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WELCOME TO THE FUTURE

Wearables are everywhere: designer smartwatches with interactive displays that send and receive notifications such as emails, messages and reminders via Facebook, Twitter and other applications. Activity monitors that record workouts and track vital signs. Smart glasses that allow users to capture and share life moments on-the-fly.

The $1.5 billion wearables market will grow to $19 billion by 2018. You’re gearing up to grab your share of this market. The relentless pressure to improve sensing methods, simplify the user interface, extend battery life and shrink form factors to make wearable products more wearable has you searching for the right technology partner. With a complete portfolio of solutions, Cypress is your wearables technology partner.

CYPRESS SOLUTIONS FOR WEARABLE PRODUCTS

TrueTouch® and CapSense® solutions provide the industry’s lowest-power, smallest touchscreen solutions with the highest signal-to-noise ratio (SNR) and best waterproofing for natural user interfaces that simplify the sending, receiving and control of notifications.

PSoC® solutions reduce time-to-market, enabling the rapid design of sensor-based systems such as programmable analog front ends (AFEs) into each new product generation.

MicroPower™ SRAM and nonvolatile F-RAM™ memories feature the world’s lowest energy needed to buffer and store data in the smallest footprint.

Bluetooth Low Energy (BLE) solutions offer an ARM® Cortex®-M0-based single-chip solution that easily integrates AFEs, digital peripherals, CapSense and a BLE radio in a tiny, single-chip solution.

The world’s smallest wafer-level chip-scale packages (WLCSps), manufactured by Cypress’s subsidiary, Deca Technologies, meet your need for smaller form factors—both now and into the future.

Partner with Cypress today to unlock the potential of your next-generation wearable products.
WEARABLES DESIGN 101

USABILITY

Wearable touchscreens are the smallest of the small. They must be intuitive and easy to use. Cypress’s CapSense and TrueTouch solutions, based on PSoC, enable you to implement a natural user interface easily with capacitive buttons, sliders, proximity sensors and touchscreens. TrueTouch Gen5 (CYTMA525) touchscreen solutions enable wake-up gestures and hover functionality for common user interface features, such as mouse-over and magnify. The Automatic Mode Switching (AMS) capability of Gen5 automatically adjusts touchscreen sensitivity for superior responsiveness under all conditions, and reliably tracks all types of touch.

LOW POWER

Wearables burn battery power even when they are not being actively used. For that reason, power consumption in standby mode is key. Cypress’s low-power touchscreen products feature the industry’s lowest standby power: 60 µA to ensure fast response to touch gestures to wake the wearable device. The Cypress BLE solution consumes just 5.7 µA average current during a 4-sec connection. Cypress SRAMs have the industry’s lowest standby current: 1.5 µA at 16 Mbit, making them the ideal technology for system memory expansion and buffering data. Our nonvolatile F-RAMs consume 130 µA (2 Mbit, 1 MHz) while writing critical data. The energy consumed for this is >200x better than EEPROM and >3,000x better than NOR flash.

SMALL FOOTPRINT

Wearables device enclosures must be small and thin for products to be worn comfortably. All Cypress products are WLCSP-ready. For example, Cypress’s Gen5 touchscreen solution is just 3.1 x 3.3 x 0.6 mm. Our BLE solution is just 3.5 x 3.9 x 0.6 mm. Cypress’s PSoC 4 and PSoC 5LP products reduce board size by integrating analog, digital and CapSense circuitry.

RELIABILITY

Wearables need to function under harsh conditions such as rain or snow. Cypress’s TrueTouch and CapSense solutions feature the industry’s best waterproofing and glove-detection technologies to ensure that wearable products work in all conditions. Cypress’s nonvolatile F-RAM memories feature nearly infinite data retention and provide the best protection for your critical data through $10^{14}$ read/writes vs. $10^5$ of flash and $10^5$ of EEPROM.
SMARTWATCHES

Smartwatches provide an interactive display for viewing notifications and sensor information. They also control certain mobile device functions in conjunction with regular time-keeping. Notifications include emails, messages, reminders, to-do lists, navigation directions and phone calls. Sensor information includes heart rate, temperature, barometric pressure, direction, distance traveled and location. Control functions include toggling settings on any connected device (e.g., media playback, airplane mode, remote camera).

