Overview

• ADS Introduction
• Wearable Device overview
• Wellness Device Overview
• Key Technologies for Wearable and Wellness Device
• ADS reference design
Avnet Design Services (ADS)

ADS is a specialized team in Avnet EM Asia with experienced and technically competent experts to offer customers with design support throughout the product life cycle.

Avnet Design Services (ADS) is well placed to assist engineers to tackle design problems with its expertise and solutions, helping them maximize cost-effectiveness and expedite time to market for their products.
Leading in demand creation

- Demand creation capability goes beyond customer's basic requirements, able to provide broadest line offerings and total solutions for a wide range of product segments and applications.

- Design support by Avnet Design Service (ADS) team to address specific design requirement: full turnkey solutions, reference design, evaluation boards and software support.

- Leverage technical know-how from 7 Design centers in Asia, each provides design support for distinct and focused product segments.

- Cooperation with Independent Design House (IDH) on diverse design services.
Unmatched Design Chain Eco-system

Accelerating Your Success™

We deliver reference & turnkey system solutions designed around our supplier’s products & technologies, to enable our suppliers & customers to get to market faster.
Services From ADS

01 Reference Design
- Demo board;
- Schematic
- BOM List
- Training,
  Set up Env of
  Development
- Design guide

02 Design Services
For special customer, we provide part or All of turn-key solution
- System definition
- Design Schematic and PCB Layout
- Provide LIB; Development for some Software module

03 Technical Support
- Review the Schematic and PCB Layout
- Software Technical support
安富利ADS方案网上资源

- ADS Solution: all solution for Asia
  http://www.em.avnetasia.com/PagesView.aspx?pagesId=68&MasterPageld=17
Wearable Device Overview
Wearable 1975-2015

Sources: Strategy Analytics, Enfodesk
Wearable Is First Wave of IoT

- Smart Energy
- Smart Home
- Smart Grid
- Smart Tags
- Smart Parking
- Smart Cars
- Smart Health

IoT
Wearable Becoming Mass-market Products

Healthcare and sports and activity trackers are rapidly becoming mass-market products. On the flipside, wearable devices like smart watches need to overcome some critical obstacles.

Sources: Strategy Analytics, ABI Research
Big Companies Access
Various Wearables
Wearables Type

Activity Monitor

Smart Watch

Heart Monitor &Wellness

Sports

Glasses & googles
Wearables Use Cases

- Professional
- Elderly
- Pets
- Animals
- Teenagers
- Health
- Industrial
- Office
- Lifestyle
- Sports
- Extreme sports
- Kids

Picture from Internet
Wearables Use Cases

- Smart Cap
- Smart Shirt
- Wearable Air-Quality Monitor
- Smart Ring
- Heart Rate strap
- Smart Shoe
Ecosystem for wearable in IoT

A) Control, notifications and sensor Data from Devices

B) Web API for Data from Partners/Service

From internet
Wearable Application in Smart Home

Cloud Services

Gateway + Router

Zigbee

WIFI

BLE

1GHZ RF

Monitor and Control
Wellness Device Overview
Wellness Ecosystem In IoT

Google Fit

Apple Health Kit

Microsoft Health

Samsung Digital Health

Google Fit

Health Kit

Microsoft Health

Samsung Digital Health

Sources: Strategy Analytics, Enfodesk
Wellness Ecosystem In IoT

阿里健康云

腾讯健康云

百度健康云

春雨健康云

Sources: Strategy Analytics, Enfodesk
被访者感兴趣的智能可穿戴设备功能

数据说明：基于328份有效被访者调研得出，问卷渠道为互联网和线下渠道，调研日期为2014年10月。

来源：EnfoDesk易观智库

www.enfodesk.com
Wellness Increasingly

**Wearable** gadgets and mobile apps are making it easier than ever before for a consumer to track his health.

Sources: Strategy Analytics, ABI Research
Wellness Function

- Pedometer
- Sleep Monitor
- UV Index
- Blood glucose
- Blood Pressure
- Thermometer
- Heart Rate
- Breathing
- SPO2
- sedentary remind
- ECG
- Sedentary remind
Key Technologies in Wearable and Wellness Device
Key Technologies

