

### Features

- High voltage
- Electrically isolated base plate
- 3000 V<sub>RMS</sub> isolating voltage
- Industrial standard package
- Simplified mechanical designs, rapid assembly
- High surge capability
- Large creepage distances
- UL E78996 approved 

170A  
230A  
250A

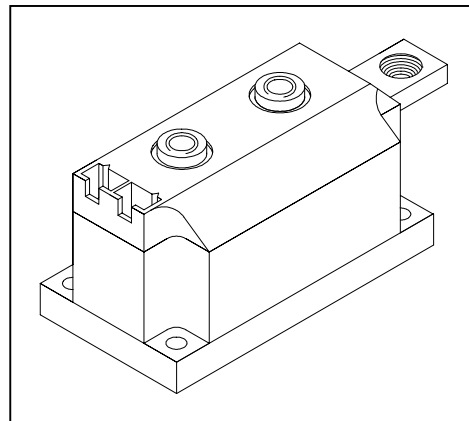
### Description

This new IRK serie of MAGN-A-paks modules uses high voltage power thyristor/thyristor and thyristor/diode in seven basic configurations. The semiconductors are electrically isolated from the metal base, allowing common heatsinks and compact assemblies to be built. They can be interconnected to form single phase or three phase bridges or as AC-switches when modules are connected in anti-parallel mode.

These modules are intended for general purpose applications such as battery chargers, welders and plating equipment and where high voltage and high current are required (motor drives, U.P.S., etc.).

### Major Ratings and Characteristics

| Parameters          | IRK.170..  | IRK.230..  | IRK.250..  | Units              |
|---------------------|------------|------------|------------|--------------------|
| $I_{T(AV)}$ @ 85°C  | 170        | 230        | 250        | A                  |
| $I_{T(RMS)}$        | 377        | 510        | 555        | A                  |
| $I_{TSM}$ @ 50Hz    | 5100       | 7500       | 8500       | A                  |
| @ 60Hz              | 5350       | 7850       | 8900       | A                  |
| $I^2_t$ @ 50Hz      | 131        | 280        | 361        | KA <sup>2</sup> s  |
| @ 60Hz              | 119        | 256        | 330        | KA <sup>2</sup> s  |
| $I^2_{\sqrt{t}}$    | 1310       | 2800       | 3610       | KA <sup>2</sup> √s |
| $V_{DRM} / V_{RRM}$ | Up to 1600 | Up to 2000 | Up to 1600 | V                  |
| $T_J$ range         | -40 to 130 |            |            | °C                 |



**ELECTRICAL SPECIFICATIONS**
**Voltage Ratings**

| Type number          | Voltage Code | $V_{RRM}$ $V_{DRM}$ , maximum repetitive peak reverse and off-state blocking voltage<br>V | $V_{RSM}$ , maximum non-repetitive peak reverse voltage<br>V | $I_{RRM}$ $I_{DRM}$ max @ 130°C<br>m A |
|----------------------|--------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------|
| IRK.170-<br>IRK.250- | 04           | 400                                                                                       | 500                                                          | 50                                     |
|                      | 08           | 800                                                                                       | 900                                                          |                                        |
|                      | 12           | 1200                                                                                      | 1300                                                         |                                        |
|                      | 14           | 1400                                                                                      | 1500                                                         |                                        |
|                      | 16           | 1600                                                                                      | 1700                                                         |                                        |
| IRK.230-             | 08           | 800                                                                                       | 900                                                          | 50                                     |
|                      | 12           | 1200                                                                                      | 1300                                                         |                                        |
|                      | 16           | 1600                                                                                      | 1700                                                         |                                        |
|                      | 18           | 1800                                                                                      | 1900                                                         |                                        |
|                      | 20           | 2000                                                                                      | 2100                                                         |                                        |

