Tutorial AR Drone Miru Mod on Windows 7 with DX6i, Part 5 **V1.3**
UFO Doctor, Aug 23th, 2011

17. VLBA experiments with external LED at Arduino Pin9

Introduction

Miru Mod 008 offered us the "Visible Low Battery Alert " VLBA, displayed by blinking LEDs at the drone wings if it is time to land, a very good and useful work!
Miru Mod 009 offers now an additional VLBA signal at ArdunioProMini, Pin 9:
You may use this Pin 9 signal for two low-power, high intensity LEDs mounted at the bottom of the drone or for a wireless alarm transmitter as proposed by Candu1.

```
#define  VLBA_THR     /*default =*/    15      /* select a value between 5 to 20
                                                (% of the remaining battery capacity)
                                                0 or > 60 turns it off */
#define  VLBA_POL     /*default=*/     1       /* 1-active high, 0-active low */
#define  VLBA_BLINK   /*default=*/     1       /* 1-blink, 0-no blink */
```

Miru worked hard for rewriting a lot of his software, thank you for your great work!

The preceding Miru tutorials Part 1 to 4 are listed here:
http://ufo-doctor.ch/descriptions/Parrot%20Infos/Tutorial%20Miru%20Part%204_V8.pdf

17.1. Experiments with serial LEDs at the Arduino Output Pin 9

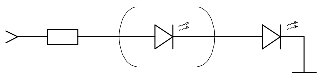
Vout R LED2 LED1	Nr. of LEDs	R Ohm	Current mA	Vout V
	1	120	18.6	4.19
	1	100	21.1	4.11
Ardunio Pin9 Gnd	2	22	20.1	4.16

Table 3. LED circuit and experimental data
LED: L934SRC-J, ∅3x5.4mm, viewing angle 50^0, 2300 mcd, max 30 mA

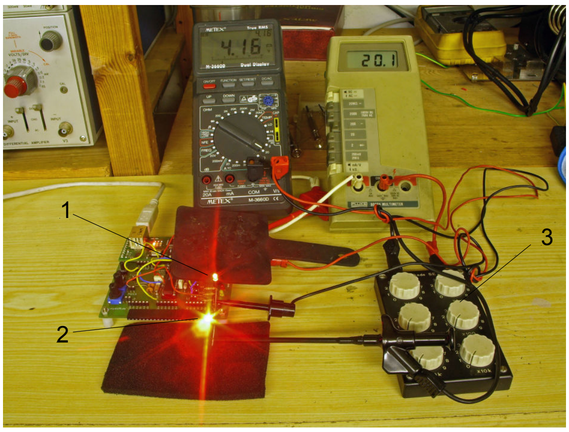


Fig. 25. LED test on myAVR Board (ATMEGABL-8PU)
1: LED1 vertical,
2: LED2 bent 45^0 toward camera
3: Serial Resistor Decade 1Ω to 1 MΩ

WARNINGS:
Do never test a LED without serial resistor or other current limiter!
Without resistor a single-use intensive flash let you know that the polarity WAS correct. The uC might be killed, too.

The current of 20 mA lets the Atmega output drop from 4.73 to 4.16 V, but this is acceptable since the maximum Atmega sink current is specified to 40 mA.

The LED1 and LED2 are mounted at the drone plug, with a single thin additional cable to the Ardunio. The serial 22 Ohm resistor to Pin 9 is mounted on the Ardunio.

VERY IMPORTANT: KEEP THE DRONE PLUG + LEDs AS FLAT AS POSSIBLE!

The clearance between a flat landing surface and the drone's bottom protection shield during hard landings is about 4mm only. The LEDs on the plug SHOULD NOT overlap this shield more than 2 mm in order to prevent shocks to the drone board.

The good news: The Miru Mod 009 (15 grams!) remains plug and play as ever!

17.2. Assembly of the LEDs on the drone plug

If you are an expert in microsurgery and electronics, you do not need any advice. But if got a MBA degree from Harvard University only, it's better to follow this guide!

