

# E3020 Systèmes embarqués

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CM2-CARACTÉRISTIQUES D'UN  
MICROCONTRÔLEUR

# Objectifs

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1. Evaluer l'ensemble des modules/fonctions insérables dans un microcontrôleur
2. Pour chaque fonction déterminer les données caractéristiques
3. Sélectionner un microcontrôleur pour une application
4. Evaluer les suites logiciels mises à disposition

# Quelles sont les modules/le cœur d'un microcontrôleur?



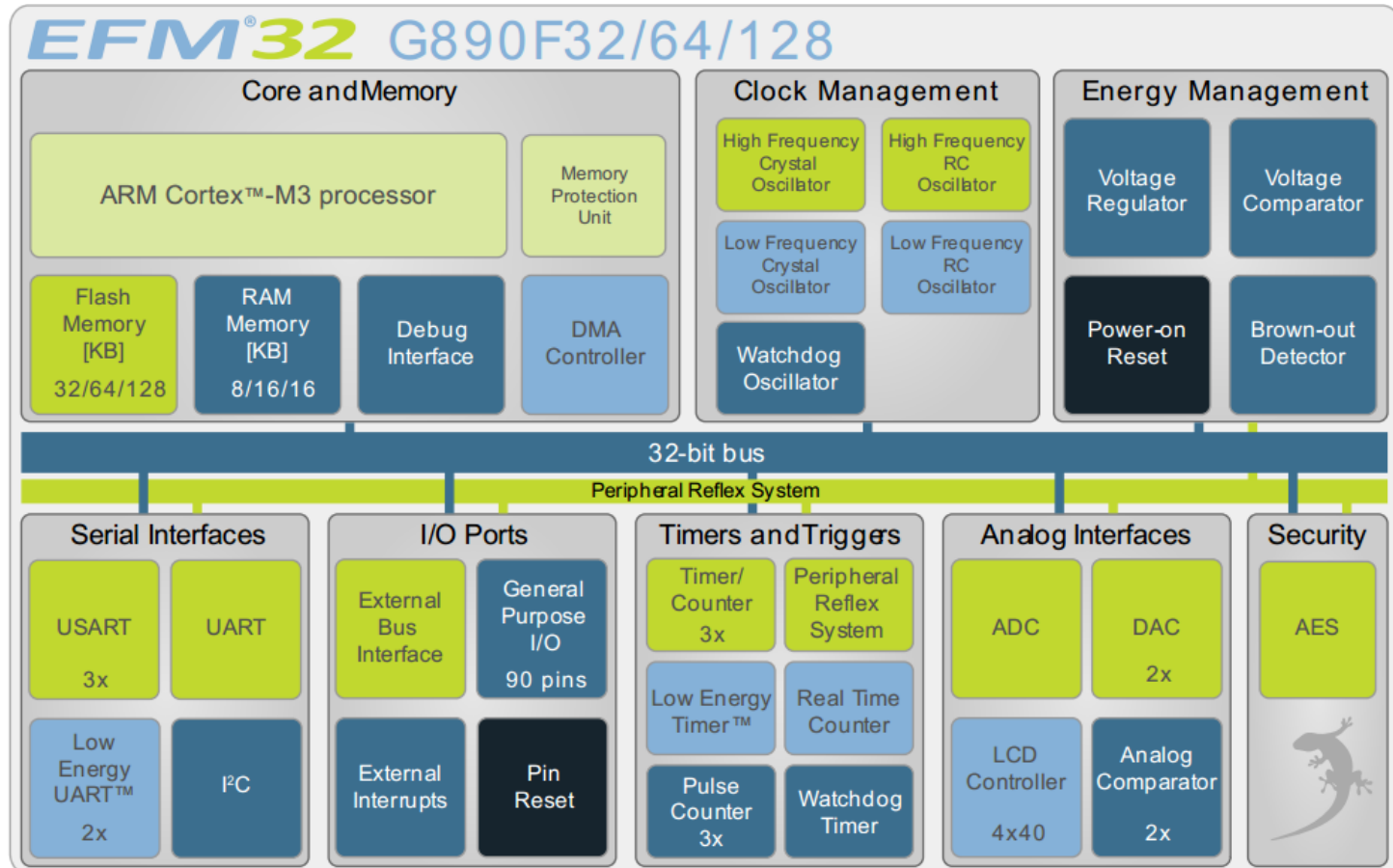
# Quelles sont les modules/le cœur d'un microcontrôleur?

