SIGIS

RESONANT

5-500 pF

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- DESIGN GUIDELINES
- OPERATING & MAINTENANCE

CLICK ON ABOVE TO INTERACT WITH THE MODEL

RVVLA-3-500-57 SPECIFICATIONS

VACUUM CAPACITOR	VARIABLE
CAPACITY Cmax (NOMINAL)	500 pF
CAPACITY Cmin (NOMINAL)	5 pF
VOLTAGE PEAK TEST Vpt	5 kV
VOLTAGE PEAK WORKING Vpw	3 kV
CAPACITY TRACKING TOLERANCE	10%
MAXIMUM CURRENT @ 13.56 MHz WITH CONDUCTIVE COOLING 10W	≤ 57 Arms
CAPACITANCE PER TURN	29.1 pF / TURN, lifetime reduced below 10% travel
ACTIVE TURNS	17
MAXIMUM TORQUE	≤ 0.15 Nm
HEIGHT	148 mm / 5.83”
DIAMETER	55 mm / 2.17”
NET WEIGHT	0.5 kg / 1.1 lbs.

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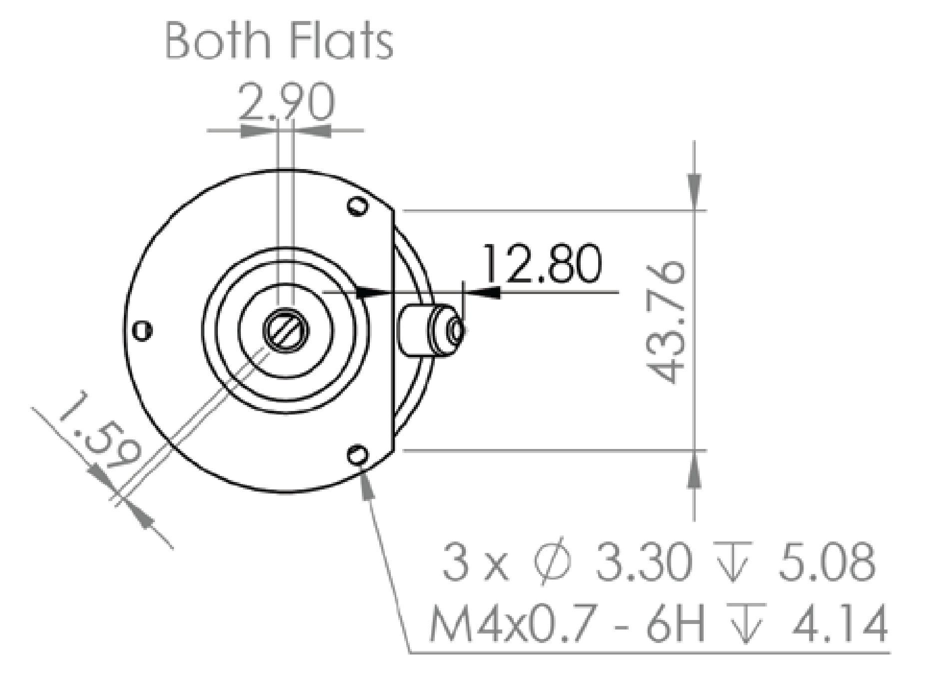
MECHANICAL DRAWINGS

