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1. Introduction to press-pack IGBTs

Press-pack IGBTs are an alternative to isolated-base plastic modules. Instead of the wire bonds and solder joints used in isolated-base modules, press-packs rely on the application of force by an external clamping system, to make contact to the chips.

They are the device of choice for applications that require series operation of IGBT devices, since it is straightforward to assemble press-packs in series stacks - a common practice for press-pack thyristors and diodes.

Ratings of press-pack IGBTs typically extend to higher currents than isolated-base modules and can cater for applications with higher current demands without the need for paralleling of devices.

They also benefit from higher reliability, since pressure contacts are typically more robust than wire bonds and solder joints.

In contrast to wire bonds, which typically fuse and render isolated-base modules open circuit in the event of a chip failure, the use of pressure contact technology ensures press-pack IGBTs fail to short circuit. In the event of a high-energy failure, press-packs also offer greater rupture resistance than isolated-base modules.

2. Dynex’s press-pack IGBT products

Dynex’s press-pack IGBT products employ a number of novel and cutting edge technologies.

Dynamic load-balancing (DLB) technology maximises safe operating area, gives high reliability and improves ease of use compared to conventional press-pack IGBT designs.

Silver-sinter bonding applied to basic units between the chip and adjacent molybdenum platelets ensures outstanding reliability and improved thermal performance.

Silicone edge passivation applied to Dynex’s press-pack chips and a hermetically sealed housing give robust high voltage blocking performance.

A dedicated auxiliary emitter connection ensures synchronisation of gate drive signals between chips, mitigating the effects of power circuit di/dt on the driver circuit.
3. Press-pack IGBT design goals

Two of the most important aims in press-pack IGBT design are to ensure uniform distribution of contact pressure across all chips within the device and to protect the gate microstructure beneath the emitter contact surface of the IGBT chips.

3.1 Pressure uniformity

Uniform distribution of contact pressure across the device promotes optimum sharing of electrical, thermal and mechanical stresses between the chips to give the largest safe operating area and the highest reliability. Conventional press-pack IGBTs have shortcomings in this respect. Their designs are an evolution of the pressure contact technology used for high power thyristor products, comprising a hermetic ceramic capsule housing an array of chip assemblies between rigid copper electrodes. Fig. 3 illustrates the basic construction of a conventional press-pack IGBT.

![Figure 3 - Cross-section of a conventional, rigid press-pack IGBT.](image)

The temperature distribution that exists from chip to case within an operating press-pack IGBT drives differential expansion of these rigid electrodes and causes them to distort, unbalancing the distribution of contact pressure and therefore thermal and electrical contact resistances, across the chips [1], [2]. These imbalances significantly reduce the safe operating area and reliability of conventional press-pack IGBT devices. Fig. 4 demonstrates the distortion that occurs. Distortion is most severe for devices with large electrode diameters.

![Figure 4 - Thermomechanical distortion of a conventional, rigid press-pack IGBT device.](image)

3.2 Microstructure protection

Beneath the emitter surface of an IGBT chip lies a microstructure comprising the polysilicon gate electrode and layers of oxide, isolating the gate and emitter regions, as shown in Fig. 5. Mechanical damage to this microstructure is likely to short the gate and emitter regions, rendering the device inoperable. Damage to this microstructure is typically the cause of failure for conventional press-pack IGBTs [1], [3].

![Figure 5 - A cross-section schematic of an IGBT chip.](image)

Conventional press-pack IGBTs use chip assemblies - commonly referred to as basic units - with floating components – i.e. no permanent bond exists between adjacent components – the connections are purely pressure contacts. Fig. 6 shows an exploded view of a floating basic unit.

![Figure 6 - An exploded view of a floating basic unit.](image)

All components in these basic units undergo thermal expansion and contraction as the device heats and cools during operation. Differential thermal expansion of adjacent components leads to abrasive wear – fretting – of their contact surfaces. For the chip, fretting eventually damages the IGBT microstructure, causing device failure. Basic units incorporate molybdenum platelets adjacent to the chips, rather than contacting the chip directly with the housing electrodes, which are typically copper. The thermal expansion coefficients of silicon and molybdenum are more closely matched than those of silicon and copper, reducing the rate of wear on the surfaces of the chips. The reduction in wear rate extends the lifetime of the chips, but still, eventually, accumulated damage causes chip failure.
4. Dynex press-pack IGBT technology

Dynex has developed a range of press-pack IGBT products that address the fundamental shortcomings of conventional designs. Dynex press-pack IGBTs incorporate a dynamic load-balancing mechanism that ensures uniform distribution of contact pressure across all chips within the device under all operating conditions. Basic units use silver sintering technology to bond the chips to molybdenum platelets, providing outstanding protection for the IGBT microstructure. The following sections describe these design features, amongst others, in detail.

