

EESA-IOT 5.0



ELEmon
Componentes Electrónicos

Agenda

- Introducción:
 - ✓ Componentes principales
 - ✓ Diagrama en bloques
- Tecnologías y productos:
 - ✓ Cortex M0+: SAMD21
 - ✓ LoRa: RN2903
 - ✓ Wi-Fi/BLE: ESP32
 - ✓ EERAM: 47L16
- Esquemáticos

Agenda

- Firmware
 - ✓ Modulo RN2903
 - ✓ Modulo ESP32
 - ✓ Micro SAMD21
- Arduino
 - ✓ Core
 - ✓ Ejemplo LoRa
 - ✓ Ejemplo Wi-Fi
 - ✓ Ejemplo EERAM
 - ✓ Low Power

Introducción

El objetivo de esta placa es proveer una plataforma de hardware y firmware que permita prototipar de manera rápida y sencilla aplicaciones IOT basadas principalmente en LoRa, y eventualmente complementadas con WiFi y/o BLE.

El diseño esta basado en un core de Arduino para placas Atmel Xplained-Pro-SAMD21, de manera de poder desarrollar prototipos programados en Arduino.

Introducción

La placa puede ser alimentada desde el USB (o cargador USB), batería o fuente externa.

Se puede programar en Arduino y/o en los respectivos ambientes de desarrollo de cada uno de los módulos.

