acceptable levels by passive filter circuits consisting of inductors, capacitors and resistors. The filter circuit allows through the fundamental frequency and diverts the harmonic frequencies to the resistor bank where they are dissipated as heat and thus lost from the system.

Low inductance is a key design feature of filter resistors. The units offered by Cressall have negligible inductance and are particularly suitable for operation at high voltages in the following applications:

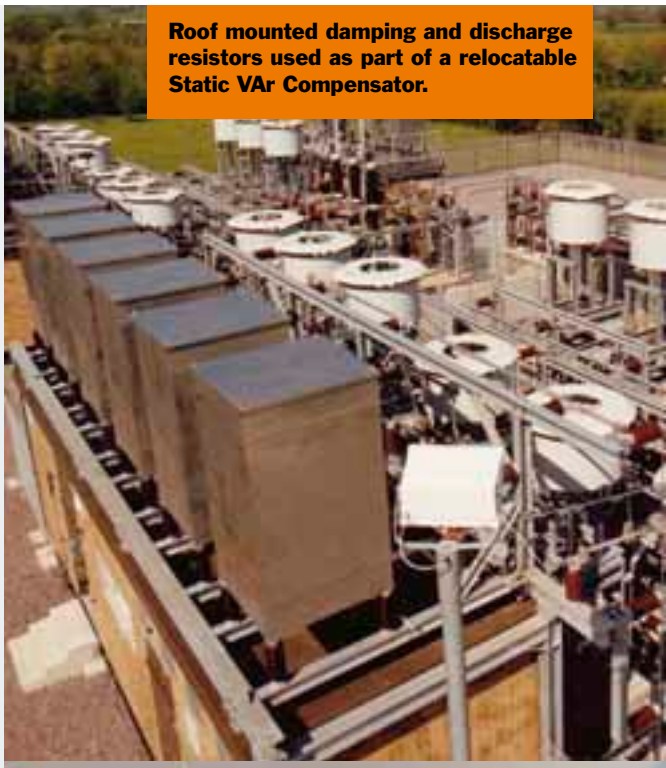
Static VAr compensators (SVCs)

HVDC transmission systems

Mechanically switched capacitor damping networks (MSCDNs)

Industrial harmonic filters

Cressall have supplied resistors for use within filter systems at every level of the electrical distribution system, from 400kV grid transformers to 415V industrial equipment, and with power ratings from a few watts to several megawatts.



Roof mounted damping and discharge resistors used as part of a relocatable Static VAr Compensator.

125kV BIL damping resistors installed as part of the upgrade to the West Coast Main Line.

Used by the National Grid Company, these filter resistors are rated 550kV BIL, 500kW per phase.

PORTABLE LOAD UNITS

24-28 DC Model

Model type	Voltage (V)	Power (kW)	Steps	Continuous current (A)	Dimensions L x W x H (mm)			Weight (kg)
DC110	28V	3.3	fully variable	120	400	200	500	10

48-54 DC Models

Model type	Voltage	Power (kW)	Steps	Continuous current (A)	Dimensions L x W x H (mm)			Weight (kg)
DC70	50V	3.5	fully variable	70	400	200	500	10
DC220	50V	11.0	fully variable	210	540	310	500	15
DC600	50V	30.0	fully variable	600	560	400	840	40

Units are each supplied with a pair of leads

- Fully variable current setting
- Cooling fan driven by test load
- Shunt for current measurement with 4mm banana sockets (all units except DC600)

AC Models

Model type	Voltage (V)	Power (kW)	Steps W(A)	Continuous current (A)	Dimensions L x W x H (mm)			Weight (kg)
AC6	220-240, 1Ø	6	333	27	495	220	415	10
AC6 Dual	110-120, 1Ø	6	333	54	495	220	550	12
	220-240, 1Ø			27				
AC30*	220-240, 1Ø	15	333	62	560	400	840	30
	380-415, 3Ø	30	1000	41				
AC 100	220-240, 1Ø	33	400	150	1150	700	800	140
	380-415, 3Ø	100	1250					

AC6 includes one (AC6 Dual Voltage: two) 1.5m long cable complete with IEC 60309-2 connectors - hard wired into the unit.

AC30 includes either a single or a three phase lead. Unless specified at time of order a three phase lead will be included automatically.

AC100 includes four female connectors to be fitted to customers' own cables, to match the male connectors on the unit.

- Cooling fan driven by test load
- Ability to set unbalanced loads
- Input connectors to BS4343/ DIN49462
- Illuminated switches
- Single and three phase operation in one unit
- DIN 48mm voltmeter, ammeter and frequency meter

AC/DC Model

Model type	Voltage (V ac or dc)	Power (kW)	Steps W(A)	Continuous current (A)	Dimensions L x W x H (mm)			Weight (kg)
Dual30 (120/240)	120	31.5	500(4)	262	600	500	800	50
	240	31.5	500(2)	131				

Units are each supplied with a pair of leads

- Full power at two voltages in a single unit
- DIN 48mm voltmeter, ammeter and separate 1.5% shunt
- Single phase ac or dc operation
- Contactor switched
- Fans and contactors driven by external 110V or 230V ac supply

Cressall's range of standard units is designed for testing ac and dc systems, including batteries, uninterruptible power supplies (UPSs) and stand-by generators.

