MRAM Application Note: AN-317
HXNV00100 1Mb MRAM, HXNV01600 16Mb MRAM, and HXN06400 64Mb MRAM Frequently Asked Questions

Honeywell

1. What is MRAM and what are important features compared to other technologies?

Magneto Resistive Random Access Memory (MRAM) is a revolutionary memory that uses the magnetism of electron spin to provide memory non-volatility without wear-out. Honeywell MRAM stores bit information in magnetic material integrated with silicon circuitry built on 150nm SOI process which allows it to deliver random access capability of SRAM with the non-volatility of Flash in a single high endurance device while reliably operating in harsh radiation environments. Honeywell MRAM devices are designed to combine the best features of non-volatility and RAM to enable "instant-on" capability and power loss protection.

Write times for MRAM are approximately an order of magnitude less than traditional EEPROM devices (1uS vs. 0.1uS) and with comparable read times. Additionally, each address can be written and re-written individually like an SRAM without any type of erase operation required as with a FLASH device. Finally, unlike FLASH there is no wear out mechanism for MRAM, allowing it to be written and re-written over and over.

Honeywell MRAM can be used wherever a need exists in aerospace and defense applications that require a reliable radiation-hardened, non-volatile (NV) memory. It can be used in applications that typically require programmable read-only memory (PROM), electronically erasable programmable read-only memory (EEPROM), FLASH, or Chalcogenide RAM.

2. Is the MRAM interface similar to SRAM?

Honeywell MRAM is similar to a synchronous SRAM interface. A clock pin is used to initiate all write or read operations to a single address on the rising edge. A chip enable, address bus, data bus, and write enable are all sampled on the rising edge of the clk. An asynchronous output enable pin puts the data bus into a high impedance condition. See the datasheets or SMD for timing diagrams and functional truth tables.

3. What size MRAM devices does Honeywell currently offer or plan to offer?

Honeywell is pleased to offer both 1Mb and 16Mb size MRAM devices. Additionally, a 64Mb MRAM device is currently in development and will be available late in 2014.

4. Has any of the Honeywell MRAM achieved QML-V or QML-Q+ certification?

The 16Mb MRAM has been QML V and Q+ Qualified and the 64Mb MRAM is pending. The 1M MRAM will be offered as a "QML Equivalent".

Honeywell Part Number	SMD Number
HXNV01600	5962-13213
HXNV06400	5962-14230 Pending

5. Why is the 16Mb and 64Mb MRAM temperature ranges only -40°C to +125°C rather than the full military range of -55°C to +125°C?

MRAM technology is qualified to -40°C. Proprietary Honeywell screening flows were developed and are in place to ensure robust performance for each MRAM part down to -40°C.

For applications that require operation below -40°C, please contact Honeywell.

6. **How does the Honeywell MRAM speed compare with an equivalent commercial MRAM?**

The commercial 16Mb MRAM design targeted speed as a higher priority design goal. The primary design goal of the Honeywell MRAM was to offer a robust non-volatile memory that has excellent reliability in a harsh radiation environment with low power consumption.

Honeywell's proprietary design significantly reduces the probability of events such as single event transients (SETs) causing inadvertent writes or persistent single event functional interrupts (SEFIs) occurring that could cause the part to become inoperable and would require external circuitry to monitor and reset. Additionally, we've hardened the design for applications that have dose rate upset and survivability requirements. These factors contributed to the final product having a longer overall access time but with very robust radiation performance and lower dynamic read power.

7. **Why is the Honeywell MRAM interface synchronous rather than an asynchronous interface like Honeywell SRAMs?**

The 1Mb MRAM synchronous interface was designed to meet a specific customer requirement and it proved very successful in meeting all required radiation specifications. When designing the 16Mb MRAM, the proven 1Mb synchronous interface was again deployed and has been demonstrated to be very robust in harsh radiation environments.

Secondly, a synchronous interface is required for stand-alone memories that are used as a boot device for radiation hardened FPGAs. The design of the 16Mb MRAM is designed such that multiple 16Mb memories can be daisy chained together to achieve the desire memory size required. Having the synchronous interface on the 16Mb MRAM die allows simple interfacing to a radiation hardened FPGA without an additional controller device in between.

Development of the 64Mb MRAM consists of incorporating four 16Mb MRAM die daisy chained together in a single package or multi-chip module (MCM).

8. **Are IBIS and Verilog models available for MRAM products?**

IBIS and Verilog models have been created for all of the MRAM products and can be obtained by contacting Honeywell.

9. **Are there special considerations that need to be taken into account regarding the device and magnetic fields?**

Honeywell's MRAM products are robust to stray magnetic fields. Similar to ESD for electronic components, stray magnetic fields must also be taken into consideration for MRAM devices. Two stray magnetic field (SMF) application notes have been created to provide specific guidance on limits during design and handling of the devices and can be found on the Honeywell website.

10. **Can the MRAM be used as a configuration memory for the Xilinx Virtex-5QV FPGA?**

The 16Mb MRAM die was designed to interface directly with the Xilinx Virtex-5QV. When in Master SelectMap x8 or x16 mode, the Virtex-5 expects data to sequentially output from the boot memory on the rising edge of every clock. The 16Mb MRAM die has a built in address counter that will cycle thru the memory on the rising edge of each clock without an external address supplied. This feature is referred to as auto increment mode in the datasheets. The 16Mb MRAM die also has the ability to be daisy chained such that any multiple of 16Mb of memory can be created to interface with the Xilinx FPGA (32Mb, 48Mb, 64Mb, etc).
The 64Mb MRAM is a multichip module (MCM) which daisy chains four 16Mb MRAM die together in a planar package. Honeywell has successfully demonstrated the boot of a Virtex-5QV with four 16Mb MRAM packages on a board without any additional logic required.

11. **What is the overall soft error rate (SER) that should use when designing with MRAM?**

Honeywell's MRAM devices have been designed for low error rates in harsh radiation environments in both static and dynamic operation. An application note has been created that describes the various soft error rate contributions and how to assess SER for various applications. It can be found on Honeywell's website.

12. Are the Honeywell MRAMs immune to radiation induced latch-up?

Yes. Honeywell's S150 SOI process technology provides excellent immunity to latch-up conditions over bulk technologies. No further systems considerations are needed.

13. What supply voltages are required for MRAMs?

Honeywell's 1Mb MRAM requires two supplies to operate correctly: a 1.80V and 3.3V IO supply.

The 16Mb MRAM requires only a 3.3V supply when using 3.3V IO. The 16Mb MRAM can also support a 2.50V IO supply. Please contact Honeywell for more information on this option for the 16Mb MRAM.

Like the 16Mb MRAM, the 64Mb MRAM will require only a single 3.3V supply but additionally will support 2.5V IO operation. When operating with 2.5V IO, a separate 3.3V is still required.

Contact Honeywell for any special cases, other questions, or assistance on MRAM applications or performance.

To learn more about Honeywell's radiation hardened integrated circuit products and technologies, visit www.honeywellmicroelectronics.com

The information provided is for reference only and does not define product performance in all applications. Accordingly, it will not form a basis for contracting. The user shall verify product and its performance in their specific application and conditions.