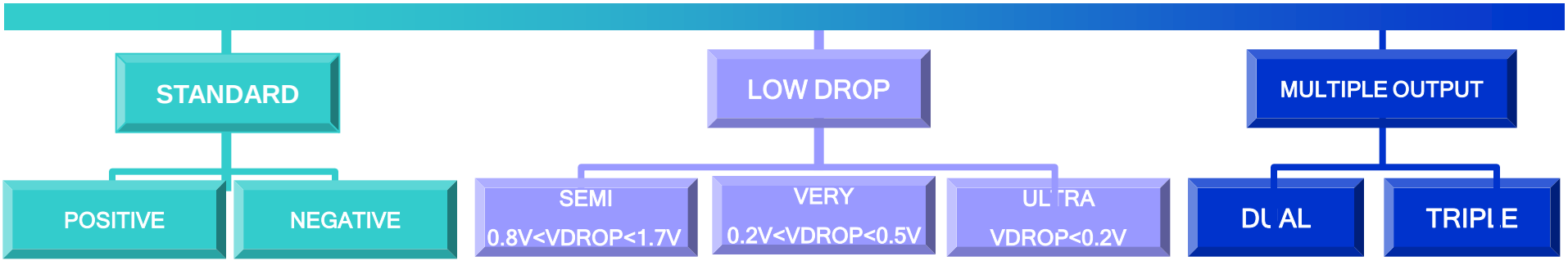
# Analog

**Power and analog key program**

**Luca Salati**

**Market development manager**

# Linear regulators – product tree




**L78Lxx** (0.1A)
**L78Mxx** (0.5A)
**L78xx** (1.5A)
**L78Sxx** (2A)
**LM217/317L** (0.1A,adj)
**LM217/317M** (0.5A,adj)
**LM117/217/317** (1.5A,adj)
**LM123/223/323** (3A)
**LM150/250/350** (3A,adj)
**LM138/238/338** (5A)
**LM723** (0.15A,SHDN)

**L79Lxx** (0.1A)
**L79xx** (1.5A)
**LM137/237/337** (1.5A)

**LD1117** (0.8A)
**LD1117A** (1A)
**LD1086** (1.5A)
**LD1085** (3A)
**LD1085** (3A)
**LD1084** (5A)
**LD1585C** (5A)
**LD1083** (7A)
**LD1580** (7A)
**ST1L04** (PPAK, 1A,adj from 0.8V)
**ST1L02** (MLP3x3, 1A, BiCMOS, Very Low Quiescent Current)

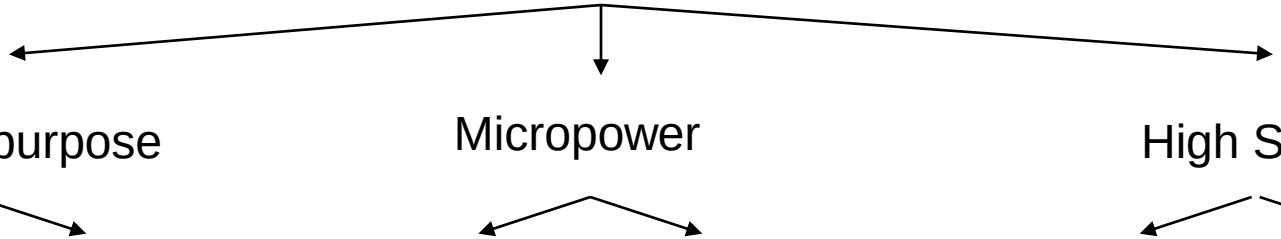
**LExx** (0.1A)
**LK115** (0.1A)
**LM2931** (0.1A)
**L4987** (0.2A)
**L4931** (0.25A)
**LFxx** (0.5A)
**KFxx** (0.5A)
**L4941** (1A)
**L4940** (1.5A)
**LD29080** (0.8A)
**LD29150** (1.5A)
**LD29300** (3A)
**LD39080/150/300** ( 0.8A,1.5A,3A)
**LD49300** (High BW,3A,Vbias=3to6V, Vi=1.4to 6V)

**LD2979** (0.05A)
**LD2980**(0.05A)
**LD2981** (0.1A)
**LD2982** (0.05A)
**LK112** (0.15A)
**LK112S** (0.2A)
**LD2985** (0.15A)
**LD3985** (0.15A)
**LDS3985** (0.3A)
**LD3980** (0.3A, Vinmin=1.7V, MLP)

**ST2L01** (3.3V+ADJ, 1A+1A, SPak-5L)
**ST2L05** (Fixed+ADJ or Fixed+Fixed,1A+1A, Low Quiescent, PPak, SPak-5L, MLP5x6)
**LDRXXYY** (Fixed+Fixed, 0.5A+1A, Dual Inhibit Very Low Drop, PPAK, SPak-7L)
**LD3986** (2x150mA, Ultra Low Drop,Flip-Chip and DFN)

**ST3L01** (2.6V/1.5A, 3.3V/1.2A, 8V/0.25A SPAK-7L)

# Comparators – product portfolio



## General purpose

### Bipolar

**LM2901/3**
200µA / Comp
1.3µs resp time
Open collector

**LM339/393**
200µA / Comp
1.3µs resp time
Open collector

**TS391**
200µA
1.3µs resp time
Open collector

### CMOS

**TS372/4**
150µA / Comp
0.6µs resp time
Open drain

## Micropower

### CMOS

**TS339/393**
9µA / Comp
1.5µs resp time
Open drain

**TS3702/3704**
9µA / Comp
1.5µs resp time
Push-Pull

### BiCMOS

**TS86x (R2R)**
6µA / Comp
3µs resp time
Push-Pull

**TS7211/21 (R2R)**
6µA
3µs resp time
Push-Pull & Open drain

## High Speed

### Bipolar

**LM311**
5mA
200ns resp time
Open E & C

**LM319**
8mA
80ns resp time
Open Collector

### BiCMOS

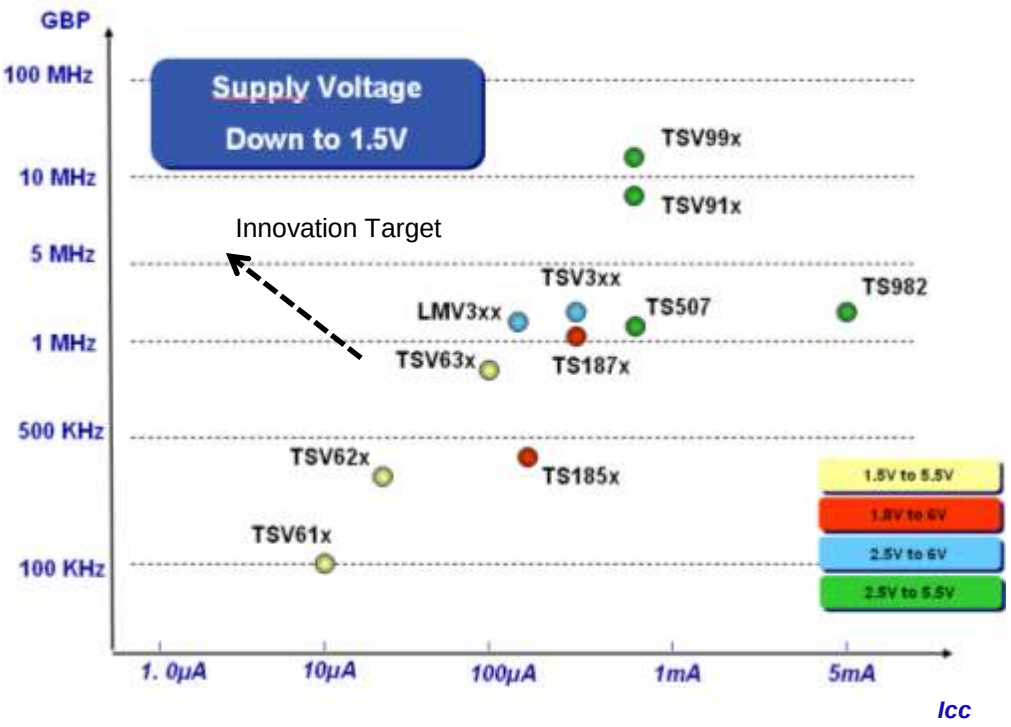
**TS302x (R2R)**
64µA
33ns resp time
Push-Pull

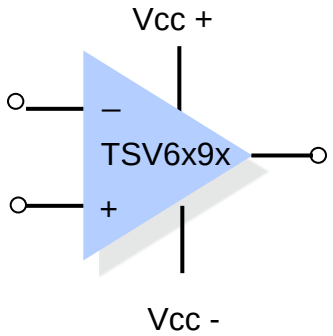
# TSV6x9x - series

**Complementing the new µPower Op. Amps family TSV6xx**

# New TSV6x9x Op. Amp. Series
## complementing the TSV6xx family

The new TSV6x9x series of Op. Amps are complementing the TSV6xx series, the new generation of µPower Op.-Amps improving the ratio of high bandwidth vs. low power consumption (< 1mA).




Key features

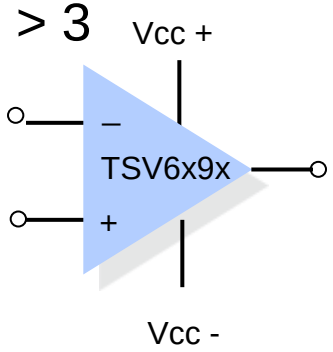
- Micro consumption
- Standby mode (some versions)
- Low supply voltage 1.5V
  - Competition only offers 1.8V
- Rail to Rail I/O
- High precision
- Integrated ESD protection
- Extended temperature range
- Tiny packages

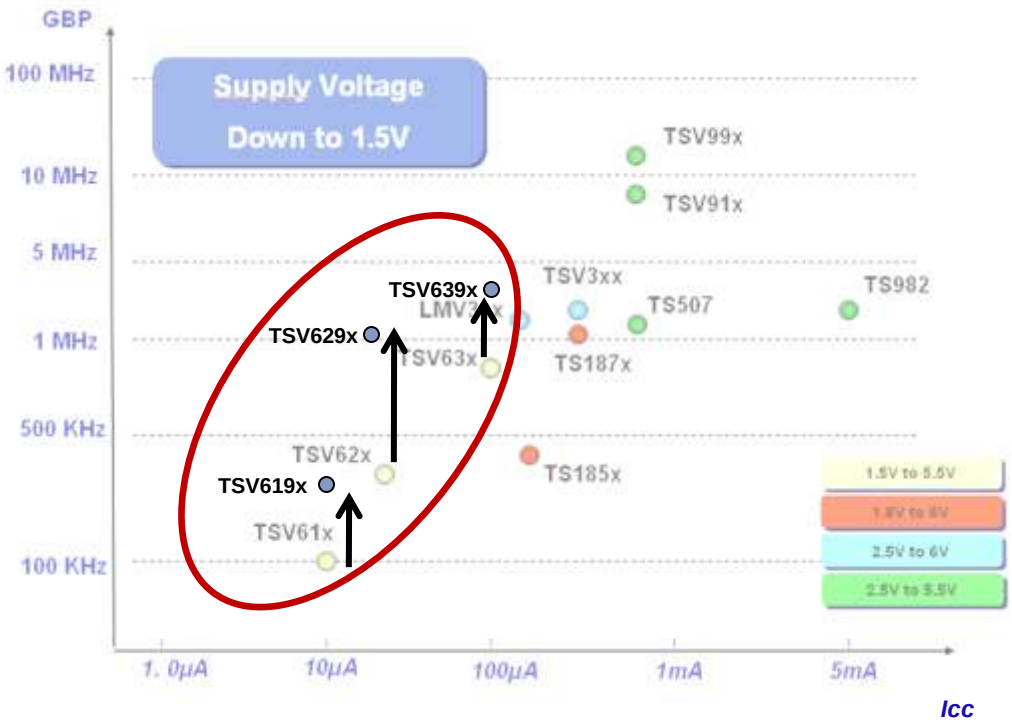
# New TSV6x9x Op. Amp. Series
## complementing the TSV6xx family

The new TSV6x9x series have a lower internal compensation capacitor

→ faster compared to TSV6xx

→ not unity gain stable – gain must be set to > 3




Additional key features of TSV6x9x

- higher speed/consumption ratio vs. complementary TSV6xx device
- same level of power consumption
- external gain setting must be > 3

