

# Radiation Hardened Planar Gate Power MOSFET 300 kRad TID Qualification

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**Abstract:** Four new radiation hardened by design power MOSFETs (MRH10N22U3, MRH15N19U3, MRH20N16U3, and MRH25N12U3) by Microchip Technology were tested to demonstrate their stable electrical performance against ionizing radiation up to an amount of 300 kRad (Si).

## Introduction

The continued expansion of space exploration and satellite-based technologies has created a critical need for power electronic components that can operate reliably in extreme radiation environments. In space, power metal-oxide-semiconductor field-effect transistors (MOSFETs) are exposed to ionizing radiation from cosmic rays, solar particle events, and trapped radiation belts, leading to performance degradation or catastrophic failure. These effects include threshold voltage shifts, increased leakage currents, and oxide charge buildup, all of which threaten mission reliability and longevity. Consequently, there is a growing requirement for radiation-hardened (rad-hard) power MOSFETs capable of withstanding total ionizing dose levels on the order of 300 kRad (Si), ensuring stable electrical performance and functional integrity throughout long-duration missions in high-radiation orbits and deep-space environments.

Four new rad-hard M6 power MOSFETs in the U3 package (MRH10N22U3, MRH15N19U3, MRH20N16U3, and MRH25N12U3) released by Microchip Technologies have been demonstrated to possess a stable electrical profile when subjected to steady-state total dose irradiation levels up to 300 kRad (Si) per MIL-STD-750 TM 1019 Condition A.

## Test Results

Four critical electrical characteristics were monitored for each device during these test campaigns. These devices were qualified to be radiation hardened up to 300 kRad (Si) if these measured electrical specifications did not violate the pre-irradiation limits prescribed in Table 1.

P/N	Electrical Specification				
	VBRDSS (V) <sup>1</sup>	VGS(TH) (V) <sup>2</sup>		IDSS (μA) <sup>3</sup>	RDS(ON) (mΩ) <sup>4</sup>
	MIN	MIN	MAX	MAX	MAX
MRH10N22U3	100	2	4	10	42
MRH15N19U3	150	2	4	10	88
MRH20N16U3	200	2	4	10	130
MRH25N12U3	250	2	4	10	210

**Table 1: The limits of each electrical specification per device (with TA = 25°C) as detailed in MIL-PRF-19500/746 (see footnotes for test condition per electrical specification) [1].**

The following four sets of plots showcase an average measured performance of VBRDSS, VGS(TH), IDSS, and RDS(ON) using 10 samples of each device type during irradiation (see Figures 1, 2, 3, and 4 for MRH10N22U3, MRH15N19U3, MRH20N16U3, and MRH25N12U3 respectively). Measurements were made at 0 kRad (Si), 100 kRad (Si), and 300 kRad (Si). In addition, the average value of three control

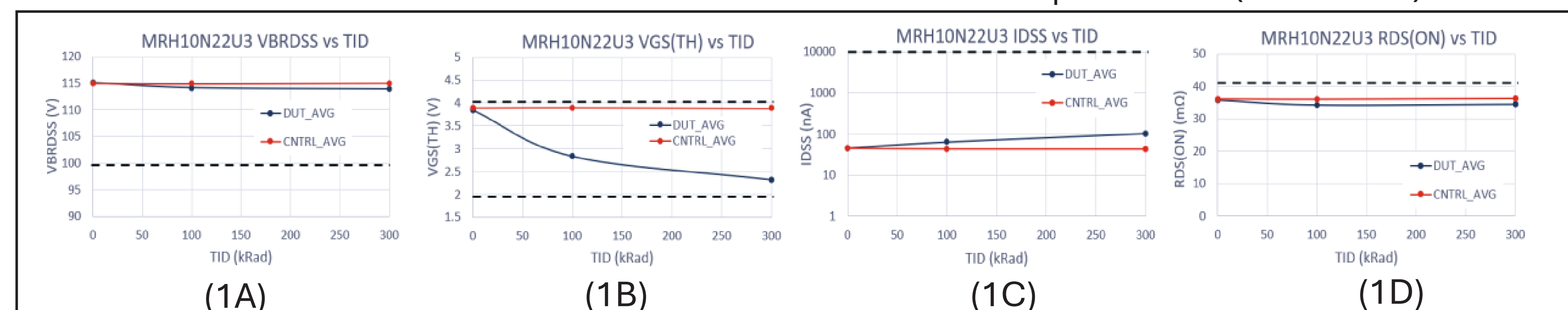
1 MIL-STD-750 TM 3407 Bias Condition C, VGS = 0V, IDS = 1mA

