

# SOC Sense

## Nano Pico Femto Sensor Nodes

### Product Summary

SOC Robotics, Inc.

## SOC Sense Overview

Sensors have come down in price to point that using lots of them to measure the behavior of real world phenomena is now economical. In addition to the sensors an sensor network needs sensor processing technology, network interconnect and cloud applications that tie the whole system together make the data available in a meaningful way. SOC Sense is a step in that direction. It consists of sensors, sensor processing nodes, wireless network and desktop management software. The system is open as source code is provided allowing specific application tuning, enhancement and protection and complete access to the network protocol.

There are three device families – Nano, Pico and Femto – with a mix of processors, software development tools, features and performance levels. There is also a set of third party supplied modules integrated with the family to simplify and cost reduces the overall system.

## Nano Sensor Nodes

Nano sensor nodes attach to the desktop as a communication gateway, development platform and sensor node. Three different Nano devices are available Nano, NanoM and NanoMP. Each addresses a slightly different need in the system. Nano and NanoM are both development platform focused while NanoMP is a communication hub.

## Pico Sensor Nodes

Pico sensor nodes are mobile sensors that collect sensor data but with local processing capability. Each Pico is able to acquire sensor data, process it locally and act on the processed data if needed and communicate with the wireless network hub.

## Femto Sensors

Femto sensors are individual sensors that measure motion, light and environmental parameters. Motion sensors are available with 3, 6 and 9DOF axis along with environmental sensors for humidity, temperature and light.

## Third Party Devices

Nano and Pico sensor nodes make use of RF modules and displays supplied by third parties. These modules are low cost, available from multiple vendors and are tightly integrated with the software running of each device. The devices plug and play with the sensor nodes.

## Wireless Network

The wireless network is based on a third party module that uses the Nordic Semiconductor RF24L01 chip. This chip operates in the 2.4G band with 126 channels, up to 2Mbps and range up to 1Km with an antenna boost model and uses an open well documented over air protocol. Also supported is a low cost serial WiFi device to allow direct integration with a local router.

## Source Code

By making the project source available and offering multiple processor options you are not tied to a specific vendor approach or tool chain. Arduino, Atmel Studio 6.2 and CooCox are supported.

## BodySense and HandSense Sensor Systems

Two turnkey sense systems are available – BodySense and HandSense. BodySense is a wireless full body motion capture system while HandSense is a hand/finger real time motion capture system.

## Nano Overview

Nanos are general purpose interface boards that support popular wireless module integration with the desktop, enable 10DOF sensor application development and provide a communication link with Pico IMU sensor nodes. The Nano and NanoM both have 10DOF sensor capability while the NanoMP is primarily a wireless sensor node hub communications device.

### Features:

- Choice of processor:
  - Nano: ATxmega128A4U
  - NanoM,MP: STM32F042, STM32F072 or STM32F303
- 12bit DAC running at 1Msps
- 12-16bit A/D running at 2Msps
- USARTS (one connected to PI)
- Two SPI interface to PI
- On chip DFU boot loader for software field upgrades
- SPI interface connector for RF2401 Wireless module
- Digital IO and Analog brought to connectors
- Expansion connectors on 0.1" centers for proto board
- Real time data acquisition application communicating wirelessly with Pico sensors using RF24L01 module
- Nano, NanoM - optional MPU-9150 9DOF sensor
- Nano, NanoM - optional BMP180 barometric
- Open source application software:
  - Nano: AVR Studio 6.2
  - NanoM, MP: CooCox IDE

The Nano and NanoM is a 10DOF sensor platform for prototype development and wireless base station use. Nano comes with a real time wireless communications application that communicates with other members of the SOC Sense sensor family. Source code for the application is available for download. An onboard bootloader allows new software to be uploaded without the need for specialized programming hardware.