**On-state Conduction**

| Parameters                                                               | IRK.170 | IRK.230 | IRK.250 | Units | Conditions                                                                                                                                            |
|--------------------------------------------------------------------------|---------|---------|---------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_{T(AV)}$ Maximum average on-state current @ Case temperature          | 170     | 230     | 250     | A     | 180° conduction, half sine wave                                                                                                                       |
|                                                                          | 85      | 85      | 85      | °C    |                                                                                                                                                       |
| $I_{T(RMS)}$ Maximum RMS on -state current                               | 377     | 510     | 555     | A     | as AC switch                                                                                                                                          |
| $I_{TSM}$ Maximum peak, one-cycle on-state, non-repetitive surge current | 5100    | 7500    | 8500    | A     | t = 10ms No voltage                                                                                                                                   |
|                                                                          | 5350    | 7850    | 8900    |       | t = 8.3ms reapplied                                                                                                                                   |
|                                                                          | 4300    | 6300    | 7150    |       | t = 10ms 100% $V_{RRM}$                                                                                                                               |
|                                                                          | 4500    | 6600    | 7500    |       | t = 8.3ms reapplied                                                                                                                                   |
| $I^2t$ Maximum $I^2t$ for fusing                                         | 131     | 280     | 361     | KA²s  | t = 10ms No voltage                                                                                                                                   |
|                                                                          | 119     | 256     | 330     |       | t = 8.3ms reapplied                                                                                                                                   |
|                                                                          | 92.5    | 198     | 255     |       | t = 10ms 100% $V_{RRM}$                                                                                                                               |
|                                                                          | 84.4    | 181     | 233     |       | t = 8.3ms reapplied                                                                                                                                   |
| $I^2\sqrt{t}$ Maximum $I^2\sqrt{t}$ for fusing                           | 1310    | 2800    | 3610    | KA²√s | t = 0.1 to 10ms, no voltage reapplied                                                                                                                 |
| $V_{T(TH)1}$ Low level value of threshold voltage                        | 0.89    | 1.03    | 0.97    | V     | $(16.7\% \times \pi \times I_{T(AV)}) < I < \pi \times I_{T(AV)}$ , $T_J = T_J \text{ max.}$                                                          |
| $V_{T(TH)2}$ High level value of threshold voltage                       | 1.12    | 1.07    | 1.00    |       | $(I > \pi \times I_{T(AV)})$ , $T_J = T_J \text{ max.}$                                                                                               |
| $r_{t1}$ Low level on-state slope resistance                             | 1.34    | 0.77    | 0.60    | mΩ    | $(16.7\% \times \pi \times I_{T(AV)}) < I < \pi \times I_{T(AV)}$ , $T_J = T_J \text{ max.}$                                                          |
| $r_{t2}$ High level on-state slope resistance                            | 0.96    | 0.73    | 0.57    |       | $(I > \pi \times I_{T(AV)})$ , $T_J = T_J \text{ max.}$                                                                                               |
| $V_{TM}$ Maximum on-state voltage drop                                   | 1.60    | 1.59    | 1.44    | V     | $I_{TM} = \pi \times I_{T(AV)}$ , $T_J = T_J \text{ max.}$ , 180° conduction<br>Av. power = $V_{T(TH)1} \times I_{T(AV)} + r_t \times (I_{T(RMS)})^2$ |
| $I_H$ Maximum holding current                                            | 500     | 500     | 500     | mA    | Anode supply=12V, initial $I_T=30A$ , $T_J=25^\circ\text{C}$                                                                                          |
| $I_L$ Maximum latching current                                           | 1000    | 1000    | 1000    |       | Anode supply=12V, resistive load=1Ω<br>gate pulse: 10V, 100μs, $T_J = 25^\circ\text{C}$                                                               |

**Switching**

| Parameters                  | IRK.170  | IRK.230 | IRK.250 | Units | Conditions                                                                                                                    |
|-----------------------------|----------|---------|---------|-------|-------------------------------------------------------------------------------------------------------------------------------|
| $t_d$ Typical delay time    | 1.0      |         |         | μs    | $T_J = 25^\circ\text{C}$ , Gate Current=1A $dI_{g}/dt=1A/\mu s$                                                               |
| $t_r$ Typical rise time     |          |         |         |       | $V_d = 0,67\% V_{DRM}$                                                                                                        |
| $t_q$ Typical turn-off time | 50 - 150 |         |         | μs    | $I_{TM} = 300 A$ ; $-dI/dt=15 A/\mu s$ ; $T_J = T_J \text{ max}$ ;<br>$V_r = 50 V$ ; $dV/dt = 20 V/\mu s$ ; Gate 0 V, 100 ohm |

