



DIYINO STARDUST v2 USER MANUAL

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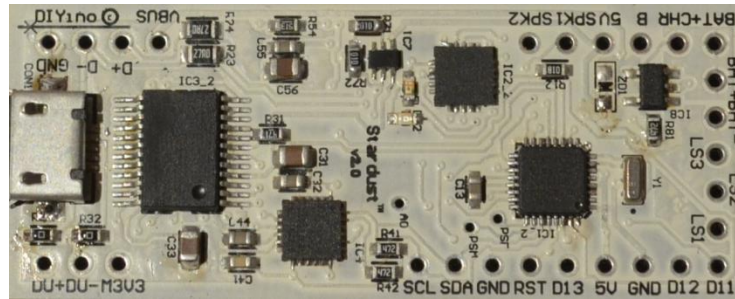
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1 INTRODUCTION

DIYino Stardust is an Arduino compatible integrated circuit board for all projects implementing **Light/Sound/Motion**. Its main field of application is to control lightsaber, blaster and other prop/replica electronics. It is Arduino compatible, i.e. it can be programmed using Arduino compatible IDE's (Arduino IDE, Eclipse etc.)



Board features on a glance:

- Compact size: **21 mm(W)x 51 mm(L)x 5 mm(H)**
- Arduino Compatible
- Gapless Wav-audio playback
- Full USB integration (code upload, sound file upload, Li-Ion/LiPo battery recharge, kill-key)
- 3W audio amplifier (supports 8Ω/4Ω speakers up to 3W)
- Built in high-end gesture detection sensor (6-axis accelerometer and gyro)
- **K³ Technology**: aka. “**Kill the Kill-Key™**”: Ultra-low power consumption in sleep/idle mode (0.3mA)
- Unique USB Kill-Key™ feature
- Includes FTDI USB2Serial chipset for plug-and-play programming using Arduino IDE or similar
- 3 PWM controlled build-in low-side drivers as power extenders with up to 2.4A current capability each
- Input voltage range 3.7V-5V
- No mechanical moving parts involved, sound files stored on on-board 16 Mbyte SPI-Flash

Warning: DIYino Stardust is an electronic board containing parts sensitive to ESD. Final wiring & assembly is under the responsibility of the user with the appropriate tools and ESD protection. If you're not familiar with ESD, please visit : http://en.wikipedia.org/wiki/Electrostatic_discharge
The manufacturer cannot be held responsible for improper use or assembly of the DIYino Stardust board.

2 GETTING STARTED

2.1 PREPARING THE BOARD FOR FIRST USAGE

The Stardust v2 boards are delivered leaving it up to the user to select the supply scheme most appropriate for the selected application (see Chapter 3). For this reason prior to plugging in the USB cable to check if the board is alive the BAT+ signal must be connected to the 5V signal, corresponding to single cell or standard supply scheme as outlined in Chapter 3.1. After these signals are connected, the 4.2V of charging output voltage of the USB charger circuit shall be present on the 5V signal, supplying the circuits in the digital and mixed signal part.

Therefore prior to plugging in the USB cable for the first time follow these steps:

1. Connect the BAT+ signal to the 5V signal (see Figure 1)
2. Using a multimeter make sure there is no short circuit between GND and 5V, and no short circuit between BAT+ and BAT-.
3. Now you are set to plug in your USB cable to the on-board USB port.
4. Using a multimeter measure the voltage between any GND and the 5V signal. The reading should show ~4.2V. This is the peak charging voltage of the USB charger and shows that the board is supplied through the USB charger and the charger is alive (at this state the battery does not need to be connected).
5. Now your 40hm/80hm Speaker can be connected between SPK1 and SPK2. Make sure using a multimeter that you measure the specified inpedance of the speaker between these two terminals and no short exists between the terminals and any of the neighboring signals.
6. The board comes delivered with a test sketch which repeats a test sound every 2 secs and shows over the Serial Monitor of the Arduino IDE the calibrated gyro- and accelero values of the MPU. To see it open Tools/Serial Monitor in the Arduino IDE (see Chapter 8), and change the default baud rate (lower right corner) from the default 9600 to 115200. Now you should hear the test sound repeated every 2 secs and see the acceleration/gyro values. Move the board and observe that the values react.
7. Now your board is proven to be working fine, you can wire it up fully (of course unpowered) and upload other “skecthes” (Arduino slang for application code).

If later on the user decides for another supply scheme, this connection can be replaced with the wiring corresponding to either one of the supply schemes in Chapter 3.

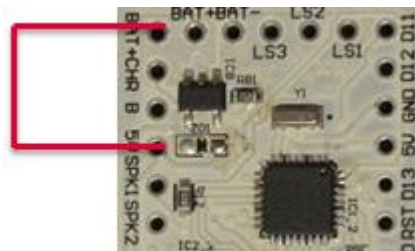


FIGURE 1: PREPARING THE BOARD FOR PROGRAMMING VIA USB

2.2 UPLOADING FIRST SOUND FILES

The Stardust v2 board stores sound files on an 16Mbyte on-board SPI-Flash module. The SPI-Flash can be used just like a pen drive via USB connection. The board has a single USB port which can be used for various purposes (see Chapter 0), among others to copy files to the SPI-Flash via USB. However to ease first time programming, the R32 and R33 resistors which connects the USB signals of the UART and the USB signals of the MP3 player chip are not mounted on the board (to know how to connect them later on refer to Figure 9).

For first time parallel programming of both the controller and the SPI-Flash you can utilize the delivered USB breakout board to connect it to the USB signals of the SPI-Flash/MP3 chip shown on Figure 2. This way your computer will see on one USB port the COM port corresponding to your board for code upload while the other USB port will see the SPI-Flash as a 16Mbyte pen drive where you can upload sound files.