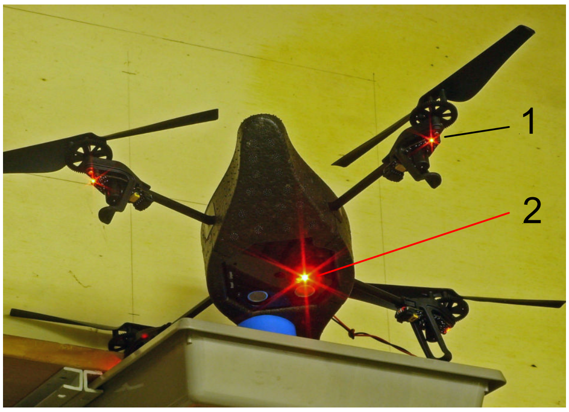


Fig. 26. Goal Nr. 1: Visibility.

The drone plug LEDs for VLBA should be visible during flying very high and also near ground, heading 12h.

Please note the high intensity of the external LED (2) compared with the LED at the wings (1)!

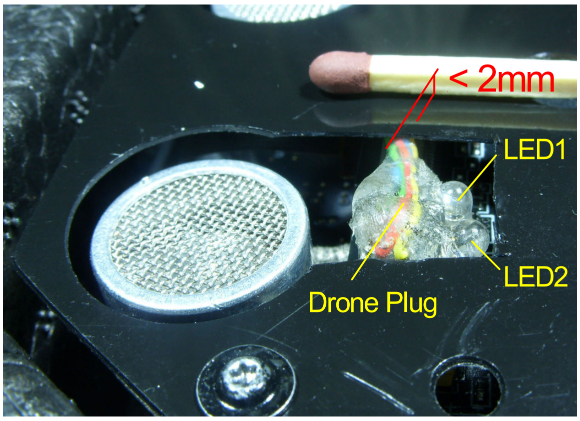


Fig. 27. Goal Nr. 2: Very flat drone plug.

The drone plug with 2 LEDs, protected by transparent epoxy, should not overlap the black shield more 2mm.

LED1 is vertical; LED2 is bent to the right by 45^0.

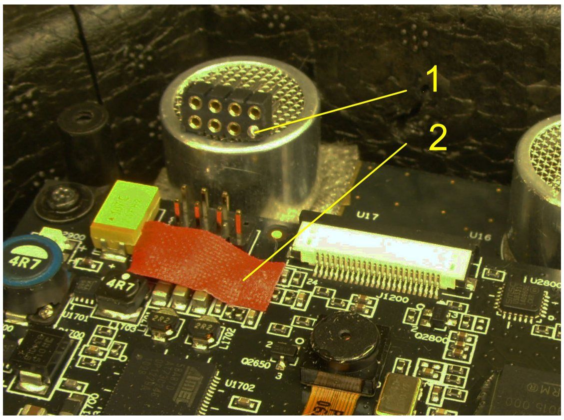
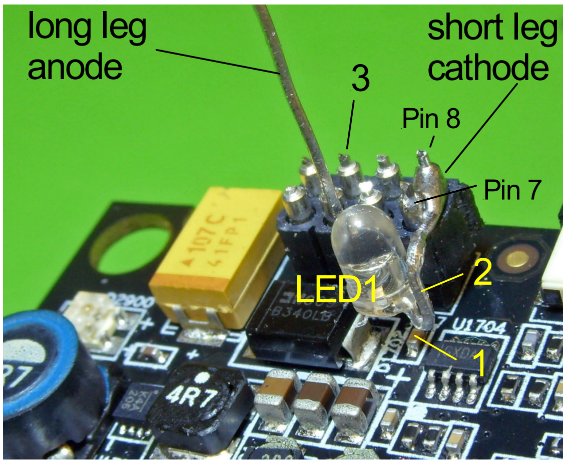


Fig. 28. Goal Nr. 3: Safety.

