MEMORY
COMPETENCE
CENTER

MEMPHIS
WE KNOW MEMORY

FACTORY AUTOMATION:
ENHANCED RELIABILITY WITH FeRAM

A CASE STUDY ON HUMAN-MACHINE INTERFACES FOR ROBOTIC SYSTEMS

Executive Summary

In modern factory automation (FA) environments, minimizing system downtime and enhancing operational continuity are critical objectives. Robotic systems, particularly those relying on Human-Machine Interfaces (HMIs), require memory components capable of high-speed data writing, non-volatility, and resilience under harsh operating conditions.

This paper examines the deployment of Ferroelectric Random Access Memory (FeRAM) in robotic HMIs and contrasts its performance with traditional Electrically Erasable Programmable Read-Only Memory (EEPROM). Through technical evaluation, comparative benchmarks, and real-world case analysis, the paper demonstrates why FeRAM represents a superior choice for high-reliability, low-latency factory automation applications.

1. INTRODUCTION

Industry 4.0 has ushered in a wave of digital transformation across industrial sectors, demanding real-time data management, automation robustness, and intelligent control systems. Memory technologies used in HMIs play a pivotal role in ensuring that robotic systems operate with consistency and recover rapidly from power disruptions. This paper focuses on FeRAM, a non-volatile memory technology that meets these stringent requirements, and details its advantages over EEPROM in robotic HMIs.

2. TECHNICAL BACKGROUND

2.1 FeRAM Architecture

FeRAM stores data using a ferroelectric layer in the capacitor structure, allowing for high-speed switching and non-volatility. Unlike EEPROM, which uses charge storage mechanisms requiring high-voltage operations and time-consuming erase cycles, FeRAM offers near-SRAM performance with the benefits of non-volatility.

2.2 High-Speed Data Logging

Parameter	FeRAM	EEPROM
Write Speed	50-150 ns	1-10 ms
Endurance (Write Cycles)	>10^10 - 10^15	~10^5 - 10^6
Power Failure Resilience	Immediate Write Commit	Vulnerable (Buffered)
Data Retention	>10 years	>10 years
Energy Consumption	Low	Higher (due to erase/write cycles)
Recovery Time After Failure	Instantaneous	Requires manual reset, longer
Data Integrity on Power Loss	Secure, no loss	Risk of incomplete writes

Endurance Comparison FeRAM sustains over 10 billion write cycles, far exceeding EEPROM

3. ROBOTIC HMIs

3.1 System Requirements

Robotic systems in FA environments require non-volatile memory for the storage of:

- Actuator parameters (e.g., joint angles, torque levels)
- Dynamic control data (e.g., position, velocity)
- Environmental feedback (e.g., sensor inputs)

3.2 Limitations of EEPROM

Despite widespread use, EEPROM is fundamentally constrained by:

- Slow write speeds leading to system lag during frequent updates
- Low endurance, especially problematic under continuous motion control operations
- Susceptibility to power loss, causing frequent data corruption or loss

3.3 Advantages of FeRAM in Robotic HMIs

FeRAM addresses all limitations of EEPROM:

- Enables real-time data logging with minimal latency
- Ensures instant data retention during unexpected shutdowns
- Supports frequent writes without degradation, extending system lifespan

4. CASE STUDY:

FeRAM Integration in a Precision Robotics Manufacturing Facility

Background: A high-precision assembly line utilized EEPROM-based HMIs to control robotic arms. Recurrent power disruptions led to repeated data loss, requiring manual reconfiguration after each incident.

Challenges:

- Downtime averaged 15–20 minutes per incident
- Operator stress due to frequent data recovery requirements
- Loss of production efficiency due to parameter resets

Solution: Transition to FeRAM modules (MB85RC256V, MB85RS1MT) allowed for real-time write capability and robust data retention.

Outcomes:

- >80% reduction in recovery time after power failures
- Zero data loss incidents over 12 months
- Increase in operational efficiency by ~12%
- Enhanced operator confidence and focus on value-added tasks

5. TYPICAL FeRAM COMPONENTS FOR INDUSTRIAL USE

Part Number	Interface	Density	Notable Features
MB85RC256V	I2C	256 Kbit	Compact, high-speed, low-power memory
MB85RS1MT	SPI	1 Mbit	Extended endurance and industrial temperature range
MB85R8MTPF	Parallel	8 Mbit	High-density for complex robotic control

6. CONCLUSION:

FeRAM offers a transformative advantage in factory automation environments where reliability, speed, and endurance are critical.

Compared to EEPROM, FeRAM drastically improves system resilience, enables real-time control, and reduces both machine downtime and maintenance overhead.

As automation continues to evolve, FeRAM will remain central to the next generation of intelligent, adaptive robotic systems.

