



Flash Memory Summit

FLASH MEMORY SUMMIT
2022
JANUARY 10-12, 2022
SAN JOSE, CALIFORNIA

Ultra-low Power NVM System Design Strategies for IoT and Wearable Applications

Omar Mohammed

Technical Marketing Manager, Macronix



MACRONIX
INTERNATIONAL Co., LTD.



Ultra Low Power Trends

24.8%

Growth of
ULP MCU Market
(2021-2026)

10.1%

CAGR

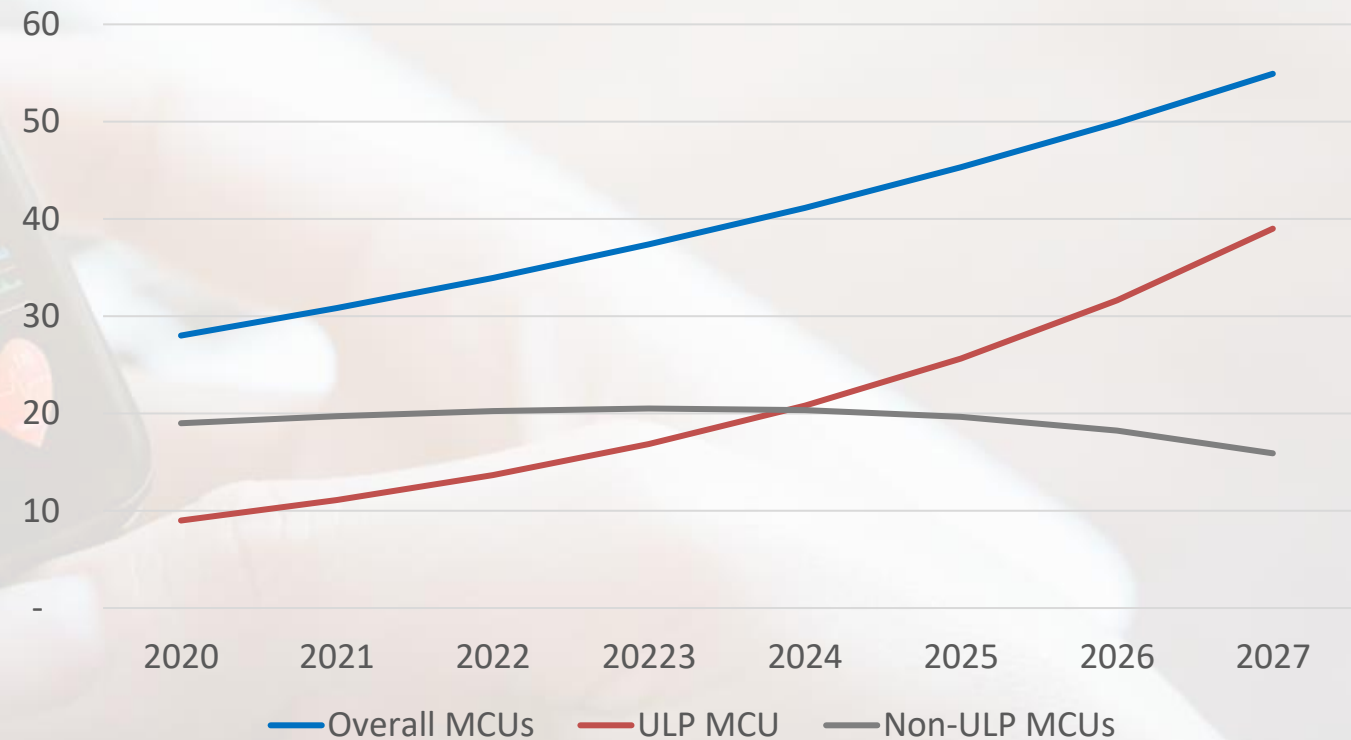
Growth of Overall
MCU Market
(2021-2026)

