



# A Healthy Dose of Data: Sensor Application for **Patient Monitoring and Dosimetry**

FTF-HCW-F1202

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# Agenda

- Medical Market
- Adherence and Compliance
- Solutions
- What products for what applications
- Open Discussion

# Quick Introduction

- Employed at Motorola / Freescale Semiconductor from February 1995 to the present, where I've had multiple careers. Most recently:
  - SoC Integration, Synthesis, Timing Closure and Verification
  - Sensor Applications / Product Definition / System Architecture
  - basically, solving applications, systems implementation problems and defining new products
- Miguel.Salhuana@freescale.com

# The Medical Market



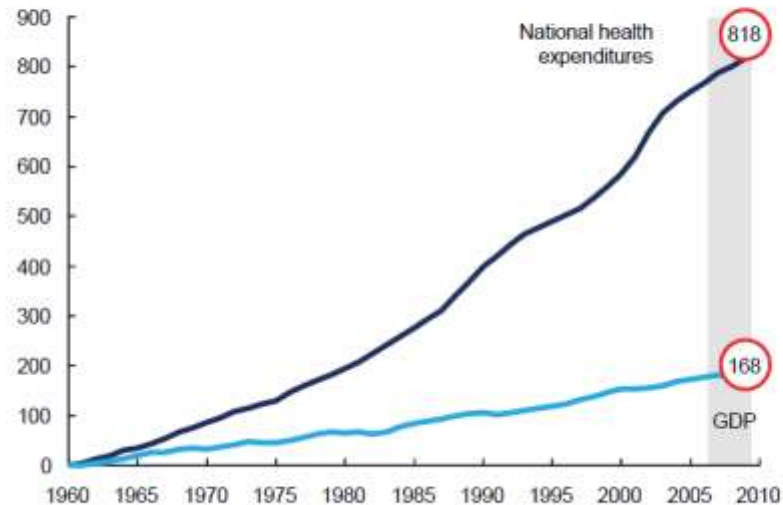
# The Challenge

- Worldwide today:
  - Adherence and Compliance continues to be an issue
  - 860 million chronic disease patients
  - 600 million elders age 60 or older
  - 75-85% of health care spending is on chronic disease management
  - 200K hospitals, 18M hospital beds

Adjusting for inflation and population growth, spending on health care has grown nearly 5 times as much as GDP since 1960

Cumulative, real, per capita growth in national health expenditures vs. GDP  
Percent growth since 1960

Focus of this report  
(2006-2009)



SOURCE: Centers for Medicare & Medicaid Services; McKinsey analysis



Obesity  
Diabetes  
Cardiac Disease

Rising  
Cost of Care

Freescale Focus  
Health Care  
Applications

Source: World Health Organization – McKinsey, Continua Alliance, Frost & Sullivan

# Opportunity for Impact



**Aging Populations**

- 65+ year-old population will triple by 2050 to an approximate 1.53B
- 80+ year-old population will quintuple by 2050



**Rising Health Care Costs**

- U.S. health care spending exceeds 17.1% of GDP, Europe not far behind
- Current US health care spending exceeds \$2.86 trillion



**Remote Patient Monitoring**

- RPM has the ability to reduce health care costs by monitoring adherence and compliance
- Mobile health projected to disrupt and shift health care delivery markets worldwide, especially in emerging economies



**Remote and Emerging Markets**

- Health care expenditure in APAC will double in the next 6 years
- APAC Health care market is expected to expand at a 12.8% CAGR which is more than double the global health care market

Sources: World Health Report, Databeans, Frost & Sullivan,, iNEMI, Economic Times

# Health Care Market Solutions



## Portable Medical

Blood Glucose Meter

Blood Pressure Monitor

Thermometer

Scale

ECG

SPO2

**Telehealth System**

**Activity Monitor**

**Smart Delivery Systems**

## Diagnostic and Therapy

Point of Care

Defibrillator

Cardiac Implant

Respiratory, Anesthesia

Hearing Aid

**Drug Delivery**

**Patient Monitoring**

BGM, BPM, ECG, SPO2

## Imaging

Ultrasound

X-Ray

CT

MRI

PET

OCT

# Freescal<sup>e</sup> Offerings

Freescal<sup>e</sup> is a trusted provider of high quality technical solutions enabling the development of breakthrough medical systems