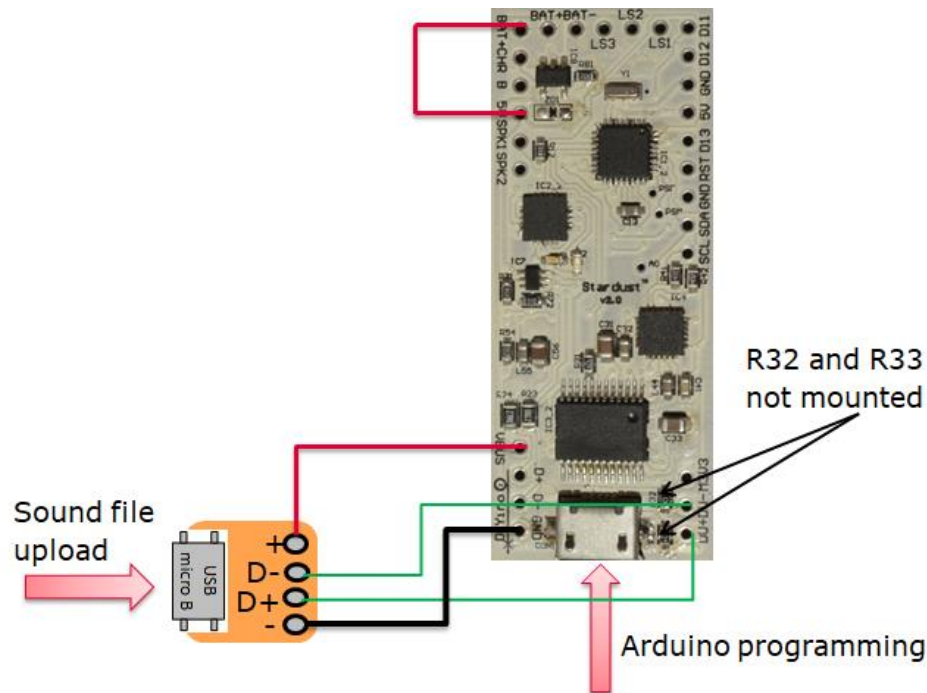


FIGURE 2: UPLOADING SOUND FILES TO THE INTERNAL SPI-FLASH

2.3 A PIECE OF ADVICE ON THE USB PORT

The delivered USB breakout board can be used to wire up a programming/recharge/sound-file-upload terminal to be accessible from the outside of your prop design. This way the electronics can be enclosed and all interaction with the electronics can be handled via this single USB port. The USB breakout board is also recommended to be used for charging the single cell Li-Ion/LiPo battery. Why it is so? You can of course use the on-board USB terminal for all these operations as well. However as opposed to the somewhat larger mini-USB port, the smaller micro-USB port is less mechanically sturdy. It has no guide pins protruding into the PCB to hold it tight in place like the mini-USB, therefore repeated plug-in and – out might dislocate the port and sever the solder between the port and the PCB. Therefore please

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handle the on-board mini-USB port with care (true for all micro-USB port, not only the one on Stardust v2!) and utilize the USB breakout board for frequent usage.

3 BOARD SUPPLY CONCEPTS

Warning: Please note that the DIYino Stardust board does not implement a reverse polarity protection. Reversing the polarity of the supply might lead to board damage!

3.1 STANDARD SUPPLY SCHEME

The DIYino Stardust board shall be supplied directly from a single Li-Ion or LiPo battery cell. Please connect the positive terminal of the battery to the 5V signal to supply the board directly from the battery.

Figure 3 shows wiring of the voltage source used to supply the board. If the USB cable is plugged in, i.e. as during sketch upload, the circuit will be supplied by the USB port, with any surplus current used to charge the battery. If there is no battery connected to the board, it can be supplied via USB through the USB charger circuitry, providing ~4.2V to the board.

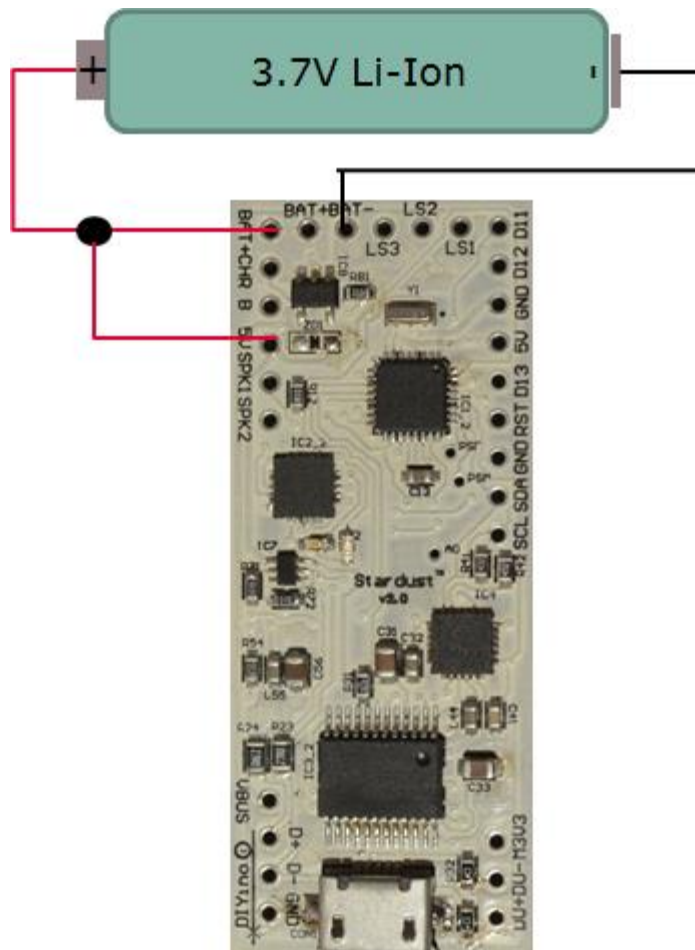


FIGURE 3: STANDARD SUPPLY WIRING

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Warning: before connecting any Li-Ion or LiPo battery to the DIYino Stardust, please ensure that your selected battery complies to the charging characteristic of the USB on-board charger (CCCV with 250mA average charge current at 4.2V charge voltage). In case of doubt please consult your battery vendor. The board manufacturer of the DIYino boards cannot be held liable for any injury or damage due to incompatibility of the used battery with the on-board Li-Ion/LiPo charger.