All units are fan-cooled, which helps to ensure a compact design. The fan supply is taken from the test load itself or from an auxiliary supply of 110 or 230V ac, according to model.

Units are fitted with over temperature protection.

To reduce weight enclosures are manufactured from aluminium and fitted with handles and where required have castors to ease manoeuvrability. Load banks are supplied with one cable and connector.

DC and AC/DC models can be operated at voltages lower than their nominal rating. Power is reduced accordingly.

Naturally cooled load banks

- High reliability
- Virtually silent operation
- No moving parts
- No auxiliary supplies
- Minimal maintenance
- Any power rating

Cressall can offer load banks that are cooled by natural convection.

These are virtually silent in operation and with no moving parts are extremely reliable, requiring minimal maintenance. Auxiliary supplies are generally not required.

A naturally ventilated load resistor rated 86MW at 13.8kV installed in Canada and used for testing gas turbines.

Force cooled load banks

- Compact design
- Cost effective
- Optional infra-red thermal protection
- Any power rating

Cressall can offer force cooled load units. At higher powers these provide a cost effective and compact alternative to naturally cooled units. Acoustic attenuation can be provided to meet specified noise levels. Units are supplied with thermal sensors and air pressure switches for protection.

All units can be supplied with switchgear and instrumentation if required.

Rated 7MW at 13.8kV this force cooled load resistor is used for testing generators in Germany.

Force cooling or natural ventilation

Suitable for any power and any voltage (ac or dc)

Single or multiple sections

Versatility

Cressall engineers can select expanded mesh with any configuration of element length, cross-section, material thickness, banking arrangement and cooling method to suit the requirements of the application.

Expanded mesh resistors can be made from any suitable resistance material. As standard Nickel-chrome and iron-chrome-aluminium alloys are used. The selection is based upon cost, temperature coefficient of resistance and magnetic properties.

Excellent heat dissipation

Expanded mesh elements provide a very large surface area relative to mass, giving excellent heat transfer capabilities and making them ideal for continuous duties.

The active material, insulators and mountings on expanded mesh resistor elements are designed to maximise the use of convecting air for ventilation. An unrestricted path through the active material avoids 'hot spots' and local overheating.

Expanded mesh resistor elements cool from 600°C to almost ambient temperature in approximately one-eighth of the time taken by an average grid. This means that expanded mesh resistors are also suitable for continual 'on/off' cycles, making full use of the 'off' periods for rapid cooling.

Light weight

Expanded mesh elements and their mountings are lighter in weight per kilowatt than any other known type.

Negligible inductance

In tests up to 1MHz, expanded mesh resistor elements have been demonstrated as non-inductive for all normal practical purposes.