EESA-IOT Componentes

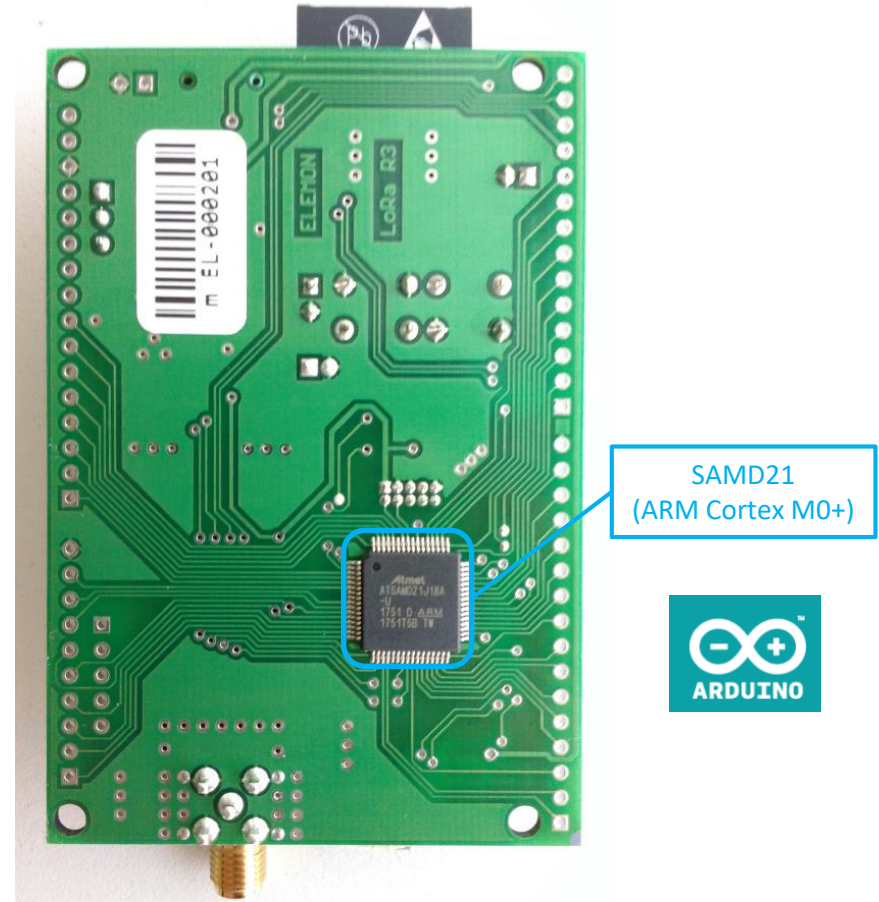
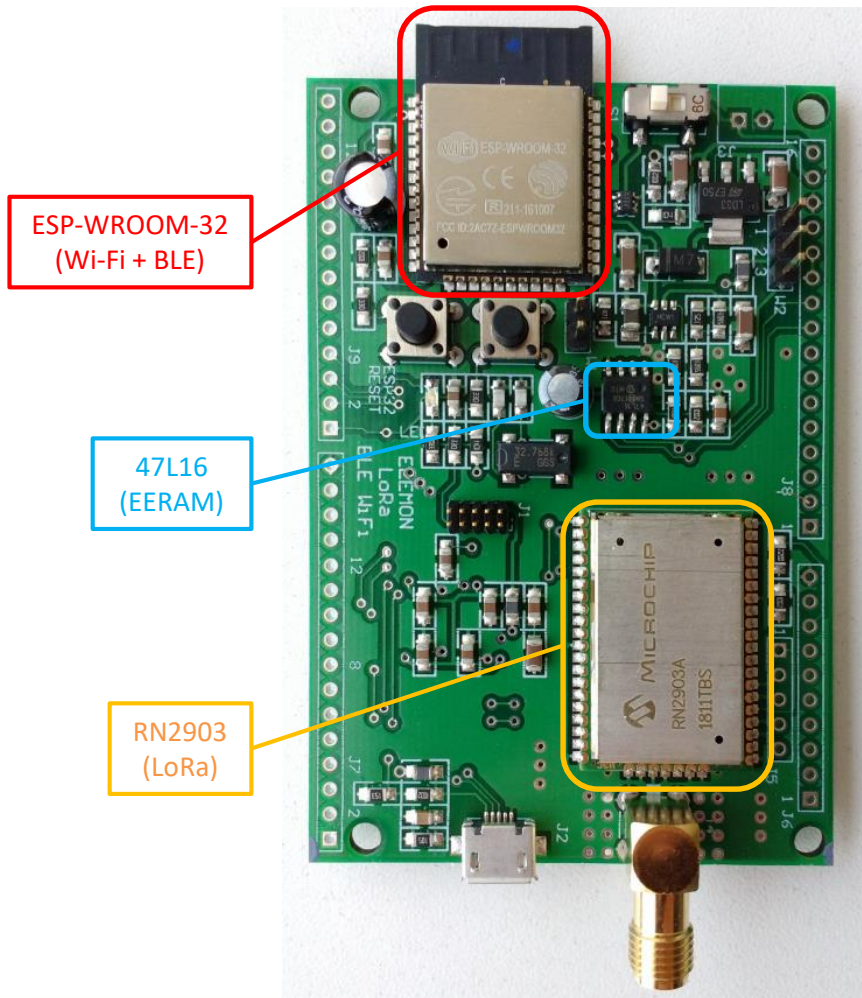
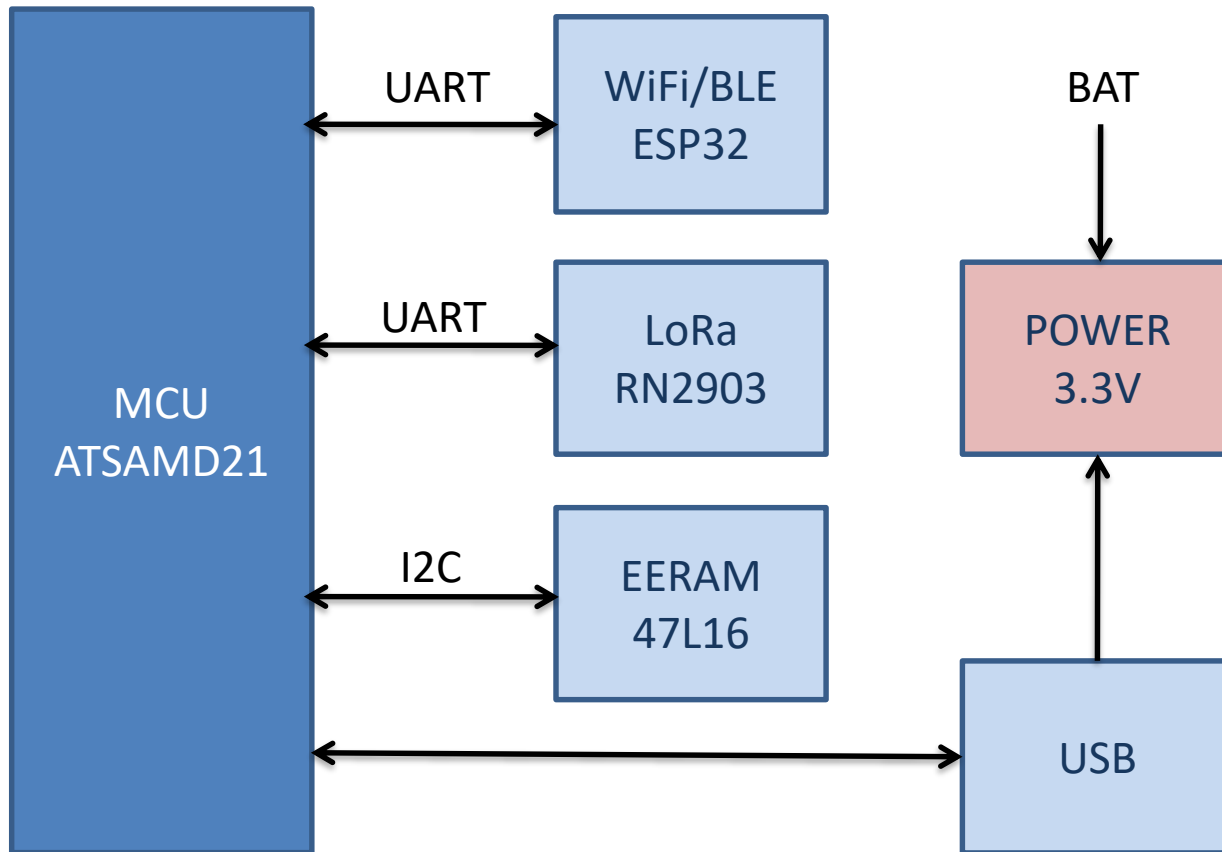
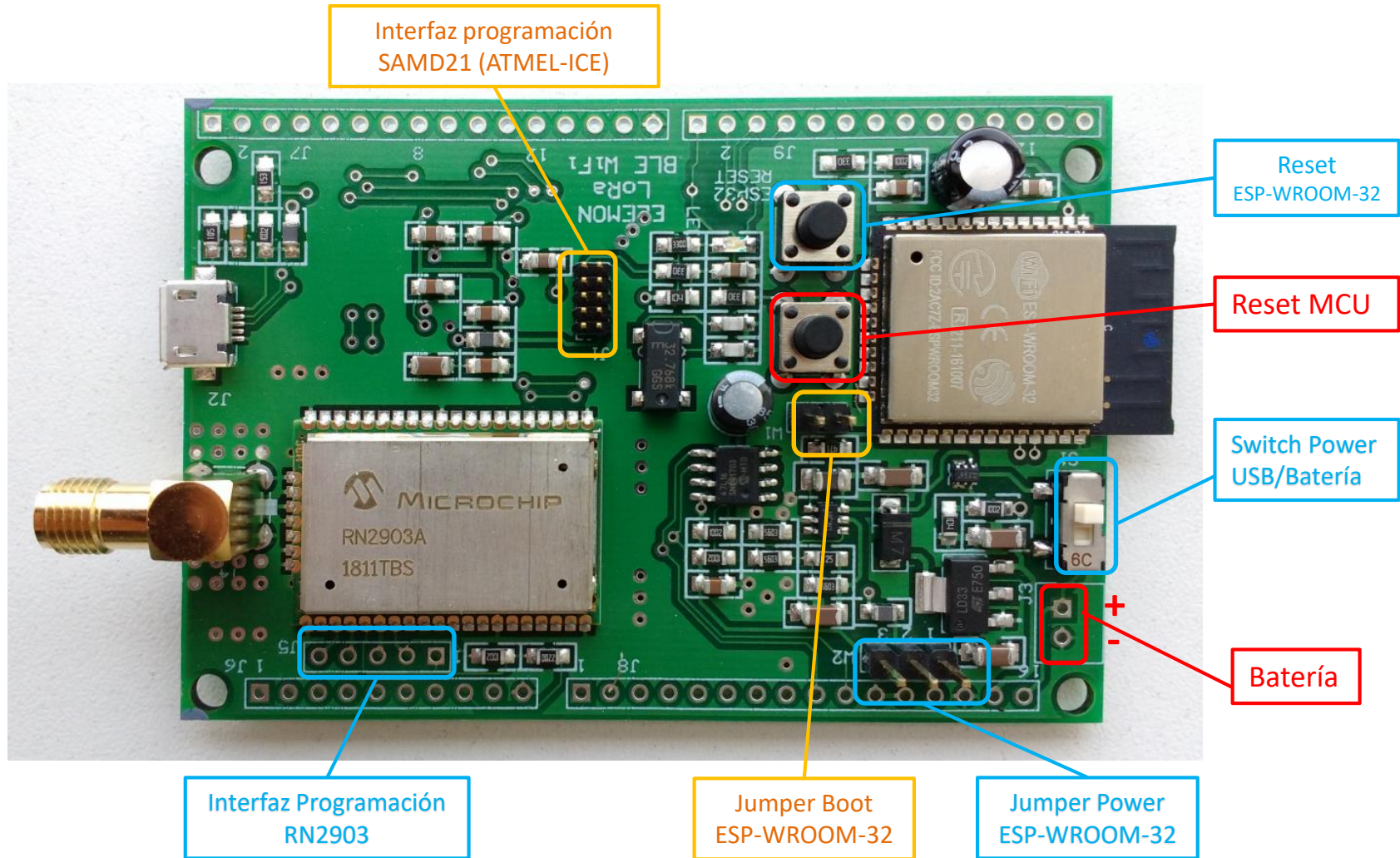


