Quick time to market with the elegant and robust capacitive touch interfaces

Enable metal touch, highest resolution sliders and 3-D gestures with the world’s lowest power MSP FRAM MCUs and CapTIvate™ technology

MSP Ultra Low Power MCU
Touch the revolution
Finding more capacitive touch in everyday applications

- Appliances
- Access control
- Industrial gauges
- Consumer applications

- Thermostats
- POS terminals
- Security systems
- Sanitary applications
Challenges of designing with capacitive touch

- Noise triggers false touch detections
- Industrial designs are driving the need for more advanced interfaces
- “Always-on” capacitive touch technology drains power
- Limited application designs due to sensitivity and resolution
- Spend months designing and optimizing capacitive touch solutions
Revolutionize your design with CapTIvate™ technology

- Noise triggers false touch detections
- IEC61000-4-6 certified touch solutions for noise immunity
- Industrial designs are driving the need for more advanced interfaces
- Metal touch, 3D gesture, glove friendly and the most configurable solutions
- “Always-on” capacitive touch technology drains power
- The world’s lowest-power FRAM capacitive touch microcontroller
- Limited application designs due to sensitivity and resolution
- Industry’s highest resolution sliders and wheels
- Spend months designing and optimizing capacitive touch solutions
- Set-up your design in five minutes or less with CapTIvate Design Center

Texas Instruments
Sixty to 70 percent of capacitive touch solutions will require IEC61000-4-x certification

- **Hardware:** Frequency hopping and zero crossing sync techniques in-silicon provide robust detection
- **Software:** Oversampling, de-bounce, AC noise filtering minimize false detects
- **System:** Comprehensive reference designs to meet EMC compliance

**Avoid false detects in presence of moisture**

- Moisture rejection using guard channel techniques helps system differentiate between a touch and moisture
- Make designs waterproof using metal overlays for outdoor or wet environments

**CapTIvate™ technology** can also reduce emissions
Reliability
Improving noise immunity

1) Multi-frequency scan from 4 frequencies
2) Spread spectrum modulation to reduce amplitude
3) Multi-frequency processing: 4 inputs, single result
4) IIR Filtering
5) Dynamic threshold adjustment
- Guard channel serves allows for palm rejection and moisture rejection.
- Guard channel reaching a certain threshold masks all other channels.
Versatility

Metal touch, 3D gesture, glove friendly and the most configurable solutions

Differentiate your solution with metal touch
- Seamlessly integrate your sensors with stainless steel or metal panels
- Increase functionality with multi-touch and force-touch
- Also supports glass and plastic overlays

Most configurable button, slider and wheel combinations
- Design up to 64 buttons with just 16 IOs to simplify designs and reduce cost
- Concurrently measure mutual and self-capacitance

Proximity and 3D gesture sensing is also possible with CapTIvate™ Technology

16 IOs = 32 buttons + 4 sliders + 4 wheels + 1 prox

16 IOs = 64 buttons
Versatility

CapTIvate™ technology supports self and mutual capacitance in the same design

Self capacitance:
- Electrode = single plate, 16 CapTIvate Touch IOs = 16 Electrodes
- Ultra high resolution sliders & wheels (> 10-bit). Eg. 12” slider = 4 electrodes
- proximity sensors resulting in higher distances

Mutual capacitance:
- Electrode is made up of two plates (one Tx, one Rx)
- Allows for up to 64 buttons with 16 CapTIvate Touch IOs (8Tx, 8Rx)
- Allows for tightly packed buttons with low cross talk
- Allows multi-touch matrix implementations.

Hybrid solutions = concurrent self and mutual capacitance
- Self capacitance for proximity/guard channel detection eg. keypad illumination
- Use mutual capacitance for multiple buttons eg. keypad
Low-power

The world’s lowest-power FRAM capacitive touch microcontroller

Up to 90 percent lower power than other solutions

- Scan up to four buttons at 0.9 μA per button with the CPU completely turned off
- Autonomous peripherals enable you to do more with less power
- Experience up to 15 years of battery life on a single coin cell battery

World’s only FRAM MCU with CapTIvate™ technology

- FRAM and CapTIvate technology on the same device allows for HMI applications with ultra-low-power datalogging and state retention capabilities
- $10^{15}$ write endurance
- 100x faster and 250x lower energy writes than other non-volatile technology

Electrode scan setup

Measure

Process
Drift compensation
Noise Filter

Above Threshold?

Y

N

Process Touch event

Delay

Delay = scan rate

MCU Active

MCU Asleep

Texas Instruments
High Resolution
Industry’s highest resolution sliders and wheels

Support low-power 3D gesture recognition
- Scans four sensors simultaneously within 500 µsec to enable advanced gesture features
- Higher proximity distances (up to 30cm)

Industry’s highest resolution slider and wheels
- Thirty centimeter slider with 0.029 cm resolution and only four sensors
- High resolution allows for high degree of linearity in sliders

Create designs with thicker glass and plastic overlays
- Detect change as low as 10 Femtofarads
- Minimize effect of parasitic capacitance for more robust designs and flexibility

Sense through 60mm thick glass
Ease-of-use

Set-up your design in five minutes or less with CapTIvate Design Center

- Simplify and accelerate touch design with CapTIvate Design Center - one stop shop for tools, software and documentation
- Intuitive GUI tools for creating, configuring touch sensors and tuning them in real time
- Tune buttons, sliders, wheels and proximity sensors for sensitivity, noise performance and power consumption
- Automated generation of complete source code projects for Code Composer Studio™ IDE and IAR® IDEs
Ease-of-use
Do more with Software Library in ROM

 היוםית
Do more with Software Library in ROM

明天
Do more with Software Library in ROM

oggle
Do more with Software Library in ROM

\begin{tikzpicture}
\node[anchor=south west,inner sep=0] (image) at (0,0) {
\includegraphics[width=\textwidth]{example-image}\};
\begin{scope}[x={(image.south east)},y={(image.north west)}]
\node[align=center] at (0.2,0.6) {Ease-of-use};
\node[align=center] at (0.2,0.5) {Do more with Software Library in ROM};
\end{scope}
\end{tikzpicture}
All the tools and support to get developers started today

MSP CapTIvate Development Kit (MSP-CAPT-FR2633)
- Based on MSP430FR2633 MCU includes Sensor PCBs demonstrating mutual, self and proximity sensing. Available on TI Store for USD $99.