The typical components of a smartwatch are a 1" to 2" interactive display, a touchscreen controller, a microcontroller/processor to run the OS, sensors to record data, an analog front end to measure biometric signals, memory to buffer, store and protect sensor and configuration data, and a Bluetooth® or WiFi radio.
**HOW CYPRESS SIMPLIFIES YOUR DESIGN:**

**Smartwatches need reliable touchscreens**
- TrueTouch Gen5 touchscreen: Makes displays interactive by tracking four touch points on screens up to 3"
- TrueTouch Gen5 wake-up gestures: Executes on-chip wake-up gestures (swipe, single/double tap, or any customizable gesture) to wake up the watch and execute pre-defined commands
- TrueTouch Gen5 hover sensing: Provides hover sensing for user interface modes such as mouse-over and magnify
- TrueTouch Gen5 glove touch: Enables interaction with the touchscreen while wearing gloves
- TrueTouch Gen5 waterproofing: Enables interaction with touchscreen in wet conditions such as rain

**Smartwatches need to be able to implement differentiated features**
- PSoC AFE integration: Enables customizable biometric sensing (heart rate, skin temperature and perspiration level)
- CapSense presence detection: Saves power when the device is not being worn

**Smartwatches need to store increasing amount of critical data**
- Ultra-low-power SRAM memory: Extends battery life by buffering packets of data in ultra-low-power SRAM to reduce radio usage
- Nonvolatile memory: Continuously stores the most vital sensor and configuration data at the lowest energy with lifetime data retention

**RECOMMENDED SOLUTIONS**

**TOUCH CONTROLLER**
- TrueTouch Gen5 (CYTMA525)
  - 3” touchscreen, 25 sense I/Os, 4-finger touch
  - Wake-up gestures
  - Hover sensing up to 10 mm
  - Glove touch with up to 5 mm thick gloves
  - Water rejection and wet-finger tracking
  - 60-µA standby current
  - Flexible choice of touchscreen sensors and stackups
  - 49-ball, 3.1 x 3.3 x 0.6 mm WLCSP

**ANALOG FRONT END**
- PSoC 4 (CY8C42XX)
  - 48-MHz ARM Cortex-M0 processor
  - Two opamps, two IDACs, 12-bit SAR ADC
  - Two comparators, analog multiplexer
  - CapSense presence detection, buttons and sliders
  - Four universal digital blocks (UDBs)
  - Two serial communication blocks (SCBs) (SPI/UART)
  - 1.3-µA standby current
  - 40-pin QFN 6.0 x 6.0 x 0.6 mm, WLCSP on request

**EXTERNAL MEMORY**
- Micropower SRAM
  - 16-Mbit MicroPower SRAM (CY62167EV18)
    - High-speed access time of 55 ns
    - Low standby current of 1.5 µA
    - Low active current of 2.2 mA at 1 MHz
  - 48-ball, 6.0 x 8.0 x 1.0 mm VFBGA, WLCSP on request

- Nonvolatile Serial F-RAM
  - 2-Mbit Serial (SPI) F-RAM (FM25V20A)
    - Low standby current of 100 µA
    - Low active current of 130 µA at 1 MHz
    - Fast writes, zero wait states
    - High endurance - $10^{14}$ read/writes
    - Direct replacement for serial flash, EEPROM
  - 8-pin, 5.0 x 6.0 x 0.8 mm DFN, WLCSP on request
**GETTING STARTED**

**TRUETOUCH GEN5**
- Visit: [www.cypress.com/touch](http://www.cypress.com/touch)
- Datasheet: CYTMA525
- Standard Development Kit: CY3290-TMA500
- Availability: Now
- For a wearable touchscreen demo, contact: truetouch@cypress.com

**PSoC 4200**
- Visit: [www.cypress.com/psoc4200](http://www.cypress.com/psoc4200)
- Datasheet: CY8C424X
- Standard Development Kit: CY8CKIT-042
- App Note: Getting Started with PSoC 4
- Availability: Now
- For a heart rate monitor solution demo, contact: psoc@cypress.com

**MICROPOWER SRAM**
- Visit: [www.cypress.com/mpwrsram](http://www.cypress.com/mpwrsram)
- Datasheet: CY62167EV18
- Availability: Now
- For more information, contact: sales@cypress.com