- TSV6294/5 available
- TSV6394/5 available

# Major Parameters of TSV6x9x

| | TSV629x | TSV639x |
|---|---|---|
| GBP typ. (MHz) | 1.3 | 2.5 |
| Icc max. (µA) | 36 | 69 |
| Vcc min. (V) | 1.5 | 1.5 |
| Slew Rate typ. (V/µs) | 0.35 | 0.7 |
| I_stdby typ. (nA) | 5 | 5 |
| Vio max. (mV) | down to 0.8 | down to 0.8 |
| Temp. Range | -40°C to + 125°C | -40°C to + 125°C |
| I_out typ. (mA) | 70 | 70 |

# TSV6x9x series – Key Benefits

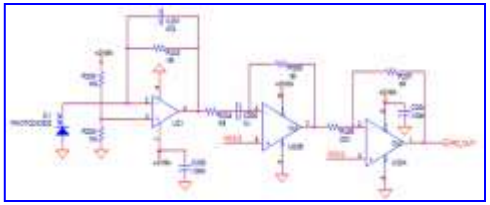
- Ideal for battery powered devices
  - Battery life extension due to µpower consumption and low supply voltage down to 1.5V
  - Standby mode with I_stby < 5nA
- Ideal for applications requiring high precision
  - Input offset voltage down to 500µV
  - Input bias current Ib typ. 1pA due to CMOS input stage
- Ideal for robust designs
  - 4kV ESD protection integrated
  - Low EMI
  - Power consumption is not affected by battery discharge or temperature variation
- Ideal for board space saving designs
  - Package range from SC70 (single) to TSSOP14/16 (quad)

# Target Applications

- Battery Powered and portable applications
  - Instrumentation
  - Consumer devices
  - Medical devices (e.g. Glucose meters)


- Sensor interfaces

- Low side current sensing
- Security systems, alarms, smoke detectors



- Signal conditioning, filtering

# TSC103/TSC1031

## High-Side Current Sense Amplifier

RtM, Q2 2010

# Current Sensing Strategies

Many systems require current measurement for regulation. Dependent on the voltage level, (AC or DC Voltage, High Voltage or Low Voltage) different methods of measurements will be chosen:

## Isolated Topology

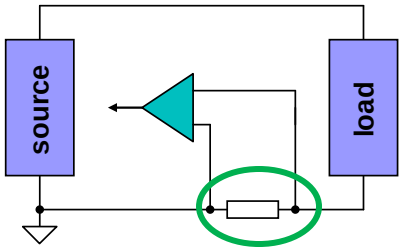
- Isolated current measurement (e.g. with a current transformer or a Hall-Effect-Sensor) is mandatory in case of measurement in system with
  - alternate voltage (e.g. 230Vac)
  - continuous voltage higher than 100Vdc

Current Transformer

Hall Effect Sensor

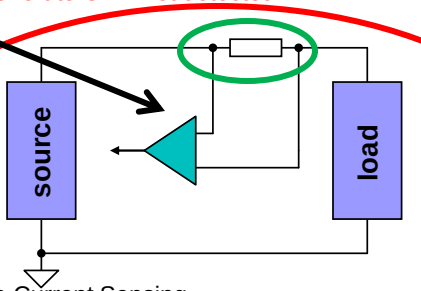
## Non-Isolated Topology

- Non-Isolated measurement through a shunt resistor + amplifier is used for voltages less then ~ 100Vdc




- **Low Side** Current Sensing
  - Cheap, easy solution usage of standard Op Amp.
  - Interruption of GND line
  - Short to GND not detected

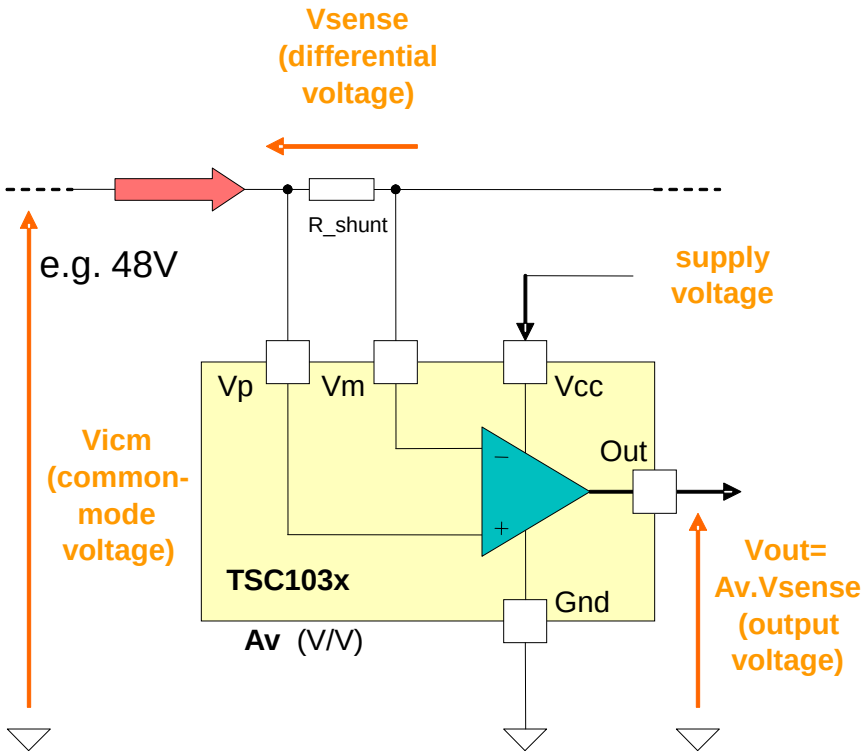
**NEW TSC103x**




- **High Side** Current Sensing
  - GND line continuity (no GND disturbance)
  - Can measure multiple outputs
  - Dedicated Op Amp topology necessary

# What are TSC103 and TSC1031?

The new High Side Current Sense Amplifiers TSC103 and TSC1031 complement the TSC10x family. They measure a differential input voltage over a shunt resistor and translate it into a GND referenced output voltage. TSC1031 has an input pin to easily connect external EMI Filter




- Major working principle:
- Input Voltage referenced to GND is equal to the Voltage of the Source
  - Working range for V_p:
    - 2.9V to 70V (single supply)
    - -2.1 to 65V (dual supply)
  - Input Voltage is managed independently of Vcc
  - Differential Input Voltage over Shunt Resistor is amplified by pin selectable gain
  - Output is buffered and referenced to GND
    - Easy signal processing possiblity

# Other major Features and Benefits

- Rugged design
  - TSC103x sustains an Input Voltage range from -16V to +75V without damage
    - -> device sustains failure condition like:
      - Reverse battery up to – 16V
      - Load Dump – Overvoltage conditions up to 75V
- High Precision
  - Low shunt resistor value can be used
    - minimum impact on the power line
- High Voltage capability
  - Includes 48V (e.g. Telecom, Automotive applications)
- Wide application Range
  - Industrial, Power Management, DC motor control, Photovoltaic systems, Battery Chargers, UPS, Precision Current Control,
  - Automotive, Telecom (Wireline Basestation)

# TSC10x family major parameters

| Product | Description | Vcc Range | Vicm Range | Surviving Vicm | Gain Value | Icc max |
|---|---|---|---|---|---|---|
| TSC101 | High Side Current Sense Amplifier | 4-24V | 2.8 – 30V | -0.3-60V | 20V/V | 300µA |
| TSC102 | High Side current sense amplifier plus Signal conditioning Amplifier | 3.5-5.5V | 2.8-30V | -16-60V | 20V/V or adj. | 420µA |
| **new TSC103** | High Voltage High Side current sense Amplifier | 2.7-5.5V | 2.9-70V -2.1-65V | -16-75V | 20,25,50, 100V/V Pin sel. | 360µA |
| **new TSC1031** | High Voltage High Side current sense Amplifier | 2.7-5.5V | 2.9-70V -2.1-65V | -16-75V | 50,100V/V Pin sel. | 360µA |

**Include e.g. 48V line monitoring**

**Protection against reversed Battery conditions**

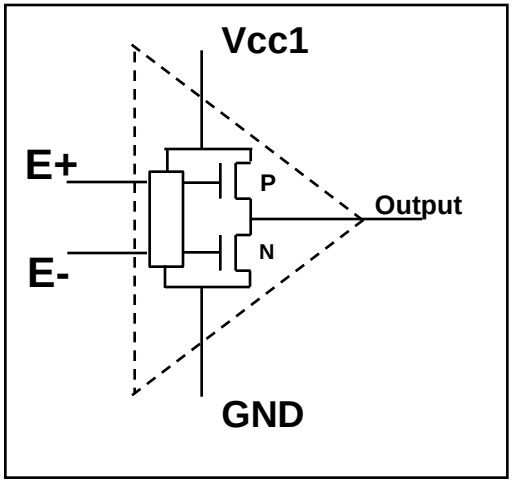
# Conclusion

- **Current sensing in High Side Configuration**
- TSC103x are enlarging the HS Current Sense Amplifier Family of ST
  - High side Measurement means: No disturbance of the GND line
  - Minimum impact on the power line over low value shunt resistor
  - High Voltage capability up to 70V
    - Ideal interface between high Voltage anlog and low voltage digital worlds
  - TSC103x sustain certain failure conditions like reverse battery or load dump without damage
  - Wide application range

# TS3021 / 22 – rail-to-rail high speed comparator

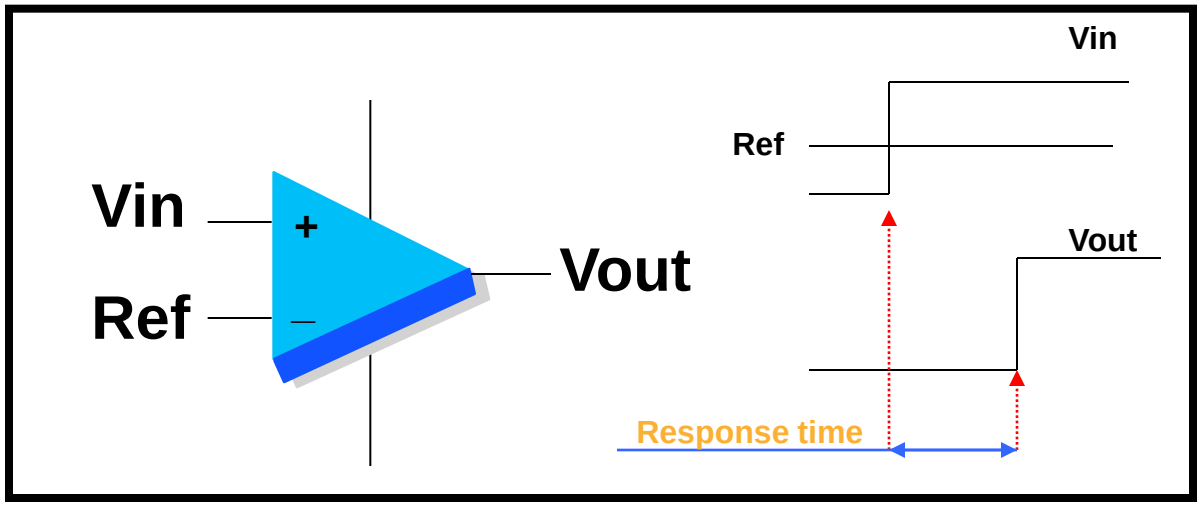
- PRODUCT DESCRIPTION
  - **64µA** power consumption
  - **33ns** response time
  - Operating From Vcc= **1.8V to 5V**
  - **Rail to Rail** Inputs
  - Push-pull Ouputs
  - **TS3022 / SO8 miniSo8**