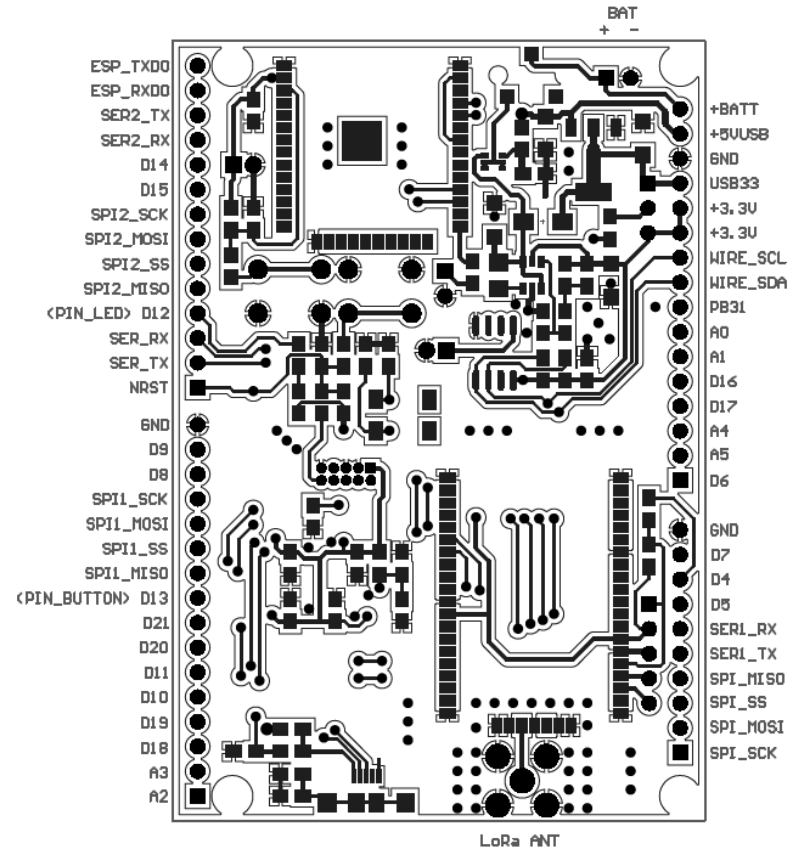
Diagrama en Bloques



EESA-IOT Interfaces



EESA-IOT Pinout



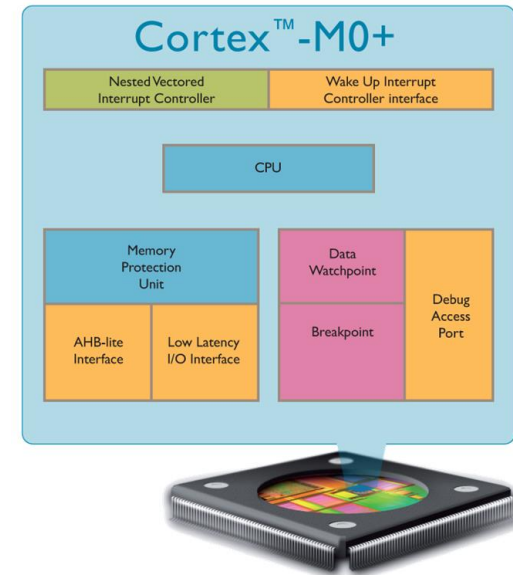
SAMD21

(ARM Cortex M0+)

SAM D Family

Powerful and Efficient Products

- 48 MHz operation
- Up to 2.14 CoreMark[®]
- Down to 70 μ A/MHz
- $\pm 2\%$ 8MHz internal RC Oscillator
- 1.62V – 3.63V
- 4 Product Series
 - 35 pin/memory/feature combinations
 - 8KB to 256KB Flash
 - 14-64 pin package
- SAM D20 -> Baseline Atmel Cortex-M0+ product series
- SAM D21 -> add USB, DMA ++ to SAM D20
- SAM D21L -> Pin optimized for Lighting/Motor Control
- SAM D10 -> Low pincount, small memory, powerful features
- SAM D11 -> SAM D10 + USB