## Portable Medical

Ultra low-power,  
highly integrated mixed-signal  
MCUs

High performance analog

Connectivity

Sensors



## Diagnostic and Therapy

Scalable MCU/MPU  
solutions for processing,  
display, and more

High performance analog

Connectivity

Sensors



Product Longevity: Up to 15  
years of assured supply for  
Medical products



## Imaging

High performance & multicore  
DSP and MPUs for advanced  
processing

High performance analog

RF amplifier



# Trends for Innovation

## Home Portable Medical



Portable



Connected

Cost Efficient

## Diagnostic, Patient Monitoring and Therapy



Doctor's office



Patient's home

Portable

## Medical Imaging



Radiology center



In the field

Connected



# Trends for Innovation

“GSMA-PwC research predicts mobile health market to be worth \$23 billion by 2017”  
February 2012 report

GSMA - Embedded Mobile - Mobile Health

About Us What we do Membership Newsroom

GSMA - Embedded Mobile - Mobile Health

Embedded Mobile

- Automotive
- Mobile Education
- Mobile Health**
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- Device Listing
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Utilities

Sign up for Newsletter

Latest Research

GSMA-PwC research predicts mobile health market to be worth US\$23 billion by 2017

One of the biggest challenges facing societies worldwide is how to make high-quality healthcare affordable and accessible for all. As the population expands in developing countries and ages in developed countries, the world is spending an increasingly high proportion of its gross domestic product on healthcare. Governments, individuals and private insurers worldwide are urgently seeking

Mobile Health

Mobile Health Services Deployment Tracker

Transforming healthcare with embedded mobile

The SIM: The Key to Better Healthcare?

Download here

# Trend for Innovation

- With mobile connectivity we have the ability to remotely monitor patients to determine adherence and compliance
- According to the National Broadband Plan drafted earlier this year by the Federal Communications Commission (FCC), the use of remote patient monitoring technology in conjunction with electronic health records (EHR) could save the health care industry \$700 billion over 15 to 20 years.
- According to the 2014 HIMSS Analytics Mobile Survey, more than a third of physicians (36%) use mobile devices to record patient data at the bedside and 69% view patient data on their mobile devices.

# Adherence and Compliance



# What is adherence and compliance

- Medication Adherence: The patient's conformance with the provider's recommendation with respect to timing, dosage, and frequency of medication-taking during the prescribed length of time
- Compliance: Patient's passive following of provider's orders
- Persistence: Duration of time patient takes medication, from initiation to discontinuation of therapy

# Background

- Medication prescriptions never filled: 20% to 30%
- Medication not continued as prescribed in about 50% of cases
- The World Health Organization estimated that by 2020, the number of Americans affected by at least one chronic condition requiring medication therapy will grow to 157 million
- In the US rates of medication adherence drop after first six months
- Only 51% of Americans treated for hypertension are adherent to their long-term therapy
- About 25% to 50% of patients discontinue statins within one year of treatment initiation
- Only about 20% of sleep apnea patients continue the use of their prescribed CPAP machine

Source: Choudhry 2011, N Engl J Med; Yeaw 2009, J Manag Care Pharm; Script Your Future press release, November 2, 2011

Source: Lindberg E, Berne C, Elmasry A, Hedner J, Janson C. CPAP treatment of a population-based sample: what are the benefits and the treatment compliance? *Sleep Med* 2006;7:553–560

# Burden of Non-Adherence

- Direct cost estimated at \$100 billion to \$289 billion annually
- Costs \$2000 per patient in physician visits annually
- Non-adherence for sleep apnea patients increases daytime sleepiness, depresses mood, increases automobile accidents, blood pressure and other cardiovascular events