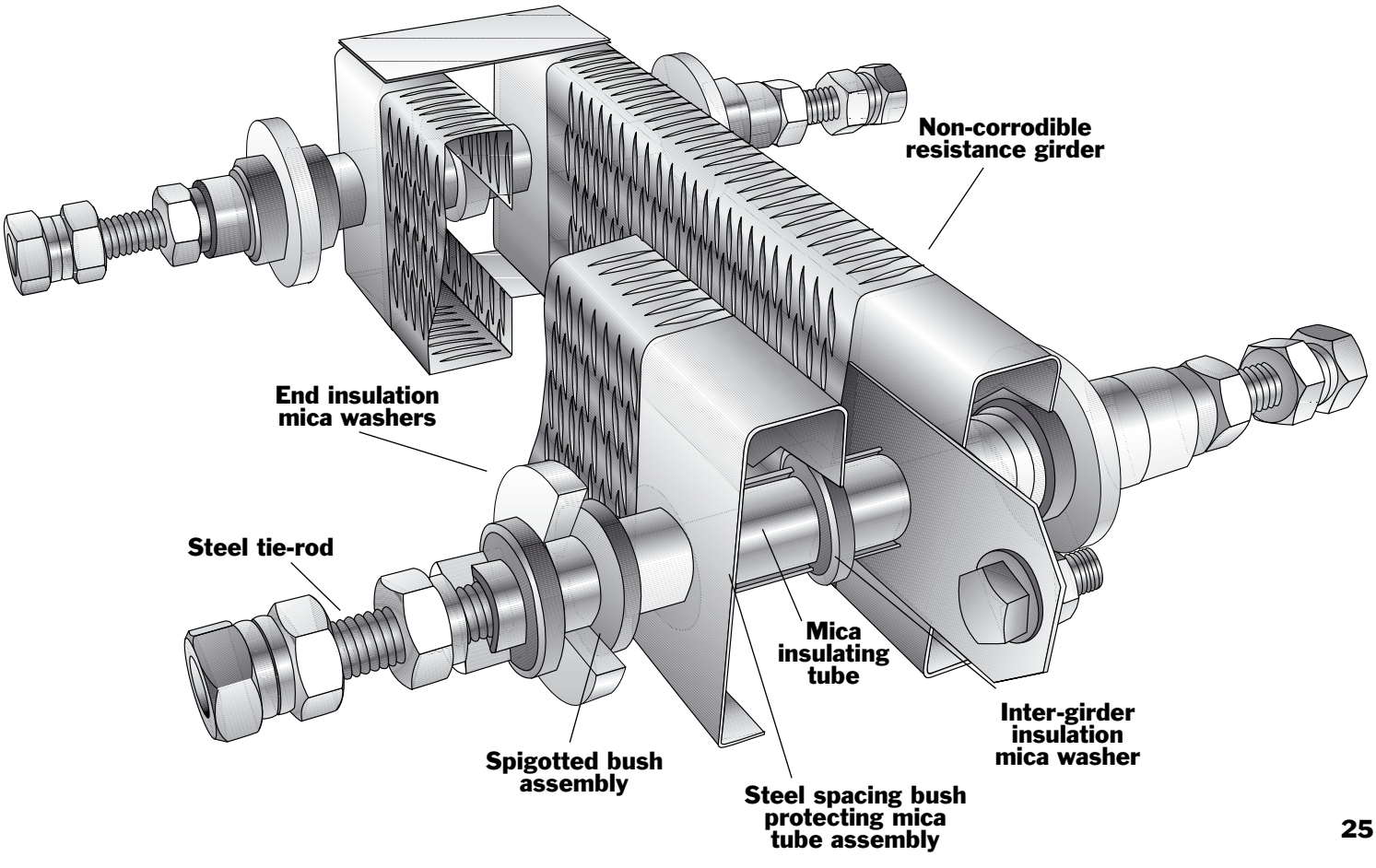
Durable construction

Expanded mesh elements are robust and capable of withstanding vibration, yet sufficiently flexible for shock absorption.

Elements have the advantage of fixed mountings: movement due to thermal expansion is absorbed within the mesh structure itself.

Although the heated part of the element and the metal supporting it are formed from a single sheet, heat is kept out of the mountings, terminations and supporting insulators to a much greater extent than with other designs.

Primary insulation consists of micanite tubes and mica washers. Secondary insulation consisting of ceramic insulators may be added to permit operation at any required voltage level.



EDGEWOUND RESISTORS

Edgewound coils

- Versatile and robust
- Good heat dissipation
- High overload capacity
- Standard coil sizes
- Standard banking designs

Cressall's edge-wound coiled strip resistors are an efficient way to package a large resistance mass into a small space. The high mass and robust design provides exceptional short-term overload capacity.

Applications include:

- Neutral earthing resistors
- Dynamic braking
- Motor starting and speed control
- Load testing

Construction

All styles are manufactured from a continuous stainless steel or copper-nickel strip wound edge-wise to form a coil which is then fitted on ridged ceramic insulators and supported on a central steel support strap.

Elements can be supplied either loose, as banked assemblies or mounted in a range of standard ventilated enclosures, according to customers requirements.

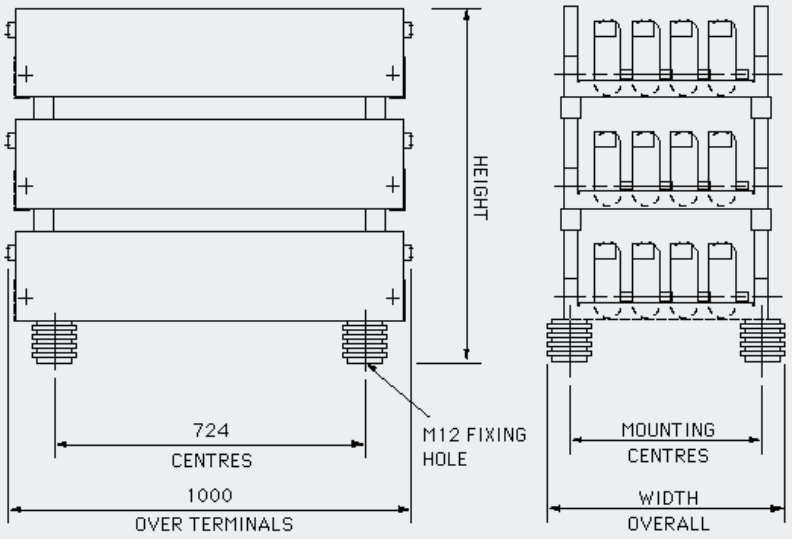
RP coils

Manufactured from an oval wound stainless steel strip the RP resistor is a very efficient method for packaging a large resistor mass in a small volume. One coil can hold up to 12kg of active resistor material. RP coils are most commonly used in neutral earthing and high energy motor control applications.