4.1 Dynamic load balancing mechanism (DLB)

The DLB mechanism replaces the rigid pillars of conventional designs with spring assemblies. These have far greater compliance than the rigid pillars, meaning flatness requirements for device electrodes and heatsinks are relaxed.

The spring assemblies are too electrically resistive to form the primary load current path by themselves, so Dynex’s DLB mechanism incorporates a novel current bypass mechanism, achieved using a flexible conductive diaphragm, as shown in Fig. 7.

When the device is clamped, the spring assemblies compress to the height of the spring locator plate at a force determined by design – the threshold force - shown by label 1 in Fig. 8. The clamping force specified in the product datasheet exceeds the threshold force, with the excess force applied to the support frame, creating pressure contacts between the diaphragm and spring locator and the spring locator and housing electrode - shown by label 2 in Fig. 8. A low resistance current path is then created between the housing electrodes through the basic unit, diaphragm and spring locator – shown by label 3 in Fig. 9.

The DLB mechanism compensates for any thermomechanical distortion that occurs, ensuring chips are uniformly pressurised, regardless of the temperature distribution in the device electrodes.

Maintaining the correct mechanical conditions for the chips ensures they perform optimally, enabling Dynex press-pack IGBTs to maintain their large safe operating area and outstanding reliability, under all operating conditions.

In addition to this, Dynex’s DLB mechanism gives two further advantages. First, the enhanced mechanical compliance of the device means that heatsinks typically used with thyristors can be used – flatness specifications of >20µm - and that onerous flatness tolerances required when using conventional, rigid press-pack IGBTs – typically 10µm – do not need to be applied, reducing the cost of assemblies using Dynex DLB press-pack IGBTs. Second, it is not possible to over-pressurise the chips in a Dynex DLB press-pack – this is a risk with conventional press-pack IGBTs - providing extra flexibility in stack assembly procedures.

Dynex press-pack IGBTs with contact diameters from 63mm to 150mm use the DLB mechanism. Devices with contact diameters smaller than this still use a conventional, rigid design concept, since the approach is acceptable for such small diameter packages containing few chips.

Table 1 lists the construction technology used by contact diameter for Dynex press-pack IGBTs.

<table>
<thead>
<tr>
<th>Contact diameter (mm)</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>Rigid</td>
</tr>
<tr>
<td>47</td>
<td>Rigid</td>
</tr>
<tr>
<td>63</td>
<td>DLB</td>
</tr>
<tr>
<td>73</td>
<td>DLB</td>
</tr>
<tr>
<td>85</td>
<td>DLB</td>
</tr>
<tr>
<td>100</td>
<td>DLB</td>
</tr>
<tr>
<td>125</td>
<td>DLB</td>
</tr>
<tr>
<td>150</td>
<td>DLB</td>
</tr>
</tbody>
</table>
4.2 Silver sintered basic units

IGBT basic units using a floating construction exhibit unsatisfactorily variable reliability and high infant mortality rates. Dynex’s press-pack IGBT basic units employ silver sinter bonding technology to bond the adjacent molybdenum platelets to the chips and overcome these limitations. Fig. 10 shows a cross-section of Dynex’s basic unit construction.

Bonding the components together in this manner makes it impossible for fretting of the contact surfaces of the chips to occur, giving robust protection to the IGBT microstructure, yielding ultra-high reliability.

The replacement of dry interfaces with layers of silver also reduces the thermal resistance of the basic units significantly. Fig. 11 illustrates the difference in thermal resistance of basic units with floating molybdenum platelets and silver sintered molybdenum platelets. The removal of the dry interface reduces the thermal resistance of the silver sintered basic unit by almost 50% relative to the floating basic unit.

Additionally, the silver sintered bond between the backside of the chip and the adjacent molybdenum platelet provides better cooling for the edge of the chip, where there is no pressure applied and therefore minimal heatsinking in floating designs. As a result, Dynex’s press-pack IGBTs demonstrate exemplary stability at high voltages and high temperatures.