TOP VIEW

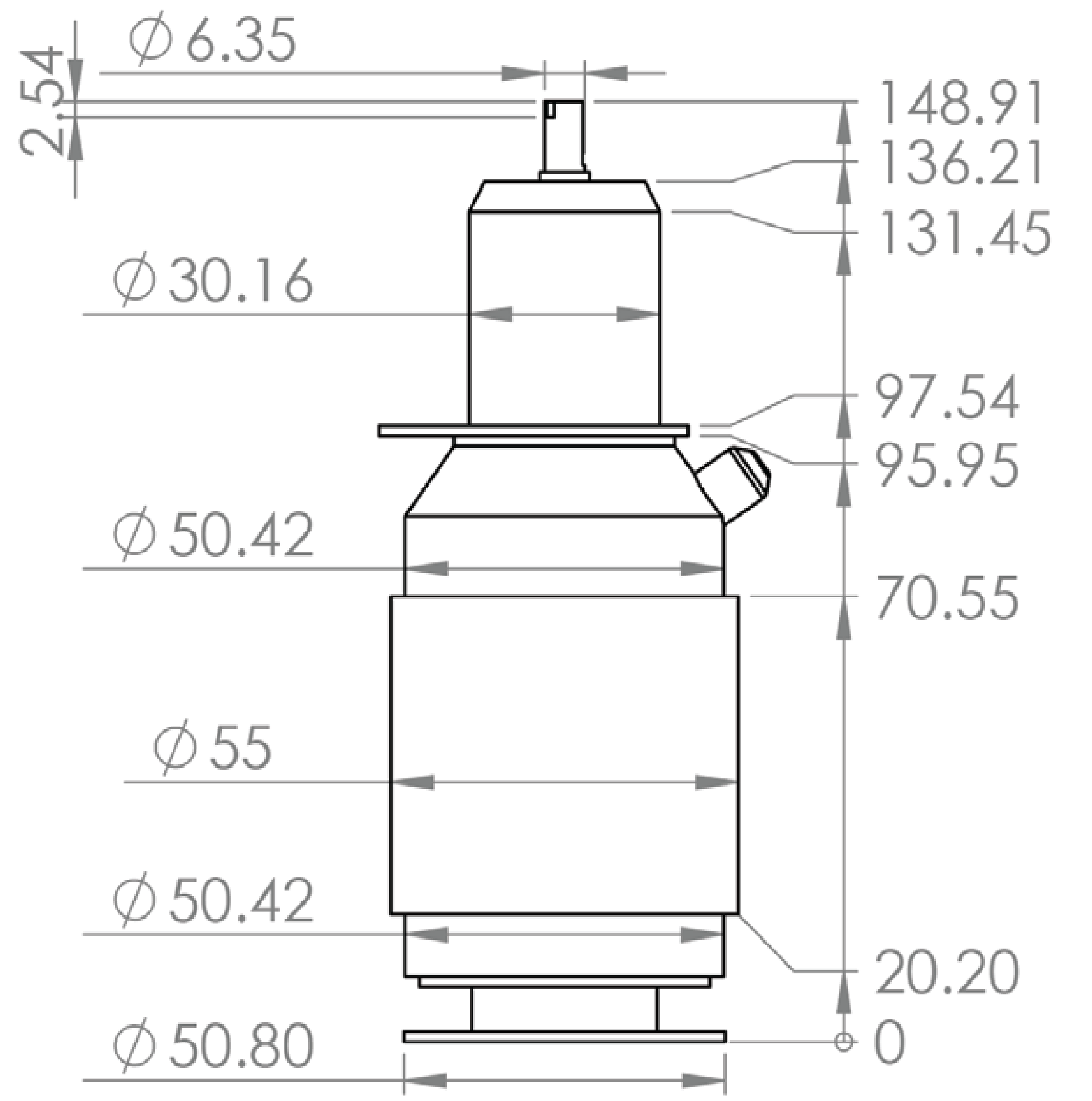


DIMENSIONS ARE IN MILLIMETERS

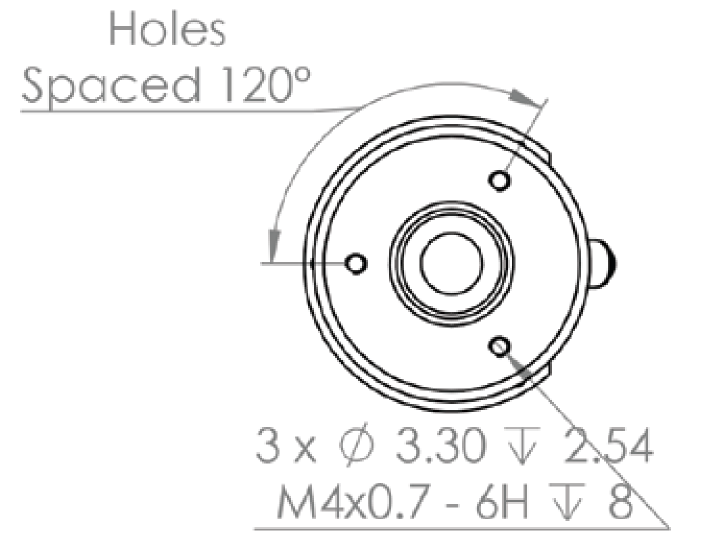
