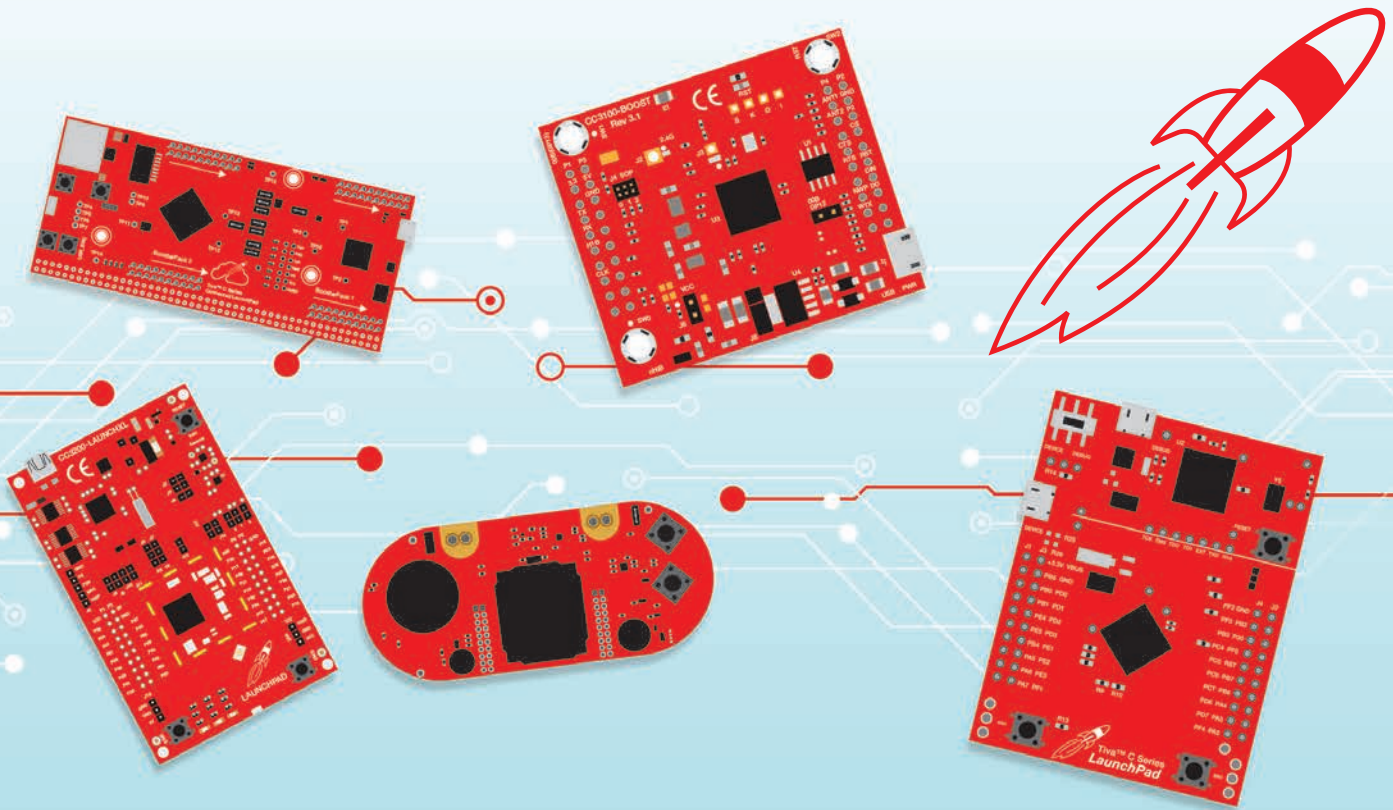


Lift-Off with the TI LaunchPad™ Development Ecosystem



Introduction

Lift-Off with TI LaunchPad: A Microcontroller Evaluation Kit

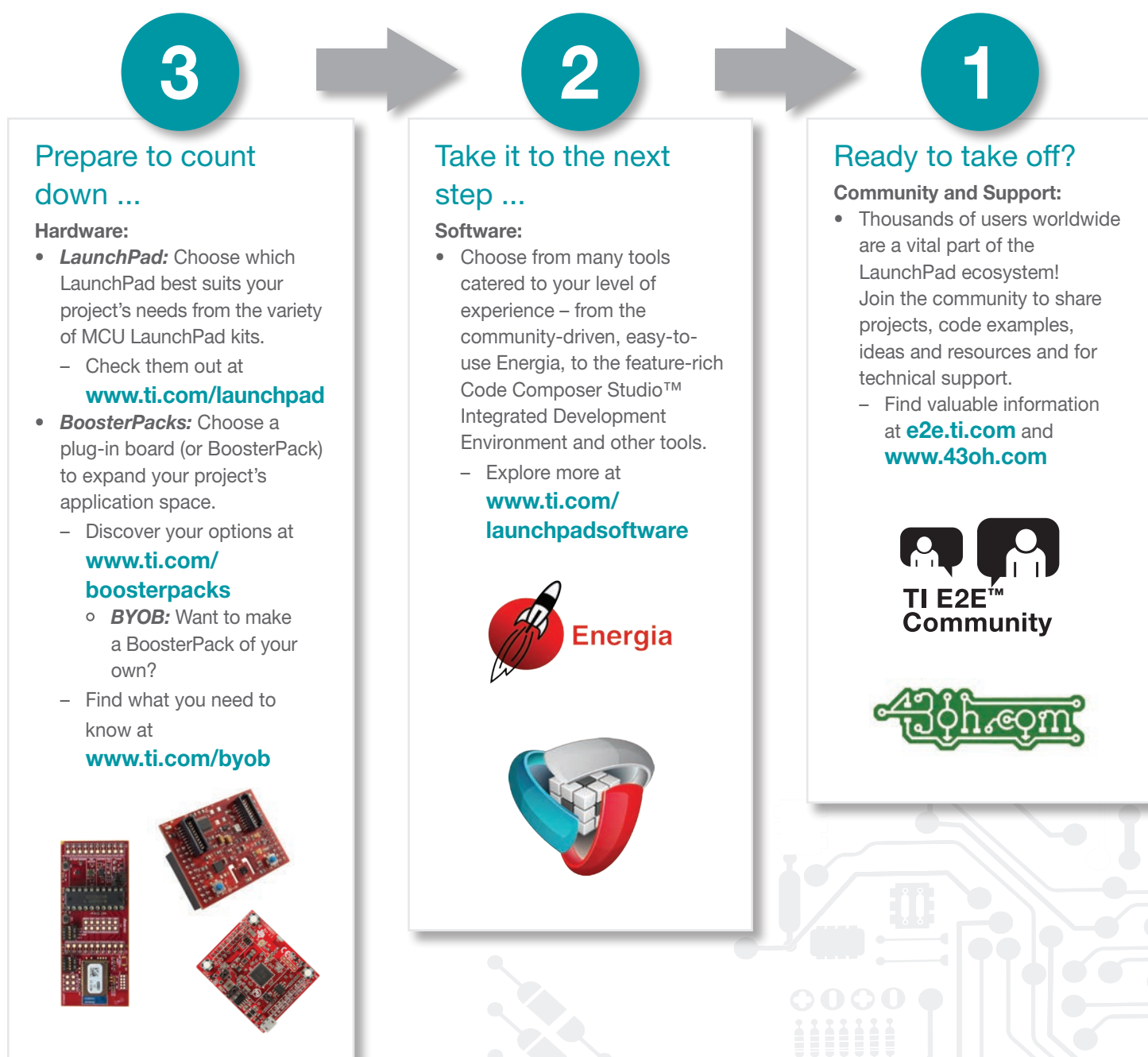
LaunchPad is a low-cost, easy-to-use microcontroller development board from Texas Instruments.