4.3 Silicone edge passivation

In order to realise the full blocking voltage capability of high voltage IGBT chips within the package, extra measures must be taken to manage the electric field external to the chips and prevent flashover.

Wire-bonded modules use dielectric gels. These gels are suited to this application, since all contacts are bonded or soldered and they readily penetrate small gaps. Their ability to penetrate small gaps makes them troublesome in pressure contact applications, however, where they can penetrate dry interfaces, increasing contact resistance.

Some press-pack devices use sulphur hexafluoride (SF₆) gas to manage electric fields. SF₆ has a dielectric strength three times greater than air so prevents flashover. However, SF₆ is a very potent greenhouse gas and its use should be avoided where possible.

Dynex’s press-pack IGBT basic units employ a silicone edge passivation, formed as a bead around the edge of the chip, to manage electric fields. Dynex products have successfully employed silicone passivation’s for decades. They give superb long-term high voltage blocking robustness, they do not penetrate dry interfaces and their potential for environmental harm is very low.
4.4 Auxiliary emitter

Synchronisation of the gate drive signals to each chip must be optimised to realise the largest safe operating area for an array of parallel chips.

Dynex’s press-pack IGBTs employ best practice in the design of the internal circuitry between the gate and auxiliary emitter terminals on the device’s case and the corresponding terminals on the chips. The primary focus has been the isolation of the emitter side of the drive circuitry from the power circuitry.

Connecting the emitter side of the gate drive directly to the power emitter electrode introduces unbalanced inductances to the emitter drive circuit for each chip within the device since the distances from the connection point to the chips vary. Fig. 12 demonstrates this. Coupled with $\frac{dI}{dt}$ in the power circuit, these inductances provide feedback within the gate circuit. Since the inductances are unbalanced, the level of feedback varies depending on the position of the chip within the device, leading to poor synchronisation.

The circuitry within Dynex’s press-pack IGBTs isolates the emitter side of the drive circuit from the power electrode by routing this through a printed circuit board within the device.

Fig. 13 illustrates the effect this has on balancing the emitter inductances in the drive circuit, regardless of the relative position of chips from the gate drive connection. Improved balance ensures optimum synchronisation.

**Figure 12 - Unbalanced emitter inductances.**

**Figure 13 - Balanced emitter inductances.**
5.1 Press-pack IGBT datasheets

The definitions for most parameters given on a Dynex press-pack IGBT datasheet are the same as those given on a datasheet for Dynex’s isolated-base IGBT modules. Guidance for these is given in Dynex application note AN5947. The significant difference, from a user’s perspective, is in the mounting of the device. This is covered in section 7 of this application manual.

5.2 Safe Operating area

Safe-operating area ratings for Dynex’s 4.5kV press-pack IGBT range permit operation with line voltages up to 3.4kV and guarantee the capability of the IGBT to turn off over-currents of up to twice the product's rated current at this line voltage.

Dynex press-pack IGBTs typically have ultimate capabilities far exceeding their datasheet ratings. To illustrate the robustness of Dynex’s press-pack IGBTs, the following examples are given.

5.2.1 IGBT reverse bias safe operating area (RBSOA)

Fig. 14 shows a Dynex 2.1kA, 4.5kV press-pack IGBT (DPI2100P45A5200) turning off 7.4kA – 3.5 times its rated current - at a line voltage of 3.4kV and a junction temperature of 125°C.

5.2.2 Short-circuit safe operating area (SCSOA)

Fig. 15 shows a Dynex 2.1kA, 4.5kV press-pack IGBT (DPI2100P45A5200) withstanding a type-1 short-circuit test performed at a line voltage of 3.4kV and a junction temperature of 125°C for a duration of 40µs – 4 times industry standard.

Fig. 16 shows a Dynex 1.6kA, 4.5kV press-pack IGBT (DPI1600P45C3616) withstanding a type-1 short-circuit test with a gate-emitter voltage of 18V, at a line voltage of 3.4kV and junction temperature of 125°C.

6. Reliability

Figure 14 – IGBT RBSOA robustness - successful turn-off of 7.4kA by a device rated at 2.1kA, 4.5kV (DPI2100P45A5200)

Figure 15 - IGBT SC5OA robustness – a 4.5kV, 2.1kA (DPI2100P45A5200) device surviving a 3.4kV, 40µs short-circuit test.

