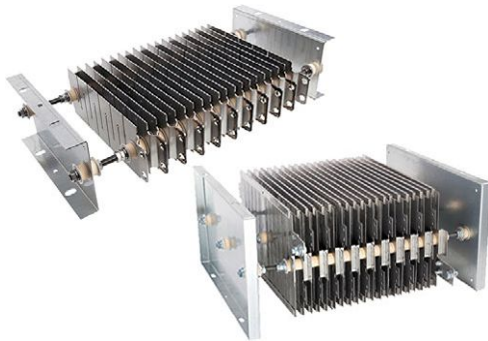




## High Power, High Current Grid Resistors, 1 kW and Larger



### FEATURES

- GRE1: high power capability to 7.8 kW at 40 °C
- GRE2: high power capability to 24 kW at 40 °C
- Standard indoor and outdoor enclosure options
- All welded construction with double insulation
- Modular or custom designs available
- Multiple terminal taps available
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT

### OVERVIEW

Vishay Milwaukee resistor offers a complete line of custom and standard grid resistors (GRE1 and GRE2), also known as steel grid, punched grid and plate resistors. With a robust all welded construction, Milwaukee resistor grid resistors are designed using stainless steel resistance elements to absorb high energy pulses, repeatedly.

### APPLICATIONS OF GRID RESISTORS

#### Dynamic Braking

When an electric motor driven load is being decelerated, the motor acts as a generator, converting kinetic energy of the load to electrical energy. The dynamic braking circuit converts this electrical energy into heat to slow the load, through the use of dynamic braking resistors. Braking resistors ensure proper motor operation, allow heavy loads to stop quickly and protect the drive from damage. Furthermore, dynamic braking resistors that are improperly cooled, incorrectly sized, physically damaged or electrically failed can cause costly unwanted down time.

#### Harmonic Filters

Within a harmonic filter installation the filter resistors are used to dissipate unwanted harmonic frequencies as heat.

#### Load Banks

Custom designed resistive load banks allow for load simulation of many electrical applications for testing purposes.

### CONTACT THE FACTORY FOR CUSTOM DESIGN AND OPTIONS FOR STANDARD DESIGN

Options include: custom mounting configurations, custom IP rated enclosures, element size / shape, power, multiple resistors in a single enclosure, etc.

For custom designs please include: duty cycle, total power and resistance and mounting requirements.

### CONTACT INFORMATION

For design assistance, contact: [vishaymilwaukeeeresistor@vishay.com](mailto:vishaymilwaukeeeresistor@vishay.com)



STANDARD ELECTRICAL SPECIFICATIONS					
GLOBAL MODEL	POWER RATING OF RESISTOR BANK W	RESISTANCE RANGE Ω	TOLERANCE ± %	TEMPERATURE COEFFICIENT (1) ± ppm/°C	GLOBAL PART NUMBER (2)
GRE1	1300	0.02 to 6.9	10	± 365	GRE1AxxxxxK00N0000
GRE1	1950	0.03 to 10.3	10	± 365	GRE1BxxxxxK00N0000
GRE1	2600	0.04 to 13.8	10	± 365	GRE1CxxxxxK00N0000
GRE1	3250	0.05 to 17.2	10	± 365	GRE1DxxxxxK00N0000
GRE1	3900	0.06 to 20.7	10	± 365	GRE1ExxxxxK00N0000
GRE1	4550	0.07 to 24.1	10	± 365	GRE1FxxxxxK00N0000
GRE1	5200	0.08 to 27.5	10	± 365	GRE1GxxxxxK00N0000
GRE1	5850	0.09 to 31	10	± 365	GRE1HxxxxxK00N0000
<b>GRE1</b>	<b>6500</b>	<b>0.1 to 34.4</b>	<b>10</b>	± 365	<b>GRE1JxxxxxK00N0000</b>
GRE1	7150	0.11 to 37.8	10	± 365	GRE1KxxxxxK00N0000
GRE1	7800	0.12 to 41.3	10	± 365	GRE1LxxxxxK00N0000
GRE2	4000	0.04 to 28	10	± 365	GRE2AxxxxxK00N0000
GRE2	6000	0.06 to 42	10	± 365	GRE2BxxxxxK00N0000
GRE2	8000	0.08 to 56	10	± 365	GRE2CxxxxxK00N0000
GRE2	10 000	0.1 to 70	10	± 365	GRE2DxxxxxK00N0000
GRE2	12 000	0.12 to 84	10	± 365	GRE2ExxxxxK00N0000
GRE2	14 000	0.14 to 98	10	± 365	GRE2FxxxxxK00N0000
GRE2	16 000	0.16 to 112	10	± 365	GRE2GxxxxxK00N0000
GRE2	18 000	0.18 to 126	10	± 365	GRE2HxxxxxK00N0000
<b>GRE2</b>	<b>20 000</b>	<b>0.2 to 140</b>	<b>10</b>	± 365	<b>GRE2JxxxxxK00N0000</b>
GRE2	22 000	0.22 to 154	10	± 365	GRE2KxxxxxK00N0000
GRE2	24 000	0.24 to 168	10	± 365	GRE2LxxxxxK00N0000