Starting at \$9.99 USD, LaunchPad boards offer a snapshot into the world of TI's broad MCU portfolio. Use this guide to help you choose the perfect LaunchPad for your project.

Blink LEDs, spin motors, make robots and much more with easy-to-use LaunchPad kits and a variety of software options to suit your maker or developer needs.

Get started with LaunchPad: www.ti.com/launchpad

The LaunchPad ecosystem

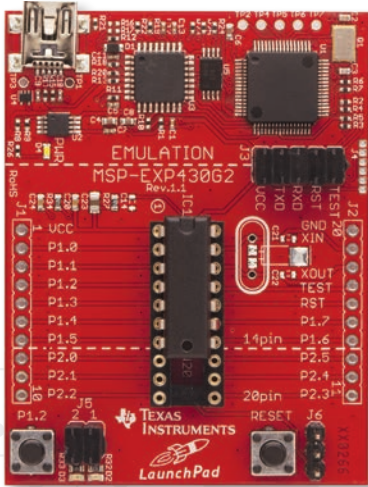


MSP MCU LaunchPads

Ultra-Low Power

Optimized to enable battery-operated and battery-free general-purpose applications

MSP-EXP430G2

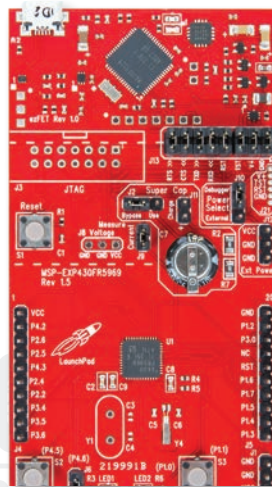


U.S. \$9.99

Why this LaunchPad?

- Ultra-low power consumption with popular 16-bit MSP430™ architecture
- Suited for general-purpose applications
- Easy to learn for beginners
- PDIP package for easy embedding after programming

MSP-EXP430FR5969



U.S. \$15.99

Why this LaunchPad?

- Lowest power MSP430™ MCU with ultra-low power active and standby operation
- Integrated 64 kB FRAM for fast, non-volatile memory-writes. True unified memory allows boundary-free access
- Advanced peripheral integration including a 12-bit differential SAR ADC and AES256 accelerator

MSP-EXP430FR6989



U.S. \$17.99

Why this LaunchPad?

- 40-pin BoosterPack header for easy breadboarding / prototyping
- Integrated 128KB FRAM with 8 MBPS in-system writes
- EnergyTrace™++ technology combined with 500-nA RTC is ideal for applications requiring the absolute lowest energy

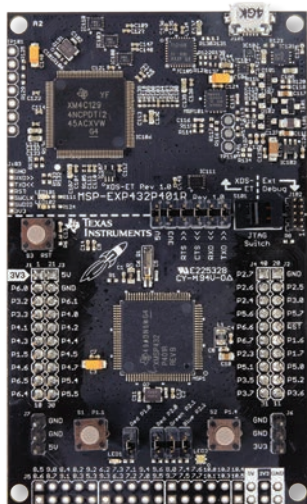
Feature	MSP-EXP430G2	MSP-EXP430FR5969	MSP-EXP430FR6989
MCU	MSP430G2553	MSP430FR5969	MSP430FR6989
Speed	Up to 16 MHz	Up to 16 MHz	Up to 16 MHz
Non-volatile memory	16 kB Flash	64 kB FRAM	128 kB FRAM
RAM	512 B	N/A	2 kB
EEPROM	N/A	N/A	N/A
Timers	2x 16-bit	5x 16-bit	5x 16-bit
Serial communication	I ² C, 2 SPI, UART	2 I ² C, 4 SPI, 2 UARTs	I ² C, SPI, UART
ADC channels	10-bit, 8 channels	12-bit, 16 channels	12-bit, 16 channels
BoosterPack pins	20	20	40
Energia support	Yes	Yes	Yes
Extra features	DIP package	Super cap	LCD controller

MSP MCU LaunchPads

Low Power + Performance

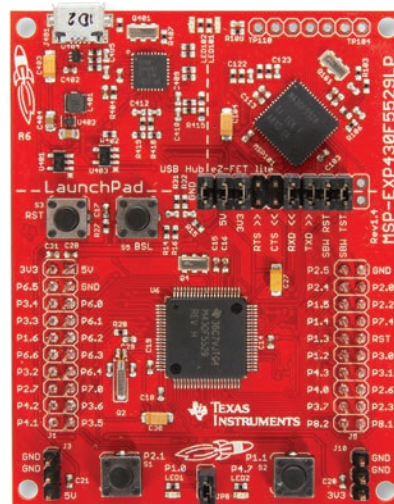
Balanced performance to deliver low power consumption and expanded peripherals for general-purpose applications

MSP-EXP432P401R



U.S. \$12.99

MSP-EXP430F5529LP



U.S. \$12.99

Why this LaunchPad?

