Zen Cape's LED Guide

by Brian Fraser
Last update: November 2, 2016

Target Linux Kernel: 4.4

This document guides the user through:

1. Enabling the tri-colour LED #2 on the Zen cape.
2. Controlling the Red, Green, and Blue lights via the Linux command line.

   Note: Use of the tri-colour LED #1 on the Zen cape is covered in the PWM guide. That LED is connected to three PWM channels and can generate mixed (analog) colours. LED #1 is connected to GPIO pins and as such each colour is either on or off.

Table of Contents

1. Zen LEDs....2
2. Device Tree: Enabling the LEDs....2
3. Driving the LEDs....2
4. Device Tree Source (ZENCAPE_LEDS.dts)....3

Formatting:

1. Host (desktop) commands starting with `$` are Linux console commands:
   ```
   $ echo "Hello world"
   ```
2. Target (board) commands start with #:
   ```
   # echo "On embedded board"
   ```
3. Almost all commands are case sensitive.

Revision History:

- Nov 2: Initial version for Kernel 4.4.

1. Zen LEDs

There are two tri-colour LEDs on the Zen cape, both to the left of the 14-seg display:

- LED1 is connected to three PWM channels and is covered in the PWM guide.
- LED2 is connected to three GPIO pins, and its operation is described here.

See the LED guide (for just the BeagleBone's built in LEDs) for more on using the LEDs.

2. Device Tree: Enabling the LEDs

For Linux to treat the red, green, and blue components of the tri-colour LED as actual LEDs (vs unconfigured GPIO pins), we must load a device tree using the cape manage.

1. Download the file `ZENCAPE_LEDS.dts` from the course website:
   ```
   # wget http://www.cs.sfu.ca/CC/433/bfraser/other/guide-code/ZENCAPE_LEDS.dts
   ```
2. Compile the device tree source (.dts) file into a "blob object" file (.dtbo):
   ```
   # dtc -O dtb -o ZENCAPE_LEDS-00A0.dtbo -b 0 -@ ZENCAPE_LEDS.dts
   ```
3. Deploy the .dtbo file to the target's /lib/firmware folder:
   ```
   # cp  ZENCAPE_LEDS-00A0.dtbo /lib/firmware
   ```
4. Using the cape manager, enable this cape:
   ```
   # export SLOTS=/sys/devices/platform/bone_capemgr/slots
   # echo ZENCAPE_LEDS > $SLOTS
   ```
5. Check listed capes (slot numbers may vary):
   ```
   # cat $SLOTS
    0: PF----  -1
    1: PF----  -1
    2: PF----  -1
    3: PF----  -1
    4: P-O-L-   0 Override Board Name,00A0,Override Manuf,ZENCAPE_LEDS
   ```

3. Driving the LEDs

1. List all files in the `/sys/class/leds/` directory:
   ```
   # ls /sys/class/leds/
   beaglebone:green:usr0  beaglebone:green:usr2  zencape:blue   zencape:red
   beaglebone:green:usr1  beaglebone:green:usr3  zencape:green
   ```
2. Change to the Zen cape's blue LED folder:
   ```
   # cd /sys/class/leds/zencape\:blue
   ```
   - Note that you cannot type ':' in a path, you must escape it.
3. Change the trigger to a heartbeat:
   ```
   # echo heartbeat > trigger
   ```
4. Manually turn on the blue LED:
   ```
   # echo none > trigger
   # echo 1 > brightness
   ```

4. Device Tree Source (ZENCAPE_LEDS.dts)

```
/*
* Configure the three signals for the tri-colour LED on the Zen cape to be an LED in Linux
* Based on: https://github.com/nomel/beaglebone/blob/master/led-header/generated/led-P9.12-00A0.dts
* Written by Brian Fraser; released under GPL and BSD.
*
* Updated Nov 2016 for Kernel 4.4
*/

/dts-v1/;
/plugin/;

/ {
     compatible = "ti,beaglebone", "ti,beaglebone-black";

     /* identification */
     part-number = "ZENCAPE_LEDS";

     /* state the resources this cape uses */
     exclusive-use =
          /* the pin header uses */
          "P9.12",        /* Red */
          "P9.13",        /* Green */
          "P9.11",        /* Blue */

          /* the hardware IP uses */
          "gpio1_28",
          "gpio0_31",
          "gpio0_30";

     /* rxDisable_pullNone state */
     fragment@0 {
          target = <&am33xx_pinmux>;
          __overlay__ {
               configure_pins_rxDisable_pullNone: pinmux_gpio_rxDisable_pullNone {
                  pinctrl-single,pins = <
                       0x78 0xf /* P9.12 Output Mode 7, no pull */
                       0x74 0xf /* P9.13 Output Mode 7, no pull */
                       0x70 0xf
                  >;
               };
          };
     };

     fragment@1 {
          target = <&ocp>;
          __overlay__ {
               zencape_led_helper {
                  compatible = "gpio-leds";
                  pinctrl-names = "default";
                  pinctrl-0 = <&configure_pins_rxDisable_pullNone>;

                  zencape-red {
                       label = "zencape:red";
                       gpios = <&gpio1 28 0>;
                       linux,default-trigger = "none";
                       default-state = "off";
                  };
                  zencape-green {
                       label = "zencape:green";
                       gpios = <&gpio0 31 0>;
                       linux,default-trigger = "none";
                       default-state = "off";
                  };
                  zencape-blue {
                       label = "zencape:blue";
                       gpios = <&gpio0 30 0>;
                       linux,default-trigger = "none";
                       default-state = "off";
                  };
               };

          };
     };

};
```