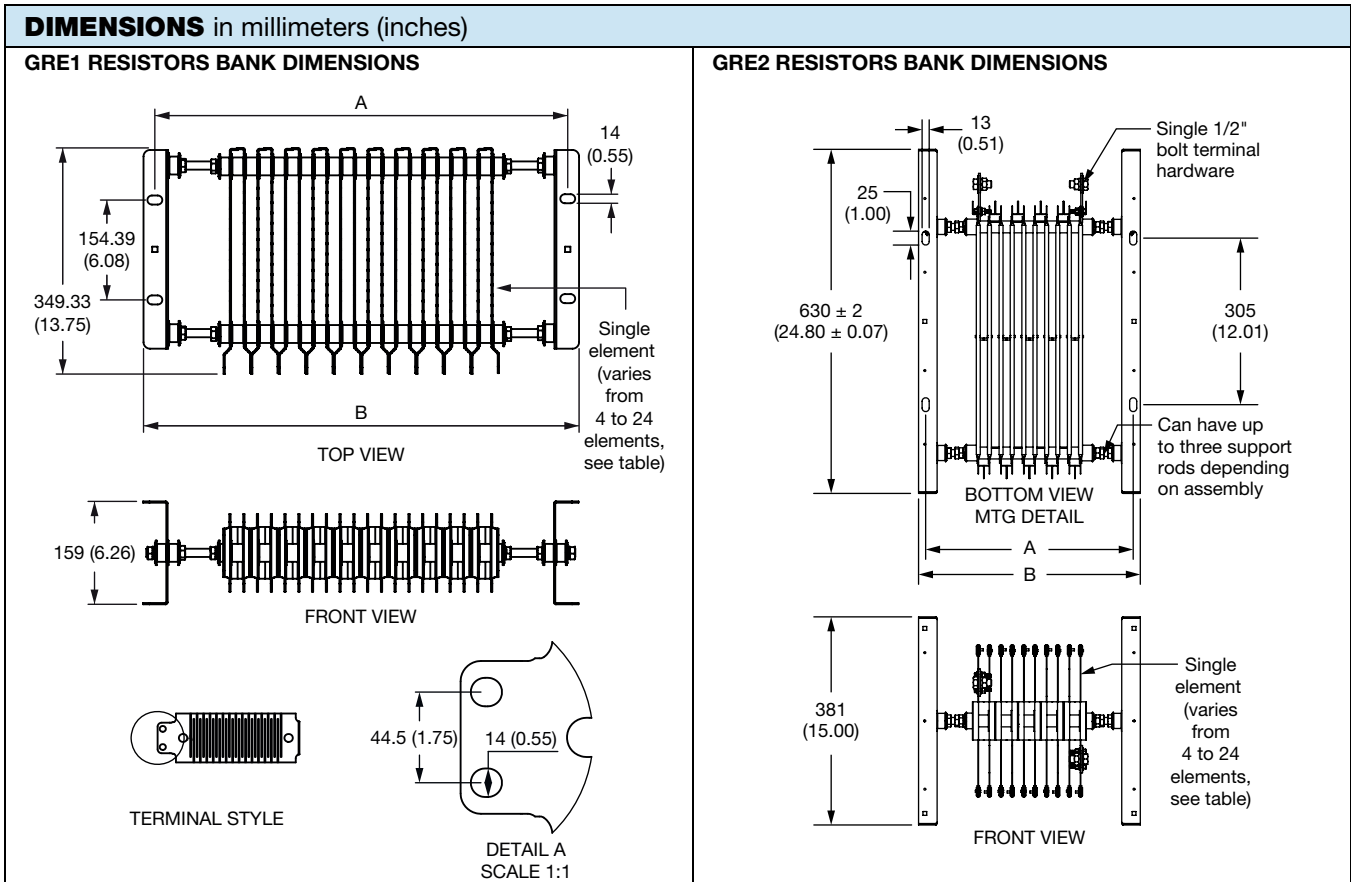
**Notes**

- Listed ratings are for individual resistor banks only. Multiple resistor banks can be combined to achieve resultant power ratings of up to 100 kW+
- Standard resistor banks are highlighted in bold
- (1) Temperature coefficient of ± 930 is available upon request and used for some designs where TCR is not a critical factor
- (2) xxxxx in global part number represents the resistance, e.g. 1R500 = 1.5 Ω

STANDARD GRE1 "MILL BANK" DESIGNS							
GLOBAL MODEL	HISTORICAL MODEL	RESISTANCE Ω	CURRENT A	GLOBAL MODEL	HISTORICAL MODEL	RESISTANCE Ω	CURRENT A
Contact factory for quote	-	0.02	525	GRE1JR6480K00N0000	MRCG-23	0.648	100
Contact factory for quote	-	0.024	520	Contact factory for quote	-	0.705	95
Contact factory for quote	-	0.028	480	GRE1JR7560K00N0000	MRCG-24	0.756	90
Contact factory for quote	-	0.034	440	Contact factory for quote	-	0.85	85
Contact factory for quote	-	0.042	400	GRE1JR9000K00N0000	MRCG-25	0.9	85
Contact factory for quote	-	0.048	370	GRE1J1R000K00N0000	MRCG-26	1	80
Contact factory for quote	-	0.059	330	Contact factory for quote	MRCG-27	1.2	73
Contact factory for quote	-	0.074	300	GRE1J1R400K00N0000	MRCG-28	1.4	65
Contact factory for quote	-	0.087	275	GRE1J1R550K00N0000	MRCG-29	1.55	65