Figure 16 - IGBT SC5OA robustness – a 4.5kV, 1.6kA device (DPI1600P45C3616) surviving a 3.4kV short-circuit test with a gate-emitter voltage of 18V.
Dynex’s press-pack IGBT has set new standards in reliability, thanks primarily to its DLB mechanism and silver sintering technology. In addition to standard product qualification tests required for release of the product, further long-term reliability tests have been carried out. Performance in a number of key reliability tests is summarised below.

6.1 Power cycling

The outstanding reliability of Dynex’s press-pack IGBT is strikingly apparent in its power cycling performance. Power cycling tests of 125mm, 2100A, 4500V devices (part number DPI2100P45A5200) have run over a $\Delta T_{vj}$ of 80°C for more than 300,000 cycles without failure.

This result is between one and two orders of magnitude greater than independently published data on cycles to failure for similarly rated conventional press-pack IGBTs using floating basic unit designs, for which the life was found to be around 6,600 cycles with a comparable temperature excursion [1]. Fig. 17 compares the technologies.

6.2 High temperature reverse bias

High temperature reverse bias (HTRB) tests lasting more than 7,000 hours have been carried out on a number of Dynex’s 125mm press-pack IGBTs at $T_{vj}=135^\circ$C (i.e. 10°C higher than $T_{vj(max)}$) and $V_{ce}=3.6kV$ (i.e. $V_{ce}=80\%$ of $V_{ces}$) without failure. Fig. 18 shows the in-test leakage current of a typical sample.

HTRB sampling is ongoing. At the time of writing, the chip-level MTBF is calculated to be in excess of 1,800 years for $V_{ce}=2.8kV$ and $T_{vj}=100^\circ$C. The chip-level MTBF can be used to calculate the MTBF for any device in the product range.

6.3 Temperature cycling

To demonstrate the reliability of the silver sinter bonding, extreme temperature cycling tests were carried out on 4.5kV press-pack IGBT basic units.

Two tests were carried out:

-70°C to +210°C for 10 cycles – extreme stress, short duration
-40°C to +125°C for 600 cycles – high stress, long duration

The following end-point measurements were performed:

$I_{ces}$ measurement at $V_{ce}=4.7kV$, $T_{vj}=125^\circ$C
$I_{ges}$ measurement at $V_{ps}=\pm20V$, $T_{vj}=125^\circ$C
IGBT RBSOA pass/fail test at $I_{c}=4I_{c(nom)}$, $T_{vj}=125^\circ$C
SCSOA pass/fail test for $t_{p}=15\mu$s at $V_{ce}=3.0kV$, $V_{ps}=18V$, $T_{vj}=125^\circ$C

All basic units passed these tests, demonstrating the robustness of Dynex’s silver sintering technology. A number of samples also underwent shear force tests before and after the high stress, long duration test, to verify the robustness of the bonds. No significant change in bond strength was detected.
6.4 Short-circuit failure mode

A key advantage of press-pack IGBT devices, in contrast to isolated-base IGBT modules using wire-bonds, is their short-circuit failure mode. Dynex has performed tests to confirm its press-pack IGBTs fail to short-circuit. A number of samples were intentionally destructively failed and subjected to endurance tests at $I_c=1000\text{A DC}$. Fig. 19 shows results of a two-hour test performed on a 125mm, 2100A, 4500V device (part number DPI2100P45A5200).

![Figure 19 - Short-circuit failure mode endurance test results.](image)

7. Mounting instructions

Device mounting should be performed in accordance with the instructions in Dynex application note AN4839 (available on the Dynex website), taking account of the additional guidance below:

7.1 Dynex DLB press-pack IGBTs

Dynex press-pack IGBTs should not be operated below the minimum clamping force specified on the product datasheet under any circumstances. Unless a force greater than the minimum clamping force is applied, it cannot be guaranteed that the current bypass in the DLB mechanism will be activated.

For assembly techniques requiring short-term mechanical overload of the devices in the stack, Dynex’s compliant press-pack IGBTs can be subjected to temporary over-clamping during assembly. However, this should not be done without prior agreement and guidance from Dynex.

7.2 Dynex rigid press-pack IGBTs

Rigid press-pack IGBTs are not suitable for any mechanical over-pressurisation during assembly or during operation, as this may damage components within the device.
8. Cooling

8.1 Clamping and cooling of Dynex DLB press-packs

By design, Dynex's DLB press-packs are cooled primarily through their collector/cathode electrode. The incorporation of the DLB mechanism means that there is minimal heat transfer from the chips to the emitter/anode electrode. Care should still be taken, however, to avoid overheating of the emitter/anode contact. Typical flatness offered for 'off-the-shelf' heatsinks, as used with pressure contact thyristors, are acceptable.

