

Android Applications With MSP430™ USB on Mobile Devices

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ABSTRACT

This application report explains the hardware and software applications required for the MSP-EXP430F5529LP and MSP-EXP430F5529 boards to work with four Android mobile devices. It addresses customers questions on the software and hardware items needed for the MSP430 USB device and software stack to enumerate and communicate with Android mobile devices.

This document frequently refers to examples found in the MSP430 USB Developers Package. The latest release of the package can be found at the following location: <http://www.ti.com/tool/msp430usbdevpack>.

Project collateral and source code discussed in this application report can be downloaded from the following URL: <http://www.ti.com/lit/zip/slaa630>.

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1 Introduction

Android is a Linux based operating system with a user interface designed for mobile devices like smartphones and tablets where touchscreen capability is important. The operating system uses touch inputs like swiping, tapping and pinching to manipulate visual objects and a virtual keyboard.

The proliferation and popularity of Android mobile devices has driven the need for MSP430 USB stack APIs to enumerate and communicate with these devices.

USB API stack allows for easy and reliable creation of simple USB data connections between a MSP430 device and an android device. The connection between the android device and the various USB device classes is established by running the application examples included in the MSP430 USB Developers Package. The USB device classes used in the application note are:

- Communications Device Class (CDC)
- Human Interface Device Class (HID)
- Mass Storage Class (MSC)

2 MSP430 USB

The MSP430 USB API stack supports only the creation of USB peripheral devices on MSP430 derivatives equipped with an on-chip USB module. It does not provide support for On-The-Go USB feature.

When a USB device is configured, it must contain one or more USB interfaces that define(s) a particular USB device class. Device classes define a USB protocol.

MSP430 USB peripheral supports USB 2.0 at full-speed and 8 endpoints including endpoint 0.

2.1 MSP430 USB Examples

The MSP430 USB Developers Package contains many examples that support CDC, HID and MSC device class types, along with the 'Examples_Guide_MSP430_USB.pdf' document that describes the examples and how to run them.

The examples in the MSP430 USB Developers Package were used to verify compatibility of the MSP430 USB stack with the Android devices listed in this document.

3 Hardware

USB equipped devices can be categorized as either host devices or peripheral devices but not both.

Host devices, like the Windows operating systems, have the ability to provide 5V power to the USB bus, as well as enumerate connected USB devices.

Mobile phones and tablets generally are considered to be peripheral USB devices in that they attach to the host and are controlled by them. All communication between host and devices are always initiated by the host.

Some Android mobile devices have the ability to act as hosts. Android devices with Android version 3.1 and above have the ability to act as either a host or a peripheral device. These devices are equipped with the USB On-The-Go (OTG) feature, which allows the device to act as a host so that devices like the USB Flash drives, keyboard and mouse can attach to them or they can switch to being a peripheral device when attached to another host.

3.1 Android Mobile Devices

The examples provided in the MSP430 USB Developers Package were verified on the following four Android mobile devices:

- Samsung Galaxy Note 8.0 GT-N5110 with Android version 4.2.2
- Nexus 7 ME370T with Android version 4.4.2
- Acer Iconia A1 with Android version 4.2.2
- Samsung Galaxy SIII phone with Android version 4.1.2

The mobile devices did not require rooting in order to run the examples.

3.2 OTG Feature

Android devices with android version 3.1 and above are capable of supporting the OTG feature.

Free applications like, *USB OTG Checker* or *USB Host Diagnostics*, can determine whether the Android phone or tablet has the hardware and the drivers necessary for supporting the USB OTG feature. If the results, after running the applications, indicate a 'no OTG' feature on the Android mobile device, rooting the device might be a way of accessing USB devices.

NOTE: Rooting might void the manufacture's warranty on the device.

3.3 Connecting an Android Mobile Device to a MSP430 USB Device

If the Android mobile device is capable of supporting OTG and is equipped with either a micro-USB port or a HDMI port, an USB OTG cable adapter supporting USB 2.0 is required to connect the Android device to the MSP430 USB device.