Contact factory for quote	-	0.099	255	GRE1J1R798K00N0000	MRCG-30	1.798	60
Contact factory for quote	-	0.115	235	Contact factory for quote	-	1.82	60
Contact factory for quote	-	0.148	210	Contact factory for quote	-	2.02	57
GRE1JR1600K00N0000	MRCG-13	0.16	200	GRE1J2R128K00N0000	MRCG-31	2.128	55
GRE1JR1820K00N0000	MRCG-14	0.182	185	GRE1J2R600K00N0000	MRCG-32	2.6	50
GRE1JR2170K00N0000	MRCG-15	0.217	185	Contact factory for quote	-	2.94	47
Contact factory for quote	-	0.24	165	GRE1J3R224K00N0000	MRCG-33	3.224	45
GRE1JR2450K00N0000	MRCG-16	0.245	170	Contact factory for quote	-	3.92	40
Contact factory for quote	-	0.267	160	GRE1J3R968K00N0000	MRCG-34	3.968	40
GRE1JR2770K00N0000	MRCG-17	0.277	150	GRE1J5R100K00N0000	MRCG-35	5.1	35
GRE1JR3240K00N0000	MRCG-18	0.324	155	Contact factory for quote	-	6.16	32
GRE1JR3600K00N0000	MRCG-19	0.36	140	GRE1J6R592K00N0000	MRCG-36	6.592	30
GRE1JR4160K00N0000	MRCG-20	0.416	135	Contact factory for quote	-	7.8	28
Contact factory for quote	-	0.421	120	GRE1J8R192K00N0000	MRCG-37	8.192	28
Contact factory for quote	-	0.468	125	Contact factory for quote	-	9.36	26
GRE1JR4780K00N0000	MRCG-21	0.478	115	GRE1J10R24K00N0000	MRCG-38	10.24	25
GRE1JR5520K00N0000	MRCG-22	0.552	110	GRE1J12R88K00N0000	MRCG-39	12.88	20
Contact factory for quote	-	0.608	100	GRE1J15R46K00N0000	MRCG-40	15.456	18