### RF24L01 Wireless Connector

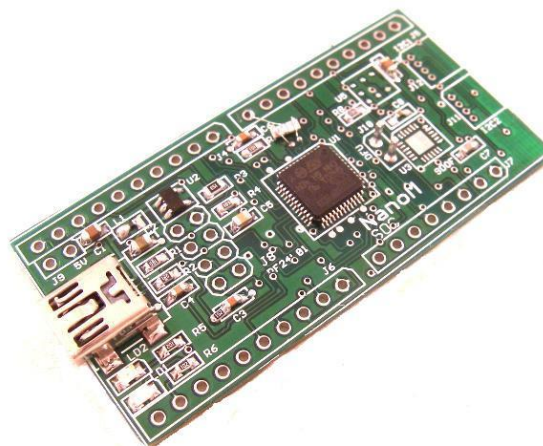
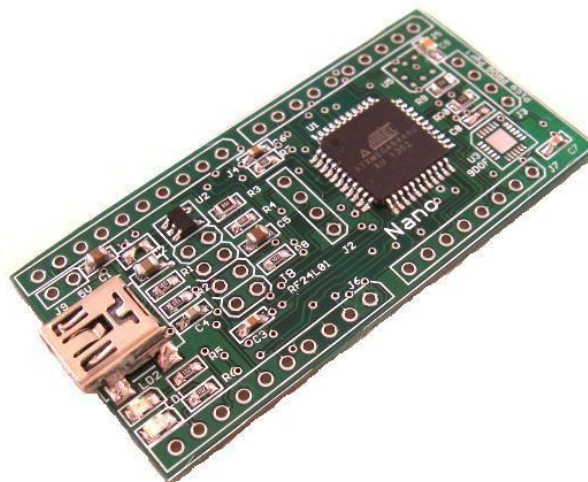
Nano has a connector that allows direct connection of a low cost RF2401 wireless communication module allowing the Nano to be a wireless base station for low cost wireless data acquisition modules.

### MPU9150 9DOF Inertial Sensor

An optional 9 Degree of Freedom Inertial sensor can be mounted. The sensor measures acceleration, rotation and magnetic heading on three axis.

### BMP180 Barometer Sensor

An optional barometer can be mounted. The barometer resolution is 75 cm.



RF Modules



RF24L01



ESP8266 WiFi

### Nano Configurations

Nanos are available in three different configurations with and without sensors. Nano has a single processor option – the ATxmega128A4U. NanoM and NanoMP are available in three different processor configurations – STM32F042, STM32F072 and STM32F303. provides analog input, analog output, digital IO, SPI, USARTs and I2C interfaces. All three have a dedicated wireless connector compatible with the popular RF24L01 wireless communication module. An optional 9 DOF Inertial sensor (MPU-9150) and barometer (BMP180) are available as well. The Nano and NanoM bring all processor signal pins to expansion ports enabling prototype development and the attachment of other sensors. All three have a dedicated connector allowing direct connection of a low cost OLED 128x64 pixel display. Nano can program Pico IMUs using the PDI programming port. Nanos also support the ESP8266 Serial WiFi module (with an adapter).

### Nano



- 10DOF (A,G,M,B)
- ATxmega128A4U
- Wireless Connector
- USB
- AVR Studio 6.2
- Project source

### NanoM



- 10DOF (A,G,M,B)
- STM32F303,72MHz, FPU (or STM32F072, 48MHz)
- Wireless Connector
- USB
- CooCox IDE
- Project source

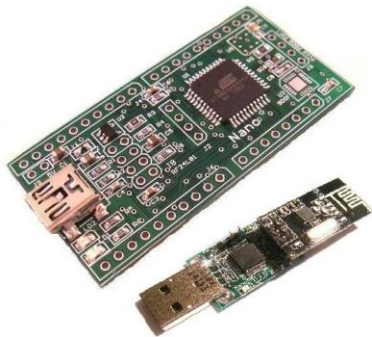
### NanoMP



- STM32F303,72MHz, FPU (or STM32F072, 48MHz)
- Wireless Connector
- USB
- CooCox IDE
- Project source

Nanos are members of the SOC Sense wireless sensor node family of products consisting of Nano, Pico and Femto sensor nodes.