Take precautions that the Drone Plug cannot be inserted the wrong way:
1: Block contact Nr. 8 by a wire soldered into the bore

The Drone Plug with LEDs should not contact any electronic components on the board, even at hard landings:
2: Protect the components by a strong adhesive insulation tape



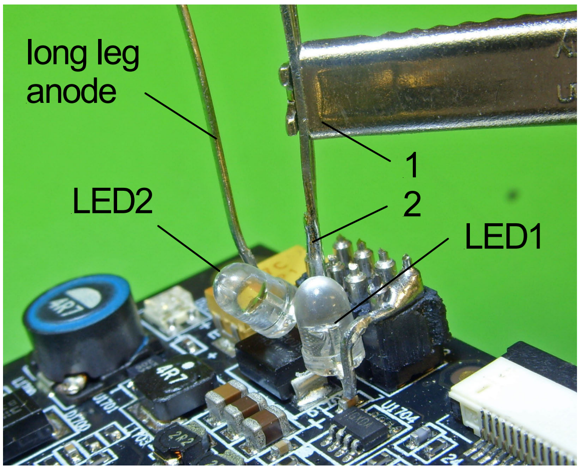
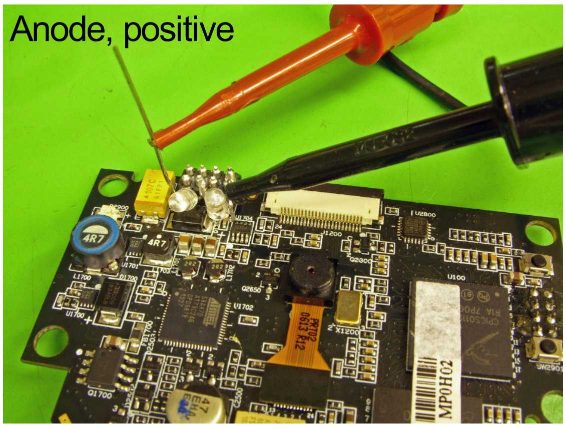


Fig. 29. Explore the available space.

1: Observe that component D1 702 is below LED1! Keep Out!
2: Bend the wires of the LED1 gently by a pair of tweezers (not with a hard long-nose pliers, the legs will break) and solder the cathode to pins 7 & 8
3. Cut the pins of the plug to minimum

Fig. 30. Assembly of LED2.

1: Clamp the short leg of LED2 to the long leg of LED1
2: Solder and cut the legs a little bit deeper than the pins of the plug



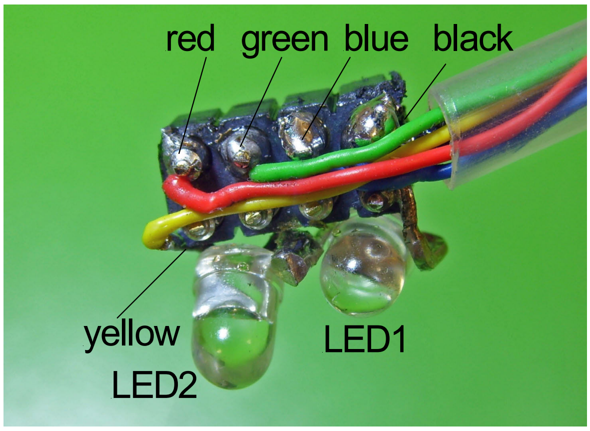


Fig. 31. Check the soldered LEDs

(Miru told me to unplug the connector for this test!)

Do you remember the warnings at Fig. 25?