**Note**

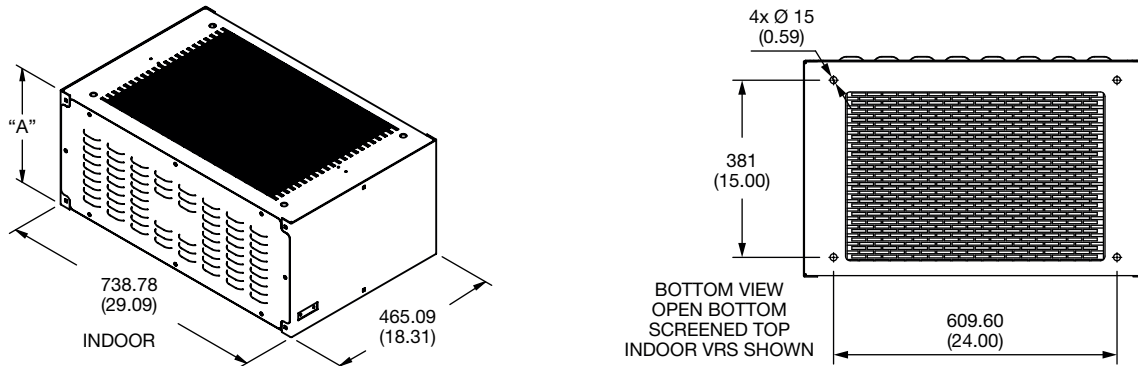
- Listed ratings are for individual resistor banks only. Multiple resistor banks can be combined to achieve resultant power ratings of up to 100 kW+



MODEL	POWER RATING OF RESISTOR BANK W	TOTAL NUMBER OF ELEMENTS IN EACH BANK	A HOLE CENTER	B OVERALL LENGTH	MAX. WEIGHT kg	GLOBAL PART NUMBER
GRE1	1300	4	269.8 (10.6)	304.8 (12.0)	7	GRE1AxxxxK00N0000
GRE1	1950	6	269.8 (10.6)	304.8 (12.0)	9	GRE1BxxxxK00N0000
GRE1	2600	8	269.8 (10.6)	304.8 (12.0)	10	GRE1CxxxxK00N0000
GRE1	3250	10	371.4 (14.6)	406.4 (16.0)	12	GRE1DxxxxK00N0000
GRE1	3900	12	371.4 (14.6)	406.4 (16.0)	14	GRE1ExxxxxK00N0000
GRE1	4550	14	473 (18.6)	508 (20.0)	15	GRE1FxxxxK00N0000
GRE1	5200	16	473 (18.6)	508(20.0)	17	GRE1GxxxxK00N0000
GRE1	5850	18	637 (25.12)	672 (26.50)	18	GRE1HxxxxK00N0000
<b>GRE1</b>	<b>6500</b>	<b>20</b>	<b>637 (25.12)</b>	<b>672 (26.50)</b>	<b>20</b>	<b>GRE1JxxxxK00N0000</b>
GRE1	7150	22	637 (25.12)	672 (26.50)	22	GRE1KxxxxK00N0000
GRE1	7800	24	637 (25.12)	672 (26.50)	24	GRE1LxxxxK00N0000
GRE2	4000	4	269.8 (10.6)	304.8 (12.0)	15	GRE2AxxxxK00N0000
GRE2	6000	6	269.8 (10.6)	304.8 (12.0)	19	GRE2BxxxxK00N0000
GRE2	8000	8	269.8 (10.6)	304.8 (12.0)	23	GRE2CxxxxK00N0000
GRE2	10 000	10	371.4 (14.6)	406.4 (16.0)	27	GRE2DxxxxK00N0000
GRE2	12 000	12	371.4 (14.6)	406.4 (16.0)	32	GRE2ExxxxxK00N0000
GRE2	14 000	14	473 (18.6)	508 (20.0)	36	GRE2FxxxxK00N0000
GRE2	16 000	16	473 (18.6)	508(20.0)	41	GRE2GxxxxK00N0000
GRE2	18 000	18	637 (25.12)	672 (26.50)	45	GRE2HxxxxK00N0000
<b>GRE2</b>	<b>20 000</b>	<b>20</b>	<b>637 (25.12)</b>	<b>672 (26.50)</b>	<b>49</b>	<b>GRE2JxxxxK00N0000</b>
GRE2	22 000	22	637 (25.12)	672 (26.50)	53	GRE2KxxxxK00N0000
GRE2	24 000	24	637 (25.12)	672 (26.50)	58	GRE2LxxxxK00N0000