![Figure 20 - Illustration of heat removal for a Dynex DLB press-pack IGBT.](image)

8.2 Clamping and cooling of Dynex rigid press-packs

Dynex's rigid press-pack IGBTs benefit from double side cooling, meaning they can be cooled through both their collector/cathode electrode and the emitter/anode electrode simultaneously for optimum heat transfer. Heatsinks should have a flatness tolerance no greater than 10µm.

![Figure 21 - Illustration of heat removal for a Dynex rigid press-pack IGBT.](image)
9. Customisation

The balance between the number of IGBT and diode chips within Dynex press-pack IGBTs is flexible, allowing products to be tailored for specific applications. The following sections give guidance on how this is achieved and typical effects on product ratings.

9.1 Dynex press-pack IGBT design

All Dynex press-pack IGBT designs are modular. Each basic unit position in a device can be populated with either an IGBT or diode basic unit, allowing the ratio between the two to be varied.

To illustrate this flexibility, Fig. 20 shows the five IGBT-to-diode ratios possible in a device containing four chips.

![Figure 22 - Potential configurations for a device containing 4 basic units.](image)

9.1.1 Standard configurations

Dynex press-pack IGBTs are offered in a number of standard configurations. These are listed in table 2.

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-IGBT</td>
<td>These devices are fully populated with IGBT basic units. These devices contain no diode basic units.</td>
</tr>
<tr>
<td>2:1 co-pack</td>
<td>These devices are populated with a 2:1 ratio of IGBT and diode chips. This is a typical ratio in high power IGBT products.</td>
</tr>
<tr>
<td>1:1 co-pack</td>
<td>These devices are populated with a 1:1 ratio of IGBT and diode chips. The increased diode chip count enhances the robustness of the diode and reduces its conduction losses. It is suitable for applications where the diode is required to handle higher fault currents (e.g. half-bridge MMC VSC-HVDC).</td>
</tr>
<tr>
<td>All-FRD</td>
<td>These devices are fully populated with diode basic units. The devices contain no IGBT basic units. They are commonly used as freewheel diodes for the all-IGBT devices.</td>
</tr>
</tbody>
</table>

Table 2 – Standard configurations for Dynex press-pack IGBTs.

9.1.2 Custom configurations

Alongside the standard configurations offered, devices can be manufactured with any IGBT-to-diode ratio possible in a given package. The ratio can be optimised to suit a given application, considering the requirements on both the IGBT and diode elements of a device. Customers considering this level of optimisation should contact Dynex with details of their application.

Devices can also be manufactured with a total basic unit count that is lower than the maximum possible in a given package. This can be useful where there is need for a device with an intermediate rating that requires a chip count falling between two standard packages.

9.1.3 Ratings for custom configurations

Dynex press-pack IGBTs are assigned current ratings based on their IGBT chip content. A device containing a given number of IGBT chips will have the same headline current rating regardless of the number of diode chips it contains.
For a given current rating, diode-related parameters will change significantly, as diode chip content varies, whereas parameters related to the IGBT will remain the same with the exception of turn-on energy (E_{on}). E_{on} depends significantly on the achievable commutation dI/dt, which is limited by the reverse bias safe operating area of the diode.

Table 3 illustrates the effects of adjusting the IGBT-to-diode ratio on key parameters for two devices with headline ratings of 1000A, 4500V, but with different configurations. In the example, the IGBT basic unit count is the same for both devices, but the diode basic unit count is adjusted.