SAM D Family Overview

SAM D Family Features	SAM D10	SAM D11	SAM D20	SAM D21	SAM D21L
Cortex M0+	8-16KB Flash		16-256KB Flash	32-256KB Flash	32-128 KB Flash
Event System					
SERCOM					
PTC(*)	14, 20 and 24 pins		32, 48 and 64 pins		32, 48 pins
12-bit 350 ksps ADC					
10-bit 350 ksps DAC	6-ch DMA				12-ch DMA
2xAnalog Comparator					
32-bit RTC w/Calendar	1x T/C for Control				Up to 4x T/C for Control
Serial Wire Debug					4x T/C for Control
BOR and POR					
Internal RCs					FS USB H&D
Watchdog					4x AC
High GPIO Count					
					I ² S

SAM D21 Series

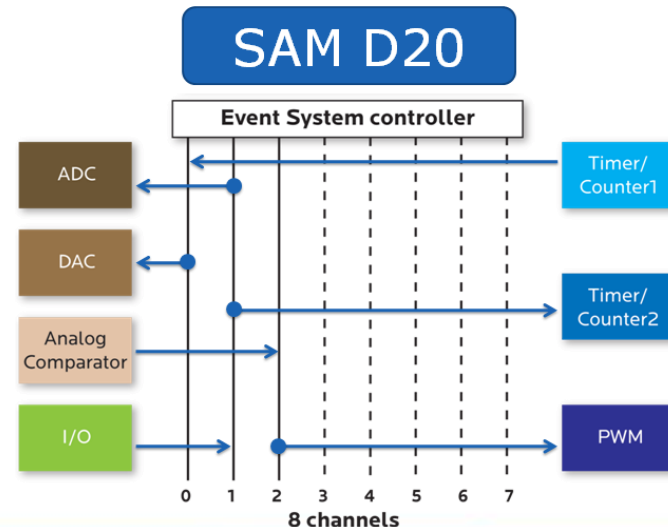
Flash / SRAM	Sub-Series		
256KB / 32KB	SAM D21E 3x 16b T/C 3x16-24b T/CC 4x SERCOM 10-ch ADC 1-ch DAC 2x An.comp 26 GPIO	SAM D21G 3x 16b T/C 3x16-24b T/CC 6x SERCOM 14-ch ADC 1-ch DAC 2x An.comp 38 GPIO	SAM D21J 5x 16b T/C 3x16-24b T/CC 6x SERCOM 20-ch ADC 1-ch DAC 2x An.comp 52 GPIO
128KB / 16KB			
64KB / 8KB			
32KB / 4KB			
16KB / 2KB			
Package	32-pin QFN and QFP	48-pin QFN and QFP	64-pin QFN and QFP

Main Features and Functions in all devices:

ARM Cortex M0+ CPU at 48 MHz, 1.62-3.6V operation, -40°C – 105°C temp grading
 12-bit 350 kps ADC, 10-bit DAC and analog comparators
 Peripheral Touch Controller, 32-bit RTC with calendar mode
 12-ch Event system and 12-ch **DMA Controller** with SleepWalking, **USB host and device**
2-ch I²S, SERCOM supports USART/UART with autobaud, SPI, I²C up to 3.4MHz, PM/SMBus, IrDA
96 MHz Fractional PLL, 3 Timer/Counters optimized for Control applications

- Inter-peripheral Communication
 - CPU independent
 - Eight independent channels
 - Synchronous and Asynchronous
- Latency-free Event Handling
 - Safe fault protection
 - Predictable reaction time
- Advantages
 - Accurate timing
 - Efficiently offloading CPU
 - Reduced power consumption

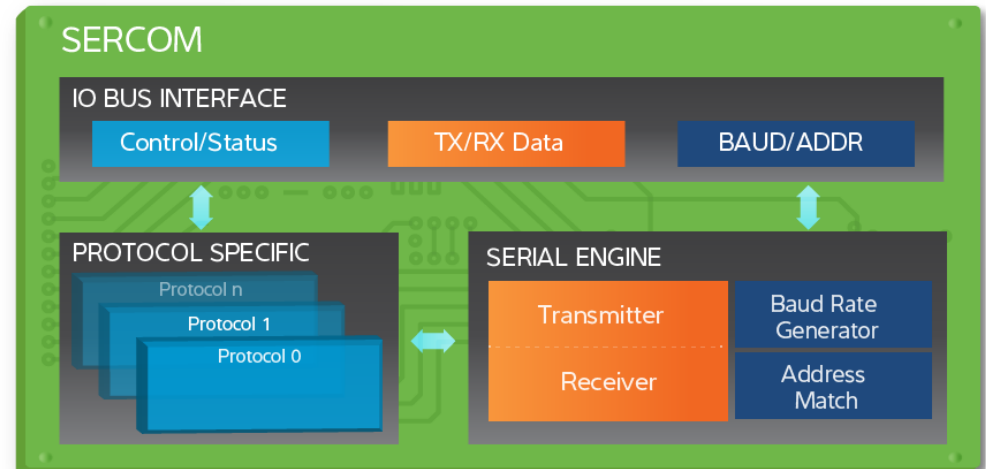
Peripheral Events
GPIO
Timer /Counter
Asynchronous Timer (RTC)
Analog Comparator
ADC
DAC
Peripheral Touch Controller



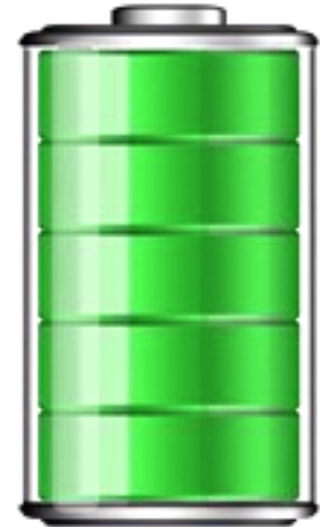
Serial Communication Module (SERCOM)