### Blocking

| Parameters                                                | IRK.170 | IRK.230 | IRK.250 | Units      | Conditions                                                    |
|-----------------------------------------------------------|---------|---------|---------|------------|---------------------------------------------------------------|
| $I_{RRM}$ Max. peak reverse and off-state leakage current | 50      |         |         | mA         | $T_J = T_J \text{ max.}$                                      |
| $V_{INS}$ RMS isolation voltage                           | 3000    |         |         | V          | 50Hz, circuit to base, all termin. shorted, 25°C, 1s          |
| $dv/dt$ Critical rate of rise of off-state voltage        | 1000    |         |         | V/ $\mu$ s | $T_J = T_J \text{ max.}$ , exponential to 67% rated $V_{DRM}$ |

### Triggering

| Parameters                                           | IRK.170           | IRK.230 | IRK.250 | Units          | Conditions                                                                                                                                |
|------------------------------------------------------|-------------------|---------|---------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| $P_{GM}$ Maximum peak gate power                     | 10.0              |         |         | W              | $t_p \leq 5\text{ms}$ , $T_J = T_J \text{ max.}$                                                                                          |
| $P_{G(AV)}$ Maximum average gate power               | 2.0               |         |         | W              | $f = 50\text{Hz}$ , $T_J = T_J \text{ max.}$                                                                                              |
| $+I_{GM}$ Maximum peak gate current                  | 3.0               |         |         | A              | $t_p \leq 5\text{ms}$ , $T_J = T_J \text{ max.}$                                                                                          |
| $-V_{GT}$ Max. peak negative gate voltage            | 5.0               |         |         | V              | $t_p \leq 5\text{ms}$ , $T_J = T_J \text{ max.}$                                                                                          |
| $V_{GT}$ Maximum required DC gate voltage to trigger | 4.0<br>3.0<br>2.0 |         |         | V<br>V<br>V    | $T_J = -40^\circ\text{C}$<br>$T_J = 25^\circ\text{C}$<br>$T_J = T_J \text{ max.}$<br>Anode supply = 12V, resistive load ; $R_a = 1\Omega$ |
| $I_{GT}$ Maximum required DC gate current to trigger | 350<br>200<br>100 |         |         | mA<br>mA<br>mA | $T_J = -40^\circ\text{C}$<br>$T_J = 25^\circ\text{C}$<br>$T_J = T_J \text{ max.}$<br>Anode supply = 12V, resistive load ; $R_a = 1\Omega$ |
| $V_{GD}$ Maximum gate voltage that will not trigger  | 0.25              |         |         | V              | @ $T_J = T_J \text{ max.}$ , rated $V_{DRM}$ applied                                                                                      |
| $I_{GD}$ Maximum gate current that will not trigger  | 10.0              |         |         | mA             | @ $T_J = T_J \text{ max.}$ , rated $V_{DRM}$ applied                                                                                      |
| $di/dt$ Max rate of rise of turned-on current        | 500               |         |         | A/ $\mu$ s     | @ $T_J = T_J \text{ max.}$ , $I_{TM} = 400\text{A}$ rated $V_{DRM}$ applied                                                               |