Liste :

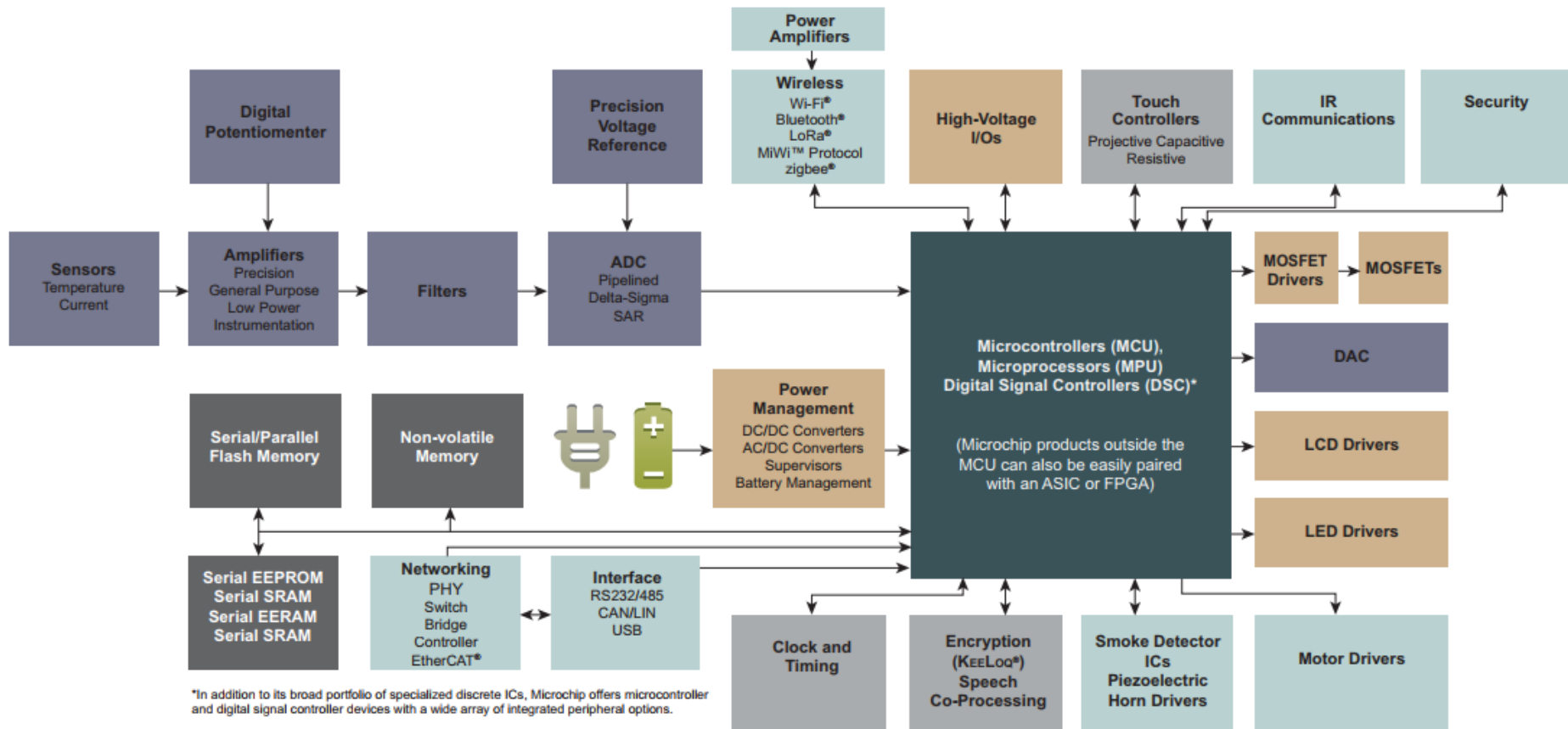
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MICROCHIP		PIC18(L)F2X/4XK22
28/40/44-Pin, Low-Power, High-Performance Microcontrollers with XLP Technology		
<b>High-Performance RISC CPU:</b> <ul style="list-style-type: none"><li>• C Compiler Optimized Architecture<ul style="list-style-type: none"><li>- Optional extended instruction set designed to optimize re-entrant code</li></ul></li><li>• Up to 1024 Bytes Data EEPROM</li><li>• Up to 64 Kbytes Linear Program Memory Addressing</li><li>• Up to 3896 Bytes Linear Data Memory Addressing</li><li>• Up to 16 MIPS Operation</li><li>• 16-bit Wide Instructions, 8-bit Wide Data Path</li><li>• Priority Levels for Interrupts</li><li>• 31-Level, Software Accessible Hardware Stack</li><li>• 8 x 8 Single-Cycle Hardware Multiplier</li></ul>	<b>Extreme Low-Power Management PIC18(L)F2X/4XK22 with XLP:</b> <ul style="list-style-type: none"><li>• Sleep mode: 20 nA, typical</li><li>• Watchdog Timer: 300 nA, typical</li><li>• Timer1 Oscillator: 800 nA @ 32 kHz</li><li>• Peripheral Module Disable</li></ul>	
<b>Flexible Oscillator Structure:</b> <ul style="list-style-type: none"><li>• Precision 16 MHz Internal Oscillator Block:<ul style="list-style-type: none"><li>- Factory calibrated to <math>\pm 1\%</math></li><li>- Selectable frequencies, 31 kHz to 16 MHz</li><li>- 64 MHz performance available using PLL – no external components required</li></ul></li><li>• Four Crystal modes up to 64 MHz</li><li>• Two External Clock modes up to 64 MHz</li><li>• 4X Phase Lock Loop (PLL)</li><li>• Secondary Oscillator using Timer1 @ 32 kHz</li><li>• Fail-Safe Clock Monitor:<ul style="list-style-type: none"><li>- Allows for safe shutdown if peripheral clock stops</li></ul></li><li>• Two-Speed Oscillator Start-up</li></ul>	<b>Special Microcontroller Features:</b> <ul style="list-style-type: none"><li>• 2.3V to 5.5V Operation – PIC18FXKK22 devices</li><li>• 1.8V to 3.6V Operation – PIC18LFXKK22 devices</li><li>• Self-Programmable under Software Control</li><li>• High/Low-Voltage Detection (HLVD) module:<ul style="list-style-type: none"><li>- Programmable 16-Level</li><li>- Interrupt on High/Low-Voltage Detection</li></ul></li><li>• Programmable Brown-out Reset (BOR):<ul style="list-style-type: none"><li>- With software enable option</li><li>- Configurable shutdown in Sleep</li></ul></li><li>• Extended Watchdog Timer (WDT):<ul style="list-style-type: none"><li>- Programmable period from 4 ms to 131s</li></ul></li><li>• In-Circuit Serial Programming™ (ICSP™):<ul style="list-style-type: none"><li>- Single-Supply 3V</li><li>- In-Circuit Debug (ICD)</li></ul></li></ul>	