Supplied either as loose coils or in banks up to twelve coils wide and up to eight tiers high, they offer a high degree of versatility to fit within any specified envelope.

The resistor stacks are mounted on base insulators and are self-supporting and free standing. This means that they can be easily incorporated in to customers own enclosures when required.

Each coil is locked on to its supporting bank by clamps and all the electrical connections between elements are made by double bolted copper connections. This allows removal of an individual element from the assembly without disturbing the complete arrangement.



RP stack dimensions

No. of coils	Width overall (mm)	Mounting centres (mm)
3	456	354
4	548	446
5	642	540
6	728	626
9	1002	900
12	1278	1176

No. of tiers	Height (mm)
1	310
2	570
3	830
4	1090
5	1350
6	1610
7	1870
8	2130

ZO, ZC and CS coils

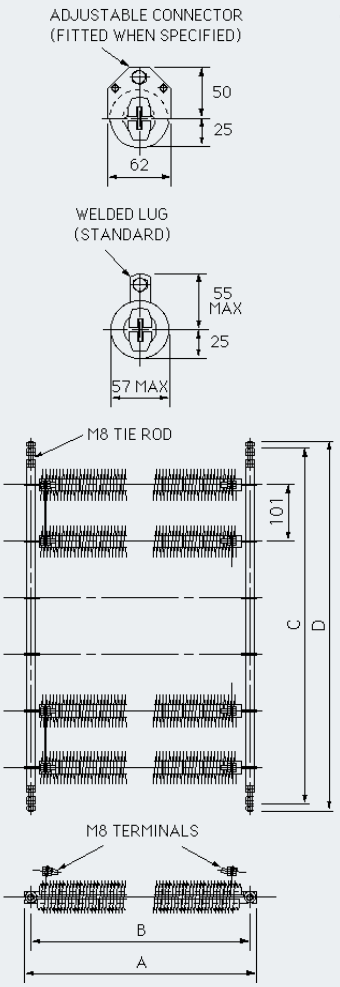
The ZO, ZC and CS styles of resistor are manufactured from edge wound stainless steel or copper-nickel strip. They offer a wide range of resistance values for medium current applications.

Units can either be supplied with fixed resistance taps or loose adjustable tapping clamps to allow customer selection of the appropriate ohmic value.

ZO coils

Insulated for operation up to 500V, ZO coils offer the versatility of 108 different designs, each of which can have its resistance set to any value below its maximum.

ZO coils can be supplied either loose, as banked assemblies or mounted in a range of standard ventilated enclosures, according to customers requirements.



ZO coil ratings

Style	Continuous current (A) for temperature rise of: 200°C	265°C	280°C	375°C	450°C	DC resistance (Ω) ±10% (20°C ambient) Z01	Z02	Z03	Z04	Z05	Z06	Z07	Z08	Z09
1	57	67	69	85	96	0.027	0.066	0.109	0.146	0.185	0.225	0.265	0.305	0.346
2	51	62	64	78	90	0.037	0.093	0.152	0.205	0.260	0.315	0.365	0.42	0.48
3	37	45	47	59	68	0.052	0.130	0.210	0.285	0.36	0.44	0.51	0.59	0.67
4	34	43	44	56	65	0.070	0.170	0.280	0.385	0.49	0.59	0.69	0.80	0.91
5	28	33	35	43	49	0.102	0.256	0.415	0.57	0.72	0.87	1.01	1.18	1.34
6	23	27	29	36	43	0.133	0.332	0.540	0.735	0.93	1.13	1.32	1.52	1.74
7	20	24	25	32	37	0.176	0.440	0.720	0.985	1.24	1.50	1.76	2.03	2.31
8	17	21	22	27	32	0.20	0.50	0.80	1.10	1.38	1.68	1.97	2.26	2.57
9	15	17	19	24	28	0.30	0.75	1.20	1.65	2.08	2.52	2.96	3.50	3.86
10	12	15	16	21	24	0.40	1.00	1.60	2.20	2.78	3.35	3.94	4.52	5.15
11	10	12	14	18	21	0.58	1.27	1.97	2.66	3.36	4.06	4.75	5.45	6.15
12	9	11	12	16	18	0.73	1.60	2.48	3.35	4.23	5.11	5.98	6.86	7.73

Types Z07, Z08 and Z09 are suitable for static equipment only

Dimensions (mm)

Coil length	Z01	Z02	Z03	Z04	Z05	Z06	Z07	Z08	Z09
A	115	190	265	340	410	485	560	635	710
B	95	170	245	320	390	465	540	615	690

Dimensions (mm)