- Ultra-low power consumption with 32-bit ARM® Cortex®-M4F performance
- EnergyTrace™+ to enable real-time current measurement
- Increased number of pins and peripherals

Why this LaunchPad?

- Ultra-low power consumption with popular 16-bit MSP430™ architecture
- Integrated USB 2.0 and increased memory
- Increased number of pins and peripherals

Feature	MSP-EXP432P401R	MSP-EXP430F5529LP
 MCU	MSP432P401R	MSP430F5529
 Speed	Up to 48 MHz	Up to 25 MHz
 Non-volatile memory	256 kB Flash	128 kB Flash
 RAM	64 kB	8 kB
 EEPROM	N/A	N/A
 Timers	4× 16-bit, 2× 32-bit	4× 16-bit
 Serial communication	4 I ² C, 8 SPI, 4 UARTs	2 I ² C, 4 SPI, 2 UARTs
 ADC channels	14-bit SAR, 24 channels	12-bit SAR, 16 channels
 BoosterPack pins	40	40
 Energia support	Yes	Yes
 Extra features	EnergyTrace+	USB

Connected LaunchPads

ARM®-Based MCUs with Connectivity

ARM Cortex®-M4-based microcontrollers with integrated connectivity options, both wired and wireless

SimpleLink™ Wi-Fi® CC3200 LaunchPad

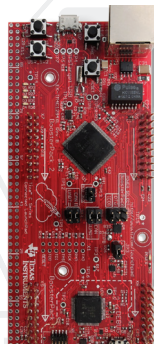


U.S. \$29.99

Why this LaunchPad?

- Enables quick development of Internet of Things designs with a single-chip low-power Wi-Fi solution (Wi-Fi 802.11b/g/n standards)
- Wi-Fi network processor with integrated TCP/IP stack, HTTP server, and many other Internet protocols
- Power Wi-Fi battery-operated designs for more than a year on two AA batteries
- Get started quickly, no Wi-Fi experience needed

EK-TM4C1294XL

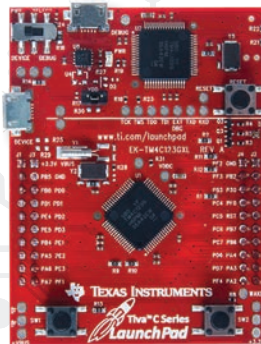


U.S. \$19.99

Why this LaunchPad?

- 120-MHz ARM Cortex-M4 with floating-point (Digital Signal Control CPU)
- Integrated Ethernet (MAC+PHY)
- Two BoosterPack XL interfaces (using stackable headers)

EK-TM4C123GXL



U.S. \$12.99

Why this LaunchPad?

- ARM-based TI MCU with high CPU frequency and horsepower
- Highly-integrated with various serial communications modules
- Best suited for general-purpose applications

EK-TM4C129EXL



U.S. \$24.99

Why this LaunchPad?

- High-performance 120-MHz ARM Cortex-M4F MCU
- Hardware crypto accelerators
- Integrated Ethernet (MAC+PHY)
- Two BoosterPack XL interfaces (using stackable headers)
- Secured cloud connection demonstration with TI RTOS, WolfSSL and Exosite

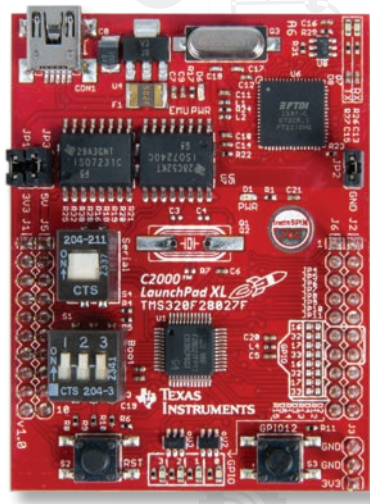
Feature	CC3200-LAUNCHXL	EK-TM4C1294XL	EK-TM4C123GXL	EK-TM4C129EXL
MCU	CC3200	TM4C1294NCPDT	TM4C123GH6PM	TM4C129ENCNPD
Speed	80 MHz	120 MHz	80 MHz	120 MHz
Flash	1 MB (external)	1 MB	256 kB	1 MB
RAM	Up to 256 kB	256 kB	32 kB	256 kB
EEPROM	N/A	6 kB	2 kB	6 kB
Timers	4x 16-bit	8x 32-bit	6x 32-bit, 6x 64-bit	8x 32-bit
Serial communication	SPI, 2 UARTs, 2 I ² S, I ² C	10 I ² C, 8 UARTs, 4 QSPI, 2 CAN, EPI, USB	6 I ² C, 4 SPI, 8 UARTs, 2 CAN, USB	10 I ² C, 8 UARTs, 4 QSPI, 2 CAN, EPI, USB
ADC channels	12-bit, 4 channels	12-bit, 20 channels	12-bit, 12 channels	12-bit, 20 channels
BoosterPack pins	40	2x 40	40	2x 40
Energia support	Yes	Yes	Yes	Yes
Connectivity options	Wi-Fi	Ethernet, USB, CAN	USB, CAN	Ethernet, USB, CAN
Extra features	SmartConfig™	Cloud support	RGB LED	Crypto accelerators

C2000™ MCU LaunchPads

Digital Controls Made Easy

The DSP core and high-performance peripherals make these devices rock in real-time control applications.

LAUNCHXL-F28027F



U.S. \$17.00

Why this LaunchPad?

- Best-suited for real-time digital control applications
- Built-in electrically isolated JTAG emulator
- Pre-loaded InstaSPIN-FOC Library in ROM
- Pair with the DRV8301 BoosterPack to spin 3-phase motors

LAUNCHXL-F28069M

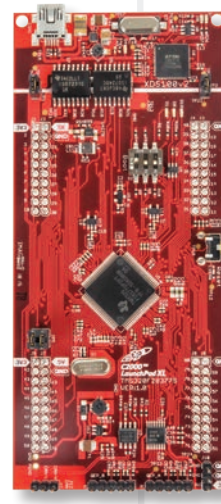


U.S. \$24.99

Why this LaunchPad?