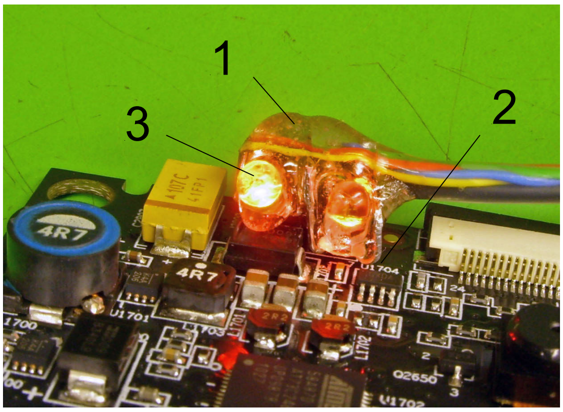
If not, your game will end here, sorry for your careful manual work up to this point!

Fig. 32. Cables (see also Fig.5, Part 1)

Start soldering with the black cable ∅0.5mm, then ∅0.3mm blue, green, red and finally yellow at the anode of LED2.

Test of a ∅0.3mm/100mm cable:

With 400 mA the voltage loss is 21mV, the resistance is 52 mΩ and nothing gets hot!



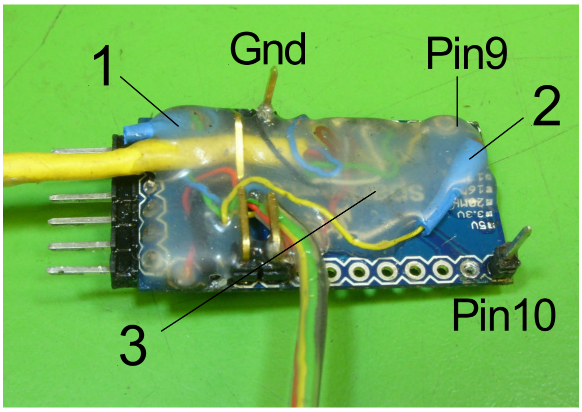


Fig. 33. Encapsulation and test

1. Apply transparent epoxy on the top of the drone plug.
   Take care that the epoxy does not drop onto the main board! Otherwise the plug cannot be disconnected anymore.
2. Check that LED1 and LED2 do not contact or press any components on the board.
3. Check the visibility of the LEDs

Fig. 34. Connection to the Arduino board

1: Resistor, about 4.7 kΩ to RXI
2: Resistor, about 22 Ω to LEDs
3: Hot glue, about 0.5 gram

The hot glue can be removed easily by a heat gun for shrinking tubes, using a plastic stick to pick the liquid glue

18. Driving external electronic equipment by the LVBA signal from Ardunio Pin9

18.1. General discussion

What would you like to drive with the VLBA? A 10 Watt Christmas tree illumination or a tiny 3.3 V 20mW transmitter?

The VLBA triggers at about 10V, the current to hover the drone is about 4 A and any high energy consuming device will reduce the remaining flight duration.

The output of the Ardunio Pin9 can deliver up to 40 mA with reduced output voltage (see Table 3: 20mA@4.16V).

18.2. Characteristics of the internal voltage regulator of Ardunio Pro Mini

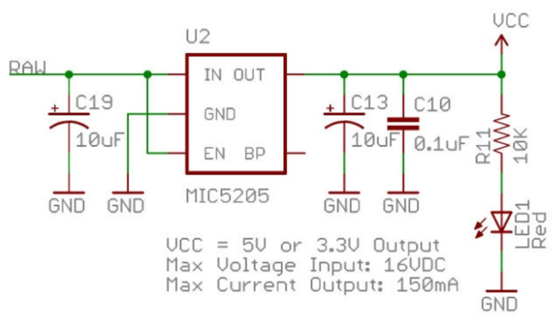


Fig. 35. Specifications of the internal voltage regulator, powered by 12V

Vraw: 12V, Vcc: 5V
Current at external load: 100mA
Dissipated power Pdis:
Pdis =(Vraw-Vcc) x Iout = 700mW

This is lost power and could produce excessive heat.

