The Forward Voltage Drop and Thermal Resistance of a disc (hockey puck) semiconductor is affected by the clamping force that is applied to the device. This is because, unlike stud type devices, the internal interfaces between, for instance, the copper electrodes and the molybdenum discs and washers, used in the construction, are dry. These interfaces contribute a contact electrical resistance and thermal resistance which add to the bulk resistances of the materials constituting the device. Figure 1 shows the theoretical thermal resistance vs load for the dry interfaces in a Dynex Semiconductor fully floating silicon thyristor.

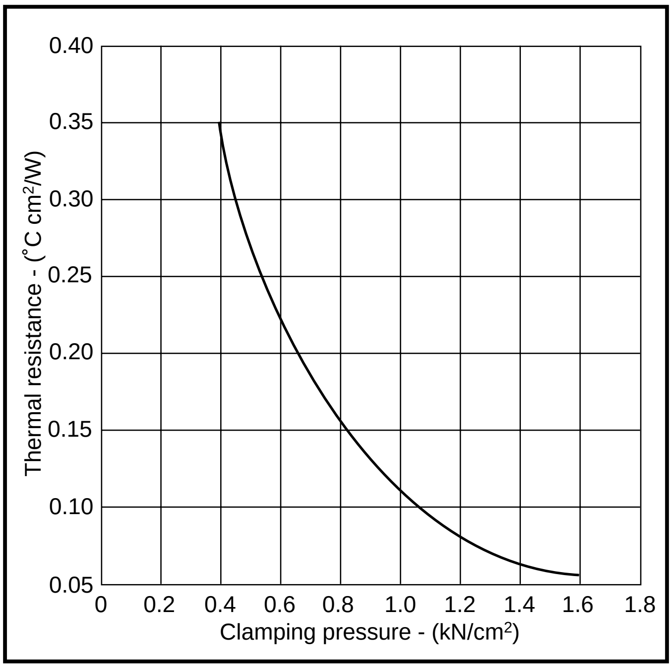

Fig.1 Additional thermal resistance for dry interfaces of a FFS thyristor

The clamping force recommended by Dynex Semiconductor in its data sheets has been established as being that force necessary to give good thermal and electrical contact between the internal and external interfaces of the device. To determine this, Dynex Semiconductor measures the Forward Voltage Drop and Thermal Resistance of the devices at different clamping forces. The minimum clamping force is determined as the force above which the Thermal Resistance and Forward voltage drop do not improve significantly. The maximum recommended clamping force is then taken to be 1.22 x the minimum value. The device is then subjected to temperature cycling tests at this higher clamping