<b>Analog Features:</b> <ul style="list-style-type: none"><li>• Analog-to-Digital Converter (ADC) module:<ul style="list-style-type: none"><li>- 10-bit resolution, up to 30 external channels</li><li>- Auto-acquisition capability</li><li>- Conversion available during Sleep</li><li>- Fixed Voltage Reference (FVR) channel<ul style="list-style-type: none"><li>- Independent input multiplexing</li></ul></li></ul></li><li>• Analog Comparator module:<ul style="list-style-type: none"><li>- Two rail-to-rail analog comparators</li><li>- Independent input multiplexing</li></ul></li><li>• Digital-to-Analog Converter (DAC) module:<ul style="list-style-type: none"><li>- Fixed Voltage Reference (FVR) with 1.024V, 2.048V and 4.096V output levels</li><li>- 5-bit rail-to-rail resistive DAC with positive and negative reference selection</li></ul></li><li>• Charge Time Measurement Unit (CTMU) module:<ul style="list-style-type: none"><li>- Supports capacitive touch sensing for touch screens and capacitive switches</li></ul></li></ul>	<b>Peripheral Highlights:</b> <ul style="list-style-type: none"><li>• Up to 35 I/O Pins plus 1 Input-Only Pin:<ul style="list-style-type: none"><li>- High-Current Sink/Source 25 mA/25 mA</li><li>- Three programmable external interrupts</li><li>- Four programmable interrupt-on-change</li><li>- Nine programmable weak pull-ups</li><li>- Programmable slew rate</li></ul></li><li>• SR Latch:<ul style="list-style-type: none"><li>- Multiple Set/Reset input options</li></ul></li><li>• Two Capture/Compare/PWM (CCP) modules</li><li>• Three Enhanced CCP (ECCP) modules:<ul style="list-style-type: none"><li>- One, two or four PWM outputs</li><li>- Selectable polarity</li><li>- Programmable dead time</li><li>- Auto-Shutdown and Auto-Restart</li><li>- PWM steering</li></ul></li><li>• Two Master Synchronous Serial Port (MSSP) modules:<ul style="list-style-type: none"><li>- 3-wire SPI (supports all 4 modes)</li><li>- I<sup>2</sup>C™ Master and Slave modes with address mask</li></ul></li></ul>	