Nano/NanoMP



Pico



Femto

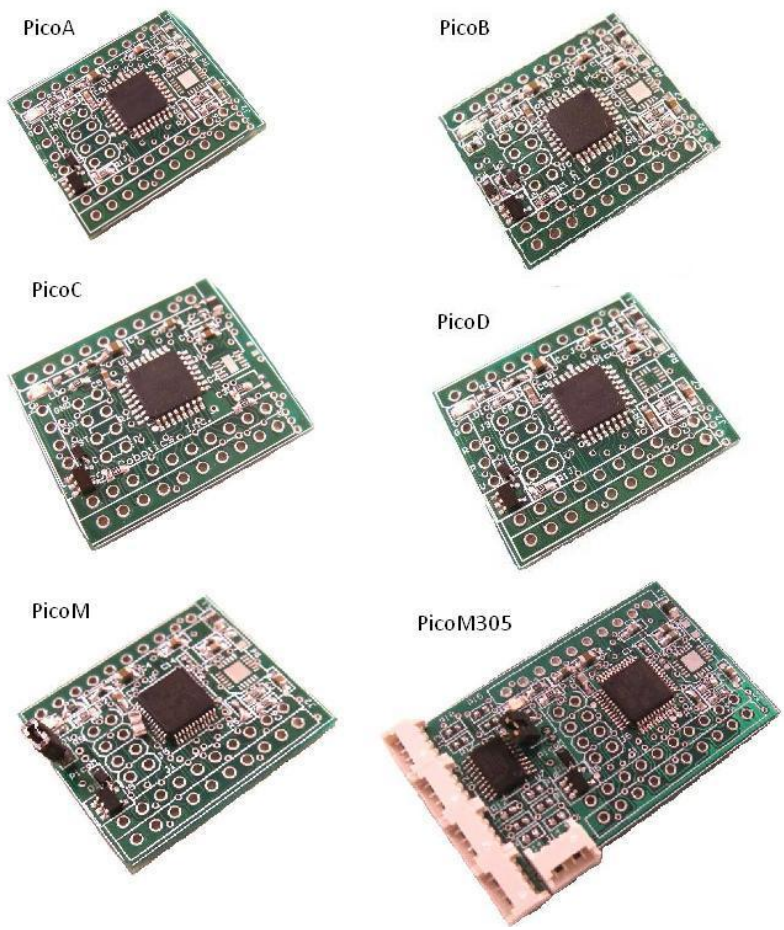


### Pico Overview

Picos are general purpose wireless sensor nodes with several processor and sensor options. PicoA,B,M and M305 are 10DOF sensor capable while the PicoC is 7DOF, PicoD is a humidity/temperature/light level sensor and PicoM305 is 50DOF sensor node. All Picos have USB, LiPo battery and wireless capability.

### Features:

- Choice of processor:
  - PicoA,C,D: ATxmega32E5, PIC14F45
  - PicoM: STM32F042, STM32F072 or STM32F303
  - PicoM305: STM32F303
- 12bit DAC running at 1Msps
- 12-16bit A/D running at 2Msps
- USARTS (one connected to PI)
- Two SPI interface to PI
- On chip DFU boot loader for software field upgrades
- SPI interface connector for RF2401 Wireless module
- Digital IO and Analog brought to connectors
- Expansion connectors on 0.1" centers for proto board
- OLED and Color TFT display support
- Real time data acquisition application communicating wirelessly with Pico sensors using RF24L01 module
- PicoA,B,M - Optional MPU-9150 9DOF sensor
- PicoA,B,C,D,M - optional BMP180 barometric
- Open source application software:
  - PicoA,C,D: AVR Studio 6.2
  - PicoB: AVR Studio 6.2, Arduino
  - PicoM, PicoM305: CooCox IDE



The PicoA,B,M and M305 are a 10DOF sensor node for and wireless base station use. Nano comes with a real time wireless communications application that communicates with other members of the SOC Sense sensor family. Source code for the application is available for download. An onboard bootloader allows new software to be uploaded without the need for specialized programming hardware.