**NONVOLATILE SERIAL F-RAM**
- Visit: [www.cypress.com/nonvolatile](http://www.cypress.com/nonvolatile)
- Datasheet: FM25V20A
- Availability: Now
- For more information, contact: sales@cypress.com

**SMARTWATCH - SUBSYSTEM BLOCK DIAGRAMS**

**PSoC 4200 Smartwatch Heart-Rate Monitor**

**OTHER CYPRESS SOLUTIONS**

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<tr>
<th>SOLUTION</th>
<th>RECOMMENDED PRODUCT</th>
<th>REASONS TO BUY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOUCH CONTROLLER</strong></td>
<td>CY8CTMG240 (Gen2)</td>
<td>Low-cost, smaller footprint option 30-ball 2.2 x 2.3 x 0.4 mm WLCSP, up to 3.6” touchscreen, 32 sense I/Os, 2-finger touch</td>
</tr>
<tr>
<td><strong>ANALOG FRONT END</strong></td>
<td>CY8C38 (PSoC 3)</td>
<td>Reduced BOM with greater analog and digital integration 4 opamps, 4 DACs, 20-bit Delta-Sigma ADC, 4 comparators, analog multiplexer, CapSense, 16-24 UDBs for I2C/SPI/UART</td>
</tr>
<tr>
<td><strong>EXTERNAL MEMORY</strong></td>
<td>CY62147EV18 (MicroPower SRAM)</td>
<td>Low-power, lower density option for buffering data 4-Mbit, 1-µA standby current, 2 mA at 1 MHz active current</td>
</tr>
<tr>
<td><strong>NONVOLATILE SERIAL F-RAM</strong></td>
<td>FM22LD16 (parallel F-RAM)</td>
<td>Low-power, higher density option for buffering nonvolatile data 4-Mbit parallel F-RAM, 104 read/writes, 90-µA standby current, 8-mA active current</td>
</tr>
</tbody>
</table>

**RELATED APPLICATIONS**

Sports, running and GPS watches
Activity monitors measure vital signs and record daily activities and workouts to monitor fitness and wellness. Measurements include distance walked or run, calorie count and sleep patterns. Vital signs measured include heart rate, skin temperature and perspiration level. Recorded information can be transferred wirelessly to a mobile device, and later to the cloud for further analysis.

Most activity monitors use segment LCDs for information display. They do not have full displays like a smartwatch. Additional components include a microcontroller to manage the device, a touch-sensing controller to implement gestures, sensors to record data, an AFE to measure biometric signals, memory to buffer, store and protect sensor and configuration data, and a Bluetooth or WiFi radio.
**RECOMMENDED SOLUTIONS**

**SYSTEM-ON-CHIP (SoC)**

- **PSoC 4 BLE (PSoC 4XX7_BLE)**
  - One-chip solution with integrated 48-MHz ARM Cortex-M0 processor, AFE, CapSense, 2.4-GHz BLE radio with integrated balun
  - Four opamps, two IDACs, 12-bit SAR ADC
  - Two comparators, analog multiplexer
  - CapSense presence detection, buttons and sliders
  - Four UDBs
  - Two SCBs (SPI/I2C/UART)
  - Segment LCD Drive
  - 5.7-µA average current for 4-sec connection
  - 68-ball 3.5 x 3.9 x 0.6 mm WLCSP

**CAPACITIVE SENSING CONTROLLER**

- **CapSense Plus (CY8C20XX7/S)**
  - 24-MHz M8C processor
  - 24 sense inputs
  - CapSense presence detection, buttons and sliders
  - Low standby current of 1.1 µA
  - WLCSP on request

**EXTERNAL MEMORY**

- **Micropower SRAM**
  - 16-Mbit async MicroPower SRAM (CY62167EV18)
  - Low standby current of 1.5 µA
  - Low active current of 2.2 mA at 1 MHz
  - High-speed access time of 55 ns
  - 48-ball VFBGA 6.0 x 8.0 x 1.0 mm, WLCSP on request