Sources: Ho 2009, Circulation; Levine et al. 2013, Annals of Neurology

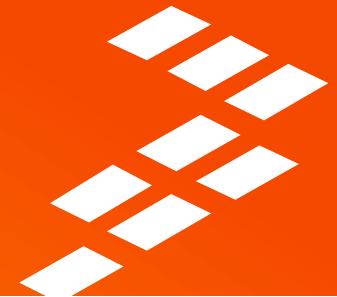
# Non-adherence—Mortality, Hospitalizations, ED Visits

- Non-adherence causes ~30% to 50% of treatment failures and 125,000 deaths annually
- Non-adherence to cardioprotective medications increased risk of cardiovascular hospitalizations (10% to 40%) and mortality (50% to 80%)
- Poor adherence to heart failure medications increased the number of cardiovascular-related emergency department (ED) visits



# Addressing the adherence and compliance dilemma

Freescale as a Trusted Partner



# Freescal's Value to the Health Care Market

- Freescale is a trusted provider of high quality technical solutions that enable the development of breakthrough Health care systems

## Trusted Partner

Freescale is on your team, delivering innovative products with long lives and the quality you expect from a leader.



History of Innovation

Long Product Lives

Quality

Service

## Healthcare Technology Leadership

Freescale is committed to the Healthcare device marketplace and has put together the technical infrastructure to provide the highest level of support in the IC industry



Medical Center of Excellence

Continua Alliance

Medical Advisory Board

Strategic Partnerships

## Product Portfolio

Freescale has one of the largest and most diverse IC portfolio's in the industry, giving customers access to nearly all the necessary components for designing breakthrough Healthcare systems



MCU's and MPU's

Sensors (Medical Grade)

Analog

Wireless

# Product Longevity Program

- The embedded market needs **long-term product support**
- Freescale has a longstanding track record of **providing long-term production support** for our products
- Freescale introduced a **formal product longevity program** for the market segments we serve
  - For the Automotive and Health care segments, Freescale will make a broad range of program devices available for a minimum of **15 years**
  - For all other market segments in which Freescale participates, Freescale will make a broad range of devices available for a minimum of **10 years**
  - Life cycles begin at the time of launch
- A list of participating Freescale products is available at: [www.freescale.com/productlongevity](http://www.freescale.com/productlongevity)



# Health Care Products Development Position

**CLASS I**    **Standard** sales operating procedure will be followed

**CLASS II**    **Standard** sales operating procedure will be followed

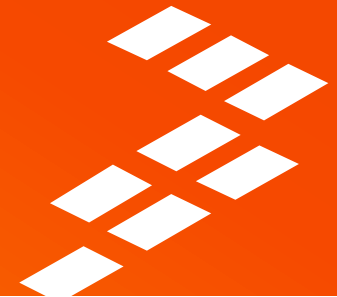
**CLASS III**    • **Risk analysis performed** as per SOP 3-14  
• All **opportunities reviewed** by Freescale Health care **Manager** and **Business Unit GM**  
• **Examples of Class III** applications for which we are currently providing solutions:

- Wireless interface for cardiac implantable
- External defibrillator
- Life vest with built-in defibrillator



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# Continua Members

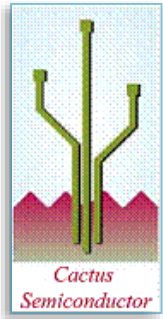


GE Healthcare



# Strategic Partnerships

- **Freescale** and **Cactus Semiconductor** consummated a partnership to provide medical device designers and their customers customized analog mixed-signal and SOC solutions, completing the signal and control chain of your system.

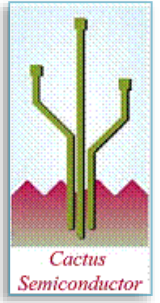


- With over 30 combined years in medical ASIC development and more than 50 patents, Cactus is an innovative medical ASIC company that provides custom analog and mixed-signal IC and SOC solutions for medical applications.
- This partnership allows Freescale and Cactus together to provide a complete integrated solution set for our medical customer base.