9/28

Billion

ULP/MCU
Global Shipment
(2020)

Comparing Overall MCUs to ULP MCUs to Non-ULP MCUs



Types of Applications Primed to Shift to Low Power

- **Wearables:** Continuous Glucose Monitors, Insulin Pumps, Smart Watches, Wireless Headphones
- **IoT:** Temperature Sensors, Pressure Sensors
- **Portable Solutions using a battery as the sole power source:** Smart Locks

Why These Applications Are Primed to Shift to Low Power



Flash Memory Summit

- **More Sensors Than Ever:** Temperature, Pressure, Blood Glucose, Accelerometer
- **More Connectivity:** BLE, WiFi, LTE
- **Rely Solely on a Battery:** Finite Power, Finite Dimensions



Why is NOR Flash Trending to Lower Vcc (Example 1.2V)

40_{nm}
& Beyond

Logic Technology

The core voltage down to 0.9V
for deep sub-micron process

**Low
Power**

$I \times V \times t$

**Metal-air &
Metal Oxide**

Battery Technology

- Silver Oxide: 1.14V - 1.6V
- Zinc-air battery: 0.9V - 1.5V

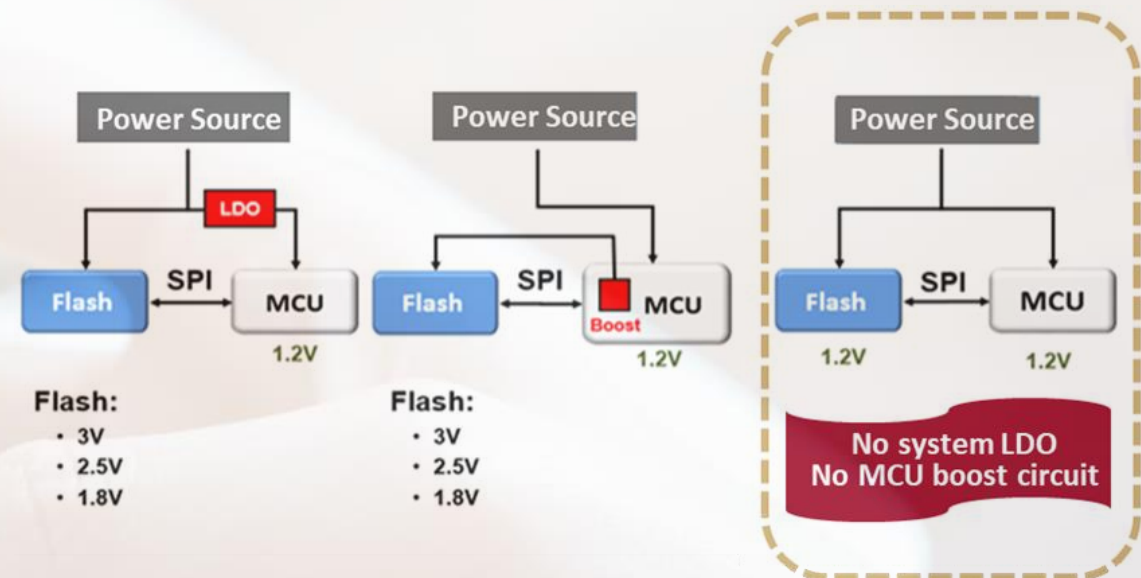
**1.2V
DDR4**

DRAM Technology

BOM ↓

1.2V NOR for simpler system

- Current: DC/DC regulator or LDO
- uC, RAM & 3-axis sensors use 1.2V



How Macronix is Supporting Shift to Ultra-Low Power: Application Example



Flash Memory Summit

Continuous Glucose Monitor (CGM) Application Design Challenges:



Single Charge,
Long Duration



Small &
Lightweight



Long Shelf Life



- Collect small amounts of data periodically
- Transmit data to a remote device / cloud service
- Low power state between data collection or transmission