3.2 ALTERNATIVE SUPPLY CONCEPTS

The standard supply scheme is explained in Chapter 3.1 The supply schemes introduced in the current Chapter are considered technically feasible to supply the DIYino Stardust board, however special care should be taken as they represent advanced concepts. Therefore please read the description and only use the below described supply schemes if you understand how to use them.

3.2.1 USB KILL-KEY™ USING THE „B-POINT“

The „B-point“, or B breakout signal can be used to decouple the battery voltage completely from the digital subsystem of the board if a supplied USB cable is plugged in. The USB will charge the battery with no load from the board electronics. Although the Stardust has an extremely low sleep/idle more quiescent current, this feature effectively disconnects the board from the battery, except for the USB charger. It is a legacy feature for those who prefer to use a Kill-Key.

It is recommended to use this feature only if the final code and sound files are uploaded to the board, as using this feature will leave the board unpowered when USB is plugged in, therefore no code upload is possible.

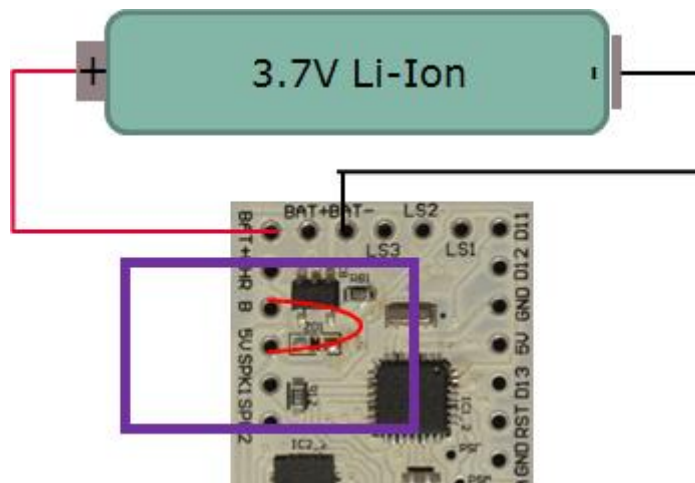


FIGURE 4: USB KILL-KEY™ WIRING

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3.2.2 SUPPLY USING 5V DC/DC BOOST

Although the Stardust can be optimally supplied from a single 3.7V battery cell, the input voltage to the board can be increased to 5V using a DC/DC boost converter. A boost converter regulates (“boosts”) the voltage from a lower input voltage to a higher output voltage. Please use a DC/DC boost converter with a 5V output.

Warning: DC/DC boost modules which are not rated at 5V output voltage usually have an adjustable voltage output, which can far exceed 5V. Using such a DC/DC boost module could cause board damage if the output voltage is not adjusted to 5V (or below) prior to connecting it to the board! Even DC/DC converters with a nominal regulated (boosted) voltage of 5V might exceed 5V, so always measure the output voltage of a DC/DC boost converter before connecting to the DIYino Stardust to avoid board damage.

The clear advantage of this supply scheme is that the board is supplied with the required 5V for best performance, while the lower input supply voltage can be used to power the LEDs/other external circuits with nominal voltages below 5V.

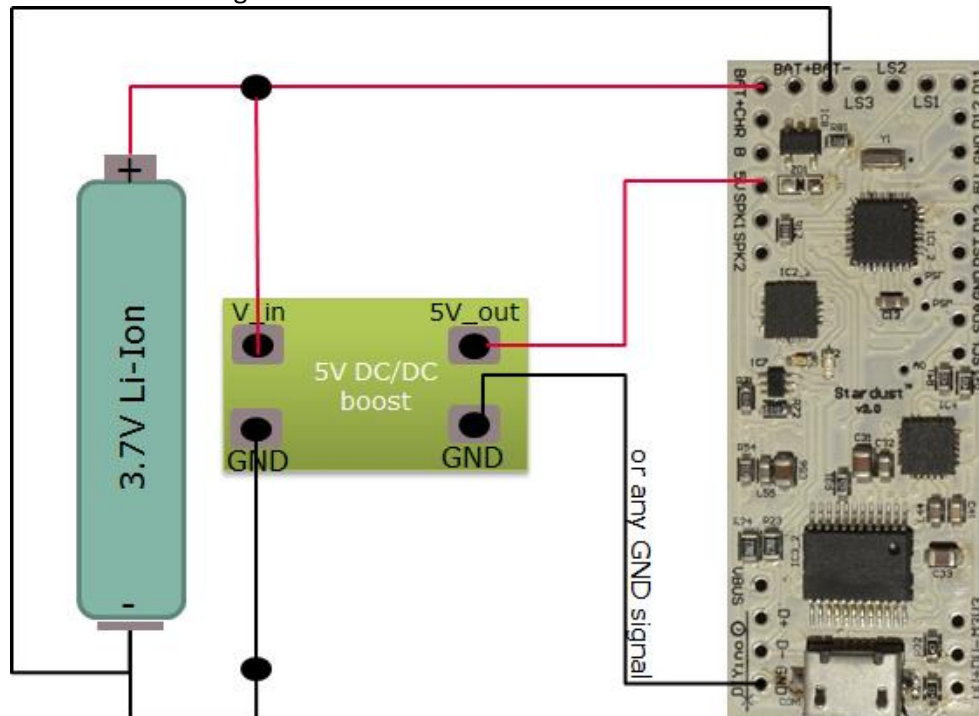


FIGURE 5: SUPPLY SCHEME USING 5V DC/DC BOOST CONVERTER

4 BASIC WIRINGS OF EXTERNAL COMPONENTS

4.1 WIRING BUTTONS AND SPEAKER

Figure 6 shows wiring of the switches and that of the speaker.

The speaker has to be connected between the SPK1 and SPK2 terminals/pins of the board. 4Ω/8Ω speaker can be used, up to 3W output power. It does not matter which terminal of the speaker you

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connect to which pin. The SPK1 and SPK2 signals are furthermore connected on-board to the ADC input pins A6 and A7 respectively, which can be used to sample the audio file played. This feature finds widespread use to control the flicker of the LEDs in-sync with the sound file being played

(**SoundTrack`ERtm**)

Switches – latching or momentary, although mostly momentary switches are supported by Arduino libraries – are connected with one terminal connected to GND and the other terminal to a digital I/O.