**Notes**

- The power rating of each bank is directly related to the number of elements in the resistor, this means the length and weight of the resistor will vary by power rating. Please consult the table above for the relevant length and weight of the grid resistor to be quoted
- Standard resistor banks are highlighted in bold

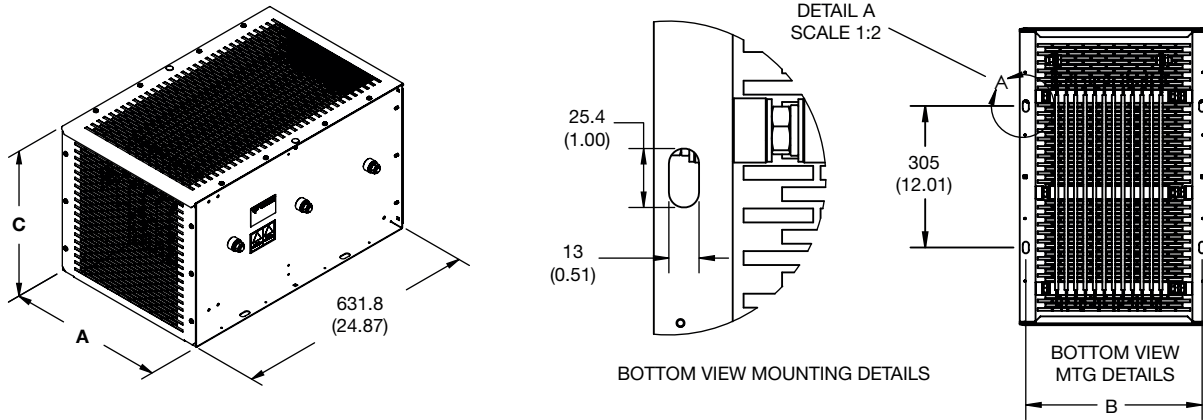
**GRE1 STANDARD ENCLOSURE OPTIONS AND DIMENSIONS** in millimeters (inches)


Indoor (IP20) version shown. Outdoor (IP23) version will have a solid elevated roof instead of the screen top shown for the indoor version.

MODEL	ENCLOSURE HEIGHT (NUMBER OF RESISTOR BANKS)	TOTAL POWER CAPACITY OF ENCLOSURES	ENCLOSURE TYPE	IP RATING	A	STANDARD MATERIAL <sup>(1)</sup>
GRE1	1	6.5 kW	Indoor rated	20	315.0 (12.4)	Mill galvanized
GRE1	1	6.5 kW	Outdoor rated	23	355.6 (14.0)	Mill galvanized
GRE1	2	13 kW	Indoor rated	20	543.6 (21.4)	Mill galvanized
GRE1	2	13 kW	Outdoor rated	23	584.2 (23.0)	Mill galvanized
GRE1	3	19.5 kW	Indoor rated	20	772.2 (30.4)	Mill galvanized
GRE1	3	19.5 kW	Outdoor rated	23	812.8 (32.0)	Mill galvanized
GRE1	4	26 kW	Indoor rated	20	1000.8 (39.4)	Mill galvanized
GRE1	4	26 kW	Outdoor rated	23	1041.4 (41.0)	Mill galvanized
GRE1	5	32.5 kW	Indoor rated	20	1229.4 (48.4)	Mill galvanized
GRE1	5	32.5 kW	Outdoor rated	23	1270.0 (50.0)	Mill galvanized
GRE1	6	39 kW	Indoor rated	20	1458.0 (57.4)	Mill galvanized
GRE1	6	39 kW	Outdoor rated	23	1498.6 (59.0)	Mill galvanized
GRE1	7	45.5 kW	Indoor rated	20	1686.6 (66.4)	Mill galvanized
GRE1	7	45.5 kW	Outdoor rated	23	1727.2 (68.0)	Mill galvanized
GRE1	8	52 kW	Indoor rated	20	1915.2 (75.4)	Mill galvanized
GRE1	8	52 kW	Outdoor rated	23	1956.0 (77.0)	Mill galvanized