Figure 1. Examples of OTG Adapter Cables with Micro-USB to USB and HDMI to USB Connectors

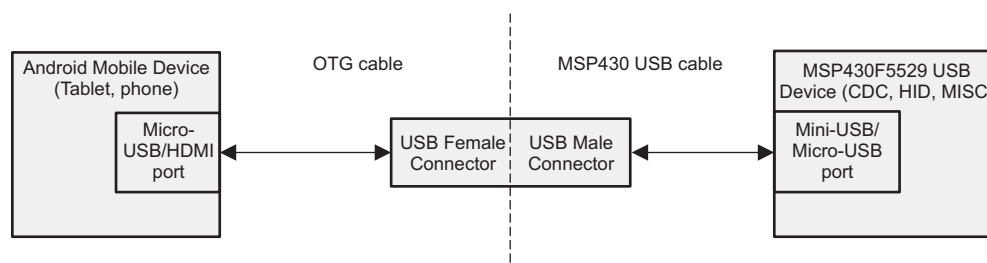


Figure 2. Android Device With OTG Adapter Connected To MSP430 Device

4 Software

In some cases, the Android mobile devices with OTG capability and with the OTG cable could not communicate with the MSP430 device (CDC, HID or MSC), even though enumeration had occurred. In these instances, where pre-loaded applications were not available or were not robust enough, third-party applications had to be downloaded from the Google Store™ online store to facilitate communication between the MSP430 device and the Android device.

4.1 Enumeration

Unlike Windows, android tablets and phones do not provide you with an in-built Device Manager type application for determining device enumeration. Applications have to be either written to list the devices or you can download the application, *USB Device List*. When run, this application lists the VID/PIDs of all the devices attached to its USB ports.