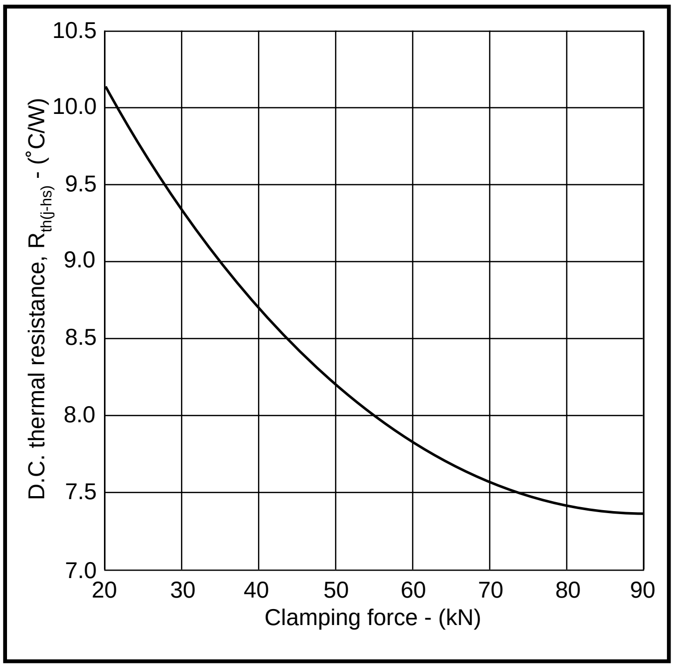

Fig.2 DCR1674SZ thyristor - variation of R_{th} with load

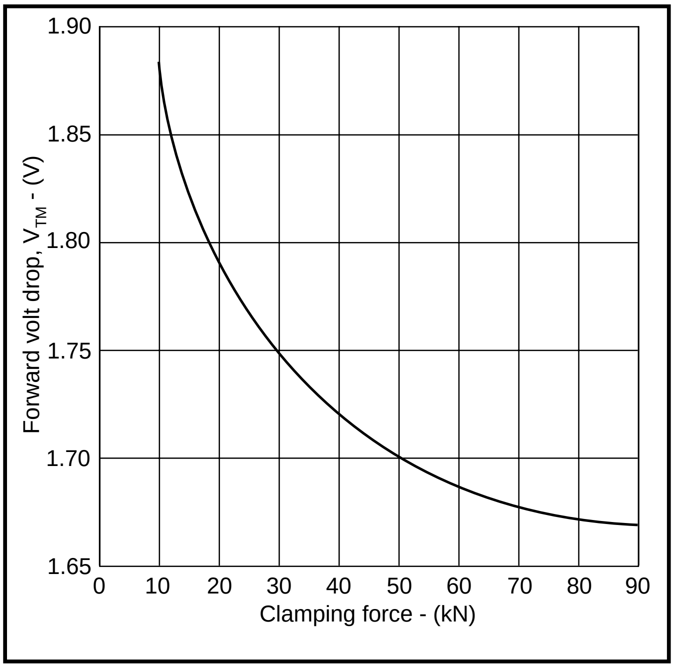

Fig.3 DCR1674SZ thyristor - variation of V_{TM} with load

force to verify that thermal expansion and contraction does not lead to device degradation. The published figure is a mean value +/- 10%. It is important, therefore, that the user takes due regard that the clamping force remains between these values under all conditions that arise from variations in tolerance of the clamps and any thermal expansion and contraction that may affect their settings. In this way the user will be sure that the thermal and electrical characteristics are within those specified on the data sheet and that the long term tolerance to thermal cycling has been verified.

Of course, this clamping force must be evenly distributed over the entire surface of the semiconductor to ensure that the above conditions are obtained. Uneven clamping can result in high thermal resistance, high forward voltage drop, and mechanical damage to the device. Care, must therefore, be taken to ensure that the clamp applies force to the centre of the pole face and that it is subsequently spread evenly over the whole contact area by suitably thick and stiff buffers.

A note of warning about clamping fully floating silicon devices at room temperature and then applying heat from an external source during subsequent testing. This heat could come from a hot plate/oven used to raise the case/junction temperature or perhaps indirectly from an adjacent device being tested on a power run.

Silicon is very strong in compression but relatively weak in tension. Because the temperature coefficients of expansion of the metal components in the thyristor housing are greater than that of the silicon, if the heat is applied from the outside of the disc, the metal components will put the silicon into tension and cracking can occur. If heat is internally generated, as in service, then the silicon remains in compression and uncracked.

Notes on mounting disc (hockey puck) semiconductors onto heatsinks using Dynex Semiconductor clamps

Warning: Too little jointing compound will lead to high thermal resistance. However, a more common error is to apply too much compound which can give a high electrical contact resistance.

DOUBLE SIDE COOLED

1. Check that the clamping force (in kN) printed on the bar, is suitable for the semiconductor device to be clamped.

2. Slip the polyester film locator over the disc device.

3. Prepare the heatsink surfaces by abrading the aluminium surface, using medium grade emery cloth such as ELC120 or 3M Scotchbrite™ pad, degrease with a solvent and carry out the mounting operation the same day. Similarly prepare the semiconductor device and then apply a small amount of jointing or interface compound, see “Interface Compounds” .

4. After loosely assembling all the components with the disc device between the heatsinks, finger tighten the two nuts on the tie bolts until they just touch their washers. Check that the bar is reasonably parallel with the heatsink and make sure that it is centrally located, i.e. not at angle to the channel in the heatsink.

5. Using a socket spanner (wrench) at the bar end (and, if necessary, a nut runner to hold the threaded rod by means of its “Loctited” nut in the ceramic insulator) carefully tighten each nut alternately, a flat at a time. Apply a steady finger pull on the gauge under the central nut and when it comes free, cease to tighten the nuts. Slide the gauge to the full extent of its slot, until the top leaf springs up, to prevent the gauge slipping back under the nut. This procedure provides a gap of 0.3mm under the nut and will allow for any relaxation in the clamp, fins or device while in service. The heights at each end of the bar above the heatsink should be within 1.0mm of each other.

6. If it is necessary to re-adjust the clamp or remove the device, then, before loosening the tie rods, slip the two leaves of the gauge back underneath the central nut. This procedure will re-set the bar clamp for further use.

7. A useful check for good mounting is to measure the electrical contact resistance of the device/heatsink joint. 100A DC may be passed across the joint and we recommend the maximum values should not exceed the following.

2µohms (0.2mV drop) for large devices and critical applications.

10µohms (1.0mV drop) for smaller devices or less critical applications.

A high contact resistance may lead to the device overheating and/or pitting of contact surfaces.

Warning: The central pressure bolt assembly is pre-set in the factory and sealed. Any subsequent adjustment of this bolt will alter the clamping force when tightening on to a device and damage may result to the device by either lack of clamping force or excess clamping force.