STEP FILE

DATA SHEET

SIDE VIEW



BOTTOM VIEW



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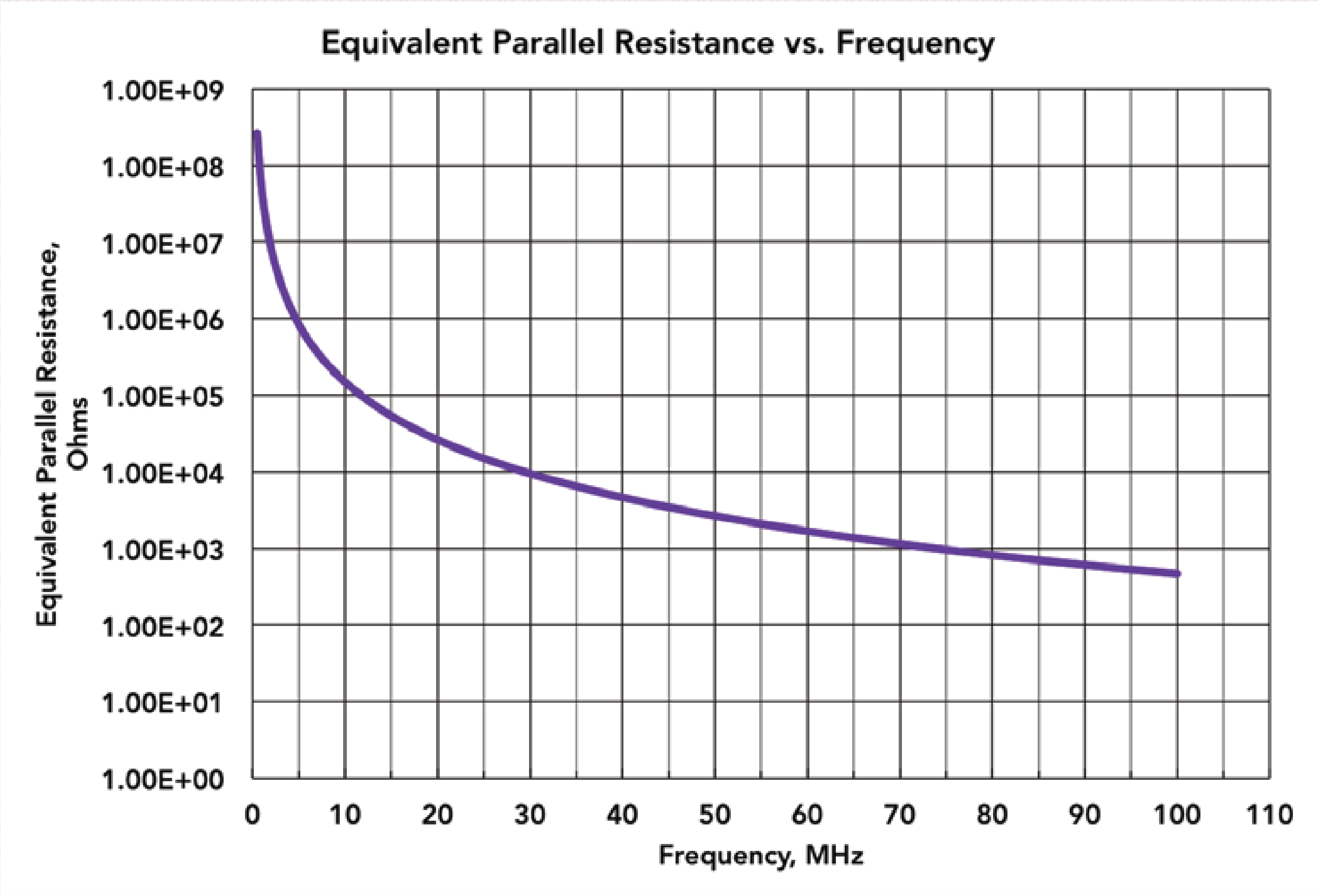