**Notes**

- Contact factory for any special requests or enclosure requirements: [vishaymilwaukeeeresistor@vishay.com](mailto:vishaymilwaukeeeresistor@vishay.com)
- (1) Stainless steel material option upon request

**GRE2 STANDARD ENCLOSURE OPTIONS AND DIMENSIONS** in millimeters (inches)


Indoor (IP20) version shown. Outdoor (IP23) version will have a solid elevated roof instead of the screen top shown for the indoor version.

MODEL	ENCLOSURE HEIGHT (NUMBER OF RESISTOR BANKS)	TOTAL NUMBER OF ELEMENTS IN EACH BANK	IP RATING	A	B	C	STANDARD MATERIAL (1)
GRE2	1	12	20	406 (16)	380 (14)	382 (15)	Mill galvanized
GRE2	1	12	23	406 (16)	380 (14)	406 (16)	Mill galvanized
GRE2	1	16	20	508 (20)	382 (15)	382 (15)	Mill galvanized
GRE2	1	16	23	508 (20)	382 (15)	406 (16)	Mill galvanized
GRE2	1	22	20	673 (26.5)	647 (25.5)	382 (15)	Mill galvanized
GRE2	1	22	23	673 (26.5)	647 (25.5)	406 (16)	Mill galvanized
GRE2	2	12	20	406 (16)	380 (13.95)	764 (30)	Mill galvanized
GRE2	2	12	23	406 (16)	380 (13.95)	800 (31.5)	Mill galvanized
GRE2	2	16	20	508 (20)	482 (19)	764 (30)	Mill galvanized
GRE2	2	16	23	508 (20)	482 (19)	800 (31.5)	Mill galvanized
GRE2	2	22	20	673 (26.5)	647 (25.5)	764 (30)	Mill galvanized
GRE2	2	22	23	673 (26.5)	647 (25.5)	800 (31.5)	Mill galvanized
GRE2	3	12	20	406 (16)	380 (13.95)	1143 (45)	Mill galvanized
GRE2	3	16	20	508 (20)	482 (19)	1143 (45)	Mill galvanized
GRE2	3	22	20	673 (26.5)	647 (25.5)	1143 (45)	Mill galvanized

**Notes**

- Contact factory for any special requests or enclosure requirements: [vishaymilwaukeeeresistor@vishay.com](mailto:vishaymilwaukeeeresistor@vishay.com)
- (1) Stainless steel material option upon request



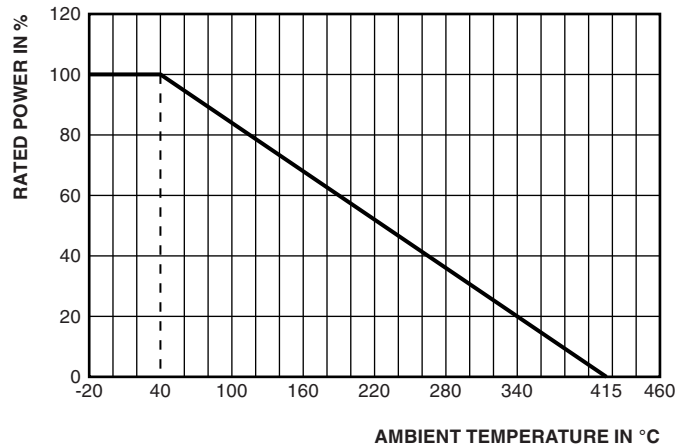
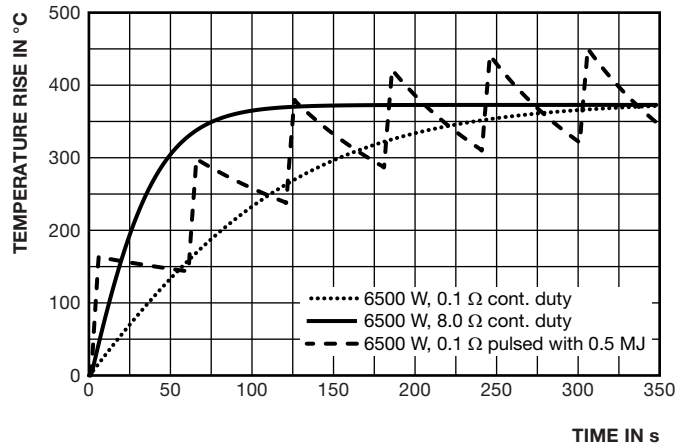
RECOGNIZED STANDARDS				
PRODUCT SERIES	POWER W	MIN. RESISTANCE $\Omega$	MAX. RESISTANCE $\Omega$	ENCLOSURE RATING
GRE1	1300	0.02	6	IP00, IP20, IP23
GRE1	1950	0.03	9	IP00, IP20, IP23
GRE1	2600	0.04	12	IP00, IP20, IP23
GRE1	3250	0.05	15	IP00, IP20, IP23
GRE1	3900	0.06	18	IP00, IP20, IP23
GRE1	4550	0.07	21	IP00, IP20, IP23
GRE1	5200	0.08	24	IP00, IP20, IP23
GRE1	5850	0.09	27	IP00, IP20, IP23
GRE1	6500	0.1	30	IP00, IP20, IP23