# Cactus Health Care Application Examples



- Cardiac Pacemakers and Defibrillators
- ECG
- Glucose Meters
  - SoCs
  - AFEs
- Heart and Respiratory Monitors
- Drug Infusion Pumps
- Ultrasound
- Implantable Neurological Sensors and Stimulators
- Implantable Surgical Sensors
- Implantable Drug Pump
- Hearing Aid IC's
- Orthopedic Sensors
  - Piezo Tx / Rx
- Sleep Apnea Devices



# Strategic Partnerships

- **Freescal** and **Monebo** announced a partnership to provide medical device designers and their customers optimized electrocardiogram (ECG) solutions and quicker time to market by delivering the industry's first ECG-on-a-chip.



- Monebo is an innovative medical device company that provides technology solutions to monitor, assess and interpret the electrical activity of the heart.
- This partnership allows Freescale and Monebo to provide a complete hardware and software solution to address the needs of the ECG market.



# Addressing the adherence and compliance dilemma

Product Portfolio



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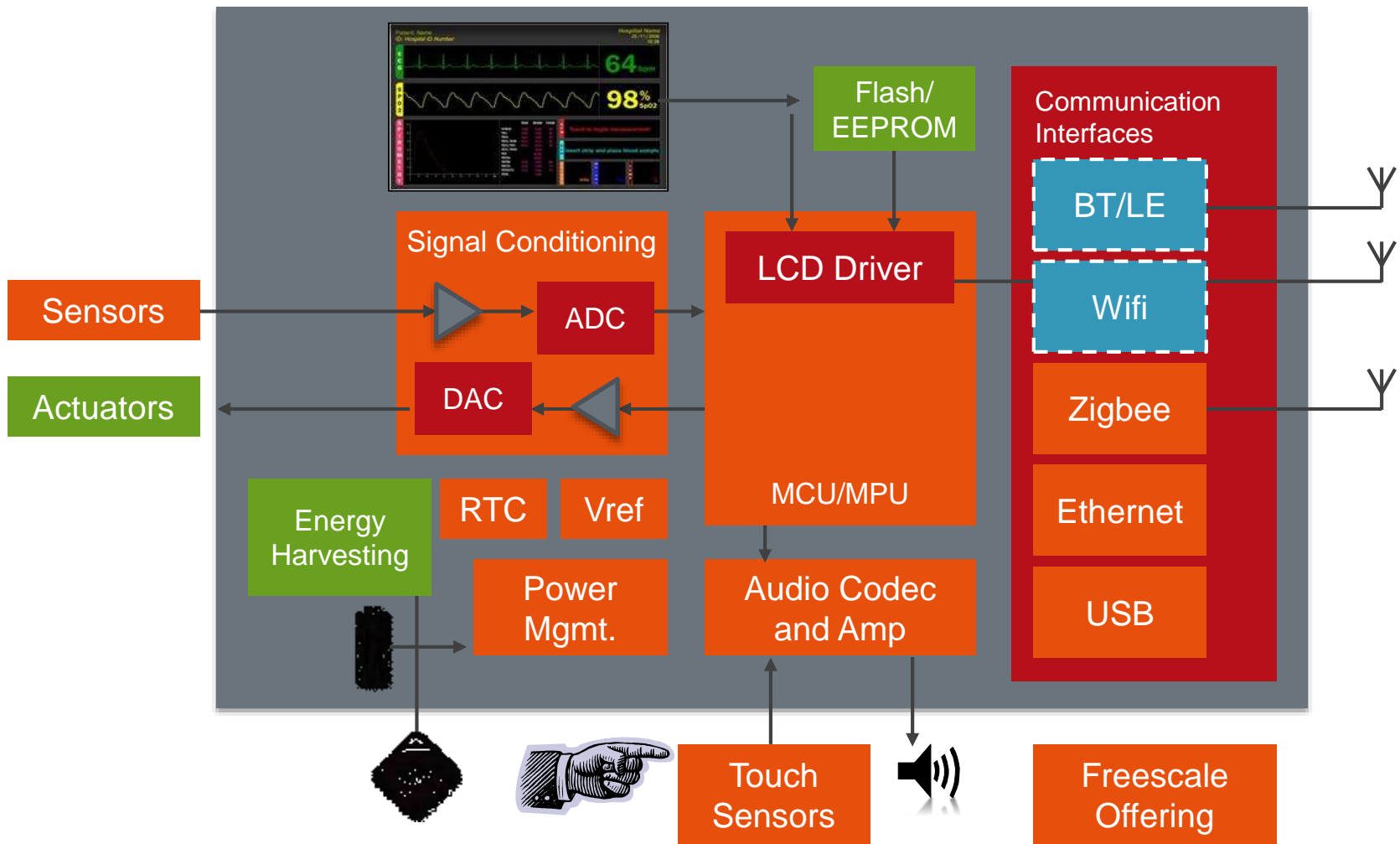
MCU's and MPU's