**Push Pull Output**




**APPLICATIONS**

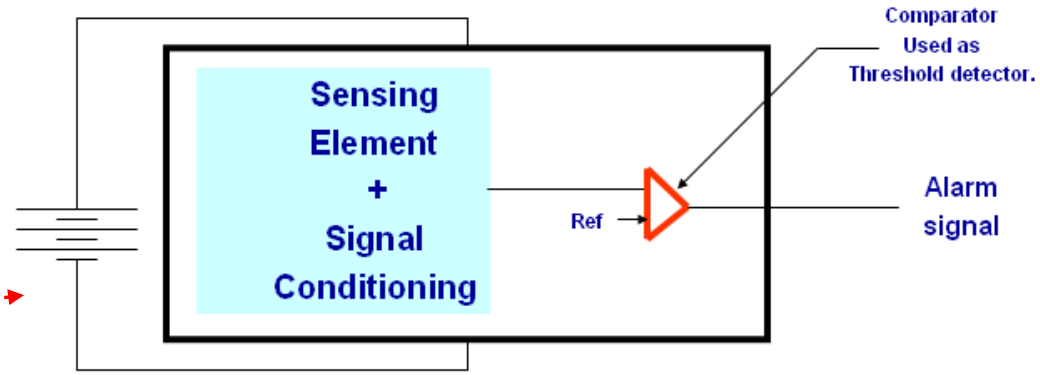
- Telecom
- Industrial
- Consumer



# TS86x micropower comparators

- PRODUCT DESCRIPTION
  - **6µA** power consumption
  - **3µs** response time
  - Operating From Vcc= **2.7V to 10V**
  - **Rail to Rail** Inputs / Ouputs
  - **SOT23-5** packages for single
  - **SO and TSSOP** for the dual & quad

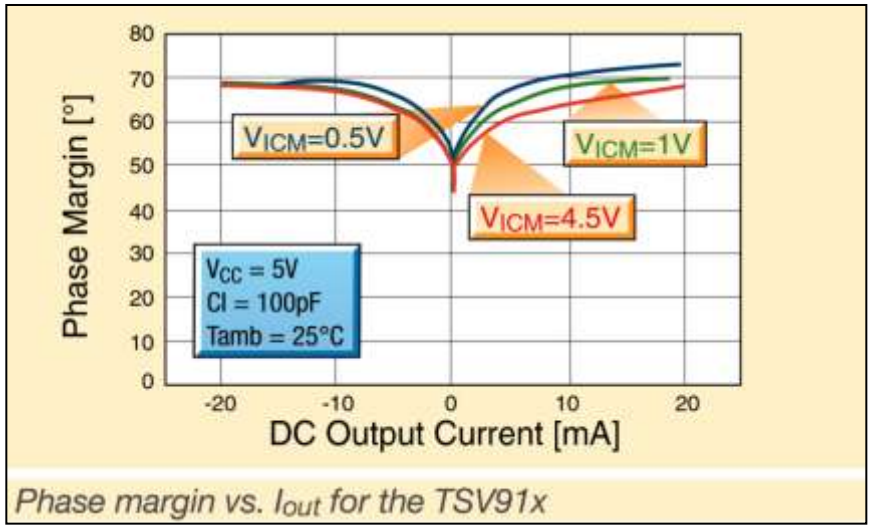

- APPLICATIONS
  - Portable electronics
  - Low voltage
  - Alarms



# TSV911 / 12 / 14

## FEATURES

- Rail to rail output
- CMOS input
- 2.5V to 5.5V supply operation
- High merit factor GBP/ICC
  - 8 MHz – 780µA per amplifier 8Mhz
- 1pA (typ) input Bias Current

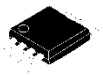


*Phase margin vs. $I_{out}$ for the TSV91x*

## APPLICATIONS

- Battery-powered applications
- Portable devices
- Sensor signal conditioning
- Medical instrumentation
- Active filtering, buffering


**SOT23-5**


**miniSO8**


**SO8**

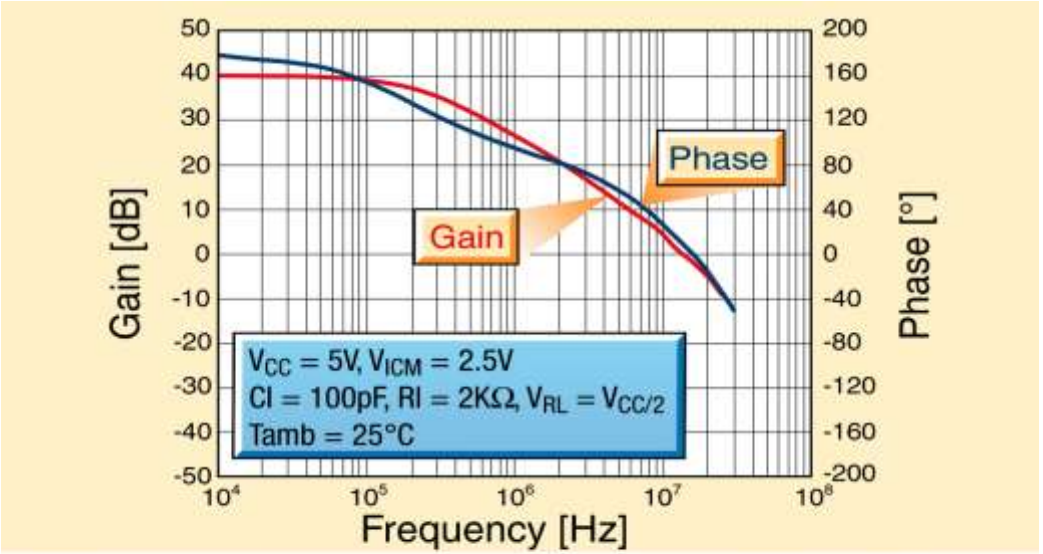

**SO14**


**TSSOP14**

# TSV991 /92 / 94

## FEATURES

- Rail to rail input / output
- CMOS input
- 2.5V to 5.5V supply operation
- Very high slew rate & GBP
  - 20MHz for gain≥3, CL=100pF
  - SR=10V/µs
  - Icc=780µA
- 1.5mV (max) input offset voltage
- 1pA (typ) input Bias Current




*Voltage gain and phase vs. frequency at $V_{CC}$ = 5V and $V_{ICM}$ = 2.5V for the TSV99x*

## APPLICATIONS

- Motor control
- Battery-powered applications
- Sensor signal conditioning
- Medical instrumentation
- Active filtering, buffering
- Instrumentation / factory automation


**SO14**


**TSSOP14**


**SOT23-5**


**SO8**


**miniSO8**

# TSV6x Main parameters

| | TSV61x* | TSV62x | TSV63x |
|---|---|---|---|
| Ultra low Vcc | 1.5V to 5.5V | | |
| Tiny packages | SC70-5/6, SOT23-5/6/8MSO8/10, SO-8, TSSOP14/16 | | |
| Low Vio | 1mV max | Down to 500µV max TSV6xA | |
| Istby typ, nA | - | 5nA | |
| Icc typ, µA | 12 | 29 | 60 |
| GBP typ, kHz | 120 | 420 | 880 |
| Extended temp. range | -40 to +85°C | -40 to +125°C | |
| Design robustness | - | EMI hardened (dual&quad) | |
| | High ESD tolerance (≥ 4kV HBM) | | |

# MEMS Products

**August 2011**

# MEMS

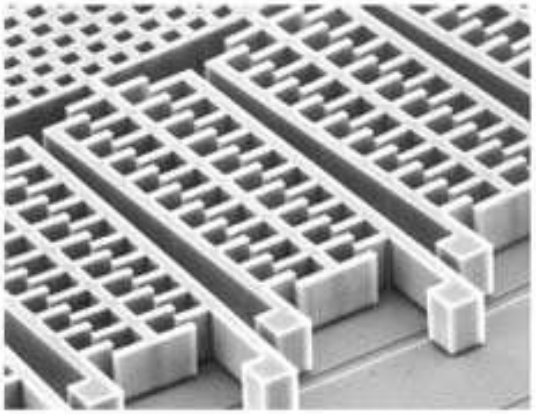
- Micro Electro Mechanical System Technology exploits the mechanical properties of silicon to create movable structures that are able to sense acceleration or vibration in each direction.

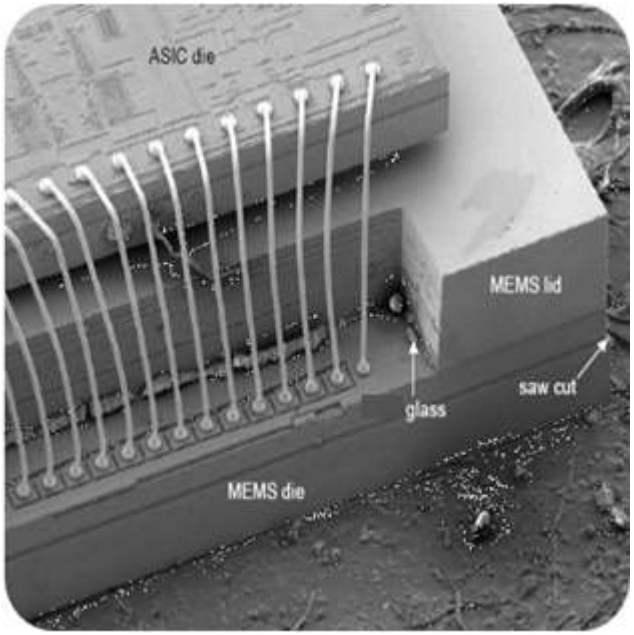
- *Applications in home & building automation:*
  - ***User interfaces***
  - ***Anti-theft systems***
  - ***Remote device control***

# What are MEMS?

- MEMS is Micro Electro Mechanical Systems
  - MEMS contain movable 3-D structure
  - Structure move accordingly to external displacement

- In MEMS not only electrons are moving!






*SEM* pictures of a capacitive micro-machined structure manufactured with THELMA process*