No. of coils	2	3	4	5	6
C	228	330	431	533	635
D	254	355	457	558	660

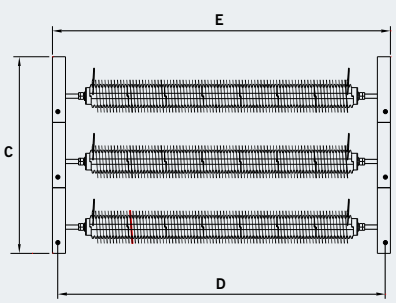
ZC coils

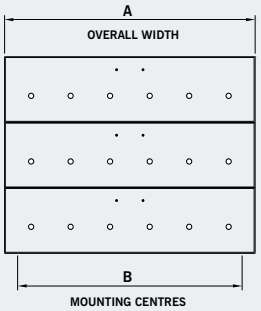
Designed for dynamic braking resistors ZC elements are similar in construction to the well established ZO range.

Supported on M8 threaded rod, ZC's are available in two lengths, they are insulated for operation at up to 800V and can be supplied loose, mounted between end plates or housed in one of our standard range of enclosures.

ZC coil ratings

Style	Continuous current (A) for temperature rise of: 200°C	265°C	280°C	375°C	450°C	DC resistance (Ω) ±10% (20°C ambient) ZC5	ZC7
1	57	67	69	85	96	0.185	0.265
2	51	62	64	78	90	0.260	0.365
3	37	45	47	59	68	0.36	0.51
4	34	43	44	56	65	0.49	0.69
5	28	33	35	43	49	0.72	1.01
6	23	27	29	36	43	0.93	1.32
7	20	24	25	32	37	1.24	1.76
8	17	21	22	27	32	1.38	1.97
9	15	17	19	24	28	2.08	2.96
10	12	15	16	21	24	2.78	3.94
11	10	12	14	18	21	3.36	4.75
12	9	11	12	16	18	4.23	5.98



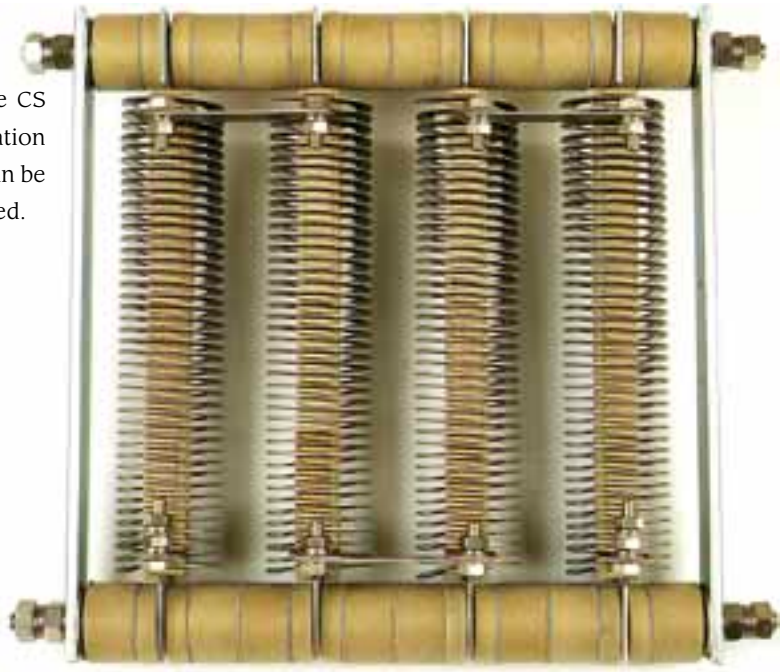


Dimensions (mm) 4 coils wide A	B	6 coils wide A	B	ZC5 D	E	ZC7 D	E
254	228	350	330	480	500	630	650

No of tiers	C
1	125
2	250
3	375

CS coils

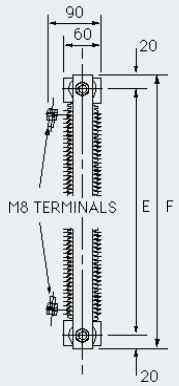
Developed for use in bank form the CS coil is as standard insulated for operation at 750V, the design is such that this can be increased to 1.5kV or 3.3kV if required.