Image Source: flaticon.com

How Macronix MX25S is Supporting Shift to Ultra-Low Power: Application Example

Continuous Glucose Monitor (CGM) Application Design Challenges: (How Macronix is addressing these challenges)



Single Charge,
Long Duration



1.14V - 1.6V for
lower IO Voltages,
save overall system power



Small &
Lightweight



Small Form Factor
e.g. 8-USON,
WLCSP, KGD



Long Shelf Life



**Ultra Low Deep
Power Down Current :**
50nA



- Collect small amounts of data periodically
- Transmit data to a remote device / cloud service
- Low power state between data collection or transmission

**Ultra Low Active
Current : 0.8mA**

Power Management capability to
switch between Ultra Low Power
Mode and High Performance Mode

Image Source: flaticon.com

How Macronix is Supporting Shift to Ultra-Low Power: Application Example

Smart Watch Application Design Challenges:



Single Charge,
Long Duration



Small &
Lightweight



Long Shelf Life



- Collect small amounts of data periodically
- Transmit data to a remote device / cloud service
- Low power state between data collection or transmission

How Macronix MX25R is Supporting Shift to Ultra-Low Power: Application Example

Smart Watch Application Design Challenges: (How Macronix is addressing these challenges)



Single Charge,
Long Duration



Ultra-Low
Active Current:
3.5mA



Small &
Lightweight



Small Form Factor
e.g. 8-USON,
WLCSP, KGD



Long Shelf Life



Ultra-Low **Deep**
Power Down Current:
7nA



- Collect small amounts of data periodically
- Transmit data to a remote device / cloud service
- Low power state between data collection or transmission

Ultra-Low Active Current: 3.5mA

Power Management capability to switch between Ultra Low Power Mode and High Performance Mode

Macronix Ultra-Low Power Flash Memory: MX25S & MX25R

Power Consumption (Typical)		1.2V (MX25S Family)		Wide Range Vcc (MX25R Family)		1.8V MX25U_32F (Family)
		HPM	ULP	HPM	ULP	
Voltage Range		1.14V-1.6V		1.65V-3.6V		1.65V-2.0V
DPD Current		0.05uA	0.05uA	0.007uA	0.007uA	0.05uA
4 I/O Read		120MHz	120MHz	80MHz	8MHz	133MHz
Power Consumption (I * V * t)	4X I/O Read	0.4X	0.4X	0.98X	3.33X	1.0X
	Page Program	0.94X	1.12X	1.23X	2.8X	1.0X
	Sector Erase	0.32X	0.34X	0.47X	0.6X	1.0X
	Block Erase	0.30X	0.34X	0.56X	0.83X	1.0X
Production Date		May, 2021		June, 2015		July, 2019



Wide Vcc Range extend battery lifetime:
1.14V - 1.6 V & 1.65V - 3.6V



The lowest DPD Current in the industry to-date:
0.007uA



The highest 1.2V Read Performance in the industry to-date:
120MHz



Ultra-Low Active Current:
0.8mA



Ultra-Low Power Consumption achieved:
30% of Conventional NOR Flash

NOTE: 1. DPD= Deep Power Down; HPM=High Performance Mode; ULP=Ultra Low Power Mode
2. Take MX25U_32F power consumption as 1.0X



**MACRONIX
INTERNATIONAL Co., LTD.**

Copyright© Macronix International Co., Ltd. 2022. All rights reserved, including the trademarks and tradename thereof, such as Macronix, MXIC, MXIC Logo, MX Logo, Integrated Solutions Provider, Nbit, Macronix NBit, HybridNVM, HybridFlash, HybridXFlash, XtraROM, KH Logo, BE-SONOS, KSMC, Kingtech, MXSMIO, RichBook, OctaBus, ArmorFlash, LybraFlash. The names and brands of third party referred thereto (if any) are for identification purposes only.



**MACRONIX
INTERNATIONAL Co., LTD.**