• Sensors
• MCU
• Wireless Connection
• Technology Challenge
Sensor
Heart Rate Monitoring sensor

• Applications:
  • Heart Rate Monitor
  • Pulse Oximetry
Accelerometer sensor

Applications:
- Pedometer (distance, speed, calories burnt by proper algorithm)
- G-sensor
- Wake up by click/shock

Vendor | Product Name | PN   
---|---|---
ADI  | MEMS | ADXL362/34/4  
ADI  | MEMS | ADXL34X  
STM  | MEMS | LIS3DH/DSH  
STM  | MEMS | LIS2DH12  
Murata | Sensor | PKGS-25NB-R  

.... and more....
Gyroscope sensor

Applications:
- Gyroscope
- Activities tracker
- Air mouse
- Joystick

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Product Name</th>
<th>PN</th>
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<td>Sensor</td>
<td>ENC-03RC-R</td>
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<td>Murata</td>
<td>Sensor</td>
<td>ENC-03RD-R</td>
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.... and more....
eCompass sensor Vendor

Applications:
- eCompass
- GPS
- Measurement devices

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.... and more....
UV, Proximity, Ambient light sensor

Applications:
- UV index measurement

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<td>UV Sensor</td>
<td>UVIS3</td>
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Applications:
- Light sensor
- Gesture control
- Power saving control

<table>
<thead>
<tr>
<th>Application</th>
<th>Vendor</th>
<th>Product Name</th>
<th>PN</th>
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<td>Silabs</td>
<td>Sensor</td>
<td>Si1141/2/3</td>
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<tr>
<td>UV + Ambient lights</td>
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<td>Silabs</td>
<td>Sensor</td>
<td>Si1145/6/7</td>
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Pressure, Temperature, Humidity sensor

• Applications:
  • Height/Pressure detection
  • GPS
  • Weather station
  • Temperature measurement
  • Humidity measurement
## Sensor PN Guide (1)

<table>
<thead>
<tr>
<th>Application</th>
<th>Vendor</th>
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<td>ECG Monitor</td>
<td>ADI</td>
<td>Diagnostic quality ECG</td>
<td>ADAS1000</td>
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<td>Pulse Ox, HRM</td>
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# Sensor PN Guide (2)

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<td>UV sensor</td>
<td>STM</td>
<td>Sensor</td>
<td>UVIS3</td>
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BLE chip
DA14580芯片特性

- Best in class power consumption
- Best RF link budget
- Single cell solution (Alkaline & NiMH)
- Most flexible Architecture
- ARM Cortex M0 core

- Smallest package
- Lowest BoM

Typ. 12mW TX/RX peak Power
Typ. 1.8uW Deep Sleep Power
Rx: Typ. -93dBm at 12mW
Tx: Typ. 0dBm at 12mW
Operational down to 0.9V
ARM Cortex M0 processor and OTP
Modern industry standard software environment with well understood tool chain

WL-CSP (2.5x2.5x0.5mm, 0.4mm bp)
500ohm Single pin antenna interface
TI CC2541 芯片特性

Features
- One-chip integrated solution with controller, host and application on one 6x6mm device
- Flash-based device
- Complete turnkey-solution from TI
- Ultra low power consumption
- Bluetooth specification version 4.0 compliant

Benefits
- 50% less boardspace required compared to competitors that need extra MCU.
- Flexibility for future updates: Device firmware can be updated in the field if necessary, and persistent data can be stored on-chip. (Competitors with ROM based solutions cannot do this).
- TI’s Bluetooth low energy solution includes system-on-chip, in-house developed protocol stack, profile software and application support.
- >1 year battery life on one CR2032 coin cell battery
- Simple certification of end products.