### RF24L01 Wireless Connector

Each Pico has a connector that allows direct connection of a low cost RF2401 wireless communication module allowing completely mobile wireless operation.

### MPU-9150 9DOF Inertial Sensor

An optional 9 Degree of Freedom Inertial sensor can be mounted. The sensor measures acceleration, rotation and magnetic heading on three axis.

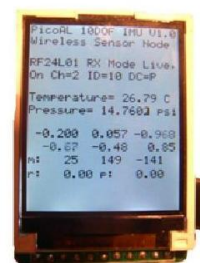
### BMP180 Barometer Sensor

An optional barometer can be mounted. The barometer resolution is 75 cm.

OLED 128x64



Color TFT 128x160



RF Modules



RF24L01



ESP8266 WiFi

**Femto Overview**

Femtos are small individual sensors for motion detection, light level and environment parameter monitoring. Femtos are peripherals that add additional sensor data input to Pico sensor nodes. For example, by using fifteen FemtoB 6DOF sensors real time finger tracking becomes possible.

**Features:**

- 3,6,9 DOF motion sensors
- RGB light sensors
- I2C communication
- Very small size
- Compatible with Nano and Pico sensor nodes
- Software application library included with Pico

The PI communicates with Paella using either a serial USART or high speed SPI connection. The ATxmega16E5 can be instructed by the user to execute complicated real time data acquisition/monitoring functions without PI intervention.

Pico software drivers are available to integrate Femto sensors.

**Software Drivers**

Each Femto sensors comes with the appropriate driver software to allow quick integration with a Pico or Nano sensor node.

**FemtoA**



- 10DOF
- 3-Axis Accel
- 3-Axis Gyro
- 3-Axis Mag
- I2C Interface
- 2 Sensors per chain

**FemtoB**



- 6DOF
- 3-Axis Accel
- 3-Axis Mag
- I2C Interface
- 4 Sensors/chain

**FemtoC**



- 3DOF
- 3-Axis Accel
- I2C Interface
- 2 Sensors/chain

**FemtoD**



- 3DOF
- 3-Axis Gyro
- I2C Interface
- 2 Sensors/chain

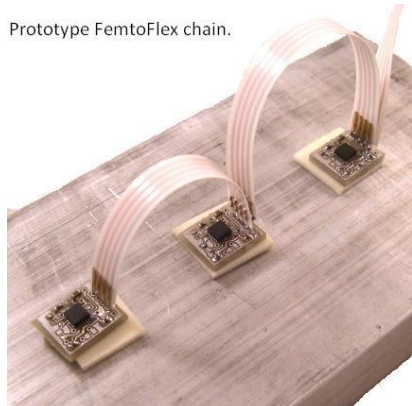
**FemtoE**



- RGC Color
- Light level
- I2C Interface

Femto sensors can be combined on a Femto flex circuit chain.

Prototype FemtoFlex chain.



FemtoB 6DOF Sensor



FemtoB uses the Freescale FXOS8700 6DOF sensor -  
3-axis accelerometer  
3-axis magnetometer

## Differences between PicoA, PicoB, PicoC, PicoD, PicoM and PicoM305

The Pico is our new 10DOF IMU family available in six different configurations with one (PicoM) available with two different processors. Why so many you may ask? Well in order to meet the needs of different users and budgets we decided to support two different 8 bit processors and the ARM Cortex M0 and M4 processor family. This allows the family to meet the needs of cost sensitive applications while also addressing the needs of high performance applications.

All Picos have a USB interface, most are 10DOF capable, lithium battery support with charger, two different wireless options, two different display options and they are a lot smaller than the IMU8420 family. The one feature dropped was the uSD – too big to put on the board so that feature is available as an option. The PicoD is not a motion control device but rather an environmental sensor with digital humidity and temperature sensing. A key feature shared by all Picos is wireless integration. PicoA,B,M07 and M30 are all 10DOF IMUs. PicoC is a 7DOF device and PicoD is an environmental sensor.