Sensors (Medical Grade)

Analog

Wireless

# Medical Device Generic Architecture



# Freescal Offers a Full Portfolio of MEMS & Sensors

eCompass



Magnetometers



Accelerometers



Touch Sensors

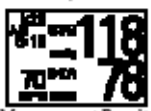
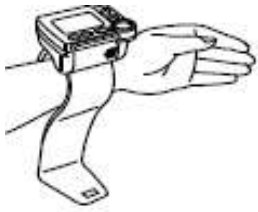


Gyro



Altimeter / Pressure

# Blood Pressure Monitors

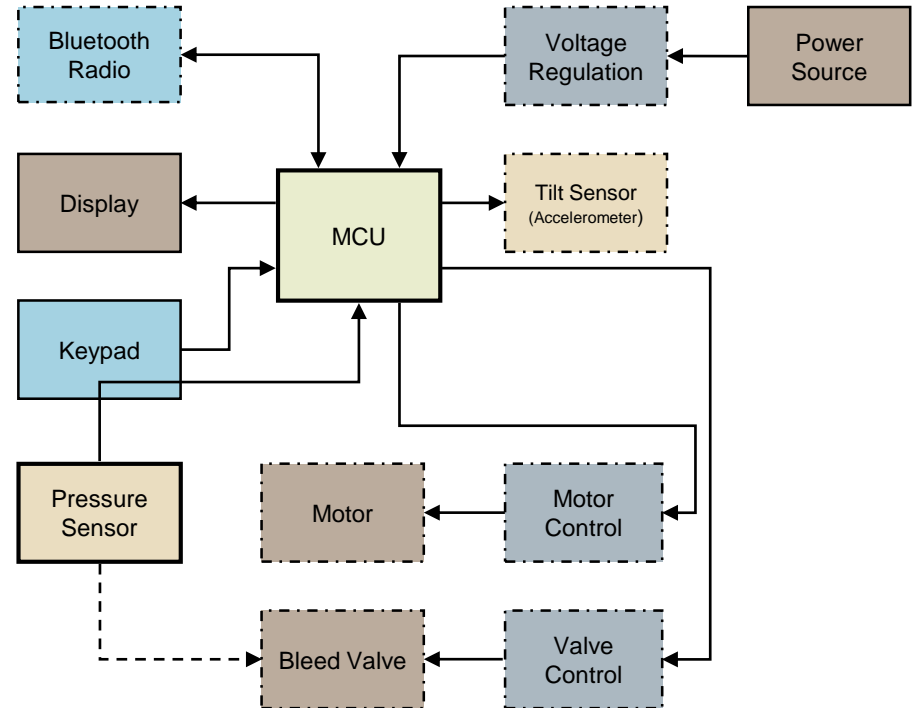


**Position** cuff on left wrist with left thumb facing upward

**Press start button.** Position sensor detects correct placement of arm in relation to the heart.