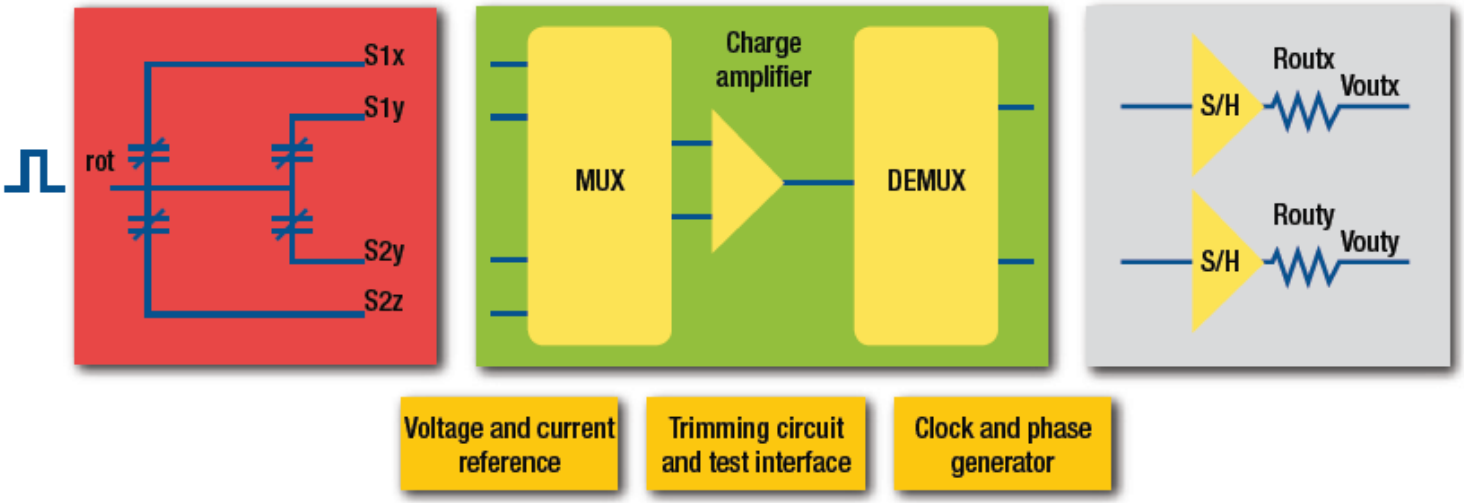


*SEM: scanning electron microscope

# MEMS: analog output

## Analog output – key features

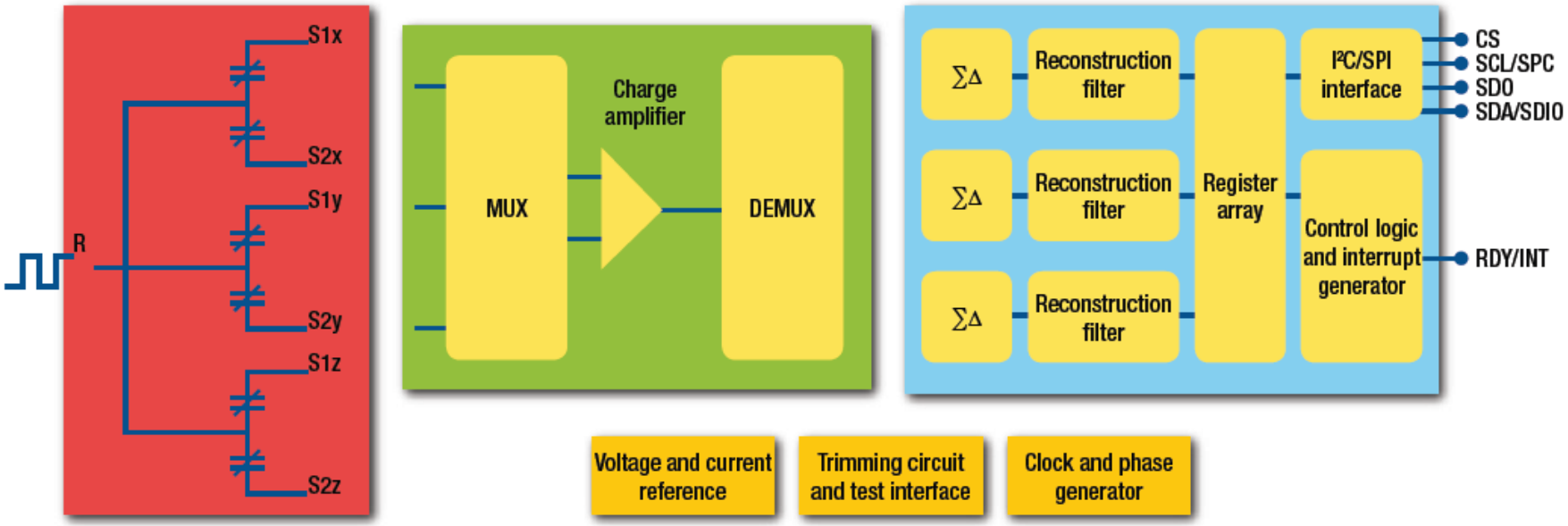
- Analog output with additional multiplexer output
- 2- and 3-axis
- Selectable full scale: +/- 2 g or +/- 6 g
- Power-down mode
- Resolution better than 0.5 mg @ 100 Hz
- <1 mA current consumption in normal mode
- <10 µA current consumption in power-down mode
- Embedded self test
- Temperature range -40 to +85 °C
- Factory trimmed parameters
- High shock survivability: 10,000G for 0.1 ms
- High thermal stability
- High lifetime stability
- LGA packages available



# MEMS: digital output

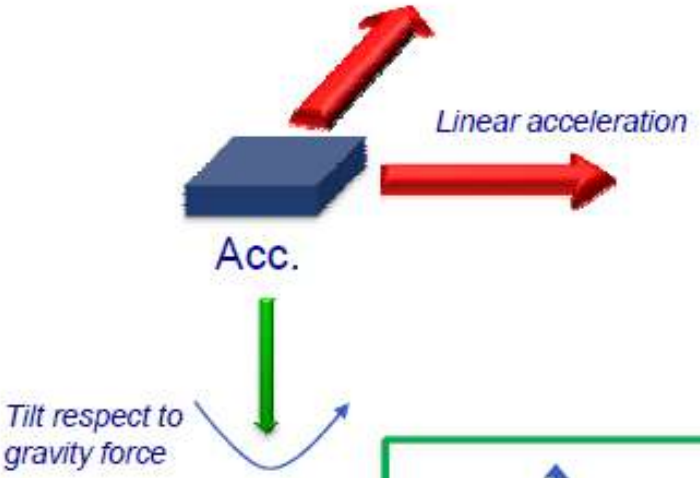
## Digital output – key features

- MEMS sensor and interface chip in one package
- 2- and 3-axis
- Direction detection
- Click and double click recognition
- Embedded high-pass filter
- I²C/SPI output
- Programmable bandwidth and data rate
- Resolution better than 1 mg
- Power-down mode
- 2 independent, programmable interrupt pins
- Wake-up/free-fall interrupt signal with programmable thresholds
- Temperature range -40 to +85 °C
- Factory trimmed parameters
- High shock survivability: 10,000G for 0.1 ms
- High thermal stability
- High lifetime stability
- LGA and QFN packages available

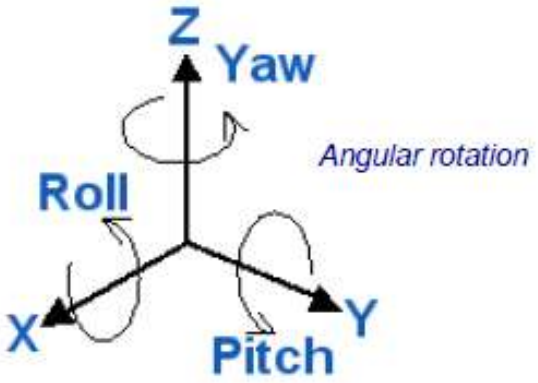


# Why accelerometers and gyroscopes?

## Accelerometers and Newton
**F = m A**




## Gyroscope and Coriolis
**F = - 2m V x Ω**




Accelerometer

*"In plane" rotations are not sensed*

# Accelerometers – Key features

- **3 Axis** sensing
- From **±2g** to **±24g** full scale
- Analog and I²C/SPI outputs
- Programmable bandwidth and data rate (**up to 5KHz**)
- Resolution better than **1mg**
- Filter, Wake-up/Free Fall/6D interrupts with programmable threshold & Axis
- Supply operation: **1.71V** to 3.6V
- Low power Normal mode (down to **22µA**)
- Power Down Mode **(<1µA**) & Low Power Mode (**down to 2µA**)
- **Self test** function on the 3-axis
- Factory trimmed parameters
  - High Shock Survivability: 10000g for 0.1ms
  - Temperature range -40 to 85°C or -40 to 105°C
    - High Thermal & Lifetime Stability
      - Qualification AEC-Q100

# IMM Applications for Accelerometer sensors

- Vibrations measurement and Tilt inclination to adjust rotation speed and fault prediction
  - For Washing machines, Domestic appliances (Robot), wind mills…
  - Power Tools (chain saw, electronic screwdriver…)
- Professional and domestic Alarms
- Asset Tracking (for shocks monitoring)
- Anti Tamper function

- Key Requirements of Accelerometers for IMM
  - Low noise density and High resolution
    → enabling high precision acceleration and small variation measurement
  - Wide range of output acceleration measurement
  - 3-Axis is many times better

The LIS331DLH meets above requirements and can therefore be perfectly suitable for many IMM applications.

# LIS331DLH

**The high-performance 3-axes *'nano'* accelerometer**

# LIS331DLH: What is it?

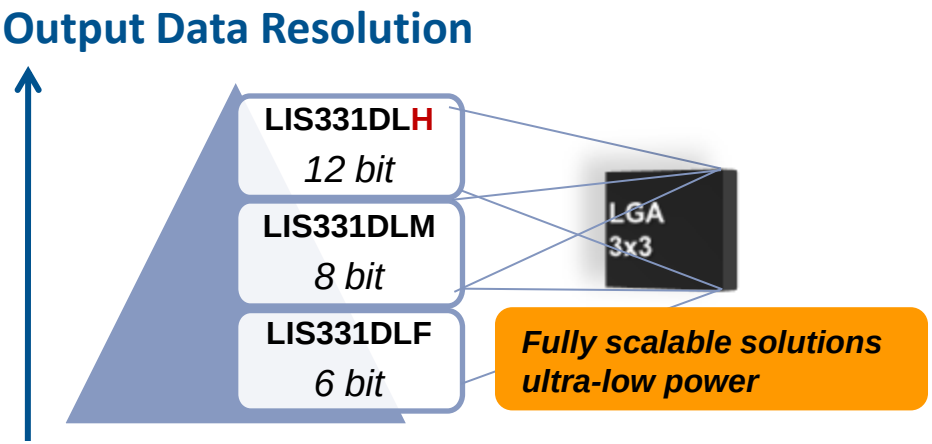
- The LIS331DL**H** is the high-performance, ultra-low-power, I2C/SPI digital-output, 3-axis linear accelerometer in 3x3x1 $mm^3$ LGA-16 package
- Like the other MEMS from ST, the device includes
  - the sensing element
  - the IC interface, able to provide a signal to the external world through an $I^2C$ / SPI serial interface → easy interfacing with microcontrollers !!
- Key Features:
  - User selectable full scale: 2g/4g/8g acceleration ranges
  - High resolution: 12-bit
  - High stability over temperature:
    - Sensitivity vs temp: ±0.01 %/°C
  - Smart power saving operation modes
    - 10µA in low power mode / 1µA in power-down mode
  - Temperature range: -40 ÷ 85°C.

# What is new: High-Performances (H version)

- The LIS331DL**x** exists in three versions:
  - - **F**: basic feature → cost-effective version
  - - **M**: medium performances
  - - **H**: high-performances

**HW: Same pinout, same functions!**

**SW: Same registers structure!**



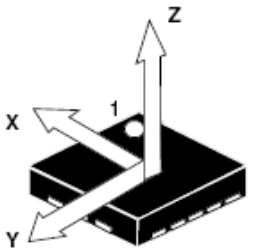

| Properties | Parameter | LIS331DL**F** | LIS331DL**M** | LIS331DL**H** |
|---|---|---|---|---|
| Mechanical | Sensitivity (*) | 62.5 mg | 16 mg | 1 mg |
| Electrical | Consumption | The same for all three versions: very low !!! | | |
| Communication | Data Resolution | 6 bits | 8 bits | 12 bits |

(*) Typical values

# LIS331DLH - Description

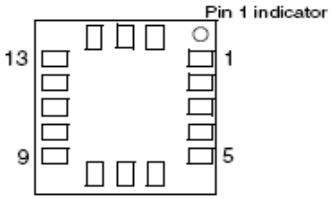
| Parameter | Value | Unit |
|---|---|---|
| Power supply | 2.16 – 2.5 – 3.6 | V |
| Full Scale | ±2, ±4, ±8 | g |
| Sensitivity | 1 / 2 / 3.9 | mg/digit |
| Sensitivity change vs Temperature | ±0.01 * | %/°C |
| Resolution | 12 | bit |
| Zero-g level offset | ±20 * | mg |
| Current Consumption (normal mode) | 250 | µA |
| Current Consumption (low-power mode) | 10 | µA |
| Current Consumption (power down mode) | 1 | µA |
| Operating temperature range | -40 ÷ +85 | °C |
| Package (dimensions) | LGA (3.0 x 3.0 x 1.0) | $mm^3$ |

ULTRA LOW-POWER HIGH-PERFORMANCE 3-AXES ‘NANO‘ ACCELEROMETER




(TOP VIEW)

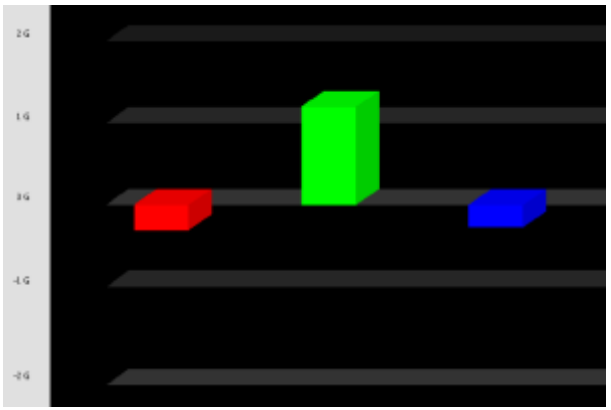
DIRECTION OF THE DETECTABLE ACCELERATIONS




(BOTTOM VIEW)

# LIS331DLH – Material Available

- STEVAL-MKI022V1 (LIS331DLH, 3-axis linear digital accelerometer evaluation board)
  - Connect the evaluation board to a PC with USB
  - PC Software
- iNEMO: Multi-sensor inertial measurement unit (IMU) devices
- Applicative boards, STEVAL-MKI029V1 and STEVAL-MKI030V1