Applications
- Mobile accessories
- Sport & fitness sensors
- Home healthcare & medical sensors
MCU Chips
STM32F401

- Packages
  - WLSCP49 (3x3 mm)
  - UFQFN48
  - LQFP64
  - LQFP100
  - BGA100

- Operating voltage
  - 1.7 to 3.6V

- Temperature range
  - -40C to 85C
  - -40C to 105C

**System**
- Power supply
- 1.8 V regulator
- POR/PDR/PVD
- Xtal oscillators
  - 32 kHz + 4 ~26 MHz
- Internal RC oscillators
  - 32 kHz + 16 MHz
- PLL
- Clock control
- RTC/AWU
- 1x SysTick timer
- 2x watchdogs (independent and window)
- 36/48/79 I/Os
- Cyclic redundancy check (CRC)

**ART Accelerator™**
- Floating point unit (FPU)
- Nested vector interrupt controller (NVIC)
- MPU
- JTAG/SW debug/ETM

**Connectivity**
- 4x SPI, 2x FS, 3x I2C
- 1x USB 2.0 OTG FS
- 1x SDIO
- 3x IISART, LIN, smartcard, IrDA, modern control

**Control**
- 3x 16-bit timers
- 2x 32-bit timers
- 3x 16-bit timers

**Multi-AHB bus matrix**
- 16-channel DMA

**Analog**
- 1x 12-bit ADC
- 16 channels / 2 MSFPS
- Temperature sensor

**Up to 256-kbyte Flash**
- 64-kbyte SRAM
- 80-byte backup registers
- 512 OTP bytes
EFM32 ARM Core

Cortex-M3 highlights

- High performance, low power platform
  - 1.25 DMIPS/MHz
  - 3.32 CoreMark/MHz
- Scalability for future products
- Software/tool compatible with Cortex-M
- Thumb-2 Instruction Set
  - 30% smaller code than 8-bit devices
  - Typically 90% 16-bit instructions
  - Fewer instruction fetches
- Memory Protection Unit (G, LG, GG)
- Embedded Trace Macrocell (LG, GG)
Technical Challenges
Wearable Challenges ---1

➢ Power Consumption

<table>
<thead>
<tr>
<th>Apple watch</th>
<th>Windows band</th>
<th>Pebble</th>
<th>Sony watch3</th>
<th>SamSung Gear</th>
<th>XiaoMi</th>
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<td>Cortex-M4</td>
<td>Cortex-M4</td>
<td>Cortex-A7</td>
<td>Cortex-A7</td>
<td>Cortex-M0</td>
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<tr>
<td>2 days</td>
<td>2 days</td>
<td>7 days</td>
<td>2 days</td>
<td>2 days</td>
<td>30 days</td>
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- 要比拼MCU 本身工作功耗和待机功耗
- MCU从睡眠中唤醒的时间-要尽量短
- 基于MPU+Android 的方案设计，低功耗难度非常大

出门要带着它？！
Wearable Challenges---2

- **Few Differents** (怎样做差异化)
  市场上的智能手环手表功能太类似了
  - 计步，睡眠跟踪；
  - 手机同步；（来电，短信，远程拍照等）
  - 健康

- **How to do Smarter**
  Google Android Wear. “Ok Google, call me a car”,

- **Smaller and exquisite**
  时尚性

- **Security and Private**
Wellness Challenges

- Veracity for Pedometer and Sleep monitor

- Influencing factor for Heart Rate Measurement
  - Tightness of the band
  - Varying skin moisture levels,
  - Hairiness of the wearer's arms
  - Inaccuracy in exercise

- Connectivity
  Signaling, bandwidth, Presence Detection, Real time.
ADS Reference Design
Basic Smart Wristband Solution Example

This is Basic Device Architecture for Smart Wristband
ADS Smart Watch Solution Example

This is Basic Device Architecture for Smart Watch
Always-Aware’ Architecture

- **MCU/ARM**
- **Interconnect**
- **Sensor Hub**

**Components**:
- E-ink/OLED/LCD
- BLE/BT/NFC/Wi-Fi
- Flash
- Rom
- SRAM

**Sensor Fusion**:
- Temperature
- GPS
- Magnetometer
- Accelerometer
- Gyroscope
- Touch
- Microphone
- Luminance

- Averaging, filtering, calibration long term trends, event alarms, use case learning etc.
Wristband Reference Design
Wristband Reference Solution

features

- Incoming calls;
- Missed calls;
- Calendar reminders;
- Pedometer;
- SMS;
- Email notification with true filtering;
- Your device is out of range;
- Find me;
- Alarm and Timer alerts;
- Low battery on iPhone, iPad or Android Smart Phone;
- Remote control photo taking on smart phone via BLE;
- Sleep monitor

BLE chip
G-sensor: MMA9555 (freescale)