**Once wrist is in the correct position** the cuff will inflate and take the measurements.

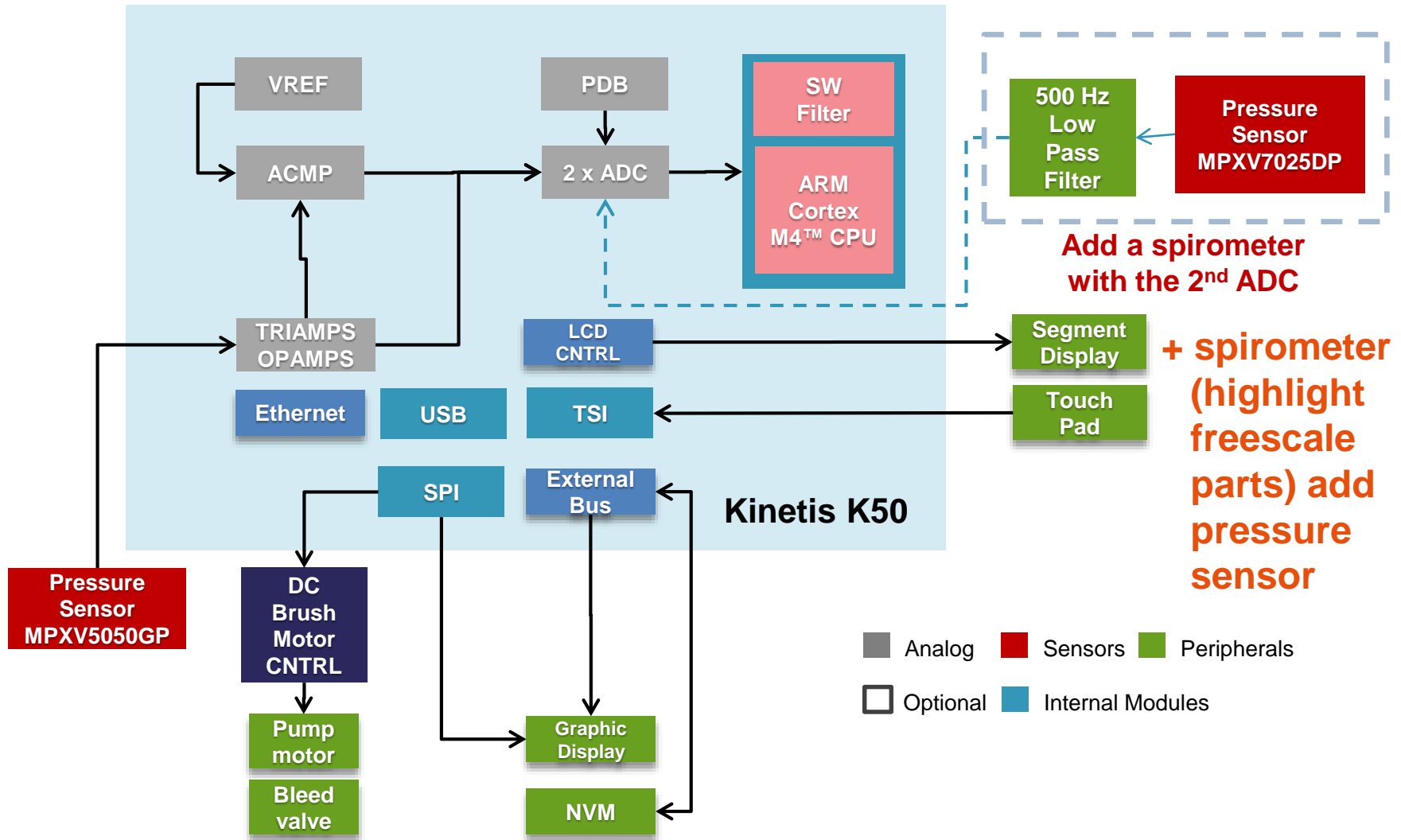
**Reading is displayed** on the LCD screen



## Pressure Monitoring

MPXV5050GP  
MPXM2053GS

# High-End Blood Pressure Monitor (BPM)





# Negative Pressure Wound Management



Negative  
Pressure  
Wound  
Therapy  
(N.P.W.T.)  
Unit

Negative Pressure Wound Management or Closed Wound Suction (CWS) is a non-invasive treatment by which controlled localized **negative pressure** (suction) is delivered to a wide variety of acute, sub-acute, and chronic wounds.