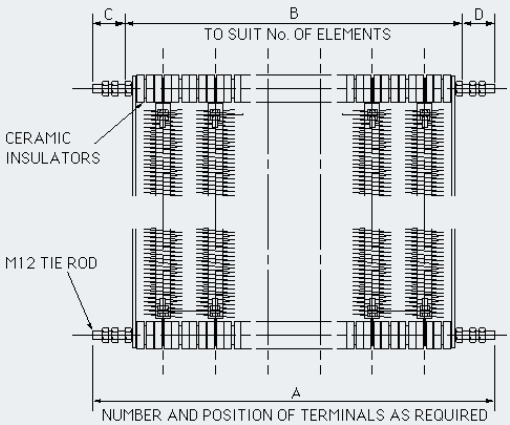


CS coil ratings

±10%	Continuous current (A) for temperature rise of:					DC resistance (Ω) (20°C ambient)		
Style	200°C	265°C	280°C	375°C	450°C	CS9	CS12	CS15
1	57	67	69	85	96	0.129	0.172	0.212
2	51	62	64	78	90	0.182	0.242	0.296
3	37	45	47	59	68	0.252	0.355	0.415
4	34	43	44	56	65	0.341	0.455	0.555
5	28	33	35	43	49	0.505	0.670	0.820
6	23	27	29	36	43	0.650	0.865	1.060
7	20	24	25	32	37	0.87	1.15	1.41
8	17	21	22	27	32	0.98	1.28	1.58
9	15	17	19	24	28	1.46	1.94	2.36
10	12	15	16	21	24	1.95	2.58	3.15
11	10	12	14	18	21	2.26	3.02	3.74
12	9	11	12	16	18	2.84	3.79	4.68

No. of elements	A	B
2	250	200
3	330	280
4	410	360
5	490	440
6	570	520
7	650	600
8	730	680
9	810	760
10	890	840





Additional dimensions (mm) for type CS

C: 25mm min.
D: 25mm min.
E: CS9 - 295mm. CS12 - 370mm. CS15 - 445mm.
F: CS9 - 335mm. CS12 - 410mm. CS15 - 485mm.
For 1.5kV primary insulation add 25mm to A & B dimensions.
For 3.3kV primary insulation add 75mm to A & B dimensions

Service grids

- **Modular**
- **Shock and vibration resistant**
- **Range of standard enclosures**
- **Specifically designed for motor control**

Service grids are a robust flat plate style of resistor manufactured from 304 grade stainless steel elements insulated using mica and welded together to form a continuous low inductance resistance path. Service grid resistors can be supplied as either open banks or housed in ventilated enclosures.

Every grid has punched holes within the welded contact section to give intermediate tapping points.

Enclosures

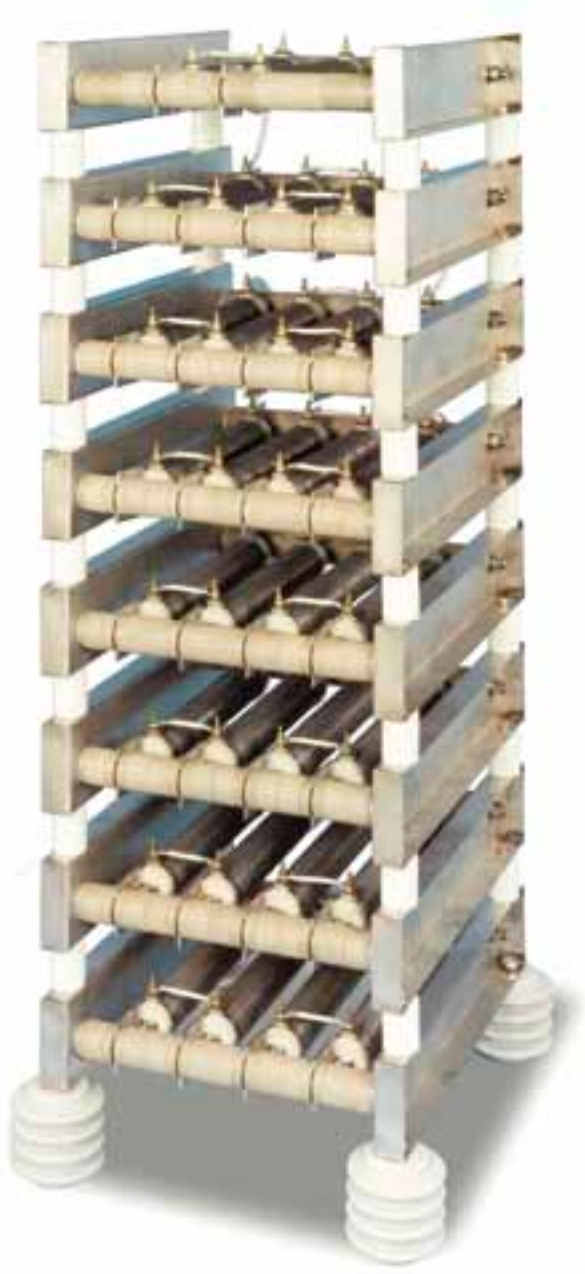
There are two standard enclosure styles for service grid resistors; Industrial Housings for general purpose applications and System 22 Housings designed for steel mills, this allows the replacement of individual banks without disturbing other banks in the enclosure.

Either type of enclosure can be supplied as painted mild steel, hot dip galvanized to BS729 or natural finish grade 304 stainless steel.

Coiled wire resistors

A compact and economical solution for high resistance and low power applications. Elements are manufactured using nickel-chrome or copper-nickel wound onto ceramic formers.