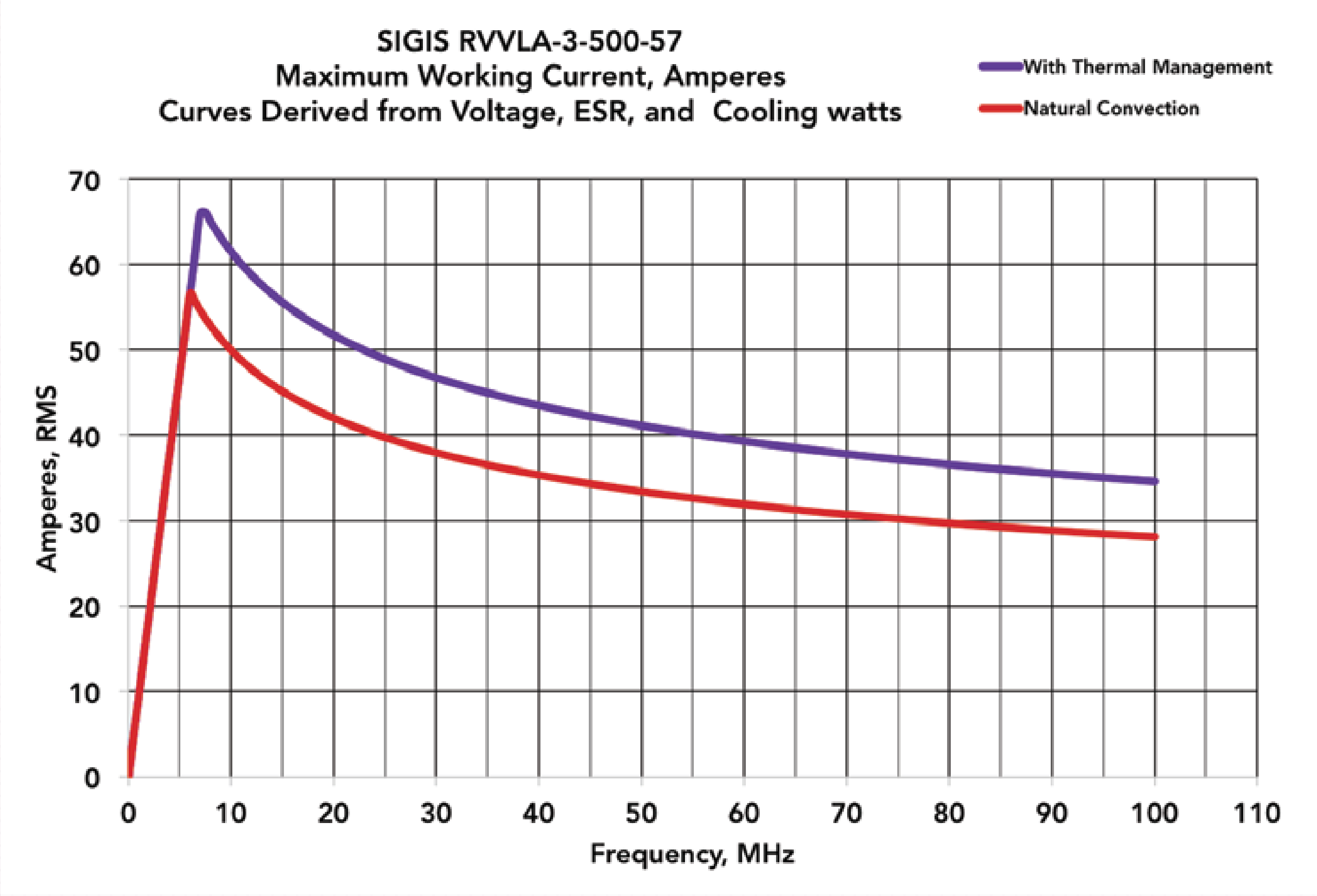
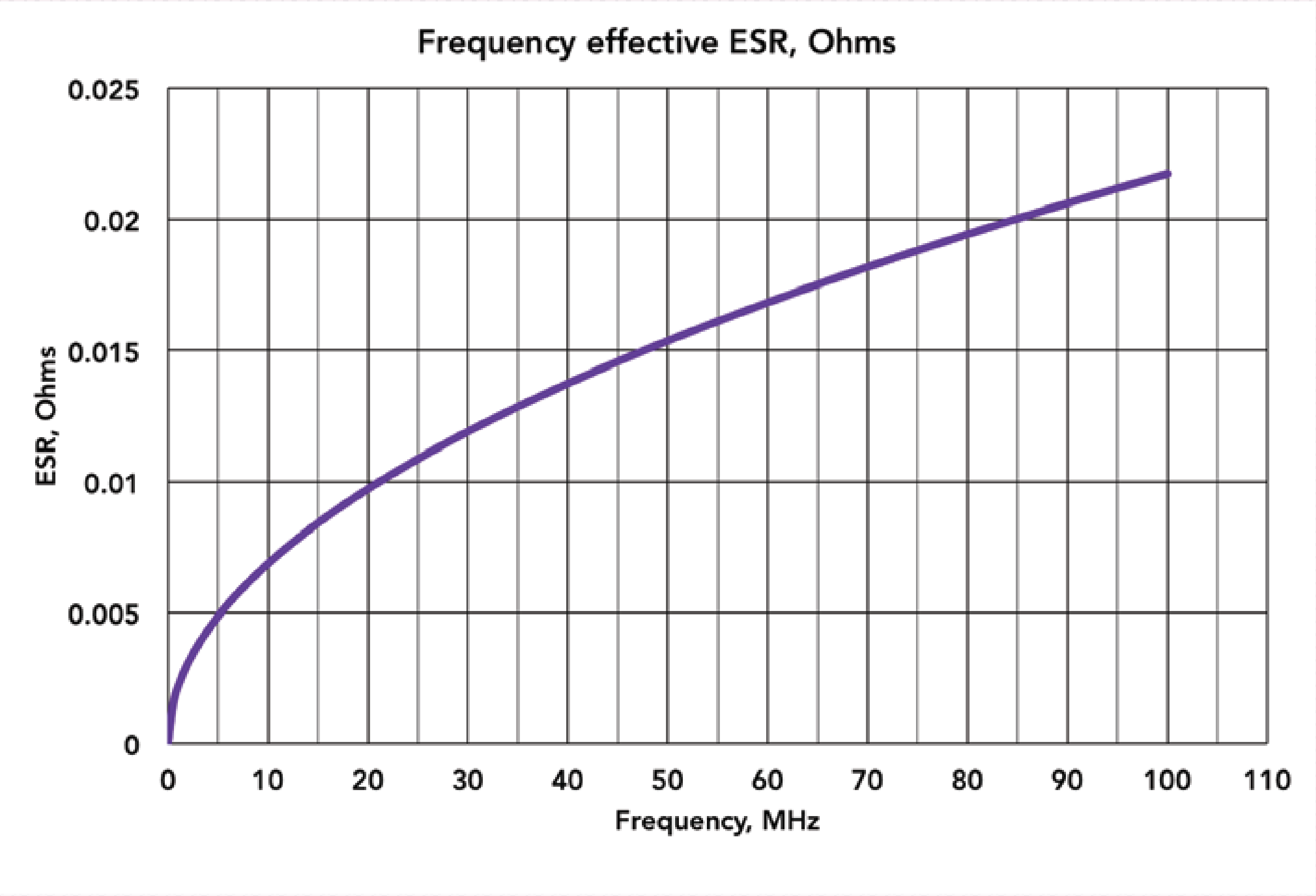
PERFORMANCE CURVES