Highly Flexible Multi-interface Communication Module

- Configurable as
 - I2C
 - SPI
 - USART
- Connected to DMA
- Double-buffered Reception
- IO Pin multiplexing
- Reconfigurable from software
- Wake-up from All Power Modes
 - I2C address match
 - SPI data reception
 - USART start detection



- Microchip is a Market Leader in Low Power
 - Industry leading 8-bit picoPower devices
 - Worlds lowest power Cortex-M with picoPower SAM4L
- Low-power Atmel SAM D Series
 - Down to 70 μ A/MHz in active
 - 3.4 μ A with RTC and Full RAM retention
 - Down to 8 μ A running Capacitive Touch
 - Ultra-low power oscillators
 - SleepWalking peripherals
 - Wake-up from low-power sleep modes on
 - Pin change
 - SPI data reception
 - I2C address match
 - UART start condition
 - PTC touch detection



Peripheral Touch Controller (PTC)

Built-in Hardware Support for Touch

- Supports Buttons, Sliders, Wheels and Proximity
- Superb Sensitivity and Noise Tolerance
- Supports Mutual and Self Capacitive Touch
- Wake-up from Power Down on Touch Detection

Package	PTC channels Mutual Cap	PTC channels Self Cap
64-pin	Up to 256	Up to 16
48-pin	Up to 120	Up to 10
32-pin	Up to 60	Up to 6
24-pin	Up to 72	Up to 16
20-pin	Up to 42	Up to 13
14-pin	Up to 12	Up to 7

- Full Speed USB
 - USB Device in SAM D11, USB Device and Host in D21
- 12-bit 350ksps ADC with gain stage
- 10-bit 350ksps DAC
- Low Power
- DMA Controller
 - Available in SAM D10, D11 and D21
- I2S with Fractional PLL
 - Available in SAM D21
- Timer/Counters
 - Available in SAM D10, D11 and D21
- High GPIO pin count on small packages
 - Available in SAM D10 and D11

- Available for free at atmel.com
- Powerfull
 - Based on Visual Studio 2015 frontend
 - Supports 8/32-bit AVR and ARM development and debugging for Atmel MCU targets
 - Supports project migration from earlier Studio versions
- Easy to use
 - Extensive embedded software library
 - Integrated training modules and examples
- Extensible
 - Rich 3rd-party ecosystem of plugins
 - Configuration tools for Atmel Touch and Wireless technologies
 - Supports data & power visualization



700,000+

Studio downloads since 2012

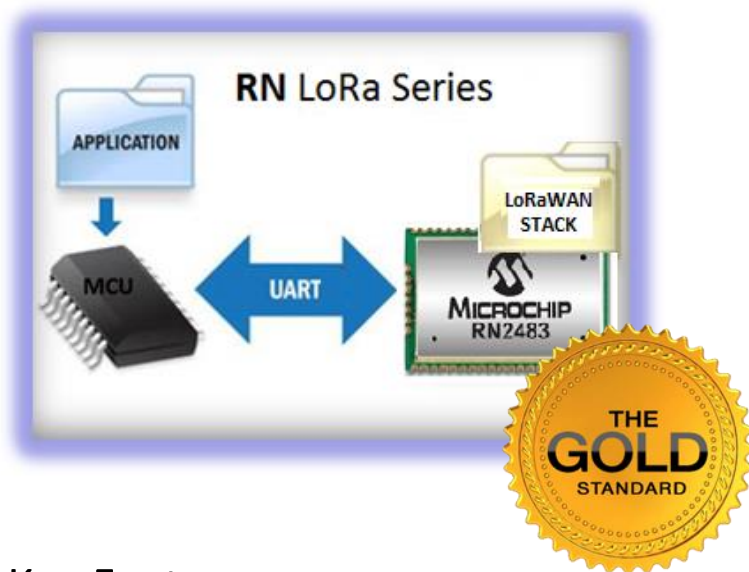
93%

Users ratings excellent, very good, good

RN2903 (LoRa Module)

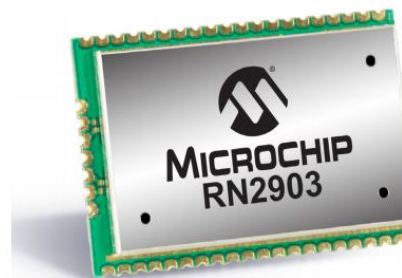
RN2903A-I/RM103

FCC LoRaWAN™ Modem



Key Features

- LoRaWANv1.0 Class-A “Golden Unit” Stack
- 915MHz, external antenna
- Integrated filtering and matching circuits
- I/O Expansion: 6x analog, 6x digital, UART, I2C
- Compact size: 27 x 18 x 3.2 mm
- FCC Modular Certification