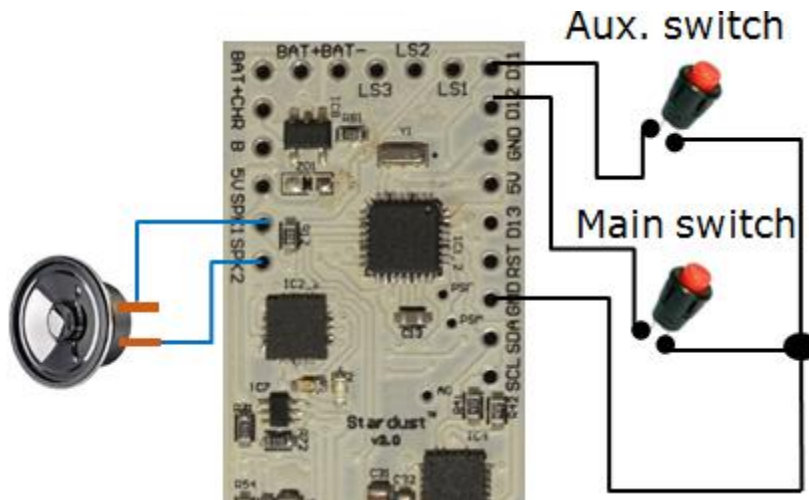
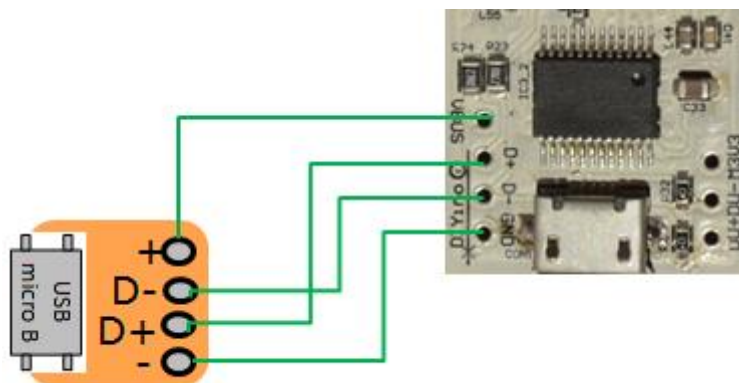


FIGURE 6: WIRING SWITCHES AND THE SPEAKER

4.2 IN-HILT RECHARGE

It is very convenient if the battery does not have to be removed from the hilt every time it needs recharging. Therefore so called in-hilt recharge ports found a wide-spread use in saber hilts together with rechargeable batteries (most common type being the 3.7V type 18650). The DIYino Stardust has an integrated Li-Ion/LiPo USB charger module integrated which can be used to charge the battery directly from USB, thus eliminating the need to include a bulky recharge port in the hilt. To ease recharging and interaction with the board like sketch upload or uploading sound files to the on-board 16Mbyte SPI Flash, a USB breakout board can be used to connect the USB signals to a port in the hilt. Connection of an external USB breakout-board is depicted in Figure 7 .



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FIGURE 7: IN-HILT RECHARGE USING AN USB BREAKOUT-BOARD

4.3 WIRING AN OLED DISPLAY (FOR BLASTER PROPS)

If you want to add a small display to your prop project - especially popular with sci-fi blaster, but you can include one for a custom MP3 player, armor gadgets etc. – there are good OLED displays using the SSD1306 driver IC.

The wiring of such an OLED display using I2C communication can be seen on Figure 8 . You need to supply the OLD display with 3.3V (some OLED displays have in-built 3.3V LDO, in which case you can also use the 5V pin to supply them) and use the Atmega328P's I2C bus signals A4(SDA)/A5(SCL) to communicate with the display.

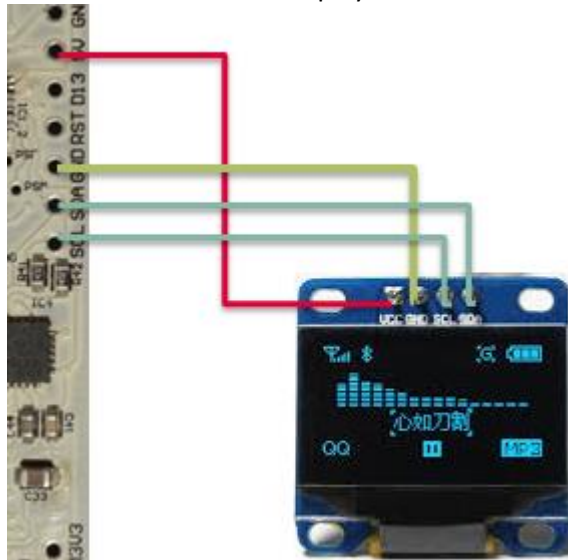


FIGURE 8: WIRING OF AN OLED DISPLAY USING THE SD1306 OLED CONTROLLED (128x32)

4.4 CHARGE STATUS INDICATION LED CONNECTION

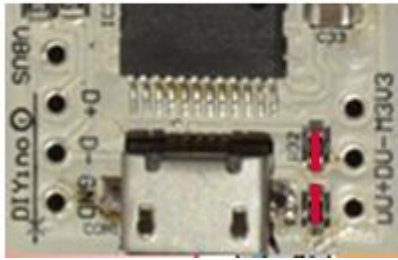
The on-board USB charger includes a charge status indication signal which can be accessed on the board via the CHR signal. The signal remains logic low during charging and changes to logic high when the battery is fully charged. This signal can be used to connect a charge indication LED via a proper resistor to light up when charging completes. Connect the LED anode (+) to the CHR signal (via a resistor if needed) and the cathode (-) of the LED to GND. Alternatively you can connect the CHR signal to the aux. Singal A0 and read the charge status voltage via digitalRead command in the sketch. This makes it possible to implement more sophisticated charge completion functions i.e. notifying via a unique sound, going back to sleep mode until charging finishes etc.