DERATING CURVES

HOME

MECHANICAL DRAWINGS

PERFORMANCE CURVES

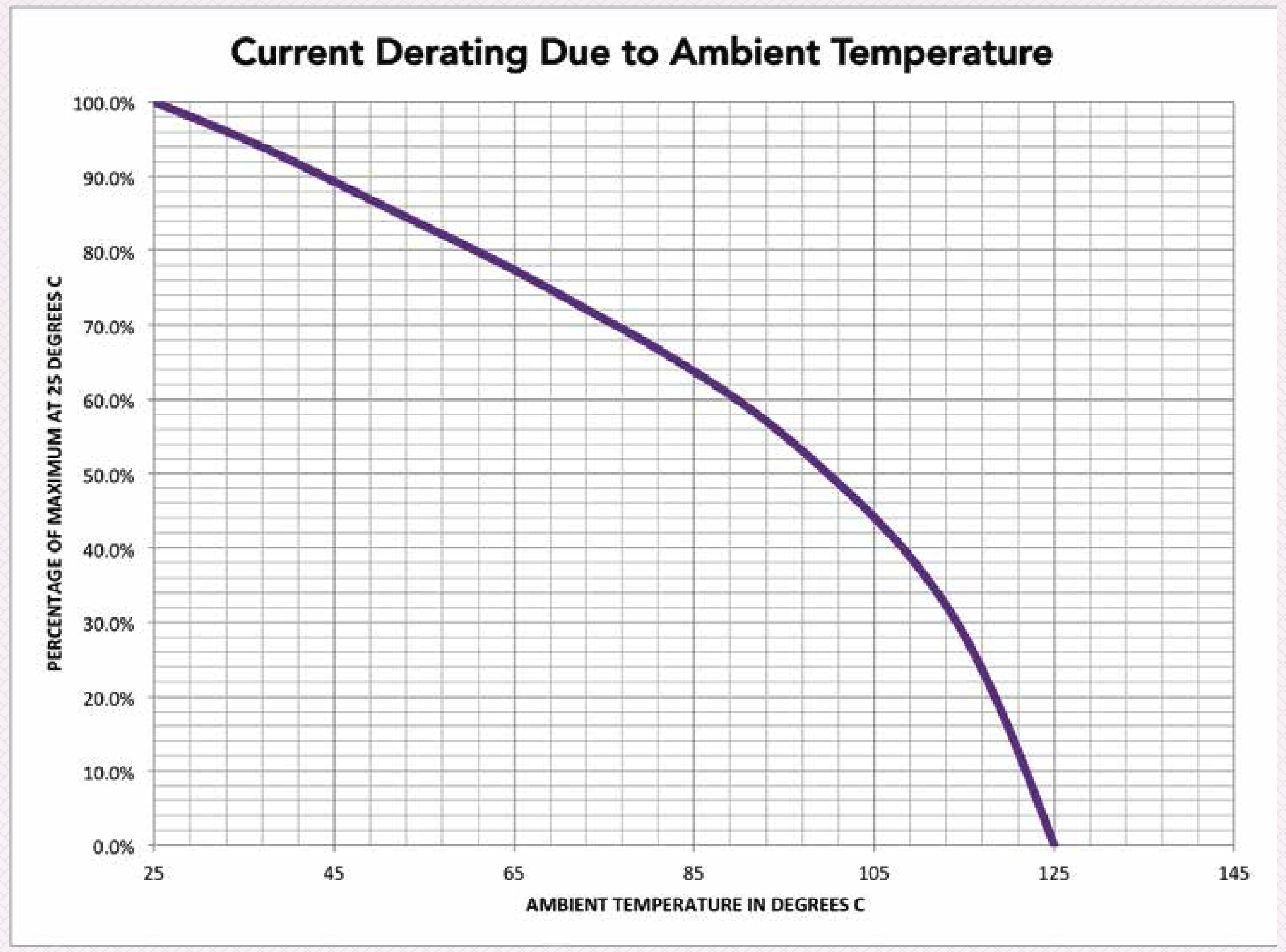
DERATING CURVES

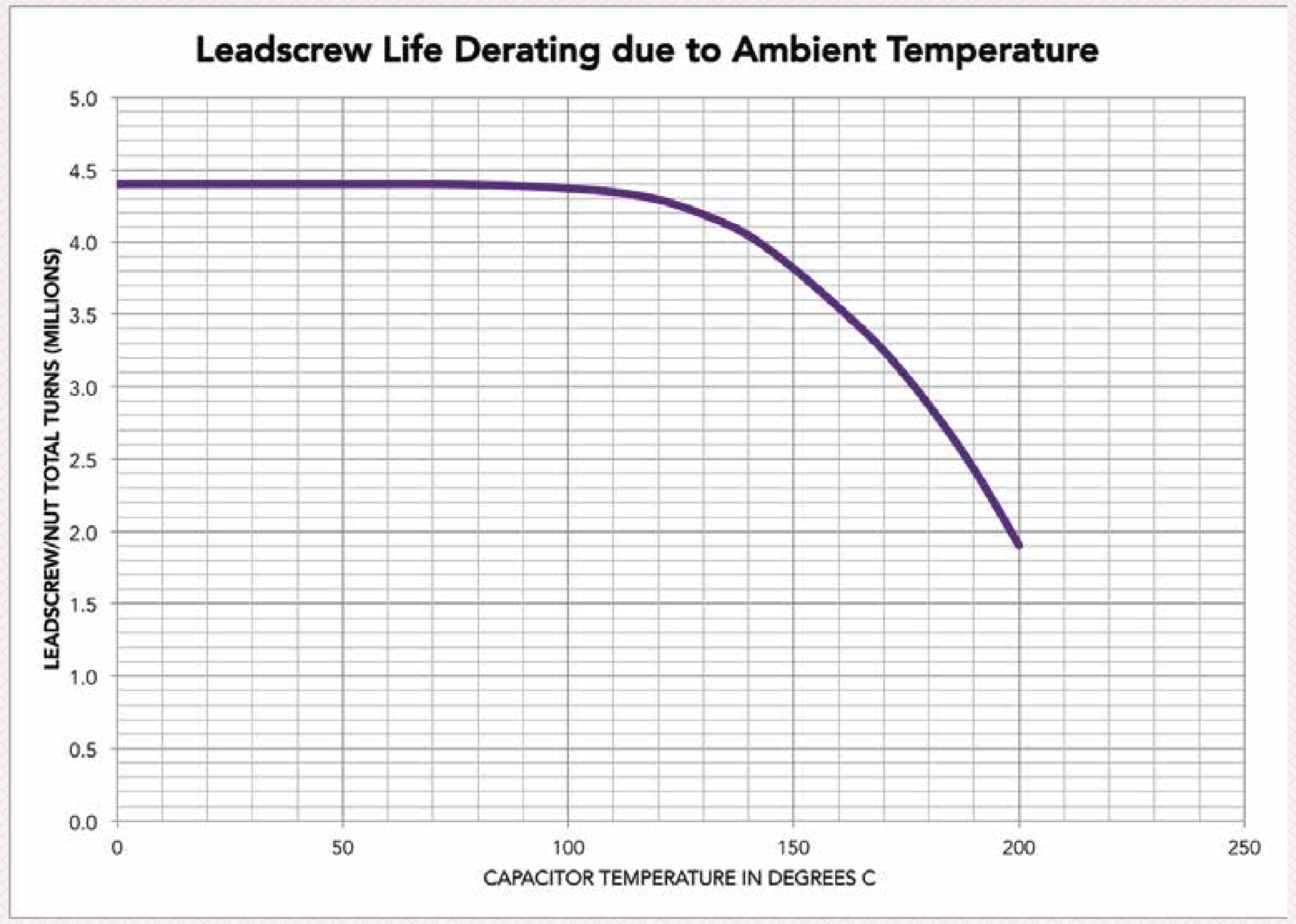
DESIGN GUIDELINES

OPERATING & MAINTENANCE

- High acceleration (greater than 30min^{-1}/ms)
- Ultra-small motion (less than several degrees)
- High speed (greater than 600min^{-1})

NOTE: Exceeding any of the conditions below may result in an extreme decrease in the life span.





CONTACT US

DESIGN GUIDELINES

CHOOSING THE RIGHT CAPACITOR

TYPE DESIGNATION

SIGIS uses the following designations for its capacitors:

R V V L A 3.5 500 57 RESERVED

- RESERVED: special configurations
- 57: maximum current at 13.56 MHz
- 500: maximum capacitance in pF
- 3.5: working voltage in kV
- A: (A)ir or (W)ater cooled
- L: (N)one, (L)eadscrew or (P)ush-pull
- V: (V)ariable or (F)ixed
- V: (V)acuum dielectric
- R: (R)ESONANT ceramic body capacitor

REPLACEMENT OF A CAPACITOR

It is important that the complete type code is specified when a capacitor is ordered. If a competitor's vacuum capacitor has to be replaced, please contact SIGIS for clarification.

support@sigisinc.com

CAPACITOR SELECTION FOR A NEW DESIGN APPLICATION

All voltages are peak values and all currents are rms values.