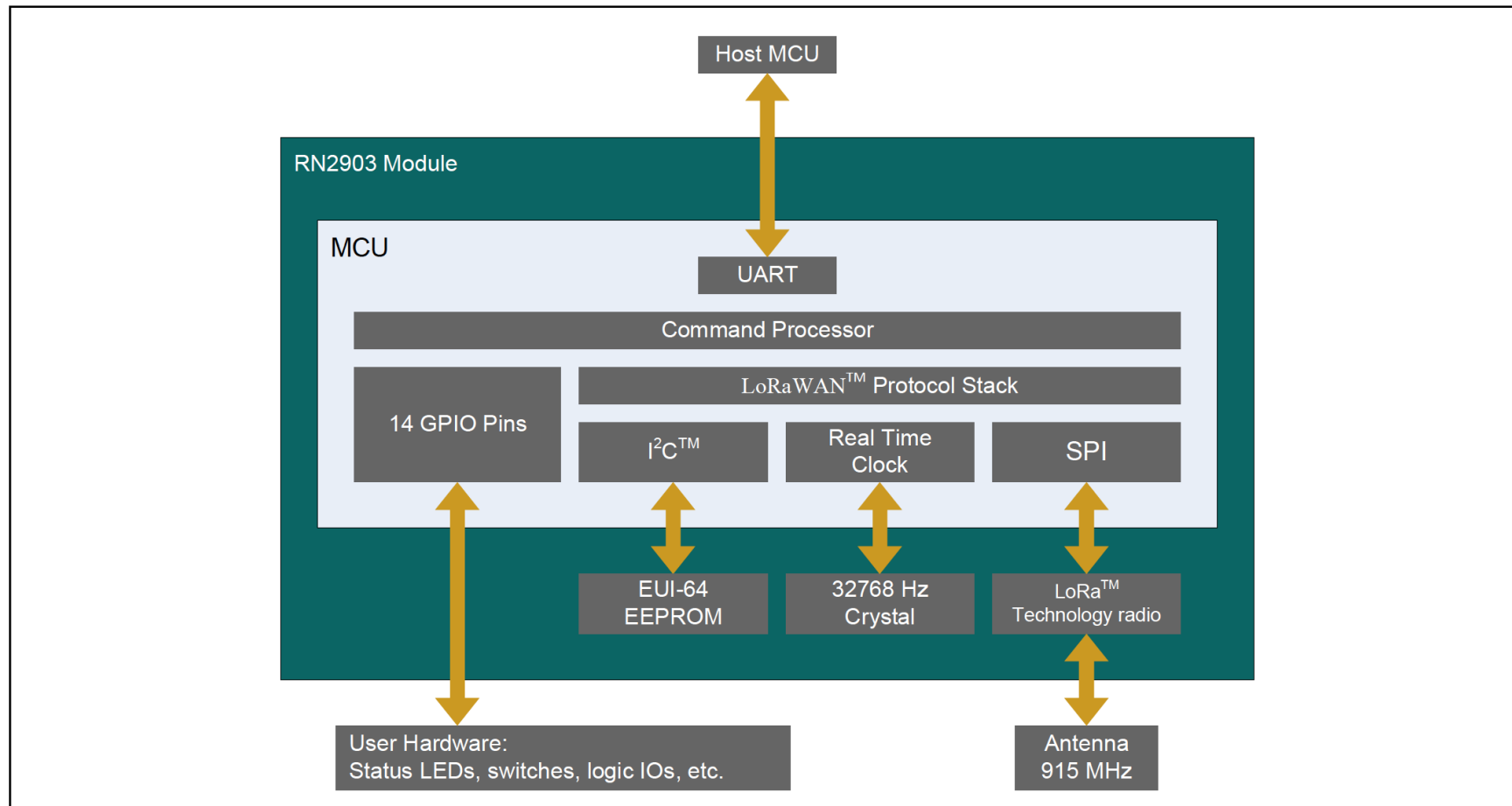


Complete Solution!

- Integrates LoRa™ Radio, PIC MCU & LoRaWAN Stack
- Pre-tested against all major LoRaWAN gateways & servers
- Simple ASCII Command Set
- Optimized for Embedded Designs
- Quick Time-to-Market
- IEEE globally unique address included

MICROCHIP RN2903 Modem Block Diagram

FIGURE 1-3: RN2903 BLOCK DIAGRAM



RN2903 Key Features

	434 MHz	868 MHz	915 MHz
High Tx OP Power	+10 dBm	+14 dBm	+18.5 dBm
High Sensitivity	-137 dBm	-136 dBm	-132 dBm
Link Budget	147 dB	150 dB	150 dB
Tx Current (Max Power)	33 mA	39 mA	124 mA
Rx Current	14.2 mA		13.5 mA
Sleep Current (25degC)	1.6 uA		1.4 uA
Embedded LoRaWAN Features	Complete LoRaWANr1.0 Class-A Functionality (E.g. ABP, OTAA, ADR ...)		
Modulation	LoRa & FSK (Selected automatically by DR)		LoRa
Test Modes	'Radio Mode' for functional test & range trials		

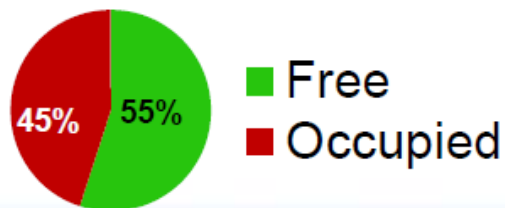
*[?]Note: 434 & 868 MHz included for RN2483 comparison. Not supported in RN2903

RN2903 Embedded App

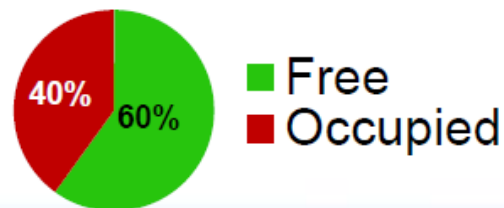
PIC[®] MCU device minimum memory

- LoRaWAN stack (minimal operation) takes about:
 - 31KB of flash
 - 1.3KB of RAM
- Estimation for PIC18LF46K22 (64KB ROM & 3KB RAM)