SINGLE SIDE COOLED

1. Check that the clamping force (in kN) printed on the bar, is suitable for the semiconductor device to be clamped.

2. Slip the polyester film locator over the disc device.

3. Prepare the heatsink surfaces by abrading the aluminium surface, using medium grade emery cloth such as ELC120 or 3M Scotchbrite™ pad, degrease with a solvent and carry out the mounting operation the same day. Similarly prepare the semiconductor device and then apply a small amount of jointing or interface compound, see “Interface Compounds”.

4. Place the semiconductor device (the appropriate way up) on the heatsink followed by the bus bar/insulator assembly. A small amount of heatsink compound should be applied between the disc and the bus bar to prevent corrosion.

5. Place the pressure bar on top of the bus bar/insulator assembly with the hexagon head of the central bolt bearing down on the insulator. The two insulated bolts should then be inserted through the holes in the pressure assembly, the bus bar insulator assembly, and the device locator, thereby aligning all three. Adjust the position of the gate connector on the semiconductor device to suit the installation.

6. Screw the bolts into the heatsink, making sure that the pressure bar is kept parallel to the heatsink. When the bolts start pulling down the pressure bar, tighten each bolt alternately a flat at a time. Apply a steady finger pull on the gauge under the central nut and when it comes free, cease to tighten the nuts. Slide the gauge to the full extent of its slot, until the top leaf springs up to prevent the gauge slipping back under the nut. This procedure provides a gap of 0.3mm under the nut and will allow for any relaxation in the clamp, fins or device while in service. The heights at each end of the bar above the heatsink should be within 1.0mm of each other.

7. A useful check for good mounting is to measure the electrical contact resistance of the device/heatsink joint. 100A D.C. may be passed across the joint and we recommend the maximum values should not exceed the following:-

2µohms (0.2mV drop) for large devices and critical applications.

10µohms (1.0mV drop) for smaller devices or less critical applications.

A high contact resistance may lead to the device overheating and/or pitting of contact surfaces.

8. If it is necessary to re-adjust the clamp or remove the device, then, before loosening the bolts, slip the two leaves of the gauge back underneath the central nut. This procedure will re-set the bar clamp for further use.

INTERFACE COMPOUNDS

It is important to use a suitable interface compound between a semiconductor device and its heatsink.

Two basic types of compound are available:

i. As designed for interfaces which are both thermally conducting and current carrying; e.g. with disc type thyristors. This type was originally developed for electical busbar joints and the thermal resistance value is not stated.

ii. Optimised for good thermal performance only, with the thermal resistance value specified.

INTERFACE COMPOUNDS

	Rhodorsil 47V5	**Dow Coming DC200**	**Aavid Sil Free 1020**	**American Oil PQ**	**BICC BX13**	**Aremco 664**	**Unial**
Max. Temp.	120˚C	315˚C	200˚C	200˚C	260˚C	285˚C	120˚C
Min. Temp.	–65˚C	–50˚C	–40˚C	-	-	-	–30˚C
Thermal conductivity	0.12W/m.K	0.155W/m.K	0.793W/m.K	16.7×10^{4} CAL(Sec.cm.˚C)	-	3.31×10^{4} CAL(Sec.cm.˚C)	-
Dielectric strength V/mm	15000	-	225	15000	-	0	0

POWER ASSEMBLY CAPABILITY

The Power Assembly group was set up to provide a support service for those customers requiring more than the basic semiconductor, and has developed a flexible range of heatsink and clamping systems in line with advances in device voltages and current capability of our semiconductors.

We offer an extensive range of air and liquid cooled assemblies covering the full range of circuit designs in general use today. The Assembly group offers high quality engineering support dedicated to designing new units to satisfy the growing needs of our customers.

Using the latest CAD methods our team of design and applications engineers aim to provide the Power Assembly Complete Solution (PACs).

HEATSINKS

The Power Assembly group has its own proprietary range of extruded aluminium heatsinks which have been designed to optimise the performance of Dynex semiconductors. Data with respect to air natural, forced air and liquid cooling (with flow rates) is available on request.

For further information on device clamps, heatsinks and assemblies, please contact your nearest sales representative or Customer Services.

http://www.dynexsemi.com

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Datasheet Annotations:

Dynex Semiconductor annotate datasheets in the top right hard corner of the front page, to indicate product status. The annotations are as follows:-

Target Information: This is the most tentative form of information and represents a very preliminary specification. No actual design work on the product has been started.

Preliminary Information: The product is in design and development. The datasheet represents the product as it is understood but details may change.

Advance Information: The product design is complete and final characterisation for volume production is well in hand.

No Annotation: The product parameters are fixed and the product is available to datasheet specification.