When capacitance and peak working voltage for the application are known, theoretical current flowing through the capacitor can be calculated as follows:

$$I_{Arms} = \sqrt{2} \cdot \pi \cdot f \cdot C \cdot Vpw$$

Vpw = peak working voltage
f = frequency (Hz)
C= capacitance (pF)

The circulating current of the RF circuit has to be added to the current determined above.

To select the right capacitor, the following data has to be known:

-Capacitance range
-Peak test voltage, i.e. multiply the peak working voltage by 1.67
-The maximum current at the operating frequency

EXAMPLE

Capacitance:	12-500pF
Peak working voltage:	1.8kV
Frequency:	13.56 MHz
Current at 12 pF:	$I_{Arms} = \sqrt{2} \cdot \pi \cdot 13.56MHz \cdot 12pF \cdot 1.8kV = 1.3A_{rms}$
Current at 500 pF:	$I_{Arms} = \sqrt{2} \cdot \pi \cdot 13.56MHz \cdot 500pF \cdot 1.8kV = 54A_{rms}$

From our website, www.sigisinc.com, we find that part number **RVVLA-1.8-500-57** would be appropriate for this application.

DESIGN GUIDELINES

VOLTAGE RATINGS

PEAK TEST VOLTAGE

This is the maximum voltage that may be applied to a capacitor for one minute without causing internal or external breakdown. Capacitors can be tested at this voltage to assess the general condition after shipment or prior to installation.

PEAK RF WORKING VOLTAGE

This is the maximum peak RF voltage which can be applied continuously to a capacitor. Usually it corresponds to 60 % of the peak test voltage.

To achieve good operating performance, the combined DC plus RF peak working voltage should not exceed the rated peak working voltage. Good engineering practice dictates that the DC voltage should not exceed 25% of peak test voltage.

When designing equipment for operation at high altitude, ambient barometric pressure must be considered, since external arcing across the ceramic envelope becomes more likely at reduced atmospheric pressure.

DC LEAKAGE CURRENT

At peak working voltage (Vpw):

Fixed vacuum capacitors	< 0.1 µA
Variable vacuum capacitors < 15 kV	< 10 µA
Variable vacuum capacitors > 15 kV	< 0.1 µA

DESIGN GUIDELINES

CURRENT RATINGS

The specified RF current is the maximum uniformly distributed rms current a capacitor can handle under normal operating condition, i.e. at 25°C ambient temperature and pure convection cooling, if not otherwise specified.

For low frequencies the maximum current is limited by the peak working voltage of the capacitor. This maximum current is shown on the current diagrams as straight capacitance lines with a positive slope starting near the lower left corner.

With rising frequency, one arrives at a point where the maximum current is limited by the skin heating effect of the frequency, not the maximum capacitor voltage. This current capacity is defined by the Joule heating of the capacitor versus the heat removal rate at 125°C in the environment in which the capacitor is installed. For example, convection cooling will result in a lower cooling rate than fan-forced cooling.

On the current diagrams shown in our catalog, these points are the intersections of the capacitance lines with positive slope with the line with a slightly negative slope, which corresponds to the thermal limit of the capacitor

Current derating diagrams must be observed for operation at elevated ambient temperature. The derating factor may depend somewhat on the type of cooling. For accurate derating factors, equilibrium temperature measurements on the flange of the capacitor are required.

DESIGN GUIDELINES

CAPACITANCE

Fixed capacitors with nominal capacitance greater than 50 pF have a tolerance of ± 5 %.

Values of less than 50 pF have a tolerance of ± 10 %. The nominal capacitance range of variable capacitors is the guaranteed minimum range. Tracking accuracy of the capacitance slope is better than ± 10 % if the low capacitance end point of the linear range is used for reference.

CAPACITANCE CONTROL: TORQUE

All SIGIS variable capacitors are available with a drive-screw or a pull-rod to control the capacitance. Maximum torque or pull force is specified for each capacitor. Any increase in operating torque should be investigated immediately to prevent damage to the operating mechanism.

All SIGIS capacitors have mechanical stops at either end of the capacitance range to prevent mechanical damage. However, it is highly recommended that the user provides his own end stops, electrical or mechanical to prevent accidental damage from over torque.