ROM



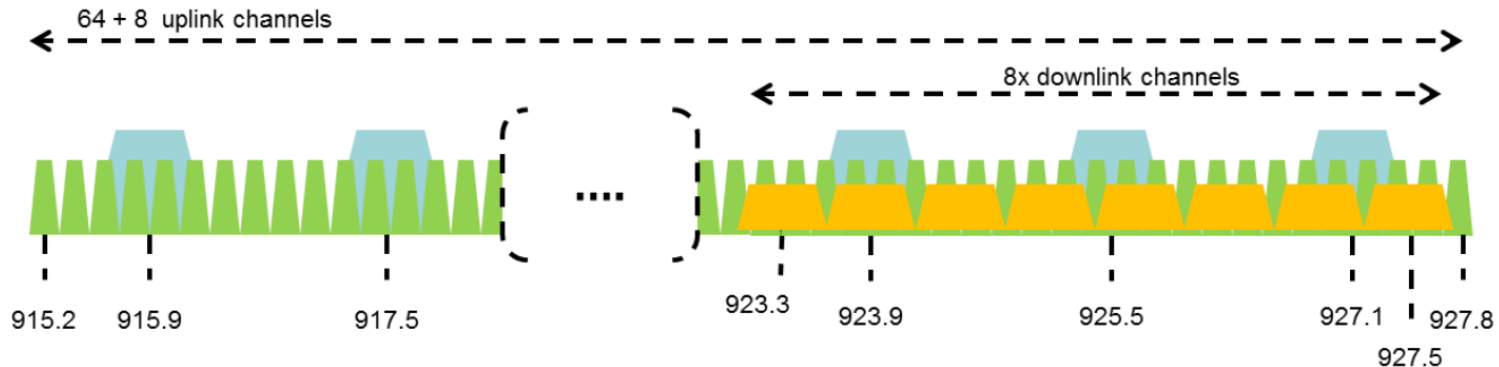
RAM



AU-915 Frequency Plan

The AU ISM Band shall be divided into the following channel plans.

- Upstream – 64 channels numbered 0 to 63 utilizing LoRa 125 kHz BW varying from DR0 to DR5, using coding rate 4/5, starting at 915.2 MHz and incrementing linearly by 200 kHz to 927.8 MHz
- Upstream – 8 channels numbered 64 to 71 utilizing LoRa 500 kHz BW at DR6 starting at 915.9 MHz and incrementing linearly by 1.6 MHz to 927.1 MHz
- Downstream – 8 channels numbered 0 to 7 utilizing LoRa 500 kHz BW at DR8 to DR13) starting at 923.3 MHz and incrementing linearly by 600 kHz to 927.5 MHz



AU915-928 channel frequencies

ESP-WROOM-32

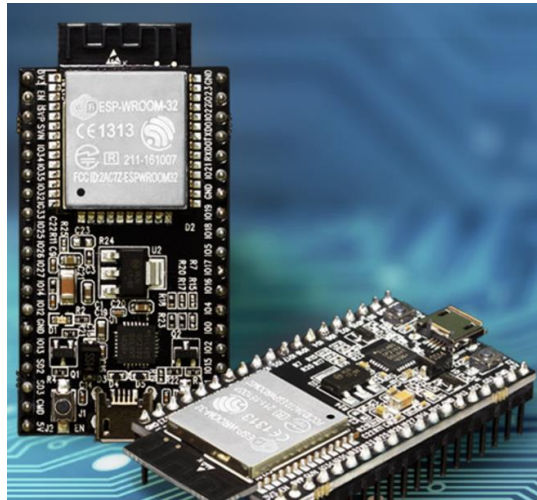
Wi-Fi & Bluetooth



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ESP-WROOM-32

Wi-Fi + BLE Module



ESP-WROOM-32

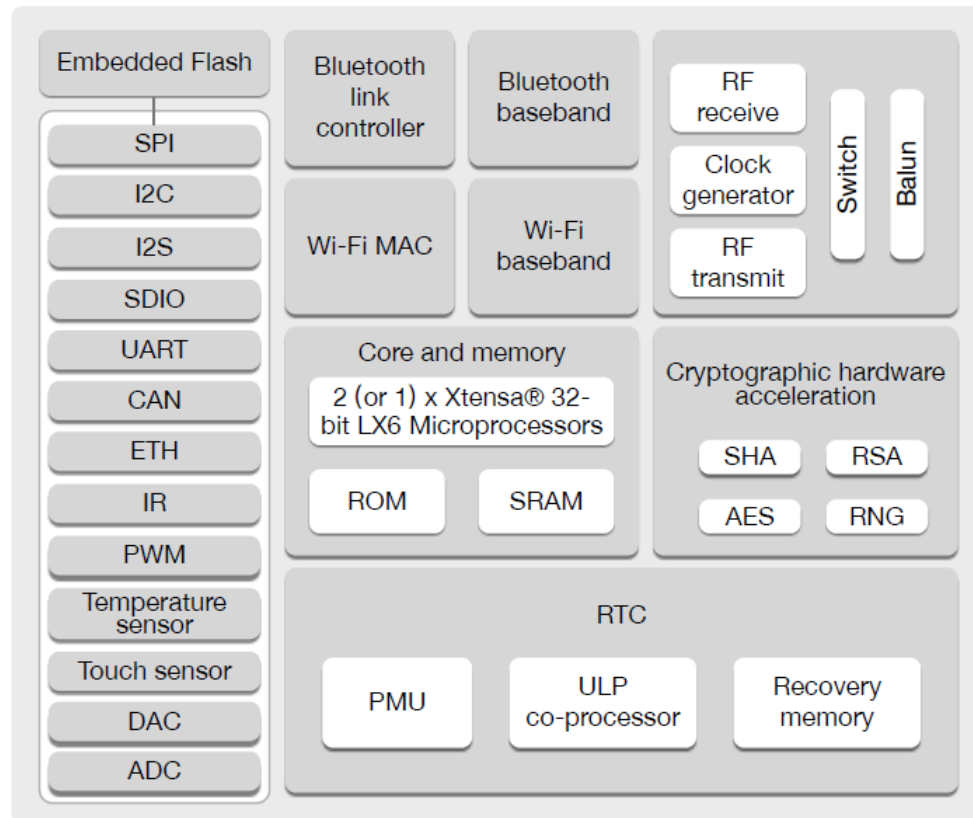
- Low Cost Wi-Fi + BLE Module based on ESP32 chipset
- 802.11 b/g/n/e/i (802.11n up to 150 Mbps)
- 32-bit integrated MCU
- Integrated antenna
- AT Command Set

ESP32-DevKitC

The ESP32-DevKitC contains the entire basic support circuitry for the ESP-WROOM-32, including the USB-UART bridge, reset- and boot-mode buttons, LDO regulator and a micro-USB connector. Every important GPIO is available to the developer.