The PicoM30 is our highest performance IMU and has all the features of the IMU8420 less the uSD and is capable of high performance sensor fusion using an Extended Kalman Filter made possible by the onchip hardware FPU. The EKF was a collaborative development between SOC Robotics and researchers at Simon Fraser University. The PicoM305 is a variation of the PicoM30 specifically designed to meet the needs of a finger tracking application. The PicoM305 is not available as a standalone device but only as part of the finger tracking system.

Feature	PicoA	PicoB	PicoC	PicoD	PicoM07	PicoM30
Processor A	ATxmega32E5	ATmega328	ATxmega32E5	ATxmega32E5	STM32F072	STM32F303
Type	8 bit	8 bit	8 bit	8 bit	32 bit	32 bit
Clock Rate	32MHz	8MHz	32MHz	32MHz	48MHz	72MHz
Hardware FPU	No	No	No	No	Yes	Yes
AST Clock (14usec)	Yes	No	Yes	Yes	Yes	Yes
Flash	32K	32K	32K	32K	128K	256K
RAM	4K	2K	4K	4K	16K	48K
EEPROM	1K	1K	1K	1K	0K	0K
uSD	No	No	No	No	No	No
Accelerometer	3-axis	3-axis	3-axis	NA	3-axis	3-axis
Gyrocompass	3-axis	3-axis	No	NA	3-axis	3-axis
Magnetometer	3-axis	3-axis	3-axis	NA	3-axis	3-axis
Barometer	BMP180	BMP180	BMP180	BMP180	BMP180	BMP180
EKF	No	No	No	No	No	Yes
Motion Sensor	MPU-9150	MPU-9150	FXOS8700		MPU-9150	MPU-9150
Humidity/Temp/Light	No	No	No	Yes	No	No
LiPo + Charger	Yes	Yes	Yes	Yes	Yes	Yes
Wireless options	WiFi/RF24L01	WiFi/RF24L01	WiFi/RF24L01	WiFi/RF24L01	WiFi/RF24L01	WiFi/RF24L01
Measure Bat Volt	Yes	Yes	Yes	Yes	Yes	Yes
Display options	OLED/TFT	OLED/TFT	OLED/TFT	OLED/TFT	OLED/TFT	OLED/TFT
A/D	12-16 bit/8 Ch	10 bit/8 Ch	12-16 bit/8 Ch	12-16 bit/8 Ch	12 bit/12 Ch	12 bit/16 Ch
D/A	12 bit/2 Ch	No	12 bit/2 Ch	12 bit/2 Ch	12 bit/2 Ch	12 bit/2 Ch
Serial Ports	2	1	2	2	3	5
Hardware PWM	Yes	Yes	Yes	Yes	Yes	Yes
Processor B	PIC16F1454	PIC16F1454	PIC16F1454	PIC16F1454	NA	NA
IDE	AS 6.2	AS 6.2/Arduino	AS 6.2	AS 6.2	CooCox 1.7.5	CooCox 1.7.5

The application software running on each Pico is provided along with an IDE specific to each processor. Three IDE's are supported - Atmel AVR Studio 6.2, Arduino (for PicoB) and CooCox 1.7.5 for PicoM. By providing project code for each Pico users can tailor, modify and enhance the core Pico application for their own specific needs and either keep the changes confidential or return them to the community.

A new desktop GUI called SOCSense is in development and will be released shortly. The GUI is designed to handle multiple Picos in a wireless network system. The GUI talks directly to Picos attached via USB or indirectly via a Nano, NanoM or NanoMP.

### Differences between Nano, NanoM and NanoMP

The Nano is a desktop focused 10DOF development board in a larger form factor than Picos and is intended to be the primary communications device for Pico wireless networks. Most of the processors pins are brought out to connectors to allow connection of other sensors or electronics circuits. Nanos are available with or without sensors.