SELF-INDUCTANCE, SELF-RESONANCE FREQUENCY, & Q-FACTOR

The self-inductance of a vacuum capacitor depends mainly on its design and dimensions. It is extremely small and constant for fixed capacitors, ranging from approximately 2 to 10 nH, depending on the type. Variable capacitors have a larger internal inductance ranging from about 6 to 50 nH. This is due to the extended structure such as the bellows, connecting the movable electrode to its external mounting flange. Consequently the inductance of a variable capacitor changes with capacitance. The self-resonance of a vacuum capacitor is determined by its capacitance and internal inductance.

Vacuum capacitors have low losses, so the Q-factor is high. The losses are caused by the RF resistance of the copper internal parts and, especially, the bellows. The losses, and therefore the Q-factor, are a function of the operating frequency. The Q-factor is generally lower for variable capacitors because of the additional series resistance added by the bellows. Typical values for Q range from about 1,000 to well over 5,000.

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CURRENT RATINGS
CAPACITANCE & MORE
COOLING OF CAPACITORS

COOLING OF CAPACITORS

COOLING AIR FLOW CALCULATIONS

$$Qs = cp\ \rho\ q\ \Delta t / 3.60$$

Forced air cooling of electronic components results in a significant improvement over natural convection cooling. Although the best way to make an accurate determination of cooling requirements is by actual test of the equipment to be cooled; a good approximation of the amount of air required can be determined from sensible heat flow.

The sensible heat flow can be expressed in SI-units (metric) as:

$Qs = cp\ \rho\ q\ \Delta t / 3.60$

where

Qs = sensible heat flow (watts)

cp = specific heat of air (1.005 kJ/kg K at sea level atmospheric pressure (100 kPa), and 20 deg C.)

ρ = air density at standard conditions (1.205 kg/m^3 at sea level atmospheric pressure (100 kPa) and 20 deg C.)

q = air flow (m^3/hr)

Δt = change in temperature (deg C.)

Here it is assumed that all of the heat to be dissipated is picked up by the air: i.e., conduction and radiation as well as natural convection effects on conductively-coupled surfaces of the equipment are ignored.

CONVECTION COOLING

Despite the very low losses of vacuum capacitors, power dissipation in the bellows of variable capacitors and in the electrodes in general is of concern at elevated currents and high frequencies. Bellows temperature is a relevant factor for the life expectancy of variable capacitors. Capacitors are frequently operated with convection cooling only.

SIGIS capacitors can be operated at temperatures up to 125ºC, measured anywhere on the capacitor surface, provided that the required RF current derating is considered. The maximum RF current rating for any SIGIS capacitor is that current, which produces a maximum temperature of 125ºC with an ambient temperature of 25ºC. The temperature de-rating diagram gives the maximum permissible current for a given elevated ambient temperature as a percentage of the maximum current at 25ºC ambient temperature. The derating also depends on the type of thermal contact which the capacitor has to the mounting structure. When designing an application that requires operation near the thermal limit, verification by equilibrium temperature measurements on the flanges of the capacitor must be made.

FORCED AIR COOLING

Additional cooling is recommended to achieve more favorable operating conditions or to increase current ratings. Substantially higher current ratings are permissible if forced air cooling is applied to the bellows. External cooling of the mounting flanges with forced air is also suitable. The customer must determine the cooling requirements by direct measurement for operating current limits other than those shown in the specifications.

HEAT + MECHANICAL DEGRADATION

DERATING OF MOVING PARTS

Variable vacuum capacitors have bellows assemblies operated by either pistons, in push-pull operation, or leadscrew/nut configurations. Both of these mechanical operating methods entail frictional wear and the potential for lubrication breadown over time. They may also be afftected by the conditions in which they are installed, such as humidity, dust and debris and in particular, elevated temperature. The following table illustrates the typical reduction in operational life that may be encountered due to increasing operational temperatures.

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HANDLING

Care must be taken when installing or removing vacuum capacitors to avoid damage to the body of the capacitor that can easily displace the electrodes. Although they look very rugged from the outside, the internal copper parts are in a soft, annealed condition and are therefore susceptible to mechanical deformation.

Avoid rough handling, dropping, machining or prying. Use existing threads and holes for mounting

STORAGE

Vacuum capacitors should be stored in a vertical position, in a clean, dry place. Keep the capacitor in its hermetically closed plastic bag with silica gel during storage.

If the capacitor is stored for a prolonged period, high voltage processing (spot knocking) must be performed before the capacitor is installed and put into service.

INSTALLATION

Convection and forced air-cooled vacuum capacitors can be mounted in any position.

We recommend that one side of the capacitor be mounted non-rigidly to prevent excessive thermo-mechanical and external forces from acting on the capacitor. Never mount the capacitor by its body; use only the mounting rings or flanges provided.

SHIPPING

For shipment, variable capacitors must be set to minimum capacitance. Whenever possible use original container.

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PHONE: (970) 300-1089

FAX: (970) 710-3128

WEB: www.sigisinc.com

EMAIL: info@sigisinc.com

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