### Thermal and Mechanical Specifications

| Parameters                                             | IRK.170    | IRK.230 | IRK.250 | Units | Conditions                                                                                                                                    |
|--------------------------------------------------------|------------|---------|---------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| $T_J$ Junction operating temperature                   | -40 to 130 |         |         | °C    |                                                                                                                                               |
| $T_{stg}$ Storage temperature range                    | -40 to 150 |         |         | °C    |                                                                                                                                               |
| $R_{thJC}$ Maximum thermal resistance junction to case | 0.17       | 0.125   | 0.125   | K/W   | Per junction, DC operation                                                                                                                    |
| $R_{thCS}$ Thermal resistance, case to heatsink        | 0.02       | 0.02    | 0.02    | K/W   | Mounting surface flat, smooth and greased (per module)                                                                                        |
| T Mounting torque $\pm 10\%$                           | 4 to 6     |         |         | Nm    | A mounting compound is recommended and the torque should be rechecked after a period of about 3 hours to allow for the spread of the compound |
|                                                        | 4 to 6     |         |         | Nm    |                                                                                                                                               |
| wt Approximate weight                                  | 500        |         |         | g     |                                                                                                                                               |
|                                                        | 17.8       |         |         | oz    |                                                                                                                                               |
| Case style                                             | MAGN-A-pak |         |         |       |                                                                                                                                               |

## IRK.170, .230, .250 Series

Bulletin I27102 rev. C 05/02

International  
IOR Rectifier

### $\Delta R$ Conduction (per Junction)

(The following table shows the increment of thermal resistance  $R_{thJC}$  when devices operate at different conduction angles than DC)

| Devices  | Sinusoidal conduction @ $T_j$ max. |       |       |       |       | Rectangular conduction @ $T_j$ max. |       |       |       |       | Units |
|----------|------------------------------------|-------|-------|-------|-------|-------------------------------------|-------|-------|-------|-------|-------|
|          | 180°                               | 120°  | 90°   | 60°   | 30°   | 180°                                | 120°  | 90°   | 60°   | 30°   |       |
| IRK.170- | 0.009                              | 0.010 | 0.010 | 0.020 | 0.032 | 0.007                               | 0.011 | 0.015 | 0.020 | 0.033 | K/W   |
| IRK.230- | 0.009                              | 0.010 | 0.010 | 0.020 | 0.032 | 0.007                               | 0.011 | 0.015 | 0.020 | 0.033 |       |
| IRK.250- | 0.009                              | 0.010 | 0.014 | 0.020 | 0.032 | 0.007                               | 0.011 | 0.015 | 0.020 | 0.033 |       |

### MAGN-A-paks Suitable for Current Source Inverters

| Thyristor |           | Diode     | $I_{T(AV)} / I_{F(AV)} @ T_C$ |               |               |
|-----------|-----------|-----------|-------------------------------|---------------|---------------|
| $V_{DRM}$ | $V_{RSM}$ | $V_{RRM}$ | 170A                          | 230A          | 250A          |
| $V_{RRM}$ |           | $V_{RSM}$ | @ 85°C                        | @ 85°C        | @ 85°C        |
| 1400      | 1500      | 2000      | IRKH170-14D20                 | IRKH230-14D20 | IRKH250-14D20 |
| 1400      | 1500      | 2000      | IRKL170-14D20                 | IRKL230-14D20 | IRKL250-14D20 |
| 1600      | 1700      | 2500      | IRKH170-16D25                 | IRKH230-16D25 | IRKH250-16D25 |
| 1600      | 1700      | 2500      | IRKL170-16D25                 | IRKL230-16D25 | IRKL250-16D25 |
| 1800      | 1900      | 2800      | Not Available                 | IRKH230-18D28 | Not Available |
| 1800      | 1900      | 2800      | Not Available                 | IRKL230-18D28 | Not Available |
| 2000      | 2100      | 3200      | Not Available                 | IRKH230-20D32 | Not Available |
| 2000      | 2100      | 3200      | Not Available                 | IRKL230-20D32 | Not Available |

For all other parameters and characteristics refer to standard IRKH... and IRKL... modules.

### Application Notes

Current Source Inverter using 9 MAGN-A-paks

#### Current Source Inverters

Current-Source Inverters (also known as Sequentially Commutated Inverters) use Phase Control (as opposed to Fast) Thyristors and Diodes.

The advantages of Current Source Inverters lie in their ease control, absence of large commutation inductances and limited fault currents. Their simple construction, illustrated by the circuit on the left, is further enhanced by the use of MAGN-A-paks which allow the power circuit of an Inverter to be realised with 6 capacitors and 9 MAGN-A-paks all mounted on just one heatsink.