Smart ring
Sportsware
# BOM for key part number

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<th>Brand</th>
<th>Parameter</th>
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<td>Dialog BLE</td>
<td>DA14580-01UN</td>
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<td>Winbond SPI flash</td>
<td>W25X10CL (Recommended)</td>
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<td>TI</td>
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Block Diagram

USB Port → Power charger → Battery

LDO

LED

SoC BLE

I2C

UART --- be used for OTP programmer

AT24C256C EEPROM

FSL MMA9555

Debug Interface

SPI
MMA9555

- MMA9555和MMA9553类似，增加了检测翻转功能以及开放6个IO口；
- 内置专业级计步器算法（计步，速度，卡路里等），加快产品上市速度；
- **MMA9555** 六个方向的检测：可以用这个功能来实现按键功能和实现睡眠质量监测功能

---

### 2.4.4 Sensing Direction and Output Response

The following figure shows the device’s default sensing direction when measuring gravity in a static manner. Also included are the standard abbreviations or names for the six different orientation modes: portrait up/down, landscape left/right and back/front.

![Diagram](image)

Figure 5. Sensing direction and output response
# Power consumption testing

<table>
<thead>
<tr>
<th>Setup</th>
<th>Data Profile</th>
<th>20 Bytes</th>
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<tr>
<td>DA14580 (be in connection)</td>
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<td>1 S</td>
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<tr>
<td>MMA9555L (works in Run mode)</td>
<td>Setting</td>
<td>MMA9553L_Pedometer_Settings1</td>
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</table>
Smart Watch (TI platform) Solution

features

- Smart Phone Peripherals
  - Incoming calls notification/caller display
  - Missed calls notification
  - Event notification
  - Alarm/Timer alert
  - Device out of range alert
- Health care support
  - Pedometer
  - Heart rate monitor
  - Blood Oxygen Measurements
- Battery Life cycle
  - Up to 8~10 days (from fully charged to fully discharged)
- OS Support
  - Android 4.3 or above
  - IOS 7.0 or above

System

- MCU: MSP430F5528 (TIS)
- Sensor: ADXL362 (ADI), AFE4400 (TIS)
- Charger IC: TI BQ24040 (TIS)
- BLE Chips: TI CC2541 (TIS)
- Display: WF0154-01-F02 1.54” E-ink

Target Applications

- Smart Watch
- Health care monitor
- Sportswear
Block Diagram

- MSP430F5528
- USB PORT
- Power Charge TI BQ2040
- LDO
- SPI
- UART
- I2C
- Display E-ink 1.54"
- BLE TI CC2541
- Motion Sensor ADI ADXL362
- Button
- LED
- I2C
- Vibration motor
- Winbond W25X40
BOM for key part number

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<th>Supplier</th>
<th>Part #</th>
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<td>3-axis MEMS accelerometer Sensor</td>
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<td>TXC</td>
<td>8Q32000005</td>
<td>32MHZ, Crystal,(30ppm)</td>
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<td>TXC</td>
<td>TAS-2520</td>
<td>16MHZ, Crystal,(30ppm)</td>
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<td>TXC</td>
<td>8Z16000001</td>
<td>8MHz Crystal (30ppm)</td>
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<td>TXC</td>
<td>9H03200012</td>
<td>32.768KHz Crystal (30ppm)</td>
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<td>Diodes</td>
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<td>Texas Instrument</td>
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<tr>
<td>ORSM</td>
<td>SFH7050</td>
<td>LED</td>
<td>1</td>
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# ADXL362: Low Power MEMS Accelerometer

<table>
<thead>
<tr>
<th>Key Facts</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| ◆ Industry’s lowest power MEMS accelerometer  
  ▪ 2 μA @ 100 Hz full measurement mode  
  ▪ 270 nA in motion-triggered wake-up mode  
  ▪ 10 nA in standby | ◆ Minimizes battery drain when fully operational.  
◆ Optimizes battery life.  
◆ Ability to operate on a coin cell battery.  
◆ Can use as part of a motion switch to control system power (industry first). |

◆ Built-in features for system-level power savings which includes an awake status output pin. This enables it be used as part of an intelligent, continuously operational, motion-activated switch.  

◆ Instantly triggers a switch that turns system functions on/off, bypassing the processor to reduce system power use.