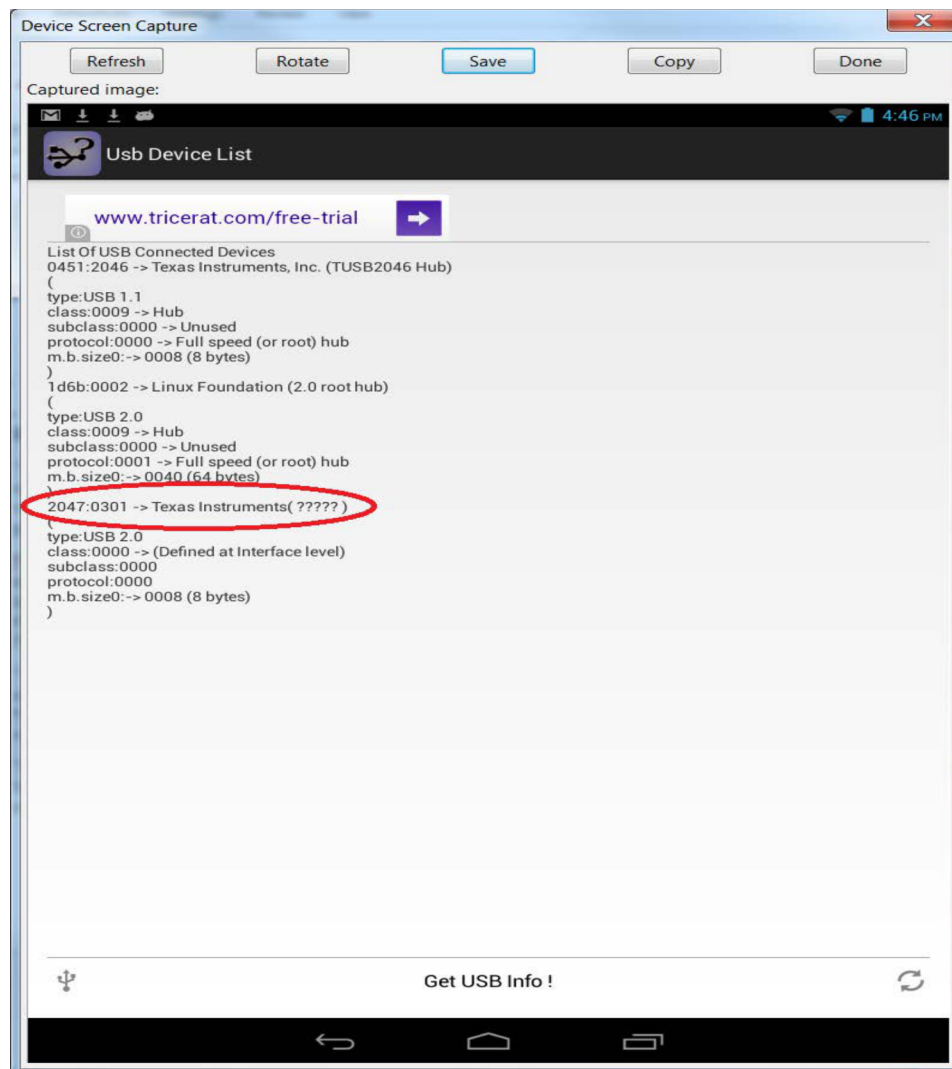


Figure 3. Enumerated HID Device With VID/PID (2047/301)

4.2 HID

Most Android devices have the ability to recognize traditional HID devices like mouse and keyboard without additional applications, however, for other HID devices that use vendor-specific report IDs and structure, additional applications might be required.

The MSP430 USB HID examples, H7_Mouse and H8_Keyboard worked on all of the mobile devices referred to in this document. For the H8 example, text editor applications like *Text Edit*, had to be installed for the MSP430 to write to a text file.

HID terminal applications, available from the Google Store, could not be used to communicate with Datapipe types of HID devices. These MSP430 HID devices use custom HID report classes that are not compatible with the HID-specific applications available at the Google store.

Unlike freeform data packets, HID reports are formatted and structured and are placed within a report descriptor, which is sent by the device to the host during enumeration. If the report structure and content sent by the HID device does not match the one expected by the host, the host and device cannot communicate to transfer and receive data between them. Because of this limitation, the *TI MSP430 HID* application was created for HID examples H0 through H6 to communicate and interface with the host.

4.2.1 Host Software for HID-Datapipe Interfaces: TI MSP430 HID App

The *TI MSP430 HID* application is an Android-based utility for interacting with TI's HID devices.

The application's source and signed apk can be downloaded from: <http://www.ti.com/lit/zip/slaa630>.

TI MSP430 HID application's functionality is similar to that of the terminal applications, except it uses TI's HID-Datapipe report ID and structure for communicating with the host.