<table>
<thead>
<tr>
<th>Device</th>
<th>1000A/4500V</th>
<th>1000A/4500V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.2:1 ratio</td>
<td>1:1 ratio</td>
</tr>
<tr>
<td>I_{c}</td>
<td>1000A</td>
<td>1000A</td>
</tr>
<tr>
<td>IGBT-to-diode ratio</td>
<td>2.2:1</td>
<td>1:1</td>
</tr>
<tr>
<td>V_{ce(sat)}</td>
<td>3.0V</td>
<td>3.0V</td>
</tr>
<tr>
<td>V_{f}</td>
<td>3.2V</td>
<td>2.4V</td>
</tr>
<tr>
<td>E_{off}</td>
<td>5.8J</td>
<td>5.8J</td>
</tr>
<tr>
<td>E_{on}</td>
<td>5.7J</td>
<td>4.7J</td>
</tr>
<tr>
<td>E_{rec}</td>
<td>3.2J</td>
<td>4.2J</td>
</tr>
<tr>
<td>R_{th(j-c)IGBT}</td>
<td>0.0104°C/W</td>
<td>0.0104°C/W</td>
</tr>
<tr>
<td>R_{th(j-c)FRD}</td>
<td>0.0229°C/W</td>
<td>0.0104°C/W</td>
</tr>
<tr>
<td>IGBT RBSoA</td>
<td>2000A</td>
<td>2000A</td>
</tr>
<tr>
<td>Diode RBSoA</td>
<td>1.3MW</td>
<td>2.6MW</td>
</tr>
<tr>
<td>IGBT SCSoA</td>
<td>4200A</td>
<td>4200A</td>
</tr>
<tr>
<td>Diode surge (I_{fsm})</td>
<td>7.8kA</td>
<td>17.2kA</td>
</tr>
</tbody>
</table>

Table 3 – Comparison of ratings between devices with different IGBT-to-diode ratios.
10. Naming convention

The following naming convention applies to Dynex press-pack IGBT and FRD devices.

10.1.1 Form

PPPCCCOVVAIIFF-SSSS

Where:
- P is the prefix
- C is the current rating
- O is the outline code
- V is the voltage rating divided by 100
- A differentiates between co-pack or all-IGBT/all-FRD
- I is the number of IGBT basic units in the package
- F is the number of FRD basic units in the package
- S is the special selection number

10.1.2 Prefix

The prefix is made up of three letters. The first two are DP for Dynex multi-chip press-pack devices, meaning Dynex Press-pack. The third changes depending on whether the device is all-IGBT (letter I), co-pack (letter I) or all-FRD (letter F).

10.1.3 Current rating

This is stated numerically in amperes.

10.1.4 Outline code

These are given in table 4.

10.1.5 Voltage rating

This is stated numerically in hundreds of volts.

10.1.6 Configuration

A = all-IGBT (i.e. contains IGBT basic units only) or all-FRD (i.e. contains FRD basic units only).
C = co-pack (i.e. contains IGBT and FRD basic units).

10.1.7 IGBT basic unit count

A two-digit number referring to the total number of IGBT basic units within the press-pack device.

10.1.8 Diode basic unit count

A two-digit number referring to the total number of FRD basic units within the press-pack device.

10.1.9 Example

DPI1600P45C3616 means a 1600A, 4500V, co-pack in a housing with a 125mm contact, 170mm flange and height of 26.5mm, with an IGBT-to-diode ratio of 36:16.

### Table 4 - Key dimensions of Dynex press-pack IGBTs for different outline codes.

<table>
<thead>
<tr>
<th>Outline code</th>
<th>Contact diameter (mm)</th>
<th>Flange diameter (mm)</th>
<th>Height (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>34</td>
<td>59</td>
<td>26.5</td>
</tr>
<tr>
<td>F</td>
<td>47</td>
<td>73</td>
<td>26.5</td>
</tr>
<tr>
<td>C</td>
<td>63</td>
<td>99</td>
<td>26.5</td>
</tr>
<tr>
<td>V</td>
<td>73</td>
<td>110</td>
<td>26.5</td>
</tr>
<tr>
<td>W</td>
<td>85</td>
<td>120</td>
<td>26.5</td>
</tr>
<tr>
<td>A</td>
<td>100</td>
<td>148</td>
<td>26.5</td>
</tr>
<tr>
<td>P</td>
<td>125</td>
<td>170</td>
<td>26.5</td>
</tr>
<tr>
<td>R</td>
<td>150</td>
<td>192</td>
<td>26.5</td>
</tr>
</tbody>
</table>
References

The products and information in this publication are intended for use by appropriately trained technical personnel.

Due to the diversity of product applications, the information contained herein is provided as a general guide only and does not constitute any guarantee of suitability for use in a specific application. The user must evaluate the suitability of the product and the completeness of the product data for the application. The user is responsible for product selection and ensuring all safety and any warning requirements are met. Should additional product information be needed please contact Customer Service.

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We annotate datasheets in the top right hand corner of the front page, to indicate product status if it is not yet fully approved for production. The annotations are as follows:-

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