4.5 COPYING SOUND FILES TO THE ON-BOARD 16MBYTE SPI-FLASH

On DIYino Stardust sound files can be stored and played back from the on-board 16Mbyte SPI-Flash module connected to the MP3 chipset.

The on-board SPI Flash can be accessed over USB, which is shared with the UART controller for communicating with the microcontroller on-board via the Arduino IDE or similar. Upon delivery of the board the two USB ports are not shorted to ease first time programming, to wire them up in parallel follow the two methods shown on Figure 9.

A: bridge terminals of
R32 and R33



B: connect signals

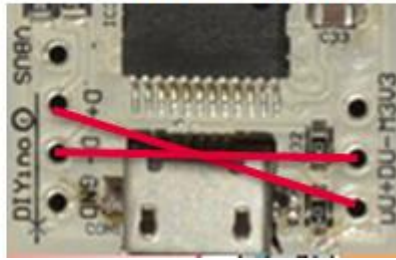


FIGURE 9: METHODS TO CONNECT USB PORTS OF SPI-FLASH AND UART

If the two USB ports are wired in parallel, you have to disable the UART (FTDI) in order for your PC to see the Flash as an USB drive. You can do it in two ways:

Option 1: Programatically you can disable the FTDI by pulling the A2 pin to HIGH using the digitalWrite function.

Option 2: Or you can use a piece of wire to connect the aux signal PSF to the 5V signal to achieve the same effect, as depicted on Figure 10 .



FIGURE 10: FOR USING THE SPI FLASH AS AN USB DRIVE, CONNECT THE PSF AUX. SIGNAL TO THE 5V SIGNAL FOR THE DURATION OF THE UPLOAD (OPTION 2)

When the FTDI is disabled, and the USB cable is plugged in, your SPI Flash shall appear as a regular USB drive. You can format it and use it to load your sound fonts to it.

Please note that due to the integrated MP3 chipset acting as an USB protocol handler, file transfer from PC to the SPI Flash might be slow. Be patient!

After you finish uploading the sound files, please disconnect the USB cable, reset the board, restart your PC before trying to connect the board again via the UART to upload code.

Sound files stored on the SPI-Flash will be indexed and accessed according to their physical copy order to the storage media. Therefore some simple rules apply to define SPI-Flash content.

1. Format your SPI-Flash, using it exactly as an USB external drive (i.e. pen drive)!
2. Select all the files from this folder and **"Drag and Drop"** them to your SPI-Flash. **NO COPY AND PASTE !!!** : We need to have this file copied in the same order as their filename order. On Microsoft Windows, Copy/paste produce an anarchic copy order, but Drag and Drop produce an ordered copy...

You can organize your files in folders to keep a better overview of the content. All what counts to the MP3/Wav chip is the physical order of the files on the SPI-Flash. You can even drag-and-drop whole folders, but inside the folder you need to establish a defined copy order by preceding files names with a numbering for instance:

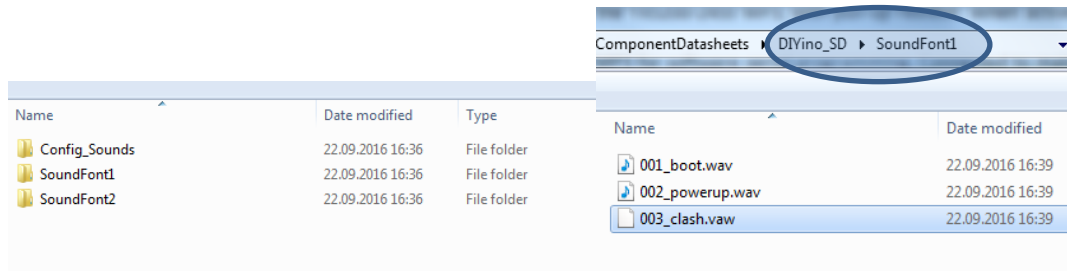


FIGURE 11: ORGANIZING FILES ON THE SPI-FLASH

4.6 SOUND FONT PREPARATION – HUM-EXTENSION

The DIYino Stardust is capable of gapless playback of sound files in WAV format, i.e. it can change from one sound track to another without an gap in the audio. This feature is mandatory for lightsaber electronics where a seamless transition is expected between the different sound files (like hum, clash, swings etc.).

While the MP3/WAV chips is capable of gapless playback, especially when it comes to relaunching the background noise of a lightsaber (so called “hum”), it cannot be done without spending a significant amount of effort and code space. For this reason a more pragmatic approach to hum-relaunch is implemented in most of the open source lightsaber software which simply relaunches the hum at certain time intervals. In order not to “loose” the hum if the saber is idling, each sound file (except lockup) has to be extended with a buffer of hum sounds. This is called a hum-extension. Modifying an existing sound font file is easy by simply copy+paste a chunk of hum sound after the end of the sound file. This can be done with freewares (Audacity for instance). A more advanced method is developed by Jakesoft – the father of Arduino lightsabers – in form of an automatic conversion program which can be downloaded here: <http://forum.arduino.cc/index.php?action=dlattach;topic=361566.0;attach=192631>

5 APPLICATION EXAMPLES

Warning : High-power LEDs (such as the Luxeon, Cree atc. Brand LED) and strings/strips of LEDs (such as LED strings composed of many single LEDs or neopixel LED moduls such as WS2812B) are extremely bright. Especially High-power LEDs are considered “class 2 lasers”! You should neither look directly to the beam nor point someone with it when the light source is not diffused/blocked, just like a powerful lamp or flashlight. Manufacturer of the DIYino Stardust board could not be held responsible for any injury resulting from the use of high-power or other type of LEDs/LED modules. To avoid injuries and retina damage due to the high brightness of LEDs, always use protective googles or other means to avoid looking directly into the light source and also take care to protect others (like children) from being able to look directly into the light source.

In this Chapter the most common lighting options of saber designs will be discussed with application notes and wiring diagrams showing how these options can be interfaced to the DIYino Stardust board.