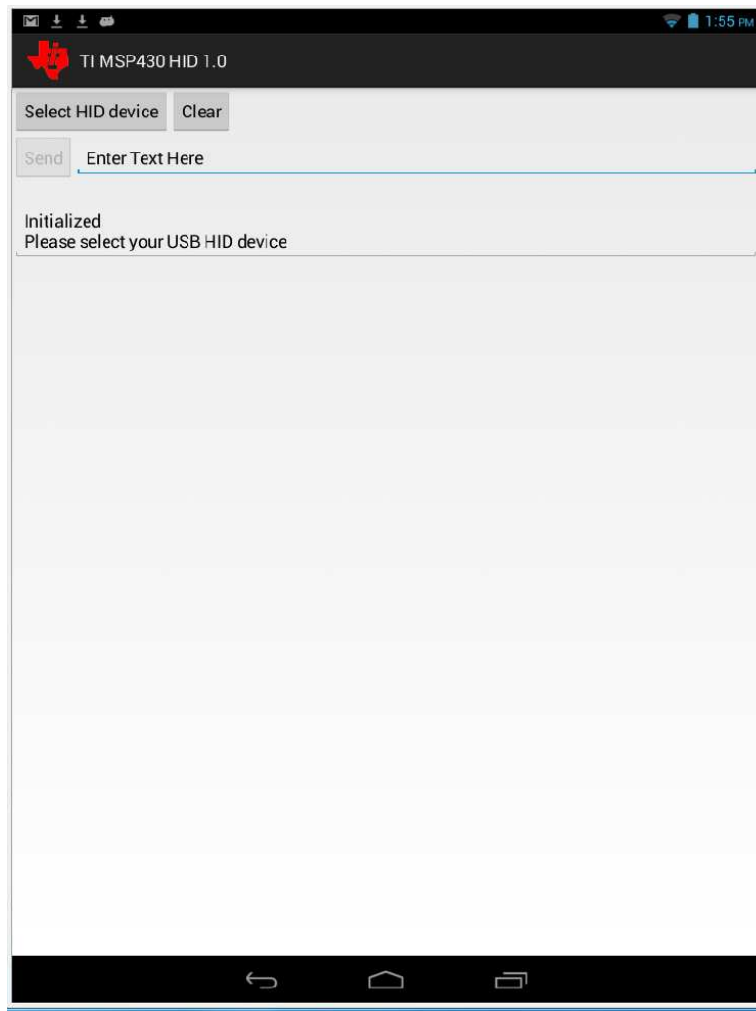


Figure 4. TI MSP430 HID App

The apk can be installed on the android devices without rooting the phone or requiring the USB debugging feature to be turned on.

4.2.2 How the Application Works

The application can distinguish any VID/PID interface on any USB device attached to the android tablet. It can also connect to the USB device; however, the application can only communicate with TI's MSP430 HID devices.

When the application comes up, select the *Select HID device* key to view a list of connected devices. If the desired VID/PID is not shown in the dialog box, the *Select HID device* key might need to be selected again.

The USB single interface HID examples (H0 through H6) all have a VID of 0x2047 and a PID of 0x0301. Once the appropriate VID/PID combination is selected, the application connects to the device.