- Best-suited for real-time digital control applications
- Built-in electrically isolated JTAG emulator
- Pre-loaded InstaSPIN-MOTION and InstaSPIN-FOC Library in ROM
- Easily create complex motion profiles using SpinTAC software

LAUNCHXL-F28377S



U.S. \$24.99

Why this LaunchPad?

- Best suited for real-time digital control applications
- Highest performance Delfino™ 32-bit MCU
- Access to a wide range of analog and control peripherals such as DACs, PWMs, eCAPs, eQEPs, sigma-delta and others

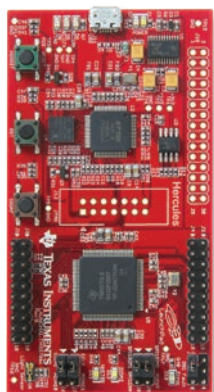
Feature	LAUNCHXL-F28027F	LAUNCHXL-F28069M	LAUNCHXL-F28377S
 MCU	TMS320F28027F	TMS320F28069MPZT	TMS320F28377SPZPT
 Speed	60 MHz	90 MHz	200 MHz
 Flash	64 kB	256 kB	1 MB
 RAM	10 kB	96 kB	164 kB
 EEPROM	N/A	N/A	N/A
 Timers	3× 32-bit	3× 32-bit	3× 32-bit
 Serial communication	SPI, I ² C, UART	2 SPI, I ² C, 2 UARTs, CAN	3 SPI, 2 I ² C, 4 UARTs, 2 McBSPs, 2 CAN, USB
 ADC channels	12-bit, 13 channels	12-bit, 16 channels	16-bit, 12 channels
 BoosterPack pins	40	2× 40	2× 40
 Energia support	Yes	No	No
 Extra features	InstaSPIN™-FOC	High-resolution PWM	USB

Hercules™ MCU LaunchPads

Safety

Specialized with dual ARM® Cortex®-R lock-step cores and safety features that are ideal for functional safety applications

LAUNCHXL-TMS57004 / LAUNCHXL-RM42



U.S. \$19.99 each

Why this LaunchPad?

- ARM Cortex-R4 32-bit lock step cores MCU for safety-critical applications
- Features Hercules TMS570 series MCU designed specifically for safety-critical automotive and transportation applications or RM4 Series MCU designed specifically for safety-critical medical and industrial applications
- MCU features integrated safety features to simplify SIL-3 (TMS570 series: SIL-3 and ASIL D) applications

LAUNCHXL2-TMS57012 / LAUNCHXL2-RM46



U.S. \$19.99 each

Why this LaunchPad?

- ARM Cortex-R4 32-bit lock step cores MCU for safety-critical applications
- Features Hercules TMS570 series MCU designed specifically for safety-critical automotive and transportation applications or RM4 Series MCU designed specifically for safety-critical medical and industrial applications
- MCU features integrated safety features to simplify SIL-3 (TMS570 Series: SIL-3 and ASIL D) applications

Feature	LAUNCHXL-TMS57004 / LAUNCHXL-RM42	LAUNCHXL2-TMS57012 / LAUNCHXL2-RM46
 MCU	TMS570LS0432 / RM42L432	TMS570 / RM46L852
 Speed	Up to 100 MHz	Up to 220 MHz
 Flash	384 kB ECC	1.25 MB ECC
 RAM	32 kB ECC	192 kB ECC
 EEPROM	16 kB ECC Flash for EEPROM emulation	64 kB ECC Flash for EEPROM emulation
 Timers	19-pin programmable High-End Timer (N2HET), Enhanced Quadrature Encoder (eQEP), Pulse Module	2 N2HET, 2 eQEP
 Serial communication	2 SPI, UART, 2 CAN, MibSPI	SPI, I ² C, 2 UARTs, 3 CAN, 3 MibSPI, USB, Ethernet
 ADC channels	12-bit, 16 channels	12-bit, 24 channels
 BoosterPack pins	40	2x 40
 Energia support	No	No
 Extra features	HALCoGen support	Ethernet and USB

Plug in Your BoosterPack

Want to add more functionality to your LaunchPad project?

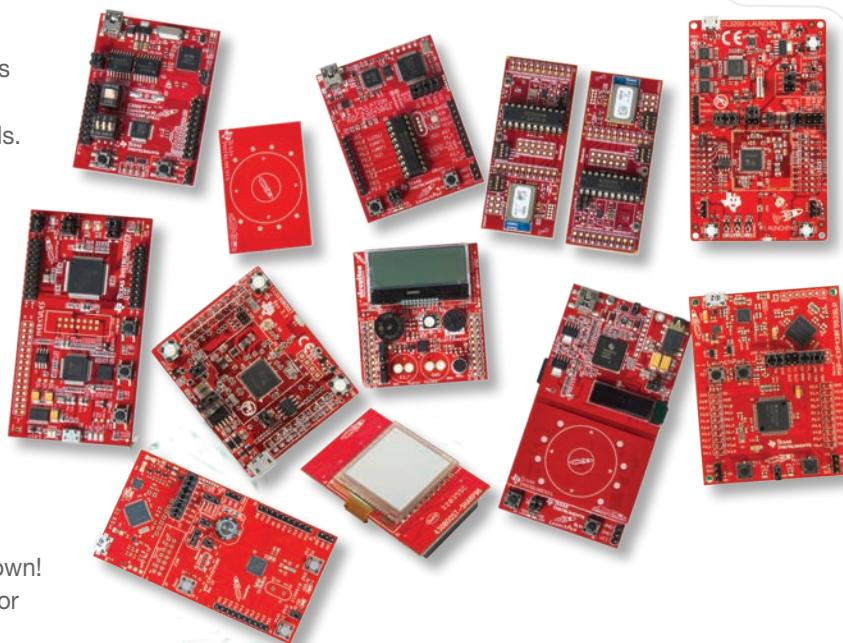
Enter BoosterPacks!



BoosterPacks are modular plug-in boards that fit on top of the LaunchPad baseboards. These modules introduce new functionality to the LaunchPad Kits including wireless, capacitive touch, LED lighting and more.

You can see some of the most popular BoosterPacks from third parties and TI. Buy BoosterPacks at www.ti.com/boosterpacks.

Feeling adventurous? Learn how you can make your own! Go to www.ti.com/byob to learn how to “BYOB,” or Build Your Own BoosterPack.