- **Nonvolatile Serial F-RAM**
  - 2-Mbit Serial SPI F-RAM (FM25V20A)
  - Low standby current of 100 µA
  - Low active current of 130 µA at 1 MHz
  - Fast writes, zero wait states
  - Highendurance: $10^{14}$ read/writes
  - Direct replacement for serial flash, EEPROM
  - 8-pin DFN 5.0 x 6.0 x 0.8 mm, WLCSP on request

**ACTIVITY MONITOR - SYSTEM BLOCK DIAGRAM**

**HOW CYPRESS SIMPLIFIES YOUR DESIGN:**

**Activity monitors need to be light and small**

- **PSoC 4 BLE one-chip integrated SoC for AFE, wireless and touch sensing:** Reduces your time-to-market and bill of materials (BOM) by integrating an MCU, AFE, BLE and CapSense on a single chip to create low-cost sensor-based systems

**Activity monitors need to be able to implement differentiated features**

- **PSoC AFE integration:** Enables customizable biometric sensing (heart rate, skin temperature and perspiration level)
- **CapSense gestures:** Enables smart gestures (swipe, single tap and double tap) for simple, low-power interaction with the activity monitor
- **CapSense presence detection:** Saves power when the device is not being worn
- **LCD matrix drive:** Drives segment LCDs to simplify your design and reduce your BOM cost

**Activity monitors need to store increasing amount of critical data**

- **Ultra-low-power SRAM memory:** Extends battery life by buffering packets of data in ultra-low-power SRAM to reduce radio usage
- **Nonvolatile memory:** Continuously stores the most vital sensor and configuration data at the lowest energy with lifetime data retention
ACTIVITY MONITOR - SUBSYSTEM BLOCK DIAGRAMS

PSoC 4 BLE Activity Monitor - Block Diagram

---

**GETTING STARTED**

**PSoC 4 BLE**
- Visit: [www.cypress.com/psoc4ble](http://www.cypress.com/psoc4ble)
- Datasheet: **PSoC4XX7_BLE**
- Standard Development Kit: **CY8CKIT-042-BLE**
- App Notes: Getting Started with PSoC 4 BLE
- Design Guide: **PSoC 4 BLE Antenna Guide**
- Availability: Q414
- For a BLE solution demo, contact: ble@cypress.com

**CAPSENSE PLUS**
- Visit: [www.cypress.com/capsenseplus](http://www.cypress.com/capsenseplus)
- Datasheet: **CY8C20XX7/S**
- Availability: Now
- For more information, contact: sales@cypress.com

**MICROPOWER SRAM**
- Visit: [www.cypress.com/mpwrsmr](http://www.cypress.com/mpwrsmr)
- Datasheet: **CY62167EV18**
- Availability: Now
- For more information, contact: sales@cypress.com

**NONVOLATILE SERIAL F-RAM**
- Visit: [www.cypress.com/nonvolatile](http://www.cypress.com/nonvolatile)
- Datasheet: **FM25V20A**
- Availability: Now
- For more information, contact: sales@cypress.com

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**OTHER CYPRESS SOLUTIONS**

<table>
<thead>
<tr>
<th>SOLUTION</th>
<th>RECOMMENDED PRODUCT</th>
<th>REASONS TO BUY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPACITIVE SENSING CONTROLLER</td>
<td>CY8CM83XX (CapSense)</td>
<td>Small footprint solution for simple capacitive buttons with 16 sense inputs and CapSense presence detection</td>
</tr>
<tr>
<td></td>
<td>PSoC 4000 (PSoC 4)</td>
<td>Low-power, small footprint solution for capacitive buttons and sliders 16-pin QFN 3.0 x 3.0 x 0.6 mm package with 16-MHz ARM Cortex-M0 processor and CapSense presence detection, 2.5-µA standby current</td>
</tr>
<tr>
<td>WIRELESS</td>
<td>CY8L10X6X (ProC™ BLE)</td>
<td>Small footprint wireless SoC for non-biometric designs 3.5 x 3.9 x 0.6 mm WLCSP package with 48-MHz ARM Cortex-M0 processor, 2.4-GHz BLE radio with integrated balun</td>
</tr>
</tbody>
</table>

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**RELATED APPLICATIONS**

Fitness band, fitness monitor, fitness tracker, activity bracelets, smart jewelry
HEARING AIDS

Hearing aids are electro-acoustic devices used by consumers to correct impaired hearing, as measured by audiometry.