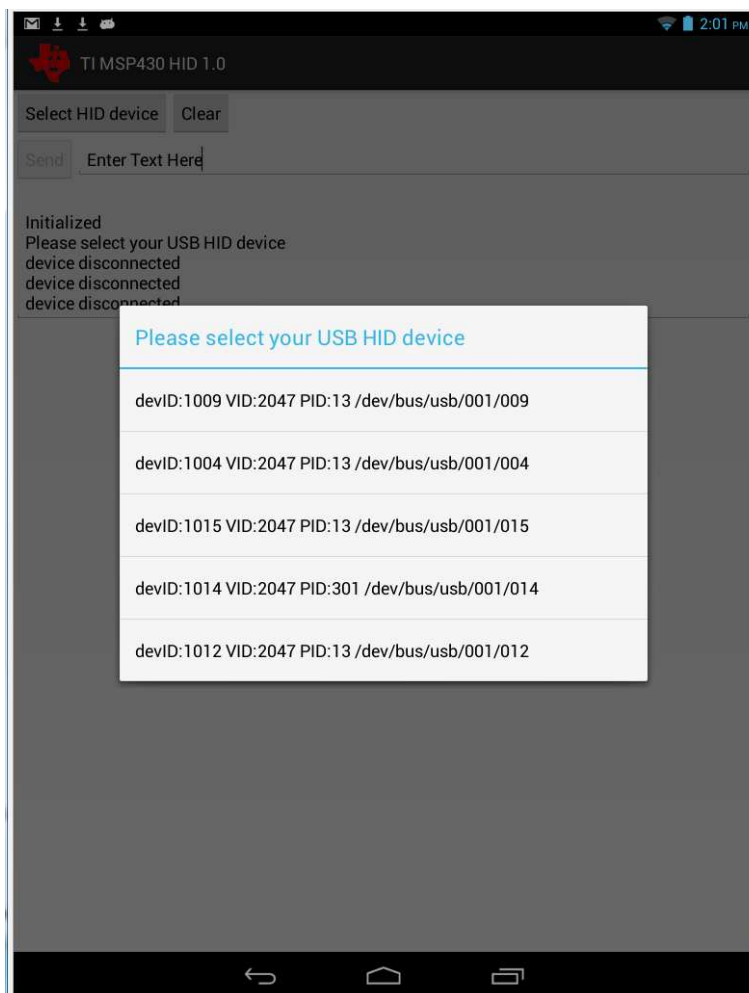


Figure 5. List of VID/PID of Connected USB Devices

Once the connection is established, user-entered data can be sent to the device by entering text in the text field displayed next to the *Send* key. Data is sent to the device when the *Send* key is selected. Data from the device is received by the application at any time and is displayed in the large text area located below the *Send* key. The receive window can be cleared by selecting the *Clear* key, as shown in [Figure 6](#).

The TI MSP430 HID application's *Send* key does not automatically add a return character when selected. Therefore, all text sent to the device should end with a "!" character before pressing send. The HID examples look for this character as a means of terminating the string.



4.3 CDC

The MSP430 CDC device, when attached to a USB host via USB, establishes a virtual COM port on the host.

CDC ports are a simple way for a host to communicate with a peripheral. It was originally designed for RS232 serial ports, but is often used today with USB protocols. Since the physical RS232 port no longer exists, the COM ports are now called *virtual COM Ports*.

For all four Android mobile devices, the *Slick USB 2 Serial Terminal* application was used to facilitate communication between the tablet or phone and the MSP430 CDC device. Examples C0 through C6 were downloaded to the tablets and phone and executed. In some cases, the full functionality of the examples was possible, while for examples C5 and C6 only partial functionality could be achieved due to the limitation of the chosen application.

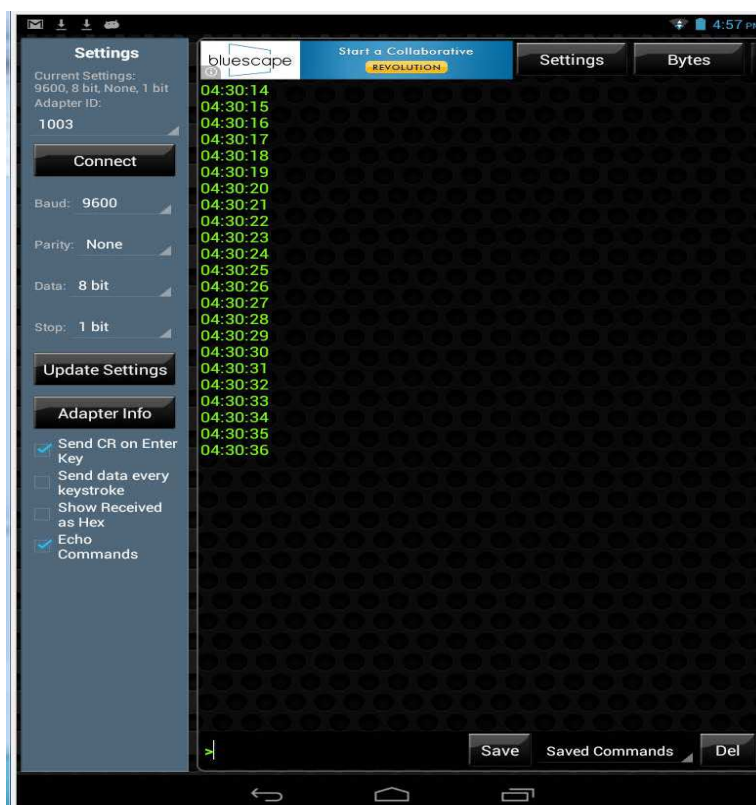


Figure 7. Slick USB 2 Serial Terminal Executing H0

4.4 MSC

The MSP430 MSC device, when attached to a USB host, displays as a storage volume on the operating system. The MSC protocol receives and executes *SCSI commands* from the host and uses the *SCSI transparent command set* for its use. All handling of SCSI commands is performed automatically by the MSP430 USB API stack with some support by the application.