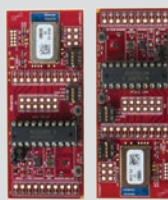
Featured BoosterPacks

SimpleLink™ Wi-Fi® CC3100 BoosterPack CC3100BOOST



- Quickly connect your design to the cloud
- 802.11 b/g/n compatible
- Station, AP and Wi-Fi Direct® modes
- **Price: U.S. \$19.99**

CC110L-Based Sub-1GHz RF BoosterPack 430BOOST-CC110L



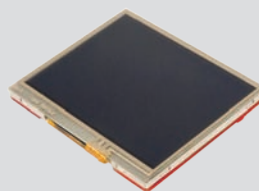
- CC110L RF transceiver enables easy wireless communications
- **Price: U.S. \$19.00**

Educational BoosterPack MKII BOOSTXL-EDUMKII



- Analog joystick
- 3-axis accelerometer
- TI OPT3001 optical light sensor
- TI TMP006 temperature sensor
- Buzzer, microphone
- RGB LED
- Color LCD screen
- **Price: U.S. \$39.99**

Kentec QVGA display BoosterPack BOOSTXL-K350QVG-S1

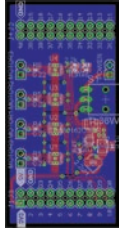


- Add resistive touch and display capabilities with one board
- 3.5" QVGA display (320×240 resolution)
- SPI interface
- 4-wire resistive touch screen
- White LED backlight with driver circuit
- **Price: U.S. \$24.99**

Build Your Own BoosterPack

The possibilities are endless

Can't find a BoosterPack that fits your needs? Have an amazing idea to make your own and need a helping hand? If you have a BoosterPack idea, we have the resources to help take your idea from concept to PCB to product in a few easy steps.

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Have an amazing BoosterPack idea?	Get your design reviewed by the community	Get a price quote for your design	Funding your BoosterPack design	Getting your BoosterPack built	Featuring your BoosterPack
Leverage our design experience by using our templates and complying with the BoosterPack pinout standard. • Templates and design tools • BoosterPack standard • Design Guide	Post your idea and design to our communities for review by experts and engineers.  	Submit your BoosterPack design to PCB manufacturers for a quote.	Put your BoosterPack design up for preorder on popular sites like Kickstarter or www.tindie.com.	Got your fund? Reach out to PCB manufacturers to build your design. 	Once you have built your BoosterPack, send the details to TI. TI will help you in featuring the BoosterPack in the community. You are now all set to fire up your BoosterPack!

Featured BoosterPacks

Fuel Tank BoosterPack BOOSTXL-BATTPACK



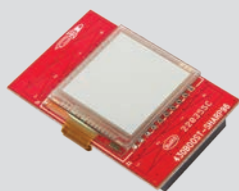
- Onboard BQ24210 lithium polymer charger
- Onboard BQ27510-G2 gas gauge
- Low battery indicator
- USB charging
- **Price: U.S. \$26.99**

MSP430™ Capacitive Touch BoosterPack 430BOOST-SENSE1



- Scroll wheel, button and proximity sensor
- 9 LEDs that provide instant feedback
- **Price : U.S. \$10.00**

Sharp® Memory LCD BoosterPack 430BOOST-SHARP96



- Low power 96×96 pixel LS013B4DN04 display from Sharp Electronics
- Capacitive touch sliders
- **Price: U.S. \$19.99**

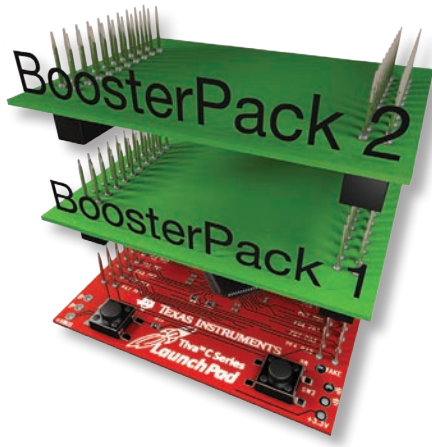
Stepper Motor BoosterPack BOOST-DRV8711



- Complete drive stage for precision stepper motor control applications
- 8-52V supply input with up to 4.5A continuous output current
- Built in 1/256-step microstepping indexer for ultra-smooth movement
- **Price: U.S. \$25.00**

Cook up a New Invention

Stack a Pack!



LaunchPad + BoosterPack combinations enable rapid prototyping of various applications and projects. Stack BoosterPacks on top of LaunchPads to create thousands of new possibilities.

Wi-Fi®-enabled meat probe “iGrill”.
Send a tweet when the temperature exceeds threshold

=

EK-TM4C123GXL
LaunchPad



+

Wi-Fi CC3100
BoosterPack



+

Thermocouple
BoosterPack
(ADS1118)



Create a battery-powered NFC/RFID
tag reader

=

MSP430G2
LaunchPad



+

NFC/RFID
(TRF7970A)



+

LiPo Battery
BoosterPack
(BQ Fuel Gauge)



Create a multi-point sub-1GHz RF
wireless temperature sensor network

=

MSP430F5529
LaunchPad



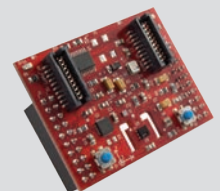
+

Sub-1GHz
(CC110L)