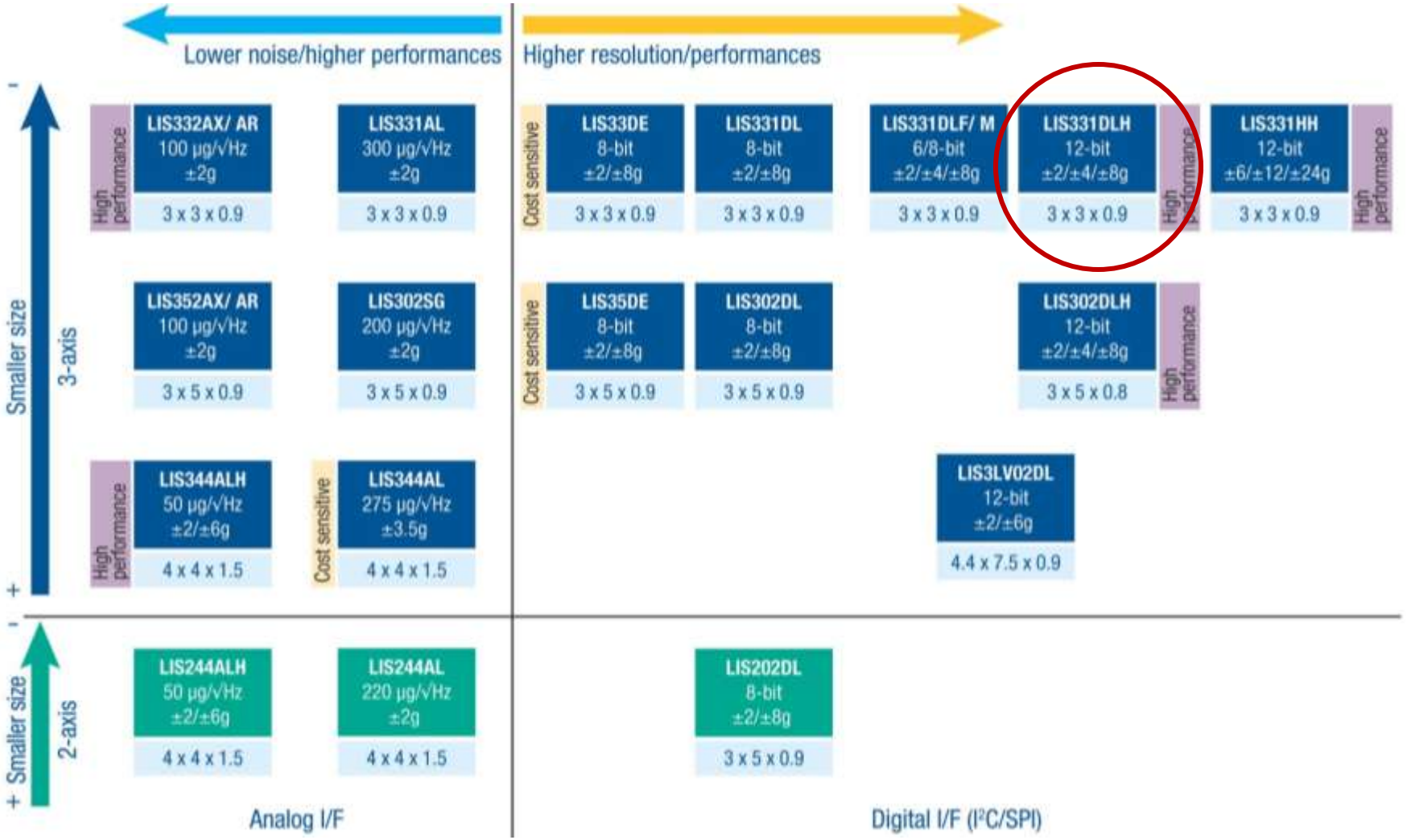
PC Software

USB Connector


Order code:
STEVAL-MKI022V1

Applicative boards

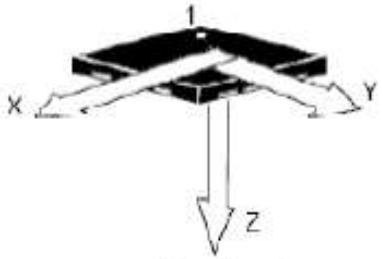
# Positioning inside ST MEMS accelerometers portfolio



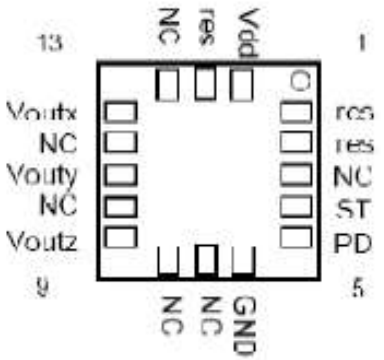
# LIS332 – high performances in small size

**Dedicated trimming to simplify integration**

| | LIS332AR | Unit |
|---|---|---|
| Axes | 3 | |
| FS | ±2 | [g] |
| Vdd Max | 3.6 | [V] |
| Vdd typ | 3 | [V] |
| Vdd Min | 2.16 | [V] |
| Idd | 0.3 | [mA] |
| Idd PD | 1 | [µA] |
| Zero g off. | Vdd/2 | [V] |
| OffDr | ±0.2 (typ) | [mg/°C] |
| So | 0.2*Vdd (0.6) | [V/g] |
| Package | 3x3 LGA | mm² |




(Top view)
Direction of the detectable accelerations

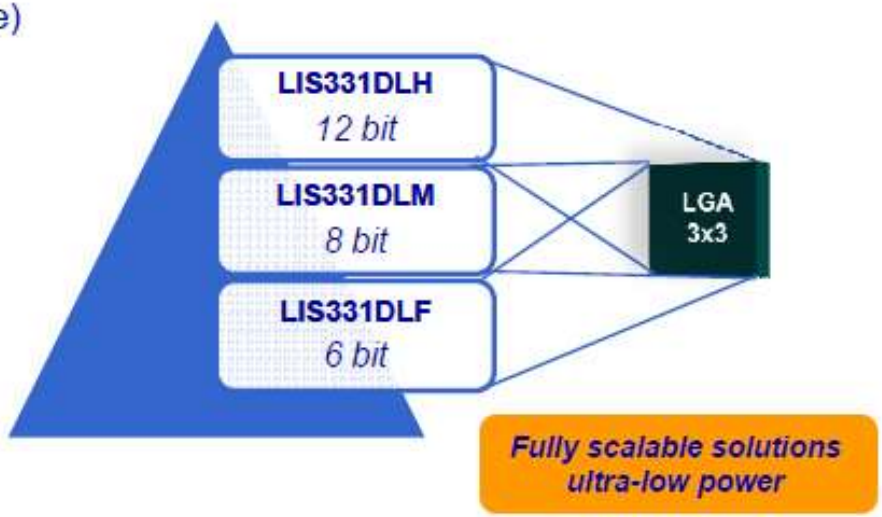



(Bottom view)

Pin to Pin and Motion compatible to LIS331AL

# Ultra low power new family

- **Main Functions/Embedded Features:**
  - 6 Direction Recognition (Portrait/Landscape)
  - Motion Wake Up
  - High Pass Filter
  - Advanced Power Management system
  - auto wake-up
  - 3 FS user selectable
  - 4 ODR user selectable
  - 2 high flexible independent interrupts
  - Advanced Self-Test




- **Target applications:**
  - User Interface (P/L, gesture recognition)
  - Tilt detection, inclinometer
  - Pedometer
  - Gaming
  - GPS wake-up
  - Tap Detection
  - 3D compass compensation

**HW: Same pinout, same functions!**

**SW: Same registers structure!**

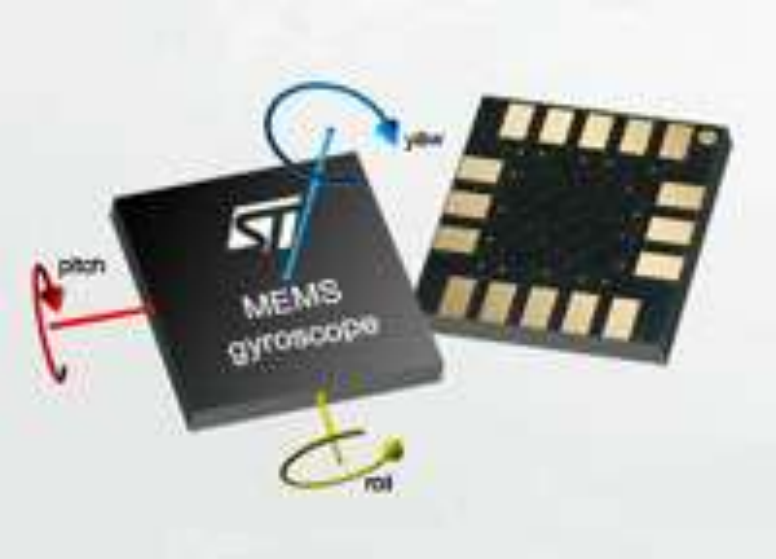
**BEST PRODUCT IN THE MARKET**
**FOR STABILITY OVER TEMPERATURE AND AFTER SOLDERING**

# Product Focus – LIS3DH

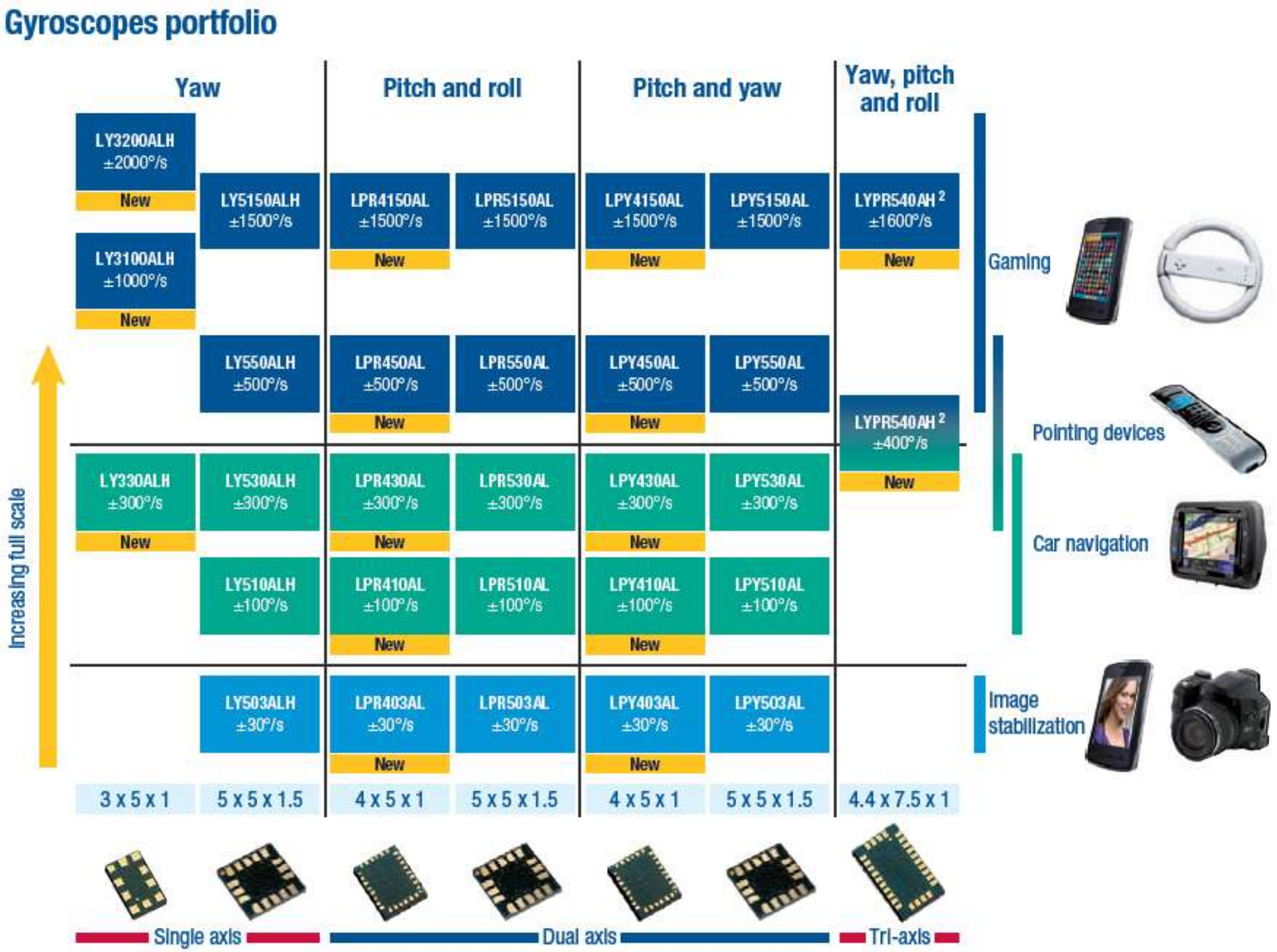
- 3-Axis Accelerometer
- Digital SPI/I2C output
- **4** selectable Full Scale: **±2, 4, 8 and 16g**
- High Resolution (12 bit)
- Very low power consumption: **11µA** in Normal mode (50Hz), **2µA** in Low power mode (1Hz) and **.5µA** in Power down mode
- Power supply 1.71 to 3.6V
- 8 ODR user selectable: 1/10/25/50/100/400/1600/5000 Hz
- **96-level FIFO** (of 16-bit data)
- **3 ADC Inputs**
  - Power down and Sleep modes: **Automatic** programmable sleep_to_wakeup & return_to_sleep
  - Self test function
  - LGA-16 3x3 Package
- **P2P with LIS331DLx AND similar SW register structure**