# EFM32G890F128 de chez EnergyMicro



## Microchip Block Diagram Support



# Première définition (*wikipedia*)

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A **microcontroller** (or **MCU** for *microcontroller unit*) is a small [computer](#) on a single [integrated circuit](#). In modern terminology, it is similar to, but less sophisticated than, a [system on a chip](#) or SoC; an SoC may include a microcontroller as one of its components. A microcontroller contains one or more [CPUs](#) (processor cores) along with [memory](#) and programmable [input/output](#) peripherals. Program memory in the form of [ferroelectric RAM](#), [NOR flash](#) or [OTP ROM](#) is also often included on chip, as well as a small amount of [RAM](#). Microcontrollers are designed for [embedded](#) applications, in contrast to the [microprocessors](#) used in [personal computers](#) or other general purpose applications consisting of various discrete chips.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other [embedded systems](#). By reducing the size and cost compared to a design that uses a separate [microprocessor](#), memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. [Mixed signal](#) microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

Some microcontrollers may use four-bit [words](#) and operate at frequencies as low as 4 kHz, for low power consumption (single-digit milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a [digital signal processor](#) (DSP), with higher clock speeds and power consumption.

# Quelles différences entre :

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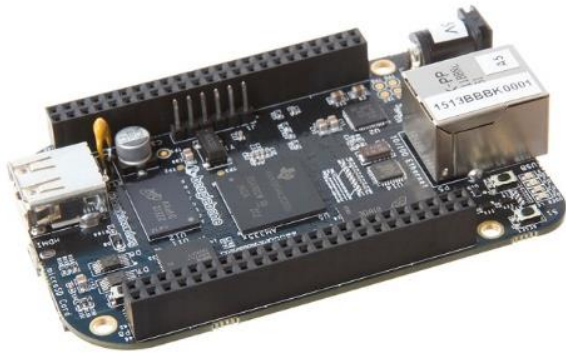
# Quelles différences entre :



Bus de données	Freq. Max	Mémoire ROM
8 bits	2 MHz	32 kB
32 bits	60 MHz	18 MB
64 bits	2,34GHz	256 GB
64 bits	3,10GHz	TB

# BeagleBone Black

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## Caractéristiques :

- ~50€
- RAM : 512MB
- Fréquence : 1GHz
- Flash : 4GB

# Caractéristiques de chaque module ?

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Fonctionnement d'une PWM  
(Partie avec comparateur omise)



Caractéristiques



# Sélectionner un microcontrôleur

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Liste des constructeurs :

- Microchip
- Motorola
- ST-micro
- NEC
- ATMEL
- Sunplus
- Hitachi
- Fujitsu
- NXP
- Toshiba
- Intel
- Zilog
- EnergyMicro
- Texas Instrument
- Analog device
- ...

# Critère de sélection

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Aptitude de la puce à faire le travail ( une seule puce nécessaire?)

- Nbre d'entrées/sorties :
  - trop peu ne peut pas faire le job.
  - trop élevé, cela représente un surcoût
- Autres périphériques présents en nombre suffisants?
  - ADC – RAM – ROM – DAC – port série
  - Est-ce qu'il y en a d'autres qui ne sont pas nécessaires
- Rendement du CPU : puissance de calcul
  - Trop faible => ne marchera jamais
  - Trop élevé => gaspillage
- Prix du microcontrôleur est-il envisageable ?