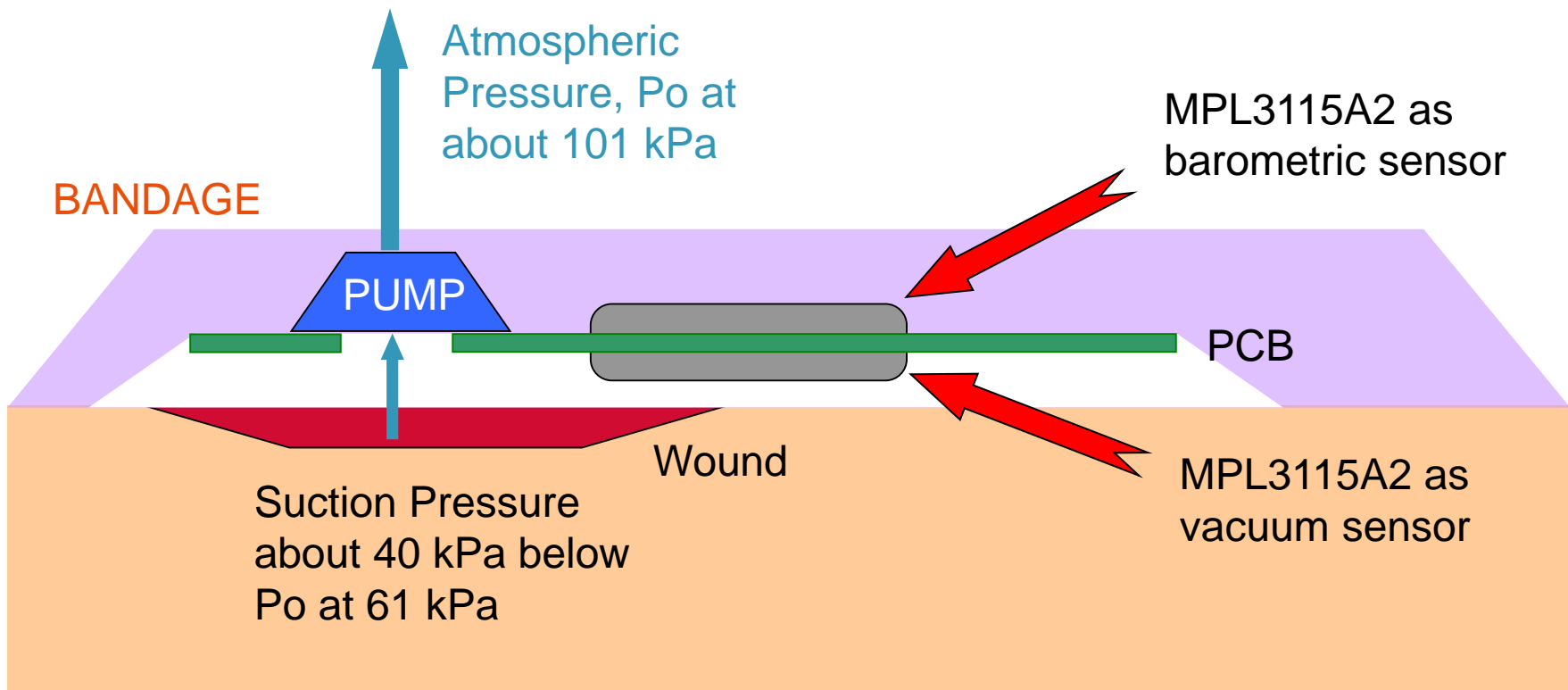


## Air Pressure Management System

MPL3115A2  
MPXM2053GS  
MPXV5100GC6U

# MPL3115A2 in Wound Management

The MPL3115A2 digital pressure sensor essentially can act as a vacuum sensor at altitudes below 10,000 Feet. Broader pressure range is achieved closer to sea level.