Elements can be supplied either loose, as banked assemblies or mounted in a range of standard ventilated enclosures, according to customers requirements.



GP resistor data

GP6/9 style no.	DC Ω ±10% @20°C GP6	DC Ω ±10% @20°C GP9	GP12 style no.	DC Ω ±10% @20°C GP12	Current ratings for 300°C temperature rise (A) Contin-uous	Short time rating (secs) 5	10	30
1	0.13	0.28	1	0.41	30	152	139	114
2	0.16	0.36	2	0.52	27	137	125	103
3	0.21	0.46	3	0.68	24	120	109	90
4	0.23	0.52	4	0.75	23	114	104	86
5	0.29	0.65	5	0.94	20	102	93	77
6	0.38	0.84	6	1.23	18	89	81	67
7	0.52	1.10	7	1.66	15	76	69	57
8	0.65	1.40	8	2.1	14	68	62	51
9	0.83	1.80	9	2.7	12	60	55	45
10	0.94	2.0	10	3.0	11	56	52	43
11	1.17	2.6	11	3.8	10	51	46	38
12	1.50	3.3	12	4.9	9	45	41	34
13	2.0	4.3	13	6.4	7.7	39	35	29
14	2.3	5.1	14	7.6	7.2	36	33	27
15	2.8	6.1	15	9.1	6.5	33	29	25
16	3.6	7.8	16	11.5	5.8	29	26	22
17	4.2	9.3	17	13.7	5.3	27	24	20
18	5.1	11.2	18	16.5	5.1	24	22	18
-	-	-	-	-	-	-	-	-
21	5.7	12.4	24	18.4	4.9	22	20	15
22	7.5	16.4	25	24.3	4.5	19	17	13
23	10.3	22.4	26	33	3.8	16	15	11
24	14.6	32	27	47	3.2	14	12	9.44
25	21.7	47	28	69	2.6	11	10	7.74
26	27	59	29	87	2.3	10	9.03	6.94
27	34	75	30	110	2.1	9.08	8.04	6.18
28	44	96	31	143	1.8	7.98	7.07	5.44
29	59	128	32	190	1.6	6.89	6.11	4.69
30	80	175	33	260	1.4	5.92	5.24	4.03
31	105	230	34	340	1.2	5.16	4.58	3.52
32	143	310	35	460	1.0	4.42	3.92	3.02
33	183	400	36	590	0.90	3.91	3.47	2.67
34	240	520	37	780	0.80	3.42	3.03	2.33
35	290	640	38	950	0.72	3.11	2.75	2.12
36	360	790	39	1170	0.65	2.79	2.47	1.90
37	450	990	40	1470	0.58	2.49	2.21	1.70
38	580	1260	41	1870	0.51	2.20	1.95	1.50
39	670	1460	42	2170	0.47	2.04	1.81	1.39
40	830	1800	43	2670	0.42	1.84	1.63	1.25
41	1030	2260	44	3360	0.38	1.65	1.46	1.12
42	1320	2880	45	4280	0.33	1.46	1.29	0.99
43	1740	-	-	-	0.29	1.27	1.12	0.86
44	2330	-	-	-	0.25	1.0	0.97	0.75
45	3130	-	-	-	0.21	0.95	0.84	0.64
46	4650	-	-	-	0.18	0.78	0.69	0.53
47	7500	-	-	-	0.14	0.61	0.54	0.42

GP coils

A well proven range of 125 units allows easy selection of the most appropriate resistor for the duty.

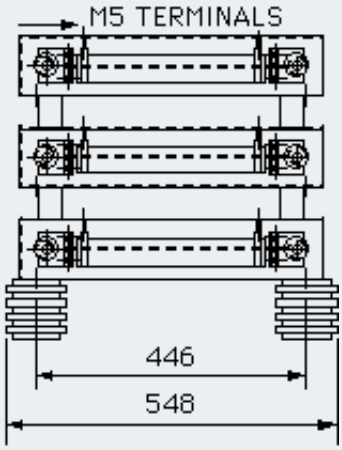
The coils are manufactured using nickel-chrome or copper-nickel alloys wound onto a solid ceramic former.

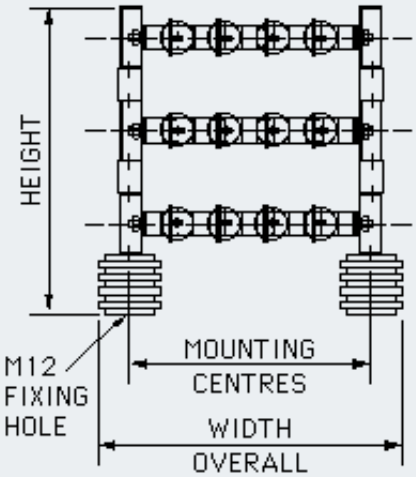
Each coil is supported on a flat steel bar which passes through the centre of the former and is secured by spring clips.

Adjustable tappings can be provided by adding one or more tapping bands.