Components of the hearing aid include a reliable digital signal processor (DSP) to convert sound into digital signals, nonvolatile memory to store recipient hearing logs and configuration parameters, an amplifier to condition the microphone output, audio codecs to improve sound quality, a battery-management IC, and a Bluetooth or proprietary 2.4-GHz wireless radio.
HOW CYPRESS SIMPLIFIES YOUR DESIGN:

Hearing aids need to be light and small with longer battery life

One-chip nonvolatile memory for firmware and data: One memory with fast read access for firmware execution and continuously writing hearing log data — in the smallest footprint and lowest energy consumption

Hearing aids require sleek and reliable user interfaces

CapSense presence detection: Saves power when the device is not being worn

CapSense gestures: Adjusts volume and turns power on/off

RECOMMENDED SOLUTIONS

NONVOLATILE MEMORY

- 2-Mbit Serial (SPI) F-RAM (FM25V20A)
- 4-Mbit Serial (SPI) F-RAM (CY15B104Q)

- Low standby current of 100 µA
- Low active current of 130 µA at 1 MHz
- Fast writes, zero wait states
- High endurance: $10^{14}$ read/writes
- Direct replacement for serial flash, EEPROM
- FM25V20A: 8-pin DFN 5.0 x 6.0 x 0.8 mm, WLCSP on request
- CY15B104Q: bare die, WLCSP on request

CAPACITIVE SENSING CONTROLLER

- CapSense MBR3 (CY8CMBR3XXX)
- 16 sense inputs
- CapSense presence detection, buttons and sliders
- 24-pin QFN 4.0 x 4.0 x 0.6 mm, WLCSP on request

GETTING STARTED

NONVOLATILE SERIAL F-RAM

- Visit: [www.cypress.com/nonvolatile](http://www.cypress.com/nonvolatile)
- Datasheet: FM25V20A, CY15B104Q
- App Note: F-RAM as One-Chip Solution for Code and Data Memory Applications
- Availability:
  - FM25V20A: Now
  - CY15B104Q: Samples: Q1 15
- For more information, contact: sales@cypress.com

CAPSENSE MBR3

- Visit: [www.cypress.com/capsensembr3](http://www.cypress.com/capsensembr3)
- Datasheet: CY8CMBR3XXX
- Availability: Now
- For more information, contact: sales@cypress.com
Wearable patches are small devices that continuously measure, process, store and protect the biometric data collected by sensors, including heart rate, respiratory rate and skin temperature. The recorded information can be transferred wirelessly to a mobile device, and subsequently to the cloud for further analysis. These devices are typically FDA-certified and require a high degree of analog precision.

Components include a mixed-signal, low-power SoC with high-precision analog processing capability and embedded memory, analog sensors to measure biometric signals, digital sensors to record activity-based data, and memory to buffer, store and protect the data. A Bluetooth Low Energy (BLE) transceiver interfaces with the system to transmit the recorded data to a mobile device for further analysis.
**WEARABLE PATCH - SYSTEM BLOCK DIAGRAM**

**HOW CYPRESS SIMPLIFIES YOUR DESIGN:**

**Wearable patches need to be light, small and accurate**

**PSoC 5LP One-Chip mixed-signal solution for high-precision analog processing:**
- High-precision, 20-bit analog enables high-performance biosensor system
- PSoC AFE integration: Enables customizable biometric sensing (heart rate, skin temperature and perspiration level)
- CapSense presence detection: Saves power when the device is not being worn

**Wearable patches need to store increasing amount of critical data**

**Nonvolatile memory:** Continuously stores sensor and configuration data at the lowest energy with lifetime data retention

**BLE connectivity:** Enables low-power wireless connection to any mobile device

**PSoC 5LP WEARABLE PATCH - SUBSYSTEM BLOCK DIAGRAM**

**OTHER CYPRESS SOLUTIONS**

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<tbody>
<tr>
<td>ANALOG FRONT END</td>
<td>CY8C38 (PSoC 3)</td>
<td>Lower-cost small footprint analog signal pre-processor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>72-ball 4.3 x 5.0 x 0.6 mm WLCSP solution with 67-MHz 8051 processor, 4 opamps, 4 DACs, 20-bit Del-Sig ADC, 4 comparators, analog multiplexer, CapSense and 16-24 UDBs</td>
</tr>
</tbody>
</table>
Smart glasses project information such as notifications, navigation data and music playlists onto a transparent heads-up display. A touch interface on the glasses’ frame that accepts gestures and other instructions from the user.