Caution: in case of a High-Power LED or LED-string setups, you can use the LS pins to adjust the current flowing through the LEDs using PWM control (Pulse Width Modulation) of the transistor gates. The transistors which connect the cathode (-) of the LEDs to the GND can act as voltage controlled variable resistors, thus limiting the current through the LED. For those LEDs having a V_{th} above the battery voltage, this intrinsic current limiting is sufficient to ensure no overvoltage/overcurrent to the LED, while still offering the full dynamic range of brightness control. But in case the LED has a V_{th} below (or even far below) the nominal battery voltage (i.e. for red/amber/yellow LEDs), depending on the electrical characteristic of the LED, this intrinsic limiting might not be enough to ensure no overvoltage to the LED, which in turn can lead to damage or degradation of the life time of the LED. Even if the limiting through the transistors is deemed sufficient, during debug the PWM level can be set accidentally to a level which causes overvoltage. Last but not least, if only a small portion of the available PWM range can be used to control the brightness, it can lead to less smooth color blending. Therefore in doubt please include a limiting series resistor, which can be calculated using the following formula:

$$R_{series} = \frac{V_{battery} - V_{th_LED}}{I_{LED}}$$

Example: suppose you use a Red LED with $V_{th_LED}=2V$ and you want the current to be $I_{LED}=700mA$, you use a $V_{battery}=3.7V$, type 18650 battery. The value of the resistor you need to wire in series to the LED is:

$$\frac{3,7V - 2,0V}{0,7A} = 2.4\Omega$$

Please check the power rating of the resistor you intend to use.

5.1 HIGH-POWER RGB LED SETUP

Figure 15 depicts connection of a High-Power LED module to the DIYino Stardust. It depicts a 3-color LED module consisting of 3 LED dies in colors Red, Green and Blue. The same wiring can be extended to all different variants of HP-LEDs, like a single die HP-LED which can be controlled with a single Low-side driver.

Please note that that maximum DC current which can be switched by the individual LS pins is 2.4A. If the HP-LED used in the design involves LED dies with a max current above this rating, you must connect the cathode of the LED die to multiple of these LS pins and ensure they are controlled in tandem to avoid violating the maximum rating of the transistors.

5.2 NEOPIXELS SETUP

“NeoPixel” is Adafruit’s brand for individually-addressable RGB color pixels and strips based on the **WS2812**, **WS2811** and **SK6812** LED/drivers, using a single-wire control protocol. Commonly used neopixels stripes are composed of individual LED segments connected together to form a ladder similar to LED-strings. The stripes can be cut at any joint and multiple striped can be connected together at these joints as well.

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Neopixel LED modules integrate RGB LEDs and a control circuit which uses PWM (Pulse Width Modulation) to control the brightness of each die individually. For that purpose each LED module has a shift register composed of 24-bits, 8-bits belonging to each of the colors Red, Green and Blue. The shift registers are connected between the DI (Data-In) and DO (Data-Out) pins of the individual segments. In a stripe configuration one segment shift register is connected serially to the shift register of the next segment. If a blade has a stripe with 100LEDs, it means during programming $100 \times 24 = 2400$ bits of data have to be transmitted to the stripe using neopixels own serial protocol to fill up all PWM registers, which in turn determine the brightness of the LEDs. This takes only a few μs , so programming can happen so fast, that transitions seem smooth to the eye.

A neopixel stripe has only 3+1 signals:

5V: supply of the stripe

DI: Data-In for the single-line serial protocol

GND: Ground or negative of the stripe

DO: Data-out, this signal has to be used only if you want to connect several stripes together which are not continuous (back-to-back stripes or think about the cross guard of a Kylo Ren style saber)

The specification of the neopixel LED segments defines 5V as nominal voltage for the stripes, however the module can work with a much lower voltage as well. A lower voltage is even necessary to minimize power loss during operation, because any excess voltage above the voltage threshold of the used LEDs (Red $\sim 2V$, Green and Blue $\sim 3.5V$) is “wasted” over protection circuits in the control logic. Therefore a voltage source around the LED V_{th} is ideal to power neopixel strings.

For a complete characterization of neopixel brightness and current consumption please see [LINK](#)

Neopixels chips consume considerable power even when all the LEDs are switched off (all 0's). This static current consumption amounts to 1mA per LED. You can quickly calculate what this means to your battery life time if you use – let's say – 60LED/m type of neopixels, back to back, in a 80cm blade. There will be 100 LEDs in your blade, drawing 100mA even if all LEDs are switched off. It will even discharge the best battery in less than one day. It is not hard to predict, that with the introduction of the 144LED/m type neopixel stripes, some blades will include much more than 100 LEDs, which will lead to an even quicker discharging of the battery. Killing power to the circuitry using a kill-key is a good method to lengthen the shelf life of your saber, but quite annoying during a show if you have to keep plugging in/out the kill key. Therefore a unique method was invented using the existing DIYino Stardust architecture. If the GND pin of the neopixels stripe is connected to the LS pins instead of the GND of the battery/DIYino Stardust, the transistors of the LS pins can be used to cut power to the neopixels stripe. If the blade is activated, the transistors have to be fully switched on (using the digitalWrite function) to connect the GND of the neopixels to the Battery(-), therefore powering the stripe. If the blade is retracted/switched off, the transistors have to be fully switched off in order to avoid the static current consumption of the stripes discharging the battery. Please take note that the restrictions as to the maximum current capability of the DIYino Stardust board apply also here (max 6A!!!).