# Patient Monitoring



## Blood Pressure Monitor Module

MPXM2051 (Measurement)+MPXM2053  
(Protection) MPXV5050

## CO2 Module

MPXV2010 (Flow measurement)  
MPL3115A2 (Digital Barometer)

## MPXM2051 Key Features

- Pressure range 0~50kPa gauge
- Temperature compensated over 0°C to +85°C
- Linearity: +/- 0.3%
- Full scale span: 40 +/- 1.5mV
- Offset: +/- 1.0mV
- Available in easy-to-use tape and reel
- Ratiometric to supply voltage
- Gauge ported

# Respirator Machine



## Air Flow Measurement

MPX2010  
MPXV7002DP  
MPXV5004DP

## Barometric Measurement

MPXH6115A  
MPL3115A2

## Freescal IPS for Respiratory Device:

- Wide pressure range product portfolio from negative to positive pressure.
- Low pressure range family ( $\pm 2\text{kPa}$ ,  $4\text{kPa}$ ,  $6\text{kPa}$ ,  $10\text{kPa}$ ) offer design flexibility.
- Ideally suited for microprocessor or microcontroller-based systems
- Easy to implement (no amplifier needed)
- Digital barometer MPL3115A2 offer  $<1.0\text{kPa}$  accuracy

# Medical Bed/Air Mattress

## Prevents

- necrosis of the muscle
- pressure sores or
- ulceration



## Pressure Monitoring

MPX5010DP  
MPXM2010GS

# Blood Circulation Therapy



Continuous  
Enhanced  
Circulation  
Therapy  
(C.E.C.T.)  
System

The system provides the optimal hemo-dynamic profile by applying intermittent, sequential **pressure** to the patient's leg in a systematic pattern, increasing the peak venous velocity (PVV) of venous blood flow and reducing the risk of clot formation.



**Air Pressure  
Management System**

MPX2010  
MP3V5010G  
MP3V5050G





# Sleep Apnea

## Cycle of Obstructive Sleep Apnea



Continuous  
Positive  
Airway  
Pressure  
(C.P.A.P.)

- Positive airway pressure (PAP) is a method of respiratory ventilation used primarily in the treatment of sleep apnea.
- Barometric measurement is also critical in some applications to avoid altitude deviation.



### Air Pressure Management System

MPXV5004GC6T1  
MPXV7002DP

### Barometric Measurement

MPL3115A2 (Digital barometer)



[www.Freescale.com](http://www.Freescale.com)



# Backup Slides



# Medical Center of Excellence

## The Facts

- Dr. Jose Fernandez Villaseñor leads Freescale's Medical Center of Excellence.
- Practicing Surgeon, EE, and Health Care Marketing
- Author, Blogger, speaks 7 languages
- Blog: Freescale [Medical by Design](http://www.freescale.com/medicalbydesign)



<http://s.eeweb.com/pulse/eeweb-pulse-2012-36.pdf>



# Blood Pressure Package

## Disposable Pressure Sensors MPX2300DT



A standard invasive blood pressure monitoring kit - sterile, single-use kits that relay blood pressure information from a pressure monitoring catheter to a patient monitoring system.

Freescall's MPX2300DT is a low cost, high volume, miniature pressure sensor package for the application.

## Key Features

- Low Cost
- Integrated temperature compensation and calibration
- Ratiometric to supply voltage
- Polysulfone case material (Medical, Class V Approved)
- Provided in easy-to-use tape and reel



[www.Freescale.com](http://www.Freescale.com)