+

Sensor Hub
BoosterPack

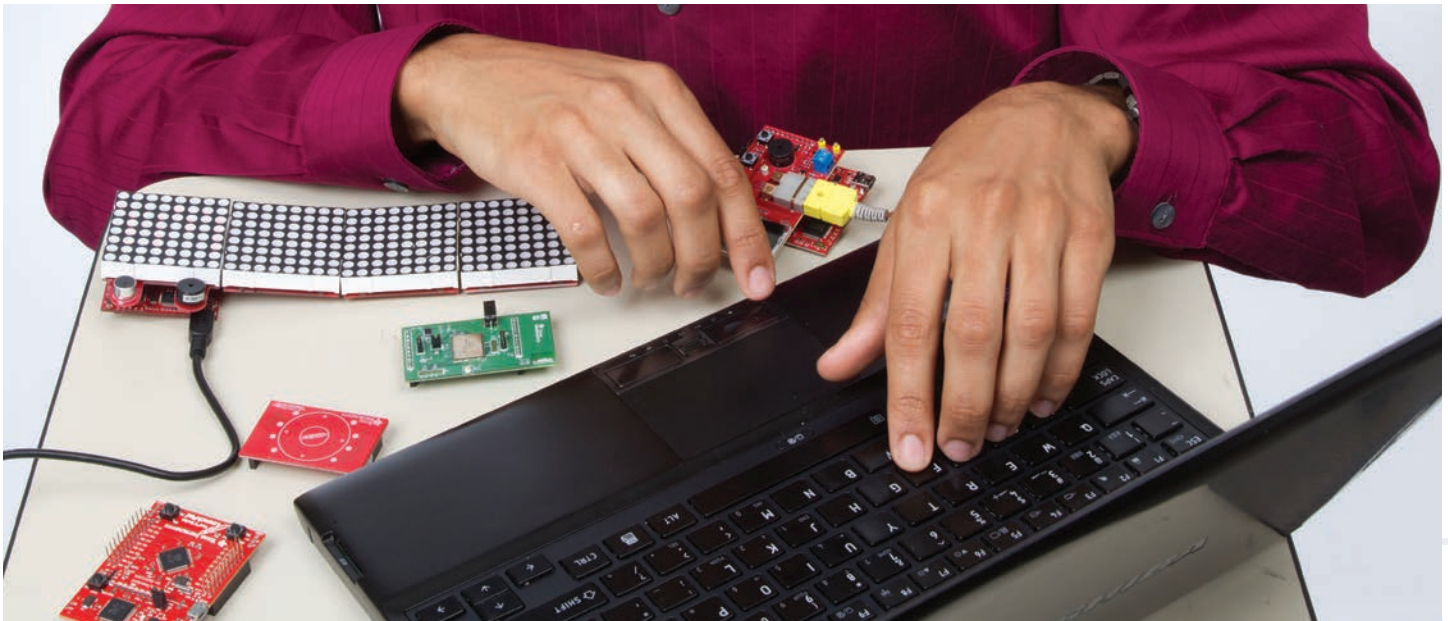


TI Microcontroller

TI Wireless

TI Analog

Choose the Software Tool for You



Beginner

Energia

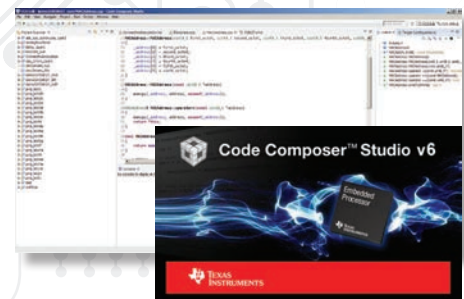
- Open-source, community-driven, wiring-based Integrated Development Environment (IDE)
- Simple and easy-to-use APIs help implement your idea
- Energia's user-friendly environment is suitable for students, makers and engineers alike
- Library-support for various BoosterPacks
- Building complex applications is easier than ever with multi-threading capability
- www.energia.nu



Professional

Code Composer Studio™ IDE

- Fully-integrated, feature-rich professional IDE from TI
- CCStudio IDE supports all of TI's embedded processing portfolio
- CCStudio IDE includes full-debug capability and also supports import of Energia sketches
- www.ti.com/ccs



Third-Party Tools

There are many LaunchPad ecosystem tools offered by third parties as well.

- IAR Systems
- Keil, An ARM® Company
- Mentor Embedded
- MSPGCC
- www.ti.com/launchpadsoftware





Energia libraries

Don't forget about software! Energia libraries are ideal companions to your hardware. One Energia library can enable any LaunchPad to work with your BoosterPack. Be sure to provide the right functionality by exposing the right functions within your library. Upload your library on GitHub!