7. REFERENCES:

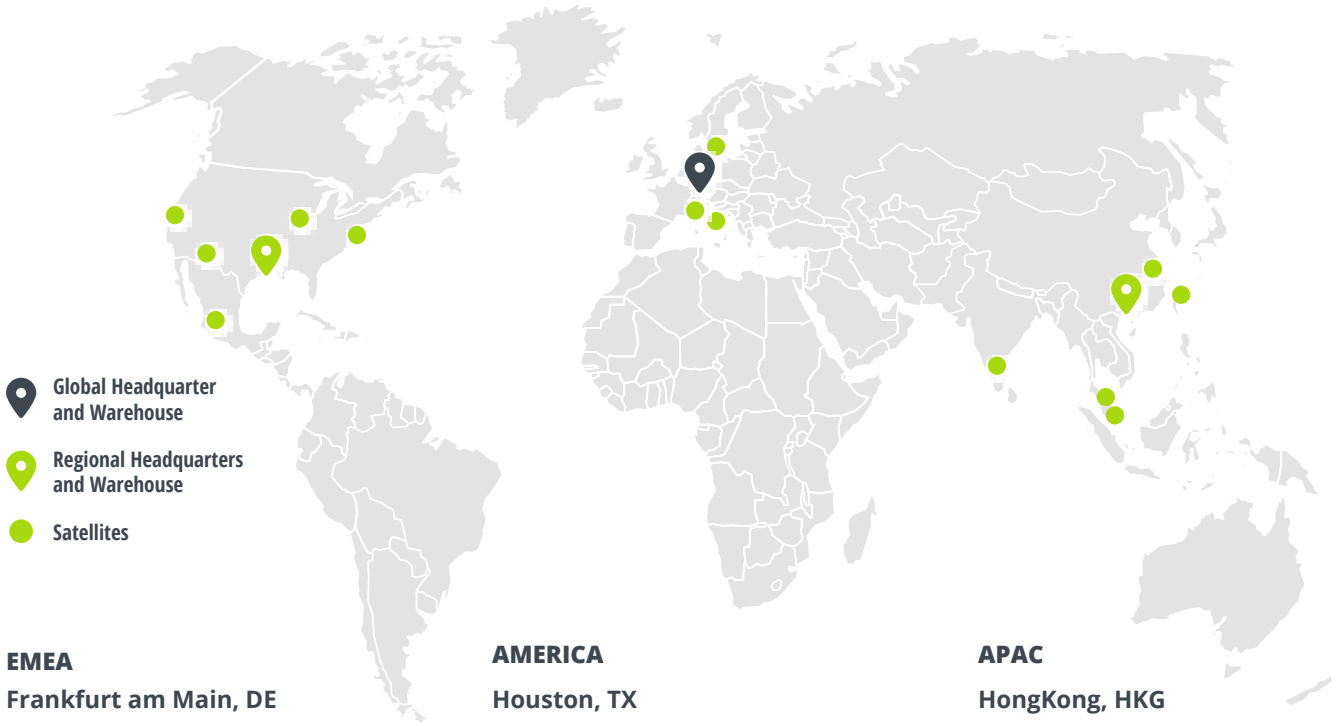
1. Fujitsu Semiconductor Memory Solution, „FeRAM Overview," Technical White Papers, 2022.
2. Texas Instruments, „Comparison of Non-Volatile Memories in Embedded Systems," Application Report, 2021.
3. IEEE Transactions on Industrial Electronics, Vol. 68, No. 7, 2021. „Memory Technologies for Industry 4.0: Comparative Review."
4. International Journal of Robotics Research, „Optimizing System Recovery in Embedded Robotic Platforms," 2020.
5. JEDEC Solid State Technology Association, „Standard Definitions for Memory Technologies," JESD21-C.

ABOUT US

MEMPHIS Electronic has been in the memory business for over 30 years. Due to our focus on memory only, we developed into a Memory Competence Center with an unmatched line card of over 18 different memory manufacturers (Samsung, Nanya, SK Hynix, Winbond, Huawei, SkyHigh, Ramxeed, Intelligent Memory, Apacer, Longsys, ESMT, Biwin and many more). We combine this with comprehensive supply chain solutions.

From legacy to latest components and modules, from standard to specialty memories – if it's a memory, we can help. Memory experts in 17 locations worldwide provide regional support and manufacturer recommendations, to ensure customers find the most suitable technology solution for every project.

MEMPHIS LOCATIONS



EMEA
Frankfurt am Main, DE
Copenhagen, DNK
Geneva, CH
Milan, IT

AMERICA
Houston, TX
Boston, MA
Chicago, IL
Phoenix, AZ
San Jose, CA
Guadalajara, MEX

APAC
HongKong, HKG
Shanghai, CN
Taipei, TW
Hsinchu, TW
Singapore, SGP
Kuala Lumpur, MY
Bengaluru, IN

CONTACT US

For further information, data sheets or samples, please reach out.
We are only an email away: sales@memphis.de

MEMPHIS Electronic GmbH
www.memphis.de
info@memphis.de

MEMPHIS
WE KNOW MEMORY