# Critère de sélection

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## Disponibilité

- Quel est l'état du stock actuellement
- Est-il toujours en production
- Quels sont les productions futures

## Support de développement disponible:

- Assemblage
- Compilateur
- Outils de debugging
- Exemples d'applications

# Mise en situation

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Sélectionner un candidat parmi la suite Microchip pour ...

# Mise en situation

Liens Microchip :

<http://www.microchip.com/maps/main.aspx>

<http://www.microchip.com/ParamChartSearch/chart.aspx?branchID=1005>

Where would you like to start?

Analog

Interface

Memory

MCUs & MPUs

Wireless

Do you have a part number? Click this button to find it

Global Part Search

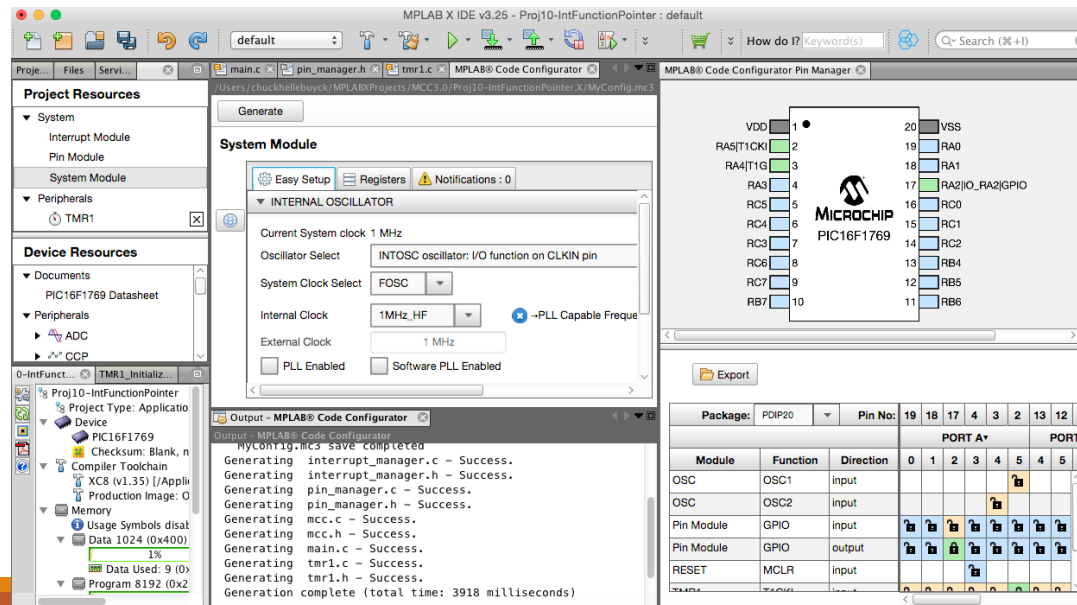
## 8-bit PIC® Microcontroller Peripheral Integration Quick Reference Guide

Product Family	Pin Count	Program Flash Memory (KB)	Data EE (B)	Peripheral Function Focus																																								
				Intelligent Analog					Waveform Control					Timing and Measurements <sup>(1)</sup>					Logic and Math		Safety and Monitoring		Communications			User Interface		Low Power and System Flexibility																
				ADC (# of bits)	Comp	HSCmp	DAC (# of bits)	HC I/O (mA)	OPA	PRG	SlopeComp	ZCD	COP/ECCP	10-bit PWM	16-bit PWM	COG	CWG	NCO	DSM	AngTMR	HLT (8-bit)	16-bit PWM (16-bit)	NCO (20-bit)	SMT (24-bit)	RTCC	TEMP/TS	CLC	MULT	MathACC	CRC/SCAN	HLT	WWDT	ELUSART/AUSART	UART with Protocols	I <sup>2</sup> C/SPI	USB with ACT	LIN Capable	mTouch® Sensing	HVCD	LCD	PPS	IDLE/DOZE/PMD	DMA/VI	
PIC10(L)F3XX	6	384–896 B	HEF	8							✓				✓					✓				✓	✓									✓										
PIC16(L)F151X/2X	28–64	3.5–28	HEF	10							✓																						2											
PIC12LF1552	8	3.5	HEF	10																				✓										✓	✓	✓								
PIC16LF155X/6X	14–20	7–14	HEF	10 <sup>(2)</sup>								✓												✓									2		✓	✓	✓							
PIC16(L)F145X	14–20	14	HEF	10	✓							✓			✓								✓										✓	✓	✓	✓	✓							
PIC1X(L)F157X	8–20	1.75–14	HEF	10	✓		5						✓		✓				✓				✓											✓			✓	✓			✓			
PIC16(L)F153XX	8–48	3.5–28	HEF	10	✓		5				✓	4							✓	✓			✓		✓								2	2			✓			✓	✓			
PIC1X(HV)F752/53	8–14	1.75–3.5	–	10	✓	✓	5/9	50	✓	✓				✓					✓	✓								✓							✓									

