Bidirectional 650-V D-Mode GaN Switch Works With Standard Gate Drivers

Renesas Electronics' TP65B110HRU is described as the industry's first bidirectional switch using depletion-mode (d-mode) GaN technology. The device is capable of blocking both positive and negative currents in a single device with integrated dc blocking. Targeting single-stage solar microinverters, AI data centers and onboard electric vehicle chargers, the high-voltage TP65B110HRU dramatically simplifies power converter designs and replaces conventional back-to-back FET switches with a single low-loss, fast-switching, easy-to-drive device (see the figure).

Renesas' field-proven 650-V SuperGaN devices are based on a proprietary normally-off technology that is simple to drive and highly robust, according to the vendor. The TP65B110HRU combines a high-voltage bidirectional d-mode GaN chip co-packaged with two low-voltage silicon MOSFETs with high threshold voltage (3 V), high gate margin (±20 V) and built-in body diodes for efficient reverse conduction (see the figure).

Compared with enhancement-mode (e-mode) bidirectional GaN devices, the Renesas bidirectional GaN switch offers compatibility with standard gate drivers that require no negative gate bias. This translates to a simpler, lower-cost gate loop design and fast, stable switching in both soft and hard switching operation without a performance penalty.

Power conversion topologies that require hard switching, such as the Vienna-style rectifier, can benefit from its high dv/dt capability of >100 V/ns, with minimum ringing and short delays during on/off transitions. The Renesas GaN device enables true bidirectional switching with high robustness, high performance and ease of use, says the vendor.

Other features of the TP65B110HRU include:

- ±650-V continuous peak ac and dc rating, ±800-V transient rating
- 2-kV Human Body Model ESD protection rating (HBM and CDM)
- 110-mΩ typical $R_{SS(ON)}$ at 25ºC
- 1.8-V, $V_{SS(FW)}$ freewheeling diode voltage-drop
- TOLT top-side cooled package with industry standard pin-out

Today's high-power conversion designs use unidirectional silicon or silicon carbide (SiC) switches, which block current in only one direction when in the off state. As a result, power conversion must be divided into stages with multiple switched bridge circuits. For example, a typical solar microinverter uses a four-switch full bridge to convert from dc to dc for the first stage, followed by a second stage to produce the final ac output to the grid.

Even as the electronics industry moves toward more efficient single-stage converters, engineers must work around inherent switching limitations. Many of today's single-stage designs use conventional unidirectional switches back-to-back, resulting in a four-fold increase in switch count and reduced efficiency.

By integrating bidirectional blocking functionality on a single GaN product, power conversion can be achieved in a single stage using fewer switching devices. A typical solar microinverter, for example, will require only two high-voltage Renesas SuperGaN bidirectional devices, eliminating the intermediary dc-link capacitors and cutting the switch count by half.

In addition, GaN products switch fast, with low stored charge, enabling higher switching frequencies and higher power density. In a real-world single-stage solar microinverter implementation, the new GaN architecture demonstrated higher than 97.5% power efficiency with the elimination of back-to-back connections and slow silicon switches.

The TP65B110HRU bidirectional GaN switch is available in quantity today. Customers can also purchase the RTDACHB0000RS-MS-1 evaluation kit for testing with different drive options, detect ac zero crossings and implement ZVS soft switching. For more information see the TP65B110HRU product page. For more on the GaN bidirectional switch half-bridge evaluation kit see the RTDACHB0000RS-MF-1-KIT page.

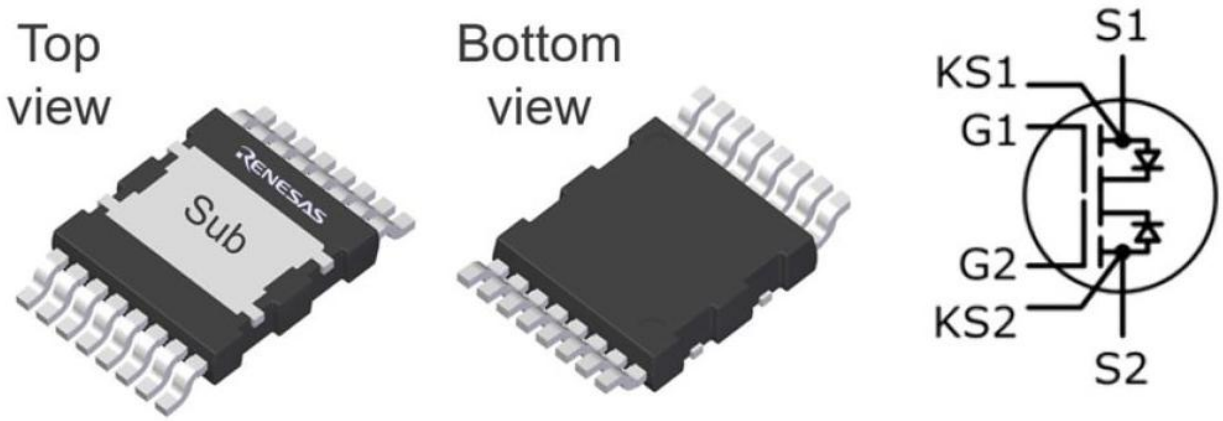

Figure. Targeting single-stage solar microinverters, AI data centers and onboard electric vehicle chargers, the TP65B110HRU 650-V 110-mΩ bidirectional power switch is said to dramatically simplify power converter designs by replacing conventional back-to-back FET switches with a single low-loss, fast-switching, easy-to-drive device. Housed in a top-side cooled TOLT, the device co-packages the d-mode GaN chip with two low-voltage silicon MOSFETs.