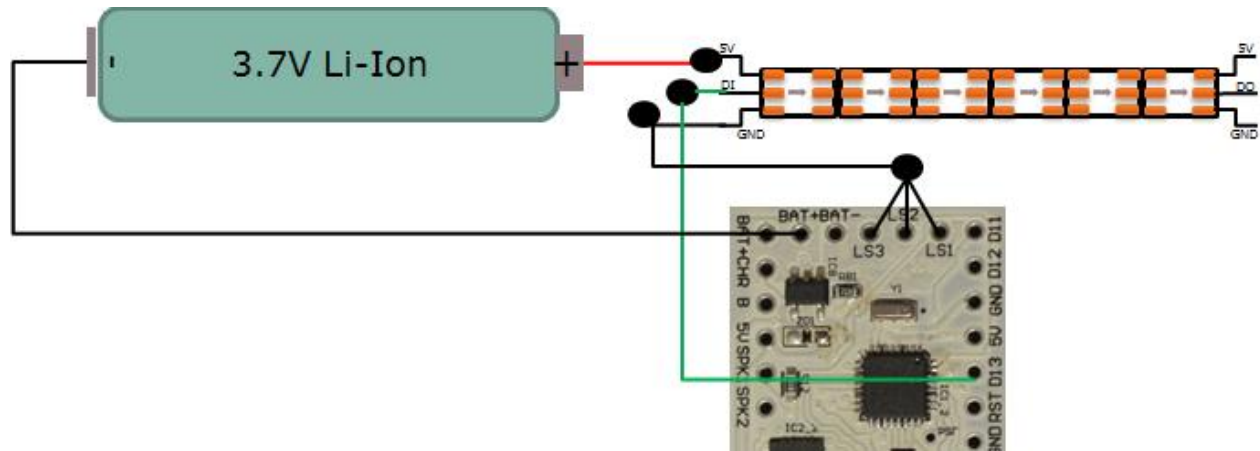


FIGURE 12: NEOPIXELS WIRING USING 3.7V VOLTAGE SOURCE, "PROGRAMMABLE KILL-KEY"

6.1 RGB HIGH-POWER LED SETUP WITH 3.7V AND SINGLE BUTTON

The Figure 13 shows the full wiring diagram of a HP-LED saber using a single 3.7V Li-Ion battery as supply, using a single main button. The HP-LED module is directly supplied from the Battery+.



On Figure 14 the full saber wiring diagram can be seen. It includes

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When connecting the programmable neopixels stripe kill-key, you have to calculate max. current consumption of your LED stripe and connect the LSx pins accordingly, i.e. if you anticipate 2A-3A's, connect 3 of the LS pins to the GND terminal of the stripe. Up to max. 3A over all LSx pins due to limited heat dissipation on the board!!!

All considerations in the Chapters describing the individual parts of this circuit diagram apply here as well. Please read them carefully.

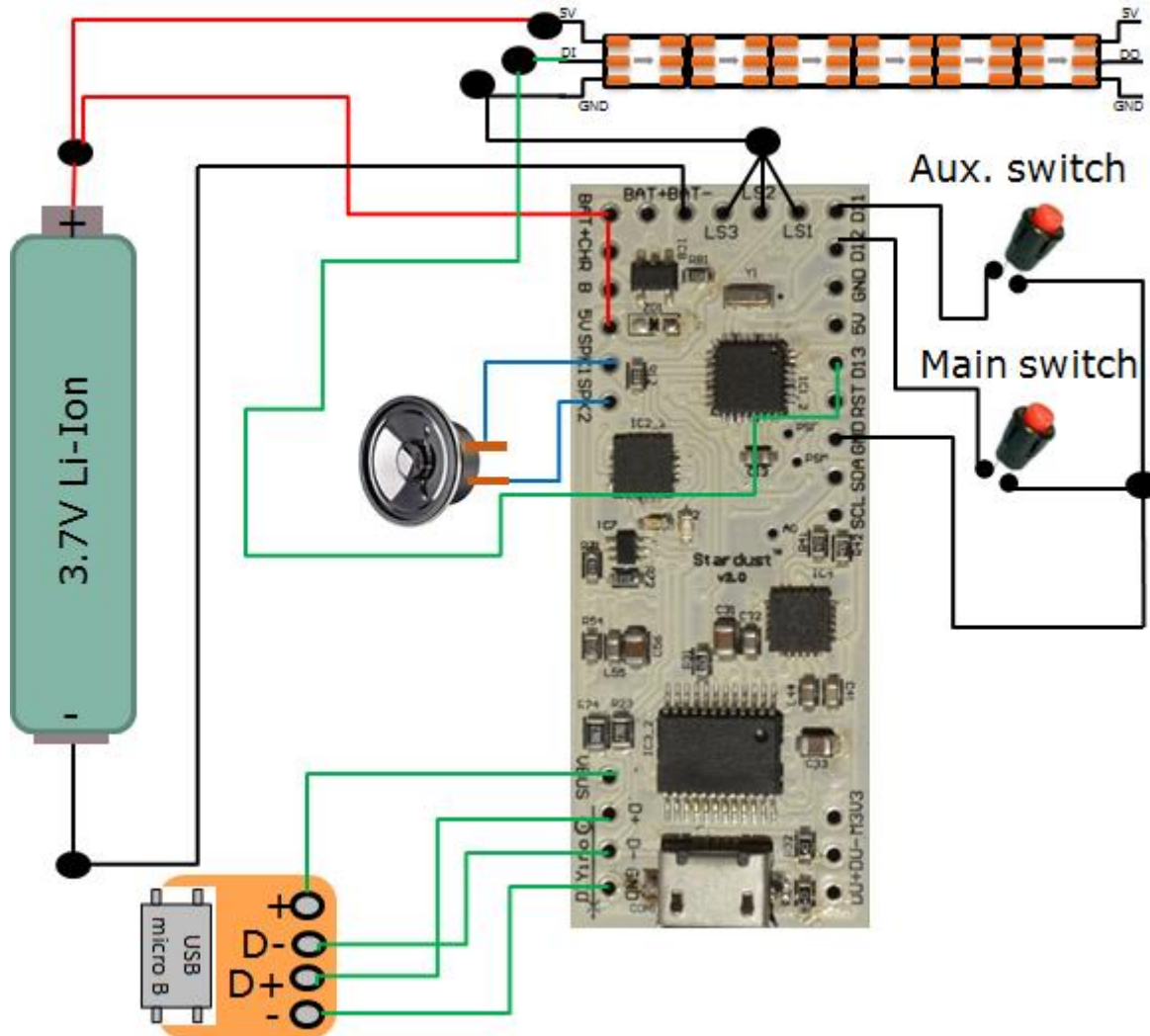
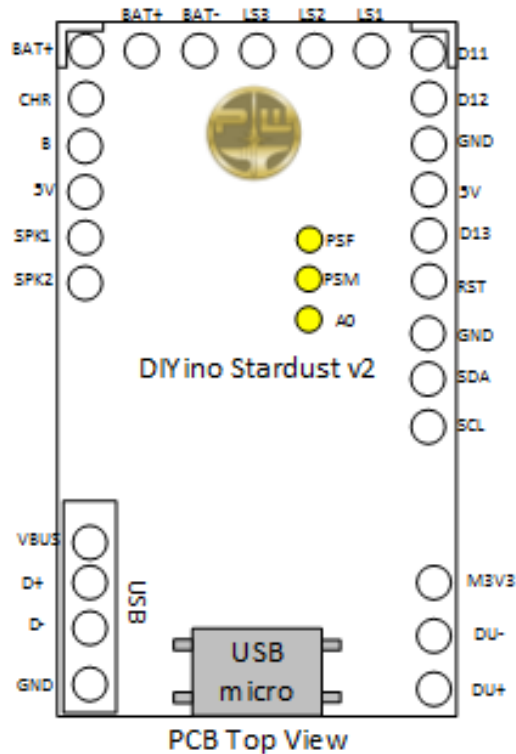