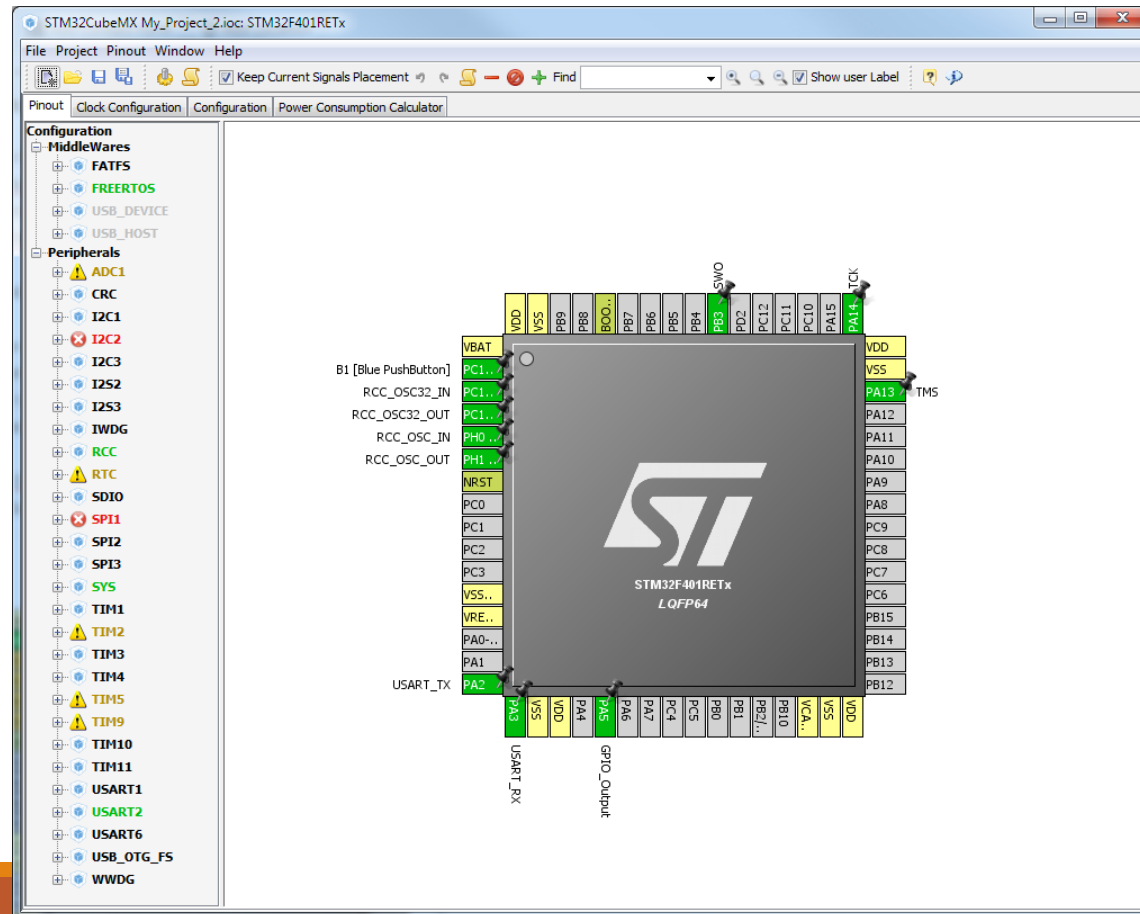


# Suite logiciel

Microchip :



# ST MICROELECTRONIC : CUBE MX



# Question de réflexion

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Comment échanger des informations entre deux éléments électroniques intelligents?