Feature	Nano	NanoM07	NanoM30	NanoMP30	NanoMP30
Processor	ATxmega128A4U	STM32F072	STM32F303	STM32F072	STM32F303
Type	8 bit	32 bit	32 bit	32 bit	32 bit
Clock Rate	32MHz	8MHz	32MHz	32MHz	72MHz
Hardware FPU	No	No	No	No	Yes
AST Clock (14usec)	Yes	No	Yes	No	Yes
Flash	128K	128K	256K	128K	256K
RAM	8K	16K	40K	16K	40K
EEPROM	2K	-	-	-	-
uSD	No	No	No	No	No
Accelerometer	MPU-9150	MPU-9150	FXOS8700	NA	MPU-9150
Gyrocompass	MPU-9150	MPU-9150	No	NA	MPU-9150
Magnetometer	MPU-9150	MPU-9150	FXOS8700	NA	MPU-9150
Barometer	BMP180	BMP180	BMP180	BMP180	BMP180
LiPo + Charger	Yes	Yes	Yes	Yes	Yes
EKF	No	No	No	No	Yes
Wireless WiFi	Yes	Yes	Yes	Yes	Yes
Wireless RF24L01	Yes	Yes	Yes	Yes	Yes
A/D	12 bit/8 Ch	12 bit/8 Ch	12 bit/8 Ch	12 bit/8 Ch	12 bit/8 Ch
D/A	12 bit/2 Ch	12 bit/2 Ch	12 bit/2 Ch	12 bit/2 Ch	12 bit/2 Ch
Serial Ports	2	3	5	3	5
On chip Op Amp	No	No	Yes	No	Yes
IDE	AS 6.2	CooCox	CooCox	CooCox	CooCox



The NanoM and MP are also available with an STM32F042 processor for cost sensitive applications. The key difference between the three STM32 processors is summarized below.

Feature	NanoM04	NanoM07	NanoM30
Processor	STM32F042	STM32F072	STM32F303
Type	32 bit	32 bit	32 bit
Clock Rate	48MHz	48MHz	72MHz
Core Processor	ARM Cortex-M0	ARM Cortex-M0	ARM Cortex-M4
Hardware FPU	No	No	Yes
AST Clock	Yes	No	Yes
Flash	32K	128K	256K
RAM	6K	16K	40K
EEPROM	No	No	No
On chip Op Amp	No	No	Yes

### Difference between Femtos

Femtoms are standalone sensors with 9, 6 or 3 Degrees of Freedom or light processor. They are designed to add additional sensing options to Picos to address special applications such as the HandSense finger tracking system. A common feature of the Femtoms is internal temperature sensing – important for calibrating the sensor.

Feature	FemtoA	FemtoB	FemtoC	FemtoD	FemtoE
Accelerometer	3-axis	3-axis	3-axis	-	-
Gyrocompass	3-axis	-	-	3-axis	-
Magnetometer	3-axis	3-axis	-	NA	-
Temperature	Yes	Yes	Yes	No	No
Light	-	-	-	-	RGB
Comm Protocol	I2C	I2C	I2C	I2C	I2C
Sensor	MPU-9150	FXOS8700	MMA8653	L3GD20	TCS3472
Type	9 DOF	6 DOF	3 DOF	3 DOF	NA

## Additional Technical Documentation

### SOC Sense

SOC Sense Product Family Overview [here](#)  
BodySense Technical Brief [here](#)  
HandSense Technical Brief [here](#)  
Difference between Nano, Pico and Femto Sensors [here](#)

### Nano Sensor Nodes

Nano Family Technical Overview [here](#)  
Nano Sensor Node Technical Brief [here](#)  
NanoM Sensor Node Technical Brief [here](#)  
NanoMP Sensor Node Technical Brief [here](#)

### Pico Sensor Nodes

Pico Family Technical Brief [here](#)  
PicoA Technical Brief [here](#)  
PicoB Technical Brief [here](#)  
PicoC Technical Brief [here](#)  
PicoD Technical Brief [here](#)  
PicoM Technical Brief [here](#)

### Femto Sensors

Femto Family Technical Overview [here](#)

### Additional Technical Documents

Pico Nano Eagle CAD Layout Templates [here](#)  
Pico Nano Expansion Port Summary [here](#)

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