# MEMS - gyroscopes

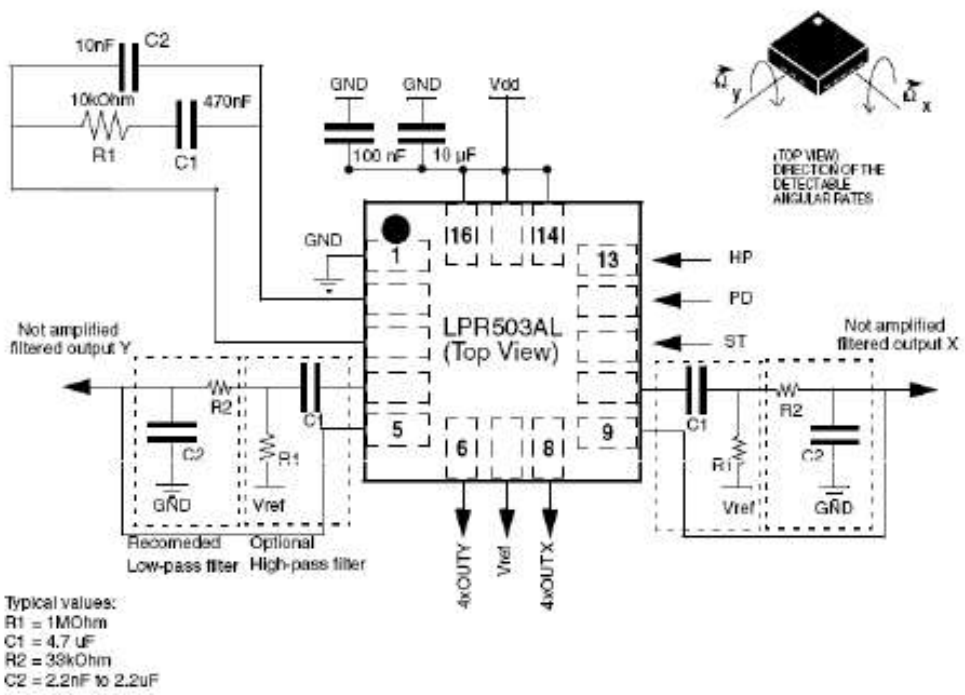
- Complete family of single-axis (yaw) and two-axis (pitch-and-roll, pitch-and-yaw) MEMS gyroscopes offers the industry's widest full-scale range, from 30 to 6000°/s.
  - Single-axis (Yaw) / multi-axis (Pitch and Roll, Pitch and Yaw) gyroscope sensor family
  - Complete range of full scale available (30°/s to 6000°/s)
  - Ultra stability over temperature
  - Low noise level (0.014°/s/√Hz)
  - Amplified and not amplified outputs contemporarily available
  - Power-down mode to ensure low current consumption for battery operated devices
  - Absolute angular rate output Internal low pass filter
  - Embedded self test High shock survivability



# Gyroscopes portfolio

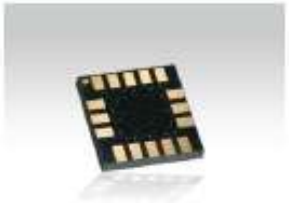


# Gyro main features



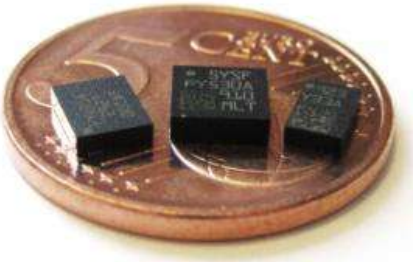

- 2.7 V to 3.6 V single-supply operation
- Wide operating temperature range (-40 °C to +85 °C)
- High stability overtemperature
- Analog absolute angular-rate output
- Two separate outputs for each axis (1x and 4x amplified)
- Integrated low-pass filters
- Low power consumption
- Embedded power-down
- Embedded self-test
- High shock and vibration survivability
- ECOPACK® RoHS and "Green" compliant

- Reference voltage available as output (Vref)
- Best in the market for stability over temperature
- Amplified and not amplified output available for each axis
- Embedded self-test to verify mechanical part functioning

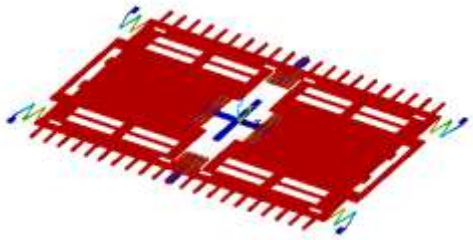


# Gyroscopes – Key features

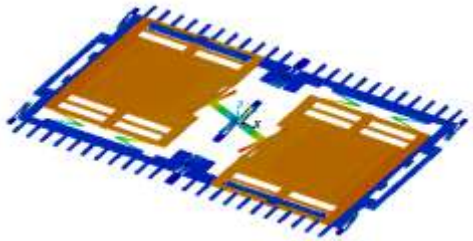
- Sensing element and ASIC in a single package
- 14 products: **1-Axis** (Yaw), **2-Axis** (Pitch/Roll and Pitch/Yaw) and **3-Axis**
- From **±30°/s** to **±6000°/s** Full scale
- **1, 2** or **3 full scales**
- Analog and Digital output
- Integrated low-pass filters
- Sleep & Power down modes
- Low power consumptions*:
  - 6.8mA (Normal)
  - 2.1mA (Sleep)
  - 1µA (Power down)
- Self test function
- **High resolution**: 0.01°/s/√Hz*
- **High** Thermal **Stability** (0.02°/s/°C)*
- Factory trimmed parameters
- **High shock** & **vibration** survivability
- Temperature range -40 to 85°C



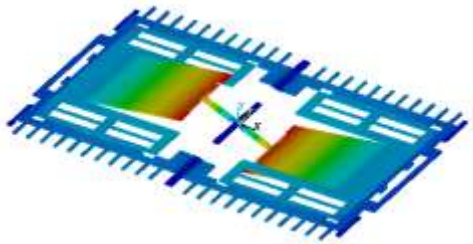
*Drive mode*



*Yaw mode*



*Pitch mode*





** Typ. Values for LPx403AL*

# Gyro product focus: L3G4200D


- **3-Axis Gyroscope**
- **Digital** SPI/I2C output, **16 bit resolution**
- **3** selectable **Full Scale**: ±250°/s, ±500°/s and ±2000°/s
- Power down and Sleep modes
- **Self test** function
- **Interrupt** and Data Ready output **lines**
- Factory trimmed parameters
- **High Sensitivity**: 8.75m°/s @ 250°/s full scale
- **High Resolution**: 0.03°/s/√Hz @ 40Hz
- **4** Output Data Rates:**100, 200, 400** and **800Hz**
- Programmable **Low** and **High** pass filters
- High Thermal Stability (0.08°/s/°C)
- High Shock Survivability: 10000g for 0.1ms
- Temperature range -40 to 85°C
- Power supply range: 2.4 to 3.6V
- Consumption: 6.1mA in normal, 1.5mA in Sleep and 5µA in power down mode
- **8-bit temperature** output
- 96-level **FIFO**
- **Small package 4x4 LGA**

# E-Compass – LSM303DLM

- MEMS Accelerometer + Magnetic sensing elements and ASIC
  - 3-axis accelerometer: ±2g/±4g/±8g full scale
    - 12 bit resolution,1mg/digit sensitivity
    - ODR with up to 1KHz
  - 3-axis magnetic sensor: from ±1.3 to ±8 .1 gauss full scale
    - 5mgauss resolution, 0.9mgauss (x,y) and 1mgaus (z) sensitivity
    - ODR with up to 220Hz
  - I²C digital interface
  - 2.16 to 3.6 voltage range (1.8V I/Os),
  - 360µA consumption, 2µA in power-down mode
  - 2 Interrupt lines, Special events detection
  - P2P compatible with LSM303DLH

**LSM303DLM**
MEMS Compass

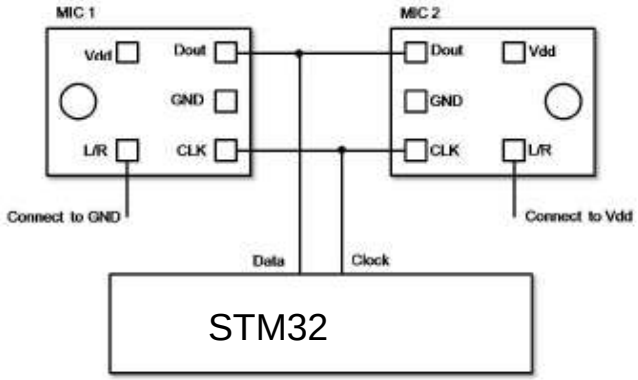
# E-Compass – LSM303DLM

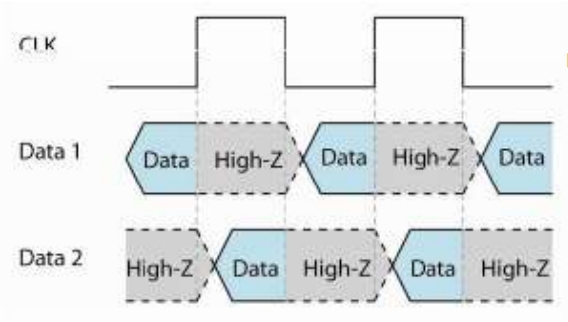
- Evaluation board:
  - STEVAL-MKI113 daughter board
  - STEVAL-MKI109 mother board based on STM32F102R8 ARM CortexTM-M3
  - Software, Application notes provided

- Targeted applications
  - Compensated compass
  - Location based services (LBS)
  - Map rotation and Position detection
  - Magnetic Signature recognition
  - 6 Degrees of Freedom for Movement reconstruction, recognition and intelligent power saving

# MEMS Microphone – MP45DT02

- Top Digital microphone, Pulse Density Modulation single bit output with stereo support
- Omni-directional sensitivity
- High level performance for :
  - Signal to noise ratio: 58dB (@1KHz)
  - Acoustic overload point: 120 dBSPL
  - Power supply rejection: -70 dBFS
  - 10ms wake-up time
- High Frequency response :
  - Voice / Hearing range 20Hz to 10 kHz




- Low power consumption (normal / low power): 650µA / 20µA
- Small Package, 4x5x1.5 HLGA package
- Single supply voltage from 1.64 to 3.6V

# MP45DT02 - More information

- Board: Microphone USB demo

- Microphone Audio Adapter

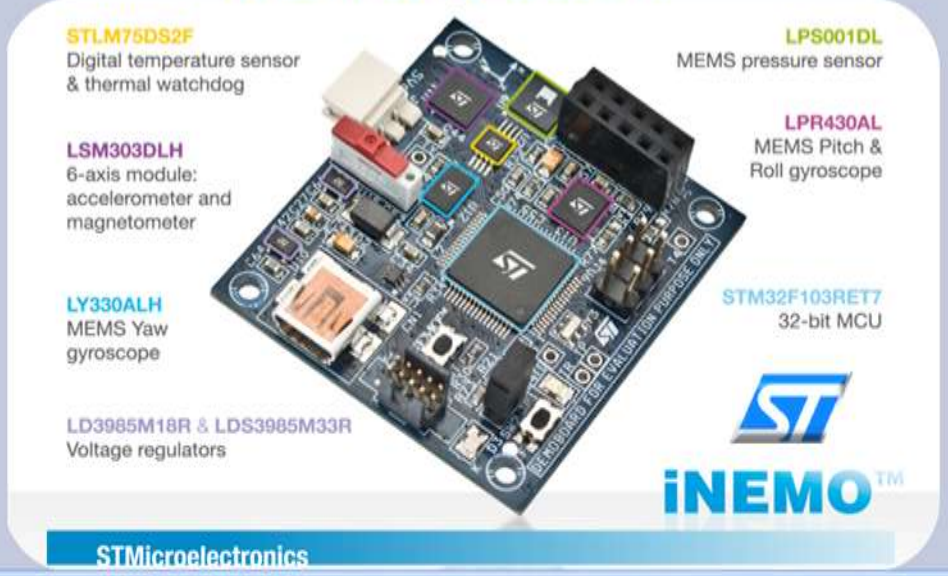
- Pricing: DCPL ~ 1.57$
- www.st.com/mems
- Datasheet available on ST web site