2 MIL-STD-750 TM 3403, VDS ≥ VGS, IDS = 1mA

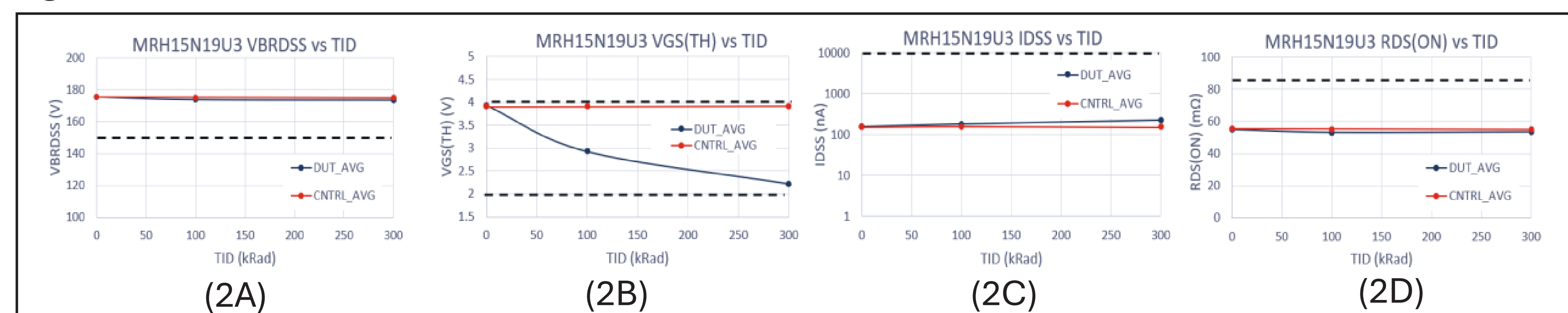
3 MIL-STD-750 TM 3413 Bias Condition C, VGS = 0V, VDS = 80% of rated VDS voltage

4 MIL-STD-750 TM 3405, VGS = 12V, ID = ID2, Condition A, pulsed

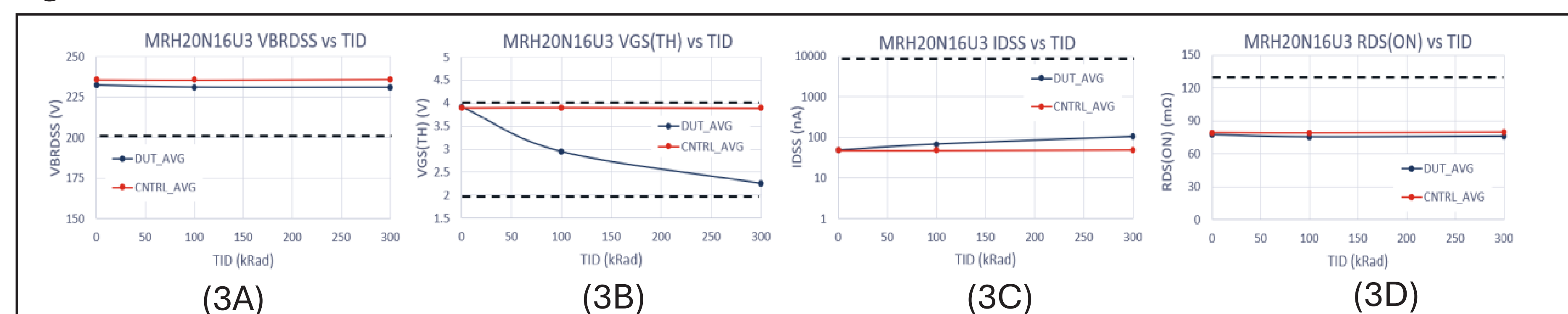
samples was included to compare the irradiated versions against a non-irradiated baseline at each measurement interval. Black dotted lines indicate the limits of each specification (see Table 1).



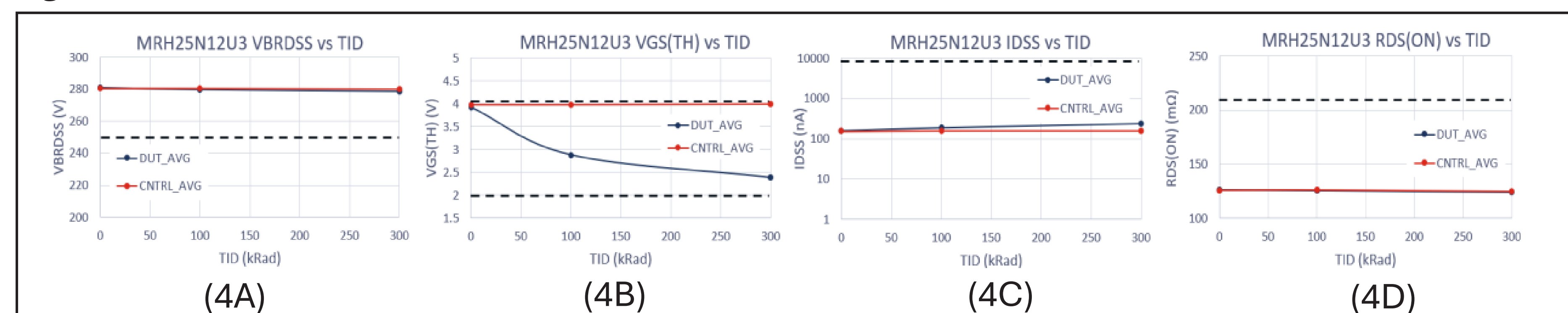
**Figure 1: VBRDSS (1A), VGS(TH) (1B), IDSS (1C), and RDS(ON) (1D) mean measurements for MRH10N22U3**



**Figure 2: VBRDSS (2A), VGS(TH) (2B), IDSS (2C), and RDS(ON) (2D) mean measurements for MRH15N19U3**



**Figure 3: VBRDSS (3A), VGS(TH) (3B), IDSS (3C), and RDS(ON) (3D) mean measurements for MRH20N16U3**



**Figure 4: VBRDSS (4A), VGS(TH) (4B), IDSS (4C), and RDS(ON) (4D) mean measurements for MRH25N12U3**

## Conclusions

According to the information above, the electrical specifications of all four device types have been verified to not violate pre-irradiation limits up to a TID level of 300 kRad (Si). These four devices were qualified to JANS requirements for space applications per MIL-PRF-19500/746.

## References

[1] Defense Logistics Agency, "MIL-PRF-19500/746D with Amendment 4", Technical Specification