TECHNICAL SPECIFICATIONS		
PARAMETER	UNIT	RESISTOR CHARACTERISTICS
Power rating	W	1.3K to 24K per resistor load bank (up to 100K+ for assemblies)
Resistance range	$\Omega$	GRE1 with $\pm 365$ TCR: 0.02 to 36 GRE1 with $\pm 930$ TCR: 0.02 to 16 GRE2 with $\pm 365$ TCR: 0.03 to 110 GRE2 with $\pm 930$ TCR: 0.04 to 60
Resistance tolerance	%	10
TCR	ppm/ $^{\circ}$ C	$\pm 365$ , $\pm 930$
Operating temperature	$^{\circ}$ C	-55 to +415
Temperature rise	$^{\circ}$ C	375 above an ambient of 40 $^{\circ}$ C
Maximum altitude	f.a.s.l. (m.a.s.l.)	Derate above 4921 f.a.s.l. (1500 m.a.s.l.)
Short-term overload (surge)		25 x, 15 x, or 10 x rated power for 5 s (varies by wattage)
Maximum working voltage	V	$(P \times R)^{1/2}$
Insulation resistance	$\Omega$	1M
Dielectric voltage	V <sub>RMS</sub>	2500 for 60 s
Creepage	inch (mm)	1.18 (30) typical
Inductance	$\mu$ H	GRE1: 5 to 50 GRE2: 30 to 150 (varies by wattage and resistance)
Electrical or mechanical customization		Consult factory: <a href="mailto:vishaymilwaukeeeresistor@vishay.com">vishaymilwaukeeeresistor@vishay.com</a>



APPLICATION FORMS AND TECHNICAL INFORMATION	
APPLICATION FORMS	WEB LINK
Harmonic Filter Resistors	<a href="http://www.vishay.com/doc?49889">www.vishay.com/doc?49889</a>
Load Bank Resistors	<a href="http://www.vishay.com/doc?49893">www.vishay.com/doc?49893</a>
Dynamic Braking Resistors	<a href="http://www.vishay.com/doc?49887">www.vishay.com/doc?49887</a>
Neutral Grounding Resistors	<a href="http://www.vishay.com/doc?49904">www.vishay.com/doc?49904</a>
APPLICATION NOTES	WEB LINK
Determining Nominal Resistance	<a href="http://www.vishay.com/doc?21044">www.vishay.com/doc?21044</a>
Understanding Load Steps and Resolution	<a href="http://www.vishay.com/doc?21045">www.vishay.com/doc?21045</a>
Understanding Tied Live Designs	<a href="http://www.vishay.com/doc?21043">www.vishay.com/doc?21043</a>
OTHER RESISTORS	WEB LINK
Wirewound Resistors Guide	<a href="http://www.vishay.com/doc?49654">www.vishay.com/doc?49654</a>