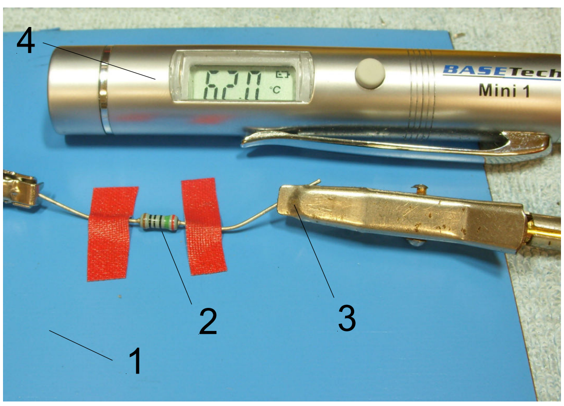


Fig. 36. Approximate thermal limits test

1: PCB (similar to Ardunio board)
2: Resistor 100Ω (size about MIC5205)
3: Clamp to variable power supply
4: Optical thermometer

Test results:

8 V, 80mA, 640mW: 62 ^{o}C
10 V, 100mA, 1000mW: 81 ^{o}C

Conclusions:

The Miru Mod (with RC receiver, but without external LED) consumes 38mA. Thus you may use this internal 5V supply for an additional load up to about 30mA.

A total power consumption of 68mA x 12V = 816mW is small compared with the drone consumption 4.7A x 12V =56.4W.

18.3. Open collector transistor for external electronic equipment

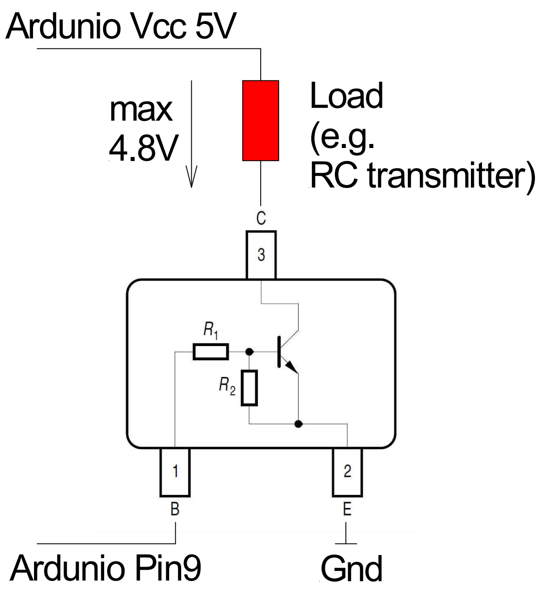


Fig. 37. Open collector for supplying an external load with 4.8V

SMD Transistor BCR 108
(with internal resistors already!)

Max. 50 V
Max. 100 mA
(limitation: Ardunio 5V, 50 mA!)

Low weight, little work, easy to solder to the Ardunio board

Minor losses at the internal Ardunio voltage regulator

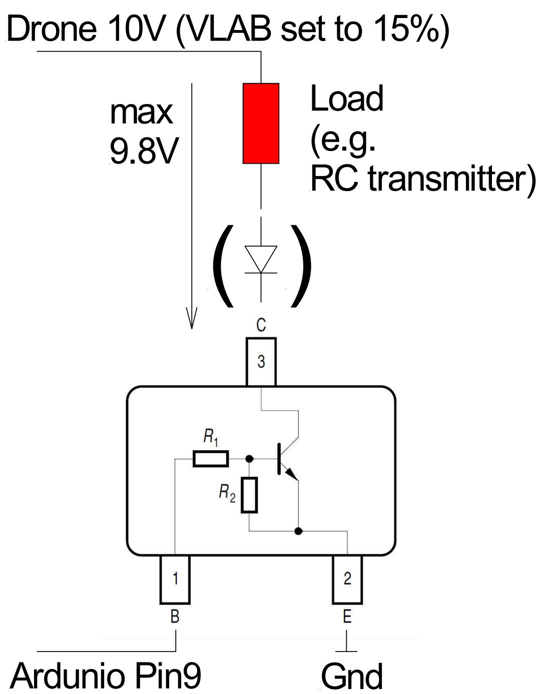


Fig. 38. Open collector for supplying an external load with 9.8V

Max. 100 mA from drone supply,
No losses at Ardunio voltage regulator.