ESP-WROOM-32

Wi-Fi + BLE Module



ESP32 Block Diagram

ESP-WROOM-32

Wi-Fi + BLE Module

Posibles Interfaces:

- Comandos AT a través de UART.
- Aplicación embebida en módulo:
 - Arduino Core disponible para ESP32
 - Espressif IoT Development Framework (ESP-IDF)

47L16

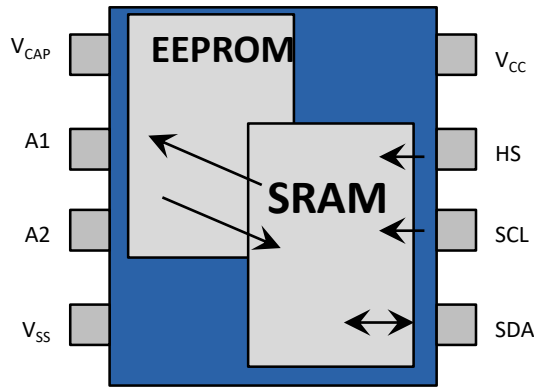
(Memoria EERAM)



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What is EERAM?

EERAM is an SRAM with a shadow EEPROM in one package



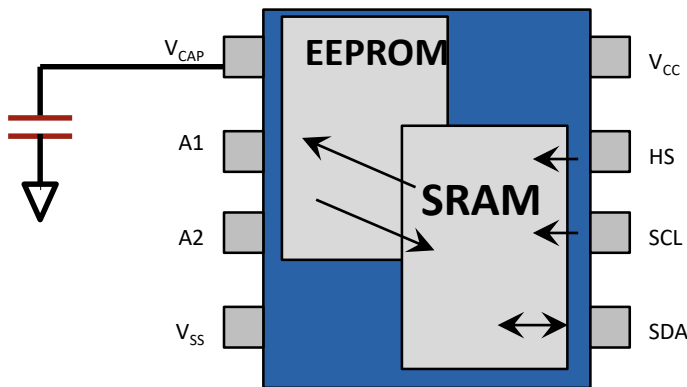
- 4Kb, 16Kb I2C (1MHz)
- 3.0V, 5.0V Options
- Unlimited Writes to SRAM
- Automatically Stores Data at power down
- No Battery Needed (needs ext. capacitor)
- Data auto recalled to SRAM on Power-Up

Combines Two Proven Technologies

“Reliability of an EEPROM with the Performance of an SRAM”

What Problem does it Solve?

- For applications that need data to be constantly updated, **EERAM offers a safe way to automatically and safely store data during a power loss event.**



The capacitor connected to the Vcap pin provides the necessary energy to safely copy RAM contents to secure EEPROM back up during power loss.

Upon Power Up data is recalled automatically from EEPROM to SRAM

Product:

- 4Kb, 16Kb I2C Interface
- 2.7V-3.6V; 4.5V-5.5V
- 1MHz Max Clock

Read/Write and Modes:

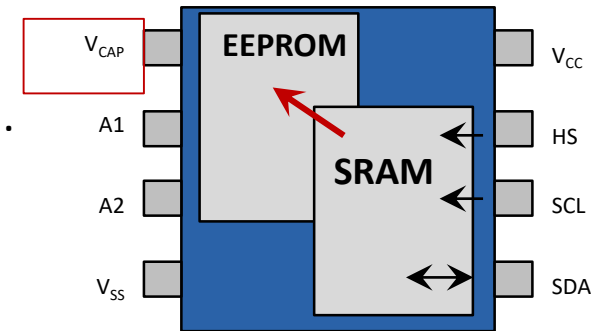
- Infinite Read and Writes to SRAM Array
- 1M+ Store Cycles to EEPROM
- Automatic Store to EEPROM on power down (3.5uF – 10uF Cap)
- Automatic Recall to SRAM array on power up

Other Features:

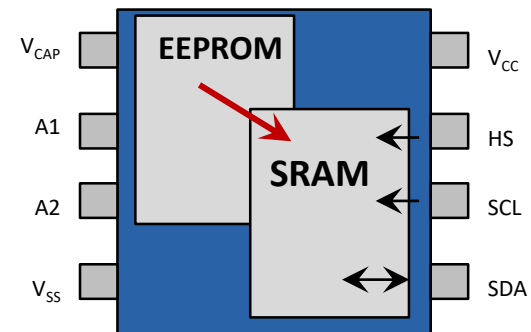
- Event Detect Flag/Pin
- Write Protection from 1/64th of array to whole memory
- Industrial and Automotive Temps (Automotive Qualified)

How does EERAM Work?

- When Vdd falls below Vtrip (Power Off):
 - Contents of SRAM is internally copied on to the EEPROM.
 - Capacitor provides energy to perform this operation.
 - Also known as the “AUTO-STORE” Operation
 - Stores can also be initiated manually via a Software Command or in Hardware by toggling Pin 7 (HS).
 - Auto-Store can be optionally disabled
- When Vdd gets back over Vtrip (Power On):
 - Contents of EEPROM is automatically copied on the SRAM with internal on-chip circuitry at Power-Up
 - Also known as the “AUTO-RECALL” Operation
 - Device Auto-Recalls automatically on power-up.
 - Recalls can also be initiated in Software at any time.



Auto Store
 $V_{dd} < V_{trip}$



Auto Recall
 $V_{dd} > V_{trip}$

- Preserve's data through power loss event
 - Automatically and Safely stores data on power loss
- No Battery Needed – More reliable
- Write as frequently as you need - Unlimited Endurance
 - Write to the memory as often as you choose
 - Useful in data logging/black box applications
- Instantaneous Writes to the Array
 - Zero Write cycle times and Random Access Writes
 - Useful for applications that need instant data transfer
- Lowest Cost Solution
 - Significantly Less expensive than competing FRAM and NVSRAM technologies
- Low Power – Lower power consumption than NVSRAM

¡¡MUCHAS GRACIAS!!



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