CapTIvate™ touch MCU+ haptic evaluation
- Part of CapTIvate MCU development Kit with haptic feedback provided by TI's DRV2605L haptic driver + Linear Resonant Actuator (LRA).
- Haptics technology enhances capacitive button, slider and wheel solution by providing mechanical (tactile) feedback to reduce user error, improve user experience and create differentiated products.
MSP430™ FR253x/263x

Features/Benefits
- IEC61000-4 certificated touch solutions for noise immunity
- Metal touch, 3D gesture, glove friendly and the most configurable solutions
- < 4 μA Wake on touch with 4 sensors.
- 30 cm slider, 1/250th cm resolution, Just 4 IOs
- Set-up your design in five minutes or less with CapTIvate Design Center
- Touch library in ROM
- Self and mutual capacitance in the same design - Upto 64 buttons

Tools
- CAPTIVATE-BSWP
- CAPTIVATE-PHONE
- CAPTIVATE-PROXIMITY

Software
- CapTIvate Touch Software Library (in ROM)
- CapTIvate Design Center – Configure, Tune sensors in real time, auto generate code

In Production

Target Applications
- Thermostats
- Electronic access control
- Lighting control

• Electronic Locks
• White goods
• Small appliances
• Personal electronics
Resources

Website: www.ti.com/CapTIvate

Videos:

Part 1: Introducing MSP MCUs featuring CapTIvate Technology
Part 2: The MSP CapTIvate MCU Development Kit
Part 3: Tune Capacitive Sensors in 5 Minutes or Less with the CapTIvate Design Center
Part 4: Low-power Features of MSP MCUs featuring CapTIvate Technology
Part 5: Capacitive Button, Slider and Wheel Interfaces
Part 6: Proximity Sensing and 3D Gestures
Part 7: Moisture Rejection in Capacitive Touch Designs
Part 8: Noise Immunity in Capacitive Touch Designs

TI Designs:
Capacitive Touch Thermostat User Interface Reference Design
64-Button Capacitive Touch Panel With TI Microcontroller With CapTIvate Technology Reference Design
Low-Power Touch Through Glass Reference Design
# HMI - Low Power Touch Through Glass Reference Design

**TI Designs Number: TIDA-00343**

## Design Features
- Single and multi-step button press
- Three or more robust buttons option implemented
- Three LEDs feedback
- Easy to use
- Variable air gap between buttons and glass
- Low power: 1.7uA/Button
- Temperature range: -40°C to 85°C

## Design Benefits
- Finger detection through tick glass (8 – 12 mm)
- Work with gloves and in harsh environment (water, oil, dust)
- No calibration

## Tools & Resources

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- **MSP430 capTIvate**
**Features**

- MSP430 CapTIvate technology based thermostat UI design
- 8 buttons with only 6 IOs and visual feedback
- < 50 µA Avg power
- FRAM NVM technology: $10^{15}$ write endurance, 100x faster and 250x lower energy writes

**Benefits**

- 2 years battery life on AAA
- Save States on FRAM memory

**Target Applications**

- Thermostat

**Tools & Resources**

[TI Design at TI.com](http://www.ti.com)

[CapTIvate Thermostat Video](http://www.youtube.com/watch?v=examplevid)
64-Button Capacitive Touch Panel

**Features**
- Single touch and multi-touch detection
- Mutual capacitance technology enables 64-buttons with only 16 pins
- More than 100 samples-per-second and 15-ms typical response time
- 0.23-µA-per-button average current with wake-on-touch mode

**Benefits**
- Demonstrates use of CapTIvate to support large number of buttons in a low power system

**Target Applications**
- Appliances and White Goods
- Industrial Control Panels
- TV, AV, and Set Top Box Interfaces
- Building Automation User Interfaces

**Tools & Resources**
- Schematics, Design files
- Released at TI.com

Video: CapTIvate 64 Button Panel
CapTIvate Remote Control: TIDM-CAPTIVATE-REMOTECONTROL

Features

- CapTIvate Capacitive Touch functions
  - 8x Touch Buttons
  - 1x Touch Slider for volume control
  - 1x GesturePad for slide and tap gestures
  - 1x Proximity Sensor for grip detection
- 2 LEDs to indicate power status and touch operation
- Wake-on grip detection with ultra-low power standby mode
- PC GUI for demo of remote control capabilities
- I2C & UART communication interface
- Bluetooth connectivity to PC through Bluetooth EVM CC2650EM-7ID
- Haptic circuitry available

Target Applications

- Smart TV & SET-TOP Box remotes
- Sound system remotes

Tools & Resources

- TIDM-CAPTIVATE-REMOTECONTROL Design Folder
- TI Design User Guide
- Design Files:
  - Schematics
  - BOM
  - Gerbers
  - Software
- Device Datasheets:
  - MSP430FR2633
  - DRV2605L
  - CC2650EM-7ID

Benefits

- Multifunctional capacitive touch panel for remote control with Buttons, Slider and GesturePad functions
- Low power in active and standby modes extends battery life
- Various communication interfaces available for future application extension