Two types are available, standard and heavy duty, rated for continuous currents of up to 20A and 60A respectively.

Each tapping band shorts out the resistance wire it covers; the consequent reduction in value of the overall resistance of the unit is in the range of 1% to 4%, double for heavy duty tapping bands.



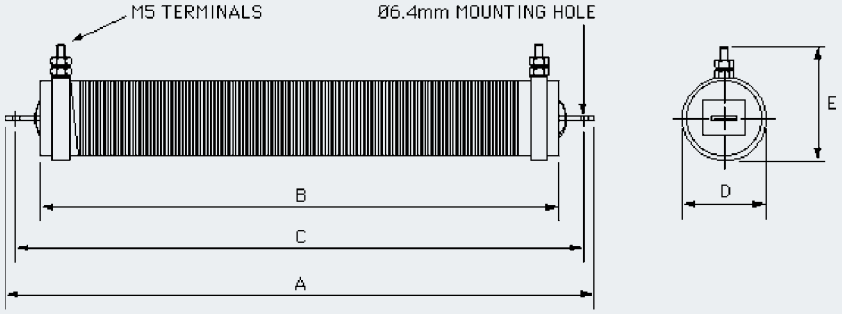


GP stack dimensions

No. of coils	Width overall (mm)	Mounting centres (mm)	No. of tiers	Height (mm)
1	266	164	1	200
2	344	242	2	351
3	423	321	3	502
4	501	399	4	653
5	580	478	5	804
6	658	556	6	955
7	737	635	7	1106
8	815	713	8	1257
9	894	792	9	1408
10	972	870	10	1559

GP resistor sizes (mm)

Unit	A	B	C	D	E
GP6	194	159	181	37	53
GP9	257	222	244	54	68
GP12	356	311	343	54	68



CC coils

The CC coiled coil resistor was developed mainly for use in dynamic braking. Its open wound coil arrangement allows operation at up to ten times its normal power rating for short periods while retaining quick cooling times.

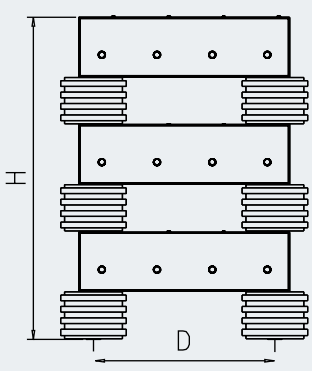
The CC coil is manufactured from a coil of nickel-chrome or copper-nickel alloy wound around a ceramic former, supported on M8 threaded rod. Up to three coils can be supported on one rod allowing easy series and parallel connection and installation.

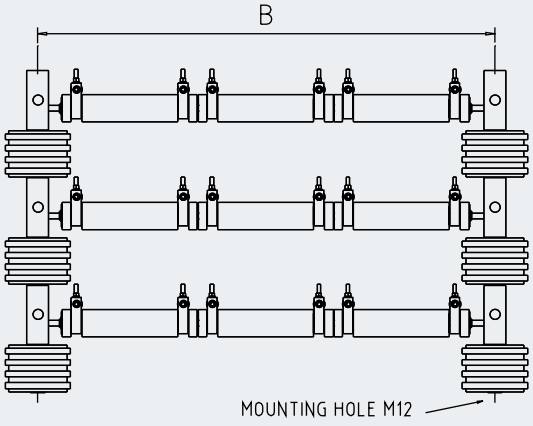
Dimensions (mm)

	3 wide B	3 wide D	4 wide B	4 wide D	No of tiers	H
1 coil long	260	200	260	250	**1**	150
2 coils long	440	200	440	250	**2**	300
3 coils long	630	200	630	250	**3**	450

CC coil rating

Coil type	Maximum resistance (Ω)±10% (@20°C ambient)	Continuous current, (A) for 600°C temp rise
CC8	5.0	10.00
CC9	8.0	7.90
CC10	10.0	7.07
CC11	17.0	5.42
CC12	25.0	4.47
CC13	35.0	3.78
CC14	55.0	3.00
CC15	70.0	2.67
CC16	100.0	2.24
CC17	130.0	1.96





REPLACEMENT RESISTORS

Cressall have been producing quality resistors for over 100 years. Our resistors have the reputation for both reliability and longevity. Over the years we have acquired other resistor companies and have successfully integrated their technology into our range. In many cases this means we have a library of technical and contract data to which we can refer.

We hold information on resistors previously supplied under the following names:

- **GEC Alsthom**
- **GEC Industrial Controls**
- **Eaton Cutler Hammer**
- **British Thompson Houston (BTH)**
- **AEI**
- **Fawcett Preston**
- **H. A. Birch**
- **Expamet**
- **E. A. Walshe**
- **BHI**
- **TPR Resistors**

We can also supply resistors that can be used to replace our competitors' products, this we can do providing we know the rating or the duty of the resistor involved.

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