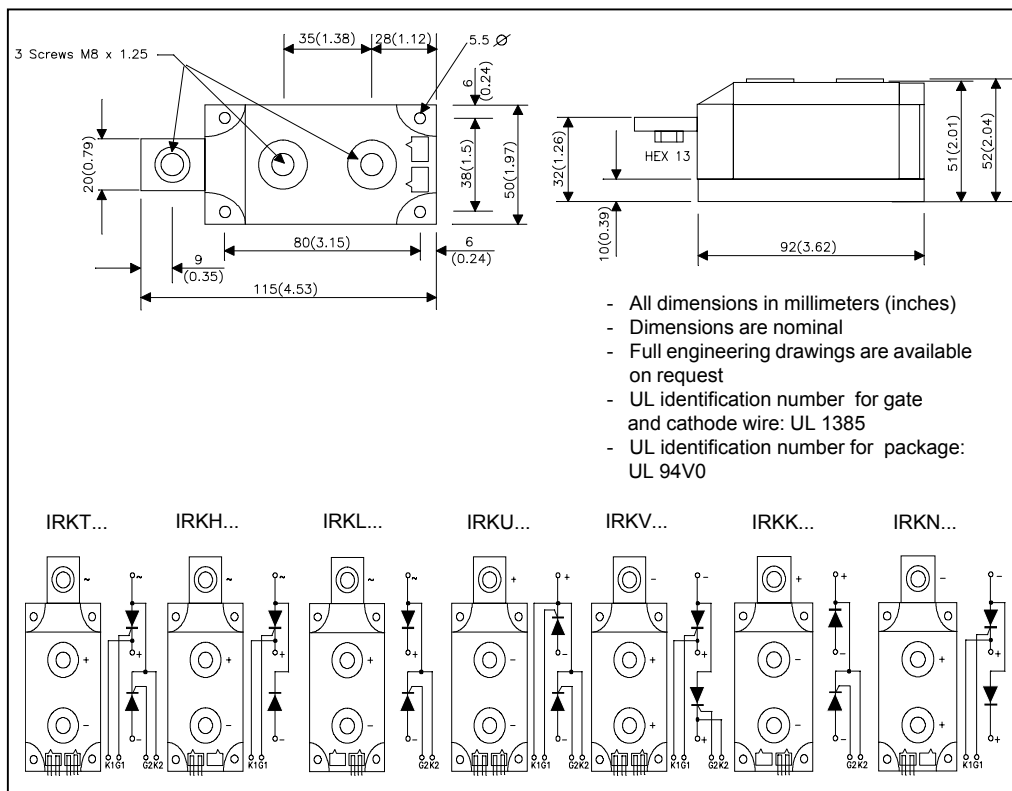
The optimal design of Current Source Inverters requires the use of Diodes with blocking voltages greater than those of the thyristors. This departure from conventional half-bridge modules is catered for by MAGN-A-pak range with Thyristors up to 2000V and Diodes up to 3200V.

### Ordering Information Table

| Device Code |   |     |   |    |     |
|-------------|---|-----|---|----|-----|
| 1           | 2 | 3   | 4 | 5  |     |
| IRK         | T | 250 | - | 14 | D20 |
| 1           | 2 | 3   | 4 | 5  |     |
| 1           | - |     |   |    |     |
| 2           | - |     |   |    |     |
| 3           | - |     |   |    |     |
| 4           | - |     |   |    |     |
| 5           | - |     |   |    |     |

- 1 - Module type
- 2 - Circuit configuration (See Outline Table)
- 3 - Current rating
- 4 - Voltage code: Code x 100 =  $V_{RRM}$  (See Voltage Ratings Table)
- 5 - Current Source Inverters Types

### Outline Table



**NOTE: To order the Optional Hardware see Bulletin I27900**

## **IRK.170, .230, .250 Series**

Bulletin I27102 rev. C 05/02

International  
**IOR** Rectifier

Data and specifications subject to change without notice.  
This product has been designed and qualified for Industrial Level.  
Qualification Standards can be found on IR's Web site.

International  
**IOR** Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
TAC Fax: (310) 252-7309  
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