# *i*NEMO™

## 10 Degrees of freedom

### 3x Accelerometer

### 3x Gyroscope

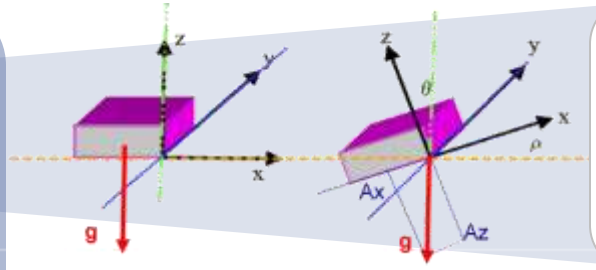



### Pressure Sensor

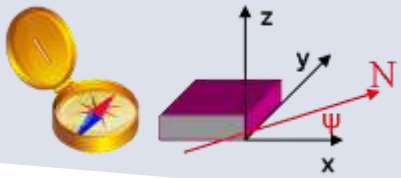
### 3x Magnetometer

The *i*NEMO V2 is the second generation of the *i*NEMO™ inertial module family. It combines five STMicroelectronics sensors: a 2-axis roll-and-pitch gyroscope, a 1-axis yaw gyroscope, a 6-axis geomagnetic module, a pressure and a temperature sensor. This sensors fusion provide 3-axis sensing of linear, angular and magnetic motion, complemented with temperature and barometer/altitude readings, representing the new ST 10 degrees of freedom (10-DOF) inertial system solution.
This inertial system represents a complete hardware platform that can be used in many applications: location-based service, human machine interfaces, and robotics.

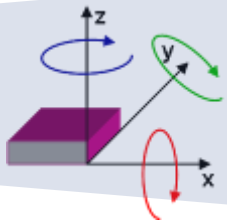
# ST MEMS the way for orientation


- The **accelerometer** senses the linear acceleration.
- In **static** conditions, the projection of gravity on the three axes allow to compute **tilt angles**

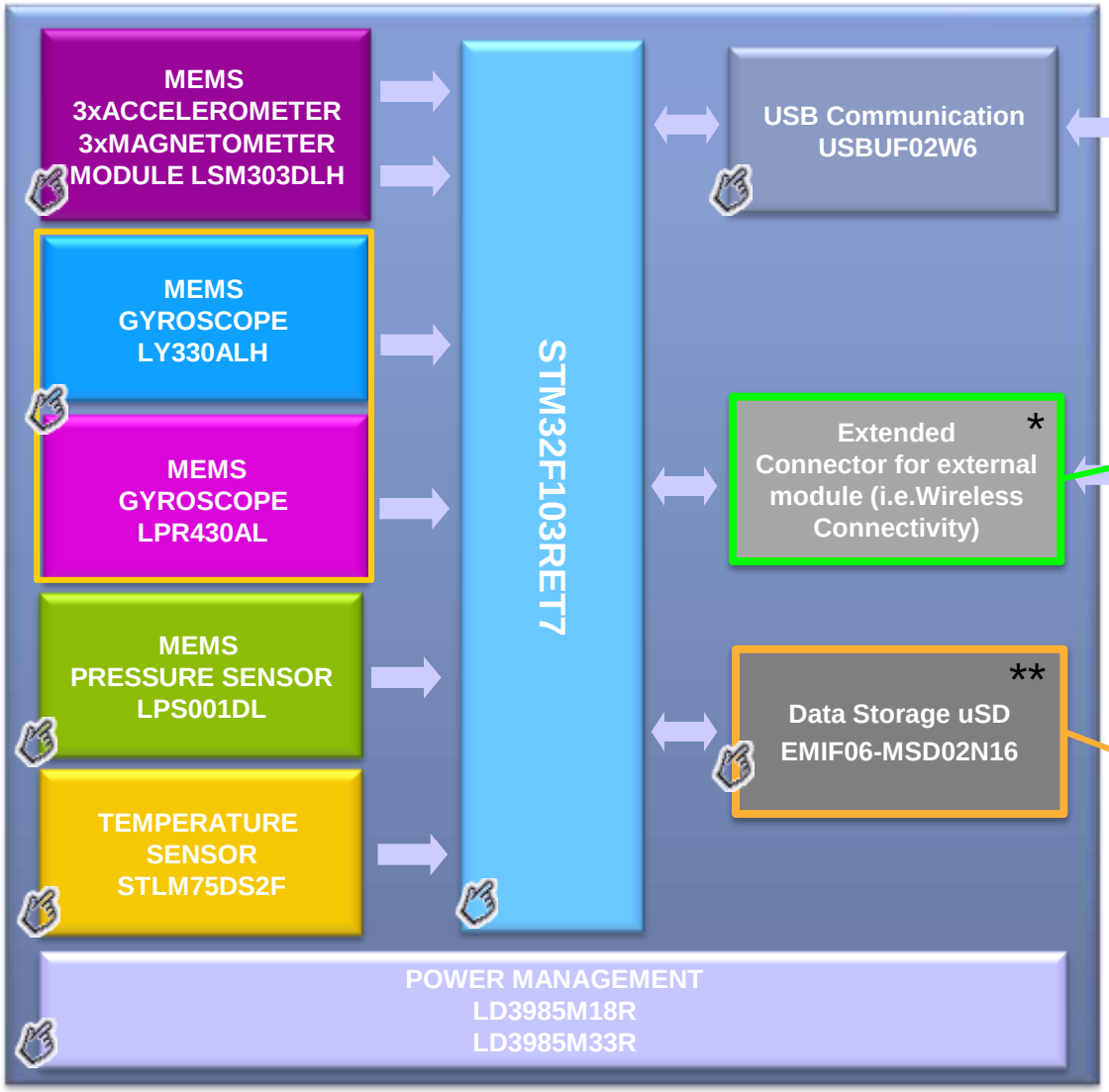

- The **magnetometer** senses the magnetic field.
- In **static** conditions, the projection of geomagnetic field on the three axes allows to compute heading angle

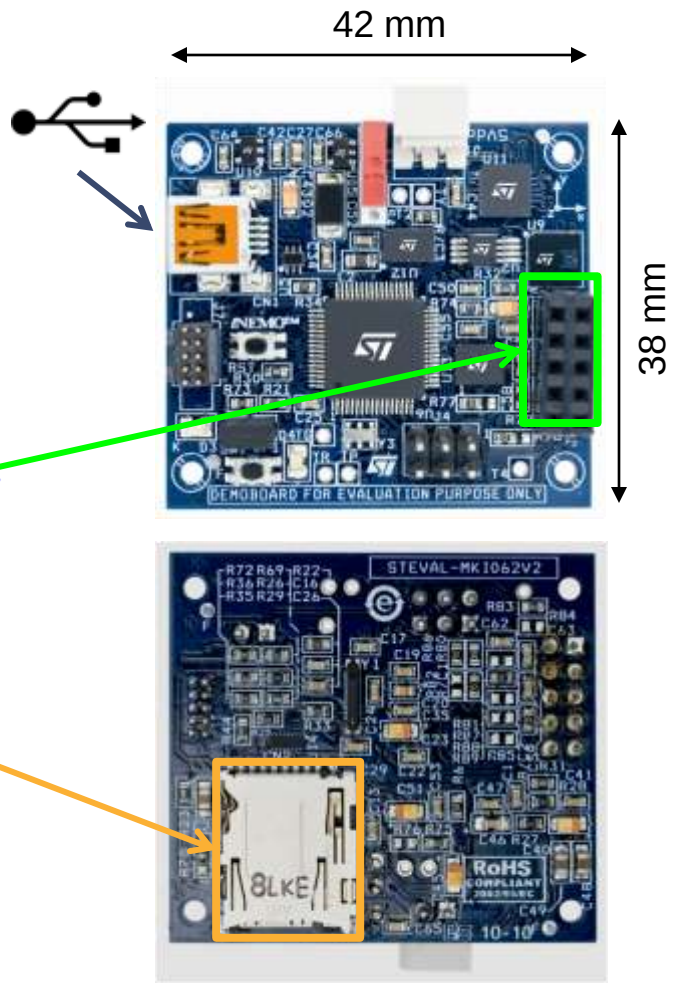




- The **Gyroscope** measures the angular rate applied to the device
- In **dynamic** conditions, by integration of the 3 axis angular rate the 3D orientations can be computes

**IMU** (**I**nertial **M**easurement **U**nit) allows sensor fusion an opens new application

# iNEMO™ V2: Block Diagram and products




* Supporting only Hw connector
**Supporting only Hw micro SD card connector

# M41T62LC6F

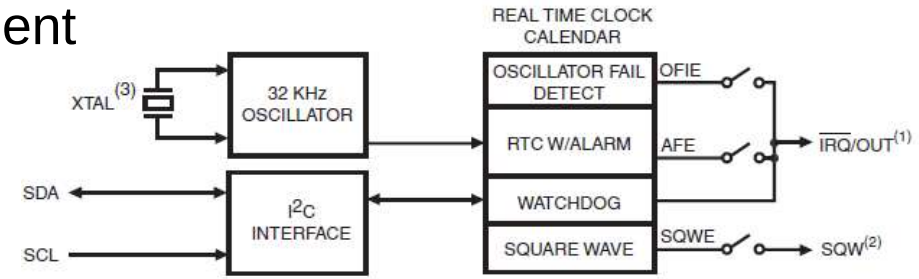
## The world’s smallest serial Real Time Clock with embedded crystal

RtM Q2/2011

# RTC – when is it needed?

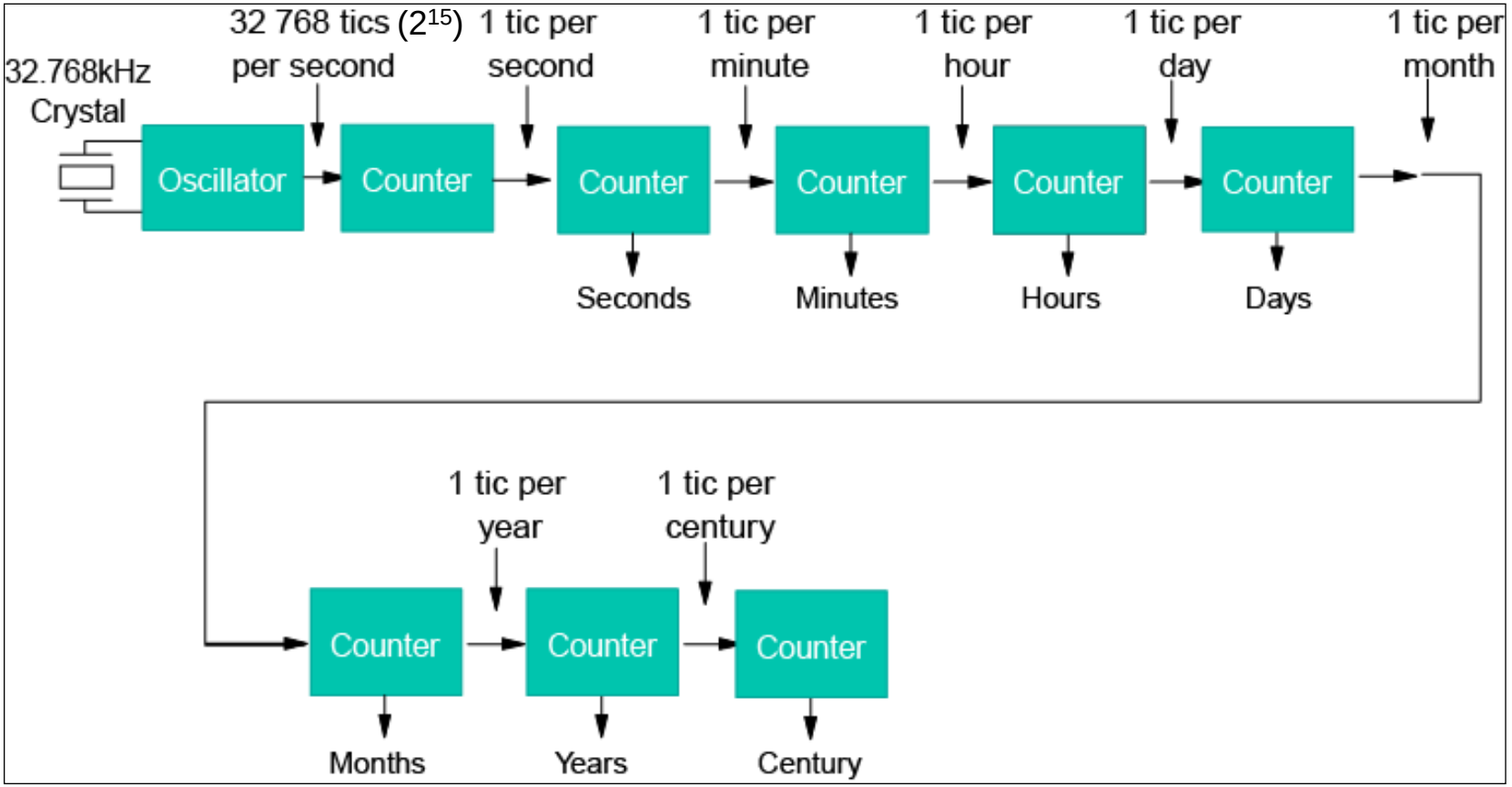
- A Real Time Clock (RTC) is basically a counter with a clock signal generated by a crystal and it is needed in many applications which require to keep track of the accurate time (incl. e.g. date, month, year, century etc.)