- Target applications that require battery life expectancy of months or years because battery replacement can be financially impractical (eg high volume requires personnel dispatch), difficult (eg hard to get to, challenging placement), or dangerous for the equipment or operator.
- 60% less current in wake-up mode; 80% less current in full measurement mode (at 100 ODR @ 2 V) than competition.
- ADXL362 is an alternative to the ADXL34x family.
# AFE4403 vs AFE4400

## AFE4403 vs. AFE4400

<table>
<thead>
<tr>
<th>Feature</th>
<th>AFE4400</th>
<th>AFE4403</th>
</tr>
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<tbody>
<tr>
<td>Package type</td>
<td>40-pin QFN</td>
<td>36-ball WCSP</td>
</tr>
<tr>
<td>Package size</td>
<td>6 mm x 6 mm x 1 mm</td>
<td>3.07 mm x 3.07 mm x 0.5 mm</td>
</tr>
<tr>
<td>Temperature range</td>
<td>0 deg C to +70 deg C</td>
<td>-20 deg C to +70 deg C</td>
</tr>
<tr>
<td>Dynamic (cycle-to-cycle) Rx power</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>cycling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LED driver supply min voltage</td>
<td>1V above VLED</td>
<td>0.5V above VLED[^1]</td>
</tr>
<tr>
<td>Maximum LED current setting</td>
<td>50 mA</td>
<td>100 mA</td>
</tr>
<tr>
<td>Number of LEDs supported</td>
<td>Two LEDs in either H-bridge or common anode configuration</td>
<td>Two LEDs in either H-bridge or common anode configuration[^2]</td>
</tr>
<tr>
<td>External Input clock frequency range</td>
<td>8 MHz+/−2%</td>
<td>4-60 MHz[^3]</td>
</tr>
<tr>
<td>Crystal clock frequency range</td>
<td>8 MHz+/−2%</td>
<td>8-24 MHz[^3]</td>
</tr>
<tr>
<td>SPI tri-state</td>
<td>Shared with other pins</td>
<td>Separate bit control</td>
</tr>
</tbody>
</table>

[^1]: VLED is the forward voltage of the LED measured at an operating current of 50 mA
[^2]: The third LED can be used when the other two LEDs are not required to be active
[^3]: Refer slide titled “Clock frequencies supported” for exact set of frequencies supported.
SFH7050

Integrated optical sensor for heart rate monitoring and pulse oximetry

**Features**
- IR LED
- Red LED
- Optical barrier
- Photodiode
- Green LED

- Multi-chip package featuring an IR/red/green LED and a 1 mm² photodiode
- Small package 4.7 x 2.5 x 0.9 mm³
- Light Barrier to block optical crosstalk

**BioMon Sensor – SFH 7050**
- Alpha Data sheet available
- Samples planned for 3/14
- SOP planned for Q3/2014 dep. on business case

**Target Markets:**
- Smart Watches
- Smart Phones
- Trackers
- Wristbands
- Apparels

[Image of BioMon sensor and heart rate monitor]
ADS Actions on TI AFE4403

- added JTAG debug interface and UART interface on TI AFE4403 EVM;
- finish porting static algorithm of HRM to MSP430F5528 on TI AFE4403 EVM;
- optimized the static algorithm of HRM based on the source code released by TI, we can get more accurate value;
- User can get the test result through UART with TI AFE4403 EVM.
- Test Environment--- Azumio APP

<table>
<thead>
<tr>
<th>AFE4403</th>
<th>azumio</th>
<th>Test Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>73</td>
<td>OSRM SFH7050 IR LED + RED LED</td>
</tr>
<tr>
<td>2</td>
<td>74</td>
<td>OSRM SFH7050 IR LED + RED LED</td>
</tr>
<tr>
<td>3</td>
<td>73</td>
<td>OSRM SFH7050 IR + Green LED</td>
</tr>
</tbody>
</table>

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Key Take Away

- Reference design package consists of:
  - Schematic
  - BOM list
  - Test reports

- Additional support available
  - Software platform preparation
  - Schematic and PCB layout review
  - RF antenna matching fine tune
  - BLE pre-test service

- Strong backend logistic supply chain and memory programming services

Accelerate Your Success!
Thank You !