GLOBAL PART NUMBER INFORMATION																							
Resistor only: GRE1J2R128K00N0000 (GRE1 6500 W 2.128 Ω 10 % IP00)																							
Resistor with two high IP20 enclosure: GRE1J2R128K2020000 (GRE1 13 000 W 2.128 Ω 10 % 2-IP20)																							
Custom resistor with enclosure: GRE2J2R128K2021111 (GRE2-1111 40 000 W 2.128 Ω 10 % 2-IP20)																							
<table style="width:100%; text-align:center; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; padding: 2px;">G</td> <td style="border: 1px solid black; padding: 2px;">R</td> <td style="border: 1px solid black; padding: 2px;">E</td> <td style="border: 1px solid black; padding: 2px;">1</td> <td style="border: 1px solid black; padding: 2px;">A</td> <td style="border: 1px solid black; padding: 2px;">2</td> <td style="border: 1px solid black; padding: 2px;">R</td> <td style="border: 1px solid black; padding: 2px;">1</td> <td style="border: 1px solid black; padding: 2px;">2</td> <td style="border: 1px solid black; padding: 2px;">8</td> <td style="border: 1px solid black; padding: 2px;">K</td> <td style="border: 1px solid black; padding: 2px;">0</td> <td style="border: 1px solid black; padding: 2px;">0</td> <td style="border: 1px solid black; padding: 2px;">N</td> <td style="border: 1px solid black; padding: 2px;">0</td> <td style="border: 1px solid black; padding: 2px;">0</td> <td style="border: 1px solid black; padding: 2px;">0</td> <td style="border: 1px solid black; padding: 2px;">0</td> </tr> </table>						G	R	E	1	A	2	R	1	2	8	K	0	0	N	0	0	0	0
G	R	E	1	A	2	R	1	2	8	K	0	0	N	0	0	0	0						
GLOBAL MODEL (5 digits)	RESISTANCE VALUE (5 digits)	TOLERANCE (1 digit)	ENCLOSURE TYPE (2 digits)	ENCLOSURE HEIGHT (1 digit)	SPECIAL (4 digits)																		
<b>GRE1A to GRE1L</b> or <b>GRE2A to GRE2L</b>  per Electrical Table on page 2	<b>2R128</b> = 2.128 Ω  R = decimal resistance value is for each individual resistor bank.	<b>K</b> = ± 10 %  Tolerance value is for each individual resistor bank.	<b>IPxx</b> = IP rating  <b>00</b> = IP00 / NEMA 0 (Open) <b>20</b> = IP20 / NEMA 1 (Screen) <b>23</b> = IP23 / NEMA 3 (Outdoor)	<b>N</b> = no enclosure (standard)  See GRE1 and GRE2 Enclosure Dimensions table for number.  Assumes all resistor banks to be identical per first 11 digits of part number and all resistors will be customer wired as required.	<b>0000</b> = standard  Engineering controlled internal document number																		

**DERATING CURVE**

**TEMPERATURE RISE OVER AMBIENT**


Standard GRE1Jxxxxx 6500 W grid banks are rated with max. design temperature rise of 375 °C over an ambient.

**Continuous Duty Application with Constant Voltage Applied to Resistor**

Solid line - GRE1J8R000K00N0000 standard 6500 W, 8 Ω resistor bank

Dotted line - GRE1JR1000K00N0000 standard 6500 W, 0.1 Ω resistor bank

Graph shows the peak element temperature is reached between 100 s and 400 s depending on active mass of material used to achieve the desired resistance. Different rates of heating occur depending on the active mass used in the design.

**Pulse Application with Non-Constant Voltage Applied to Resistor**

Dashed line - GRE1JR1000K00N0000 standard 6500 W, 0.1 Ω resistor bank

Graph shows the peak element temperature of about 450 °C over ambient is reached with an average continuous duty temperature of 375 °C over ambient when a continuous voltage 0.5 MJ energy pulse is applied to the resistor for 5 s once every minute, cycled continuously. Average temperature at continuous cycling is 375 °C (peaks above and below).

**MATERIAL SPECIFICATIONS**

Plate element	Stainless steel
Insulators	Ceramica / alumina / mica
Mounting frame	Mill galvanized steel (stainless steel available upon request)





## Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.