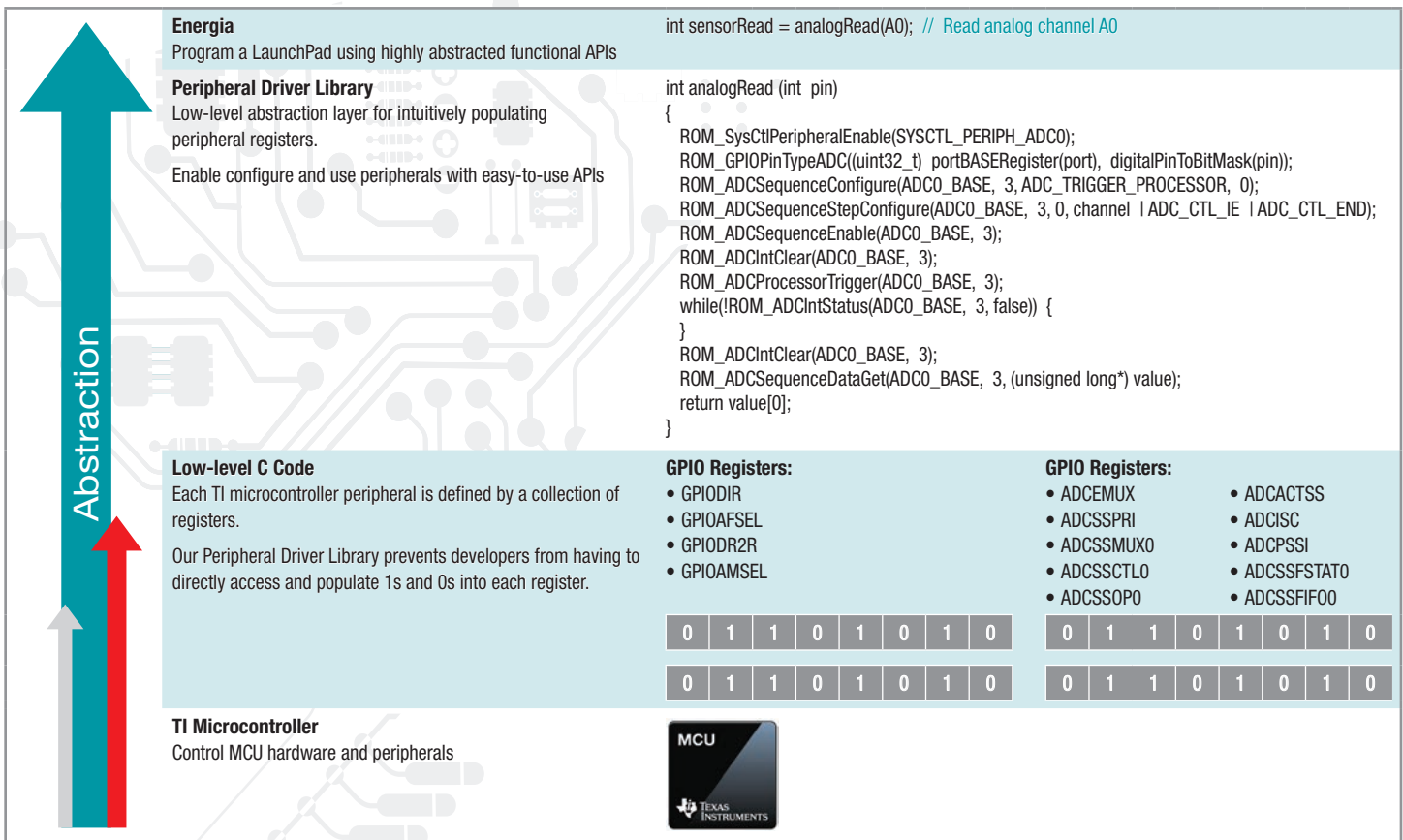
The Energia difference

- Send and receive wireless data within minutes using simple APIs
 - `Radio.begin(parameters);`
 - `Radio.Transmit(parameters);`
 - `Radio.receiverOn(parameters);`
- 100% source code compatibility/consistent APIs across MCU, including MSP430™, MSP432™, C2000™ and TM4C LaunchPads
- IDE | Language | Community
- Open source and community driven
- Fork of the popular wiring framework
 - The basis of the Arduino IDE
 - Code enabling multi-architecture abstraction and source code compatibility across supported LaunchPads
- Robust collection of intuitive APIs for controlling your LaunchPad's I/O
- Immediately develop code for I²C, UART, PWM, ADCs, SPI and more

Energia abstraction

Fly high above the bits and bytes

{ Boils it down to **1** line of code }

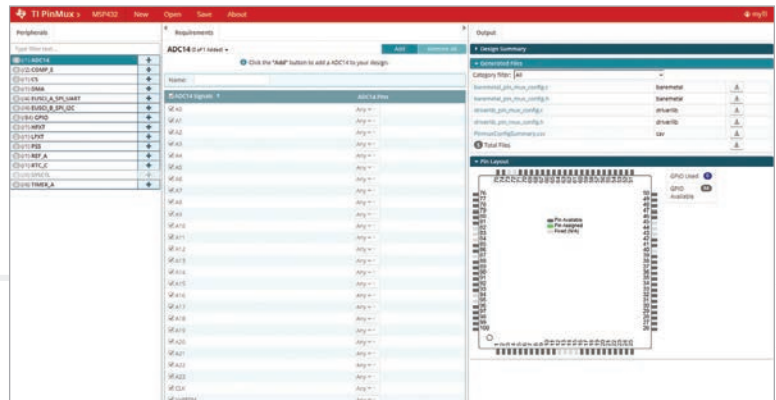
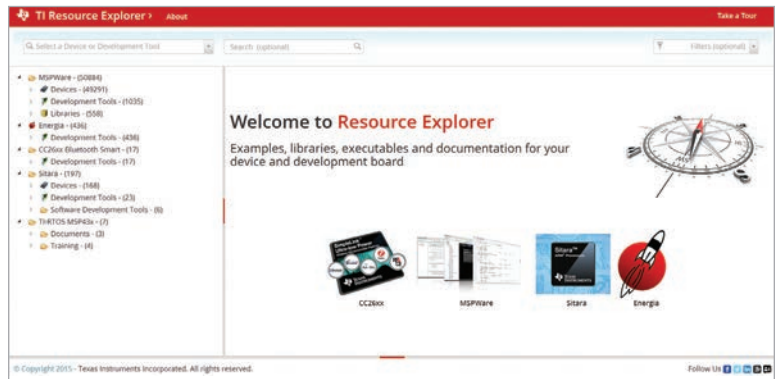


TI Cloud and Professional Tools

CCS Cloud and Resource Explorer

- Browser-based code editing tool to get your started quickly
- Access Resource Explorer to get the latest code examples, design files, and more.
- Cross platform and allows you to upload firmware using TI Cloud Agent
- Focus on bringing all parts of the design process to the cloud
- Instant evaluation of TI products

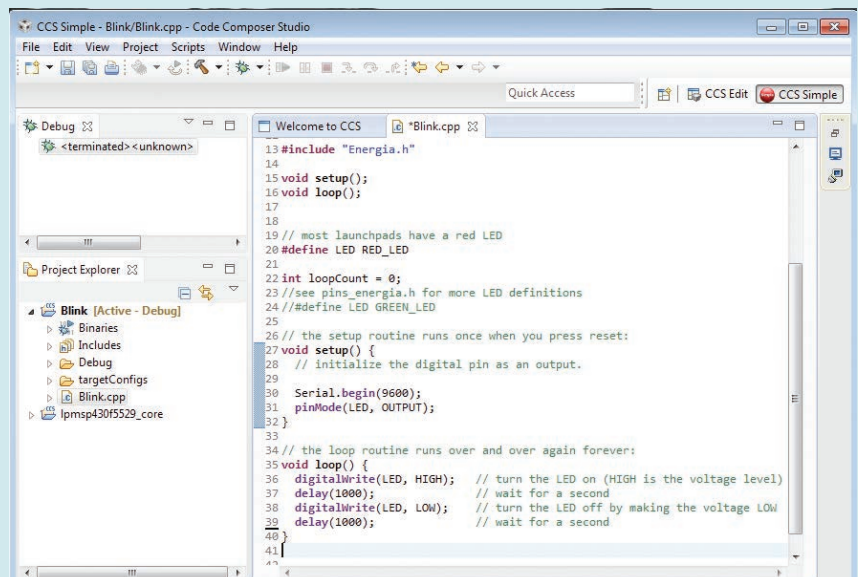
<http://dev.ti.com>



Code Composer Studio™ IDE 6

- Eclipse-based IDE for professional firmware developers that supports all TI processors
- CCStudio App Center allows you to stay current with the latest plugins and updates
- Use tools such as EnergyTrace™, Grace™ and more to optimize your workflow and application
- Resource Explorer exposes thousands of code examples and technical materials