- They can be found in many different application fields like:
  - Industrial Controls
  - Medical equipment
  - Test & Measurement equipment
  - Meters
  - Consumer Electronics
  - Telecommunications
  - GPS



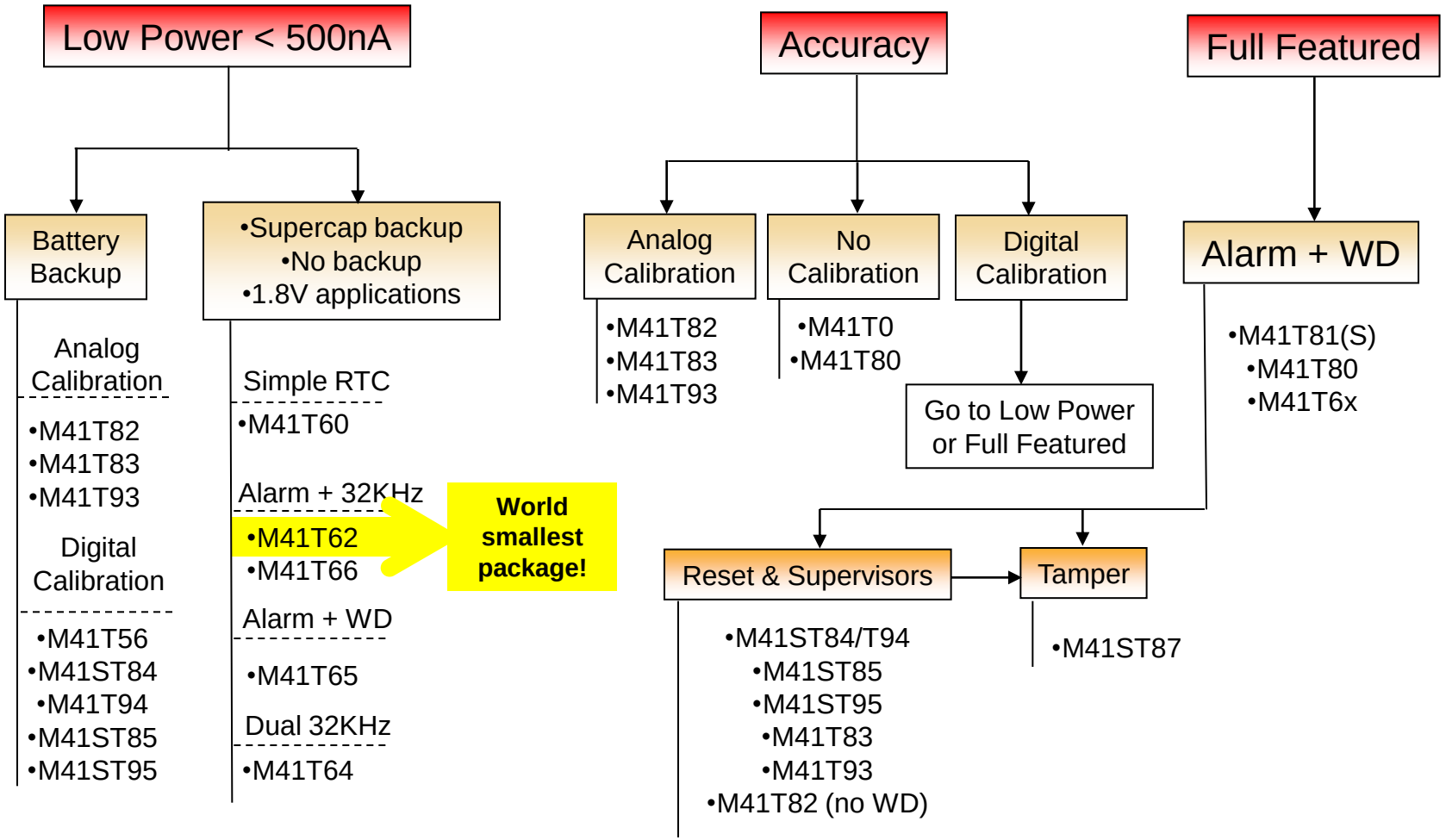
# Real-Time Clock / Calendar

- How does it work?




Accuracy of the RTC depends on accuracy 32KHz oscillator

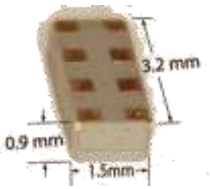
# Portfolio of RTCs



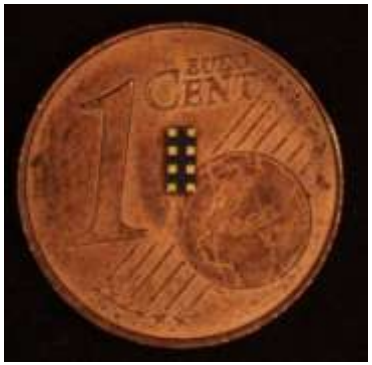
# M41T62LC6F – what is it?

- The M41T62LC6F is the latest product of the M41T6x serial RTC family. It is coming in the worlds smallest package with an embedded 32.768 kHz crystal – making it ideal for portable applications

- Main Features:
  - Ultra low Stdby
    - 350nA (typ. @ 3.0V)
  - Timekeeping down to 1.0V supply
    - for longer battery life
  - 1.3V to 4.4V operation
    - can be driven directly by a rechargable Li-Ion battery
  - Provides a 32kHz output on start-up
    - suitable for drivng a µC in low-power mode
  - 400kHz I2C interface
  - Oscillator Fail detection
  - Programmable alarm with interrupt function and repeat mode
  - Watchdog timer with programmable timeout (62.5ms to 31min.)

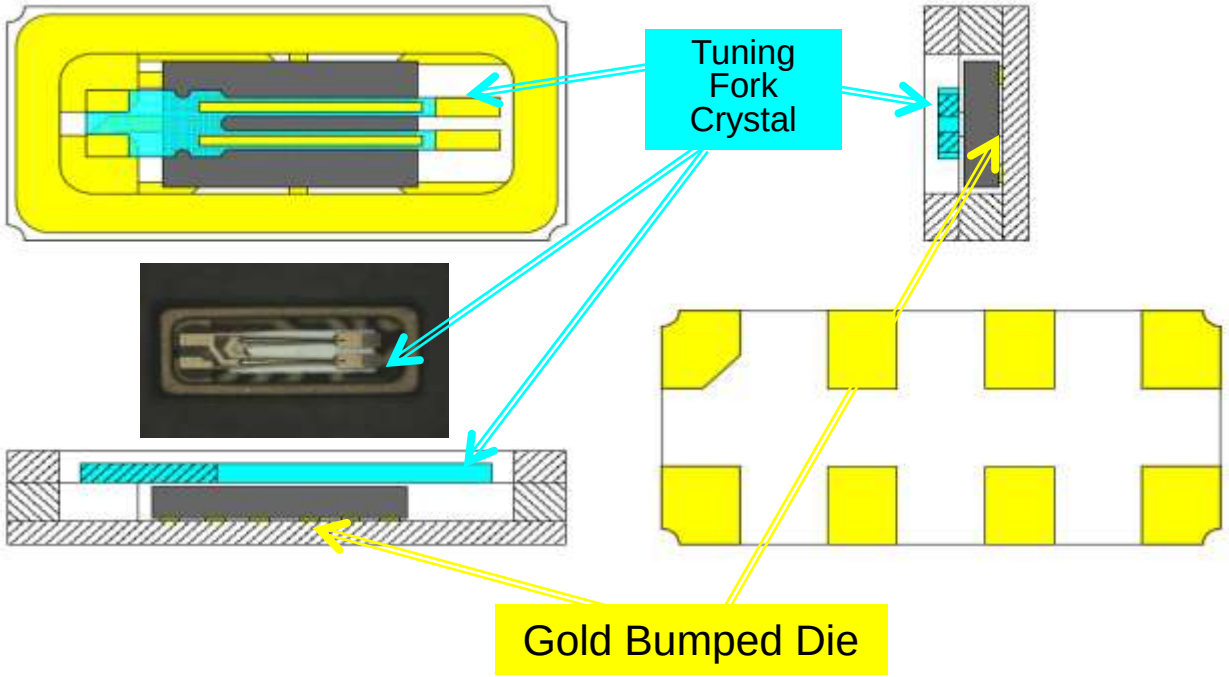



**LCC8**
**1.5mm x 3.2mm**



# M41T62LC6F – how is it build?

- Physical structure of the device




- The Product is a joint development with an European crystal company.
  - We provide the die, they put the die together with the crystal into the crystal package
    - Exact commercial second source
    - Both companies are promoting this product

# Stand Alone vs. µC integrated RTC

- There are many good reasons for preferring a Stand Alone RTC vs. using the integrated RTC of a Microcontroller

| Feature | Stand Alone RTC | µC - RTC |
|---|---|---|
| Current consumption | 350nA | ~1µA |
| Low battery detection | YES | NO |
| Voltage backup | Down to 1V | Down to 1.65V |
| RTC format | BCD format | BCD format or 32bit format (needs a software) |
| Alarm in back-up mode | YES | Yes, back up with higher consumption mode |
| 32 kHz output | YES | NO<br>(cannot drive a bluetooth module e.g) |
| Voltage maximum | 4.4V | 3.6V<br>(cannot be connected directly to LiIon battery – end of charge @ 4.2V) |
| 10th & 100th of seconds | YES | YES (resolution down to RTC clock) |
| Analog Calibration | YES (for some) | NO<br>(cannot test the accuracy on the assembly line) |

- However – as the decision about Stand Alone or embedded RTC is dependent on the application requiremets, costs etc. – ST offers the benefit to customers of providing both - State-of-the-Art micros **AND** serial Real-Time Clock ICs

# Summary M41T62LC6F

- Key requirements of portable applications

| | | |
|---|---|---|
| Lowest power consumption | → | 365nA typ. @ 3V |
| Smallest size | → | 3.2mm x 1.5mm LCC8 |
| Operation to lowest possible voltage | → | Timekeeping down to 1.0V |
| Used with rechargable batteries | → | 1.3V to 4.4V operation (suitable for Li-Ion) |
| Safe operation | → | Oscillator fail detect |
| Stable 32kHz for the µC to start correctly | → | Provides 32kHz ouput on start-up |

- Key features of M41T62

- Conclusion
  - This product introduction is particularily excellent for all (portable) solutions where size and consumption matter, and it comes at a time where Epson who dominate the market, are having major crystal delivery issues following the earthquake disaster in Japan!
  - Pricing: DCPL ~ 1.5$