Take care not short circuiting the drone supply! It’s a nasty very hot game and water will not help to extinguish the fire at the lipo!

If you need more current you may choose a powerful NPN transistor and external resistors:
R1 ca. 2.2kΩ, R2 ca. 47kΩ

Any n-type MOSFET would be fine, too.

If you need to reduce the voltage at the load, you may insert diodes (0.6V forward voltage) in series between load and collector C

If you need a current limitation, you may insert a serial resistor between load and collector C.

18.4. Voltage regulator for external electronic equipment

If your equipment needs a precise voltage, you need to add a voltage regulator. There are voltage regulators with an enable input, you can use pin 9 to drive it.

http://www.micrel.com/_PDF/mic5205.pdf

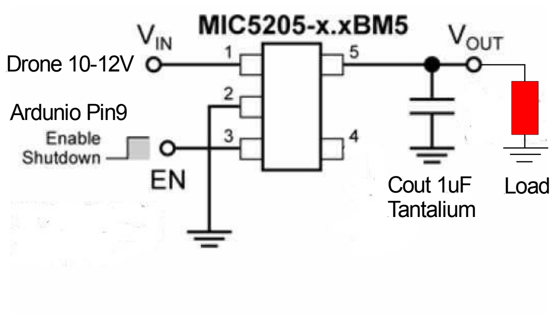


Fig. 39. Voltage Regulator

Vout: 13 items from 2.5 to 5V, or adjustable by user

Current: 150 mA max

Size: SOT-23-5 (M5) (3x3x1.3mm!)

18.5. Voltage controlled current source for high power LEDs

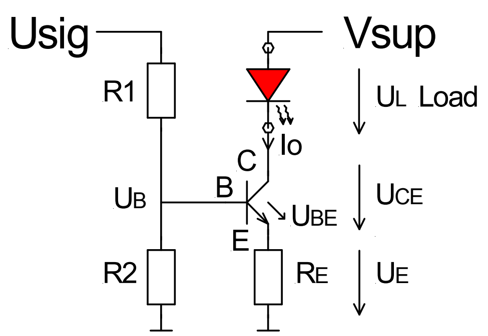


Fig. 40. Current source with NPN transistor

$I_o = U_E / R_E$

max current: see data of LED and transistor

U_{BE} = 0.6 V (approx.)

$U_E = U_B - U_{BE}$

U_{CE} = 0.2V min (saturation)

U_L max. = $V_{sup} - U_E - U_{CE}$

Do not select a U_B below 1V, since U_{BE} will vary with temperature!

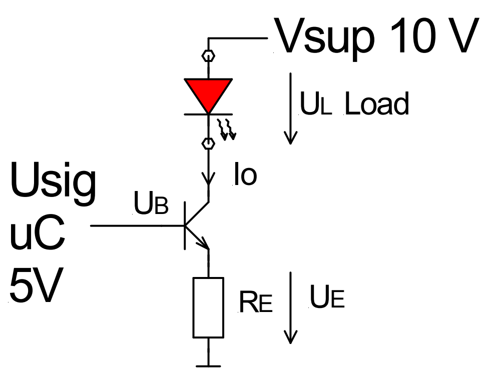


Fig. 41. Current source with NPN transistor, driven directly by the Ardunio Pin9, powered by drone battery:

Vsup = 10 V at VLBA 15% battery capacity

U_B = 5 V

U_E = 4.4V

$I_o = U_E / R_E$

U_L = 5.4V max.

Conclusions:

Choose the right circuit for your specific application and calculate the resistors. Test the circuit on an experimental board, if you are not a genius!

Good luck and have fun!

Kind regards
UFO Doctor