Components include a powerful microprocessor; cameras and sensors to track the environment, such as accelerometers, gyroscopes and magnetometers; a trackpad for user input, and Bluetooth, WiFi and baseband processors for wireless connectivity.
HOW CYPRESS SIMPLIFIES YOUR DESIGN:

Smart glasses need reliable user interfaces
- Touch gestures: Enables touch gestures such as swipe, single tap and double tap on smart glasses
- Look-for-touch: Keeps the user interface in lowest power until the user takes action
- Presence detection: Saves power when the device is not being worn

Smart glasses need to have sleek industrial designs for customer adoption
- Custom module design: Allows the technology to fit in tiny, curved industrial designs

SMART GLASSES - SYSTEM BLOCK DIAGRAM

RECOMMENDED SOLUTIONS

CYPRESS TRACKPAD MODULE
- Multiple distinct scanning areas with a one-chip architecture
- Flexible overlay assembly and lamination
- Compliant with UL, CSA and TUV standards
- Optimal module thickness, <1-mm stackup (sensor to component)

ADVANCED PROCESSING
- 32-bit ARM Cortex-M0 processor
- Multi-finger detection and communication with embedded gesture detection
- Low-power idle and look-for-touch modes
- Optional raw data interface for advanced host processing
- In-system upgradeable firmware

PRODUCT SUPPORT
- On-site support for customer product introduction available
- Incoming and outgoing test equipment available

GETTING STARTED
- To view our trackpad demo, or for more information, contact: sales@cypress.com
ADDITIONAL RESOURCES

WAFFER-LEVEL CHIP-SCALE PACKAGING (WLCSP)
DECA TECHNOLOGIES

Deca Technologies is a majority-owned, fully independent subsidiary of Cypress Semiconductor, part of Cypress’s Emerging Technologies Division. Deca’s advanced wafer-level-interconnect foundry creates the industry’s smallest, low-cost wafer-level chip-scale packaging which is critical for the wearables market.

Having adapted the solar wafer manufacturing processes and autoline technology of Cypress’s former subsidiary, SunPower Corp.—one of the world’s largest and most-successful solar companies—Deca significantly reduces cycle times for prototype and production manufacturing.

Deca’s technology serves RF, analog, mixed-signal, memory and microcontroller companies, as well as Cypress itself. Please visit www.decatechnologies.com to learn more about Deca’s offerings, or email sales@cypress.com to find out more about Cypress’s WLCSP solutions.

WAFFER AND DIE SALES

Cypress’s Deca Technologies subsidiary creates the industry’s smallest WLCSPs.

Cypress’s products are sold in both wafer and die form. Cypress classifies them as follows:

Wafers: Wafers are probed at both room temperature and high temperature to guarantee full functionality.

Known good die: KGD are available as both die-in-wafer and background die. Die shipped in wafer form are not background. Background die are sawed and shipped in waffle packs.

Email us at sales@cypress.com to learn more about our wafer and die offerings.

The Cypress Developer Community™ (www.cypress.com/go/community) offers a rich array of resources to help you get the most out of your wearables project. You can:

Post questions, solve design problems and dialog with other designers in one of our technical forums.

Watch demos, explore labs and access our video training.

Learn new techniques geared to the projects you’re working on from Cypress experts through our technical blogs.
## WEARABLE SOLUTIONS

### CYRESS WEARABLE SOLUTIONS SELECTOR GUIDE

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<td>PSoC® 4</td>
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1 For more information, contact sales@cypress.com

### DESIGN WINS: POWERED BY CYRESS TOUCH-SENSING SOLUTIONS

**Powered by TrueTouch® touchscreen controllers**

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- Qualcomm® Toq™
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**Powered by CapSense® controller**

- Garmin® Vivosmart™
CONTACT US

Cypress Semiconductor Corporation
198 Champion Court
San Jose, CA 95134 USA
Tel: +1 (408) 943-2600
Fax: +1 (408) 943-6848
Toll-free: +1 (800) 858-1810 (U.S. only)
Email address: sales@cypress.com