www.ti.com/ccstudio



Energia Import in CCStudio IDE Version 6

- Import an Energia sketch into Code Composer Studio™ (CCStudio) Integrated Development Environment (IDE) v6 and **pick up right where you left off.**
- **CCStudio IDE introduces full debug capability** and other professional features to further optimize your design.
- **Modularize your code** and leverage Energia APIs and libraries within CCStudio IDE.
- **Enable “hybrid” projects** that leverage lower-level C, assembly and even abstracted Energia APIs enabling a developer maximum flexibility during code development.

```

Blink

// most launchpads have a red LED
#define LED_RED_LED

//see pins_energia.h for more LED definitions
//define LED_GREEN_LED

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(LED, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(LED, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000); // wait for a second
  digitalWrite(LED, LOW); // turn the LED off by making the voltage LOW
  delay(1000); // wait for a second
}
    
```

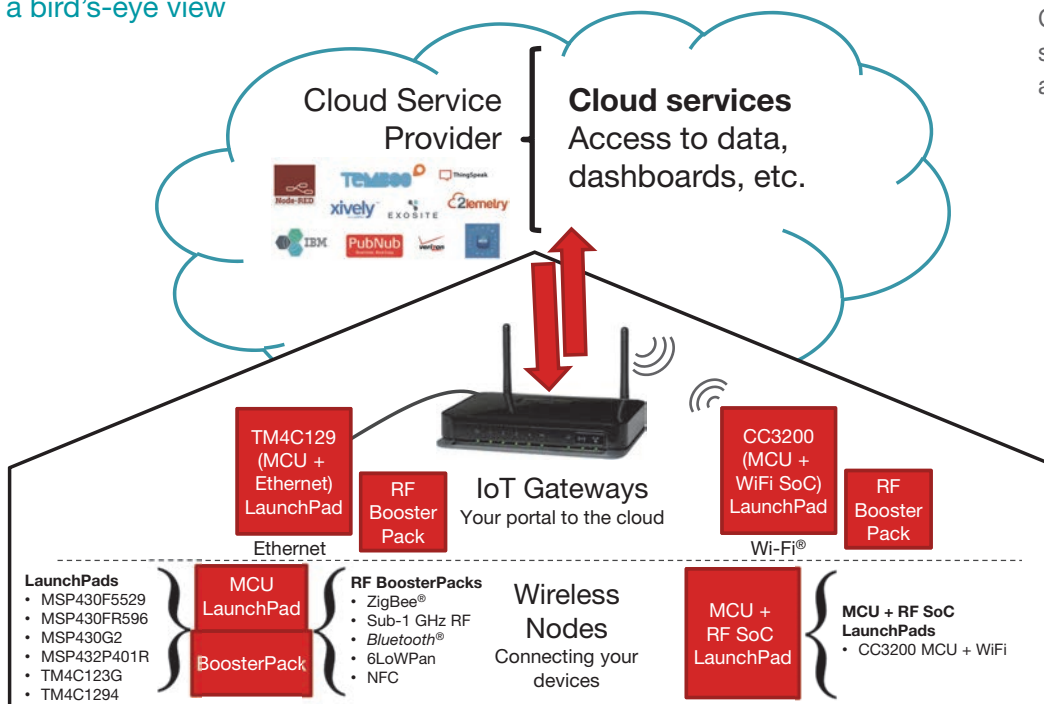


```

CCS Simple - Blink/Blink.cpp - Code Composer Studio

13 #include "Energia.h"
14
15 void setup();
16 void loop();
17
18
19 // most launchpads have a red LED
20 #define LED_RED_LED
21
22 int loopCount = 0;
23 //see pins_energia.h for more LED definitions
24 //define LED_GREEN_LED
25
26 // the setup routine runs once when you press reset:
27 void setup() {
28   // initialize the digital pin as an output.
29   Serial.begin(9600);
30   pinMode(LED, OUTPUT);
31 }
32
33
34 // the loop routine runs over and over again forever:
35 void loop() {
36   digitalWrite(LED, HIGH); // turn the LED on (HIGH is the voltage level)
37   delay(1000); // wait for a second
38   digitalWrite(LED, LOW); // turn the LED off by making the voltage LOW
39   delay(1000); // wait for a second
40 }
41
    
```

LaunchPad and IoT a bird's-eye view



LaunchPad in the cloud

Cloud-connected LaunchPads offer support for various cloud partners and protocols via Wi-Fi® or Ethernet.



Launch Your Design

LAUNCH YOUR DESIGN



IoT made easy

By 2020 there will be 50 billion IoT devices – Get yours today!

The SensorTag allows quick and easy prototyping of IoT devices. It simply works – Connect your sensor solution to the Cloud in three minutes. Get started with Wi-Fi®, Bluetooth® smart, or 6LoWPAN development for only U.S. \$29.

www.ti.com/sensortag

TI SensorTag apps

Download the SensorTag apps for iOS or Android™ to connect to your SensorTag and explore the sensors in a few minutes. The SensorTag app is used to configure the sensors and set up the connection to the cloud interface.



Single-board computing

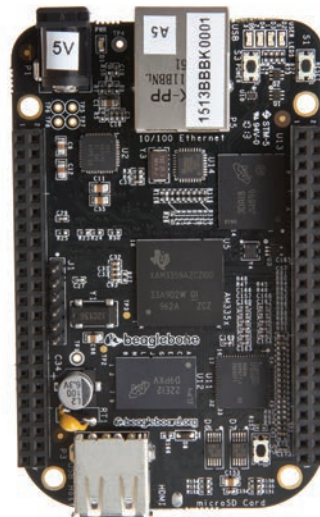
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www.beagleboard.org

BeagleBone Black



Community and Resources

Join the community!

Community

- Post queries, seek answers or gain advice regarding your LaunchPad project
- Share ideas and resources to join the DIY-spirit of makers
- Posting your projects online? Be sure to tag: **#tilaunchpad**
 - And check out www.ti.com/launchpadprojects for LaunchPad-related projects and ideas



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Resources

"Getting Started with the MSP430 Launchpad"



- 200 pages explaining LaunchPad concepts
- 25+ projects
- Energia and BoosterPack in detail
- Available on Amazon/Elsevier

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