The MSP430 USB stack does not have the capability to mount MSC devices and, therefore, applications created for the MSC device must implement the volume to be mounted. If the application does not mount the volume, the MSC interface might enumerate but the volume might not be mounted. Once the volume is mounted, the USB stack is able to read and write to FAT12, FAT16 or FAT32 formatted drives.

The Samsung Galaxy Note 8.0 GT-N5110 required using the *OTG Disk Explorer Lite* application to open and read the storage volumes represented in examples M1 through M5 while the Nexus 7 tablet required the *Nexus USB OTG File Manager* application, and could only open FAT32 formatted drives.

The Acer Iconia A1 tablet and the Samsung Galaxy S3 phone required no additional applications to be downloaded for M1 through M5 examples to work. Both mobile devices' pre-loaded file management applications were able to open and read FAT16 and FAT32 formatted files.

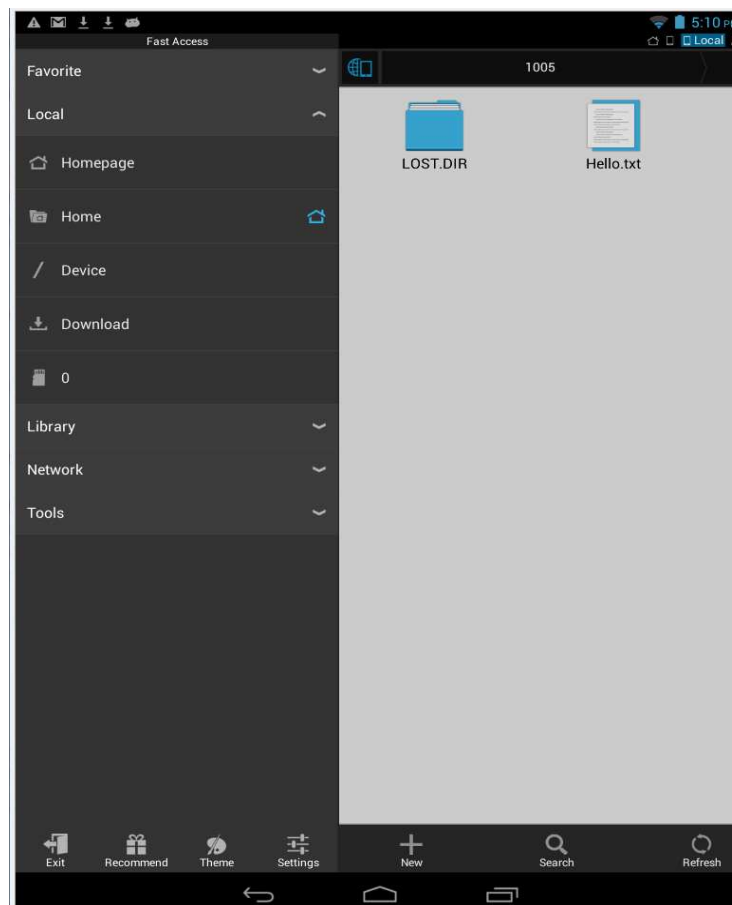


Figure 8. ES File Explorer Accessing MSC Device

5 Conclusion

The MSP430 USB peripherals worked well with some of the available applications at the Google store, however, for the HID examples, a vendor-specific HID tool was required.

[Table 1](#) summarizes the applications used to communicate with the USB peripherals:

Table 1. List of Devices and Compatible Applications

USB Peripheral	Android Device	Application
HID	All devices	TI MSP430 HID
CDC	All devices	Slick USB 2 Serial Terminal
MSC	Samsung Galaxy Note 8.0 GT-N5110	OTG File Explorer Lite
	Nexus 7	Nexus USB OTG File Manager
	Samsung Galaxy S3	Built-in File Manager
	Acer Iconia A1	Built-in File Manager and ES File Explorer

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