FIGURE 14: FULL WIRING DIAGRAM OF A NEOPIXEL STRIPE BASED SABER

7 TECHNICAL SPECIFICATION

7.1 CIRCUIT PINOUT



Pin	Functionality	Comment
BAT+ (2x)	Positive terminal of a single Li-Ion or LiPo 3.7V battery cell.	2 breakout signals
BAT-	Negative terminal of a single Li-Ion or LiPo 3.7V battery cell.	
LS1	Drain of the Low-Side switch 1	HP-LED: connect cathode of Red die here (via resistor if needed)
LS2	Drain of the Low-Side switch 2	HP-LED: connect cathode of Green die here (via resistor if needed)
LS3	Drain of the Low-Side switch 3	HP-LED: connect cathode of Blue die here (via resistor if needed)

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CHR	Charge completed signal of the USB charger circuit.	Can be connected to the anode of an LED (via resistor if appropriate) to light up when battery is fully charged over USB.
B	The „B“-point!!!	It can be used to implement the <i>USB Kill-Keytm</i> Feature
5V (2x)	Legacy Arduino name of board logic supply.	2 breakout signals.
RST	Reset pin of the Atmega328P, with pull-up to 5V.	Pin used for burning bootloader.
D11	D11 digital I/O of Atmega328P, PWM capable, connected to Gate of LS6 Low-Side driver, with 100kΩ pull-down to GND. MOSI pin for ICP.	Pin used for burning bootloader.
D12	D12 digital I/O of Atmega328P. MISO pin for ICP.	Pin used for burning bootloader.
D13	D13 digital I/O of Atmega328P. SCK pin for ICP.	Pin used for burning bootloader.
GND (3x)	Board(-) or GND. Connected to GND plane of the PCB.	Pin used for burning bootloader.
SPK1	Speaker terminal 1. Connect to speaker directly. Other speaker terminal to SPK2.	Connected to A6 of the Atmega328 for <i>Sound-Track'ERtm</i>
SPK2	Speaker terminal 2. Connect to speaker directly. Other speaker terminal to SPK1.	Connected to A7 of the Atmega328 for <i>Sound-Track'ERtm</i>
GND	Board(-) or GND. Connected to GND plane of the PCB.	Connected to BAT- via star-point. Digital GND, do not connect to battery negative terminal. 3 breakout signals.
SDA	A4 digital I/O of Atmega328P	SDA I2C signal for

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	with input 10-bit ADC.	communication with MPU6050 or an external device using I2C protocol (i.e. OLED display).
SCL	A5 digital I/O of Atmega328P with input 10-bit ADC.	SDA I2C signal for communication with MPU6050 or an external device using I2C protocol (i.e. OLED display).
M3V3	Output of the 3.3V LDO of the YX5200-24SS chip.	Supplies the SPI Flash as well as the MPU6050 accelero- and gyro sensor.
PSF	FTDI power switch	Pulled to GND. Can be connected to 5V signal to disable FTDI chipset.
PSM	MP3 power switch	Pulled to GND. Can be connected to 5V signal to disable MP3 chipset and Audio Amp.
A0	A0 digital I/O of Atmega328P with input 10-bit ADC.	Auxiliary signals, see Chapter Error! Reference source not found.
VBUS	USB supply voltage	5V voltage input from USB bus or USB charger. Breakout signal for external USB connector hook-up
D+	USB positive	Breakout signal for external USB connector hook-up
D-	USB negative	Breakout signal for external USB connector hook-up
DU+	USB positive signal of the YX6300-24SS MP3 chip	Connected to D+ via resistor on-board.
DU-	USB negative signal of the YX6300-24SS MP3 chip	Connected to D- via resistor on-board.

7.2 MODULE DESCRIPTION

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7.2.1 LOW-SIDE DRIVERS

In order to control High-Power LEDs or LED strings consisting of multiple LEDs, the DIYino Stardust board implements so called Low-Side drivers to connect the negative side of loads (i.e. cathode of LEDs) to the GND. A Low-Side driver consists of an n-channel type MOS transistor with its source connected to GND of the board, the drain is connected to an LS terminals (LS1 to LS6), and the gate is controlled via PWM by PWM capable pins of the Atmega328 uController.

Therefore code-wise in order to adjust the drive from the Low-Side drivers the PWM capable pins have to be addressed; the mapping is shown in the next table:

LS pin on DIYino Stardust	Corresponding PWM capable pin
LS1	D5
LS2	D6
LS3	D9

TABLE 1: MAPPING OF PWM CAPABLE ATMEGA328 PINS TO THE LOW-SIDE DRIVER PINS

Wiring of loads via the LS pins is depicted in Figure 15, using as example a RGB(W) HP-LED setup., but the concept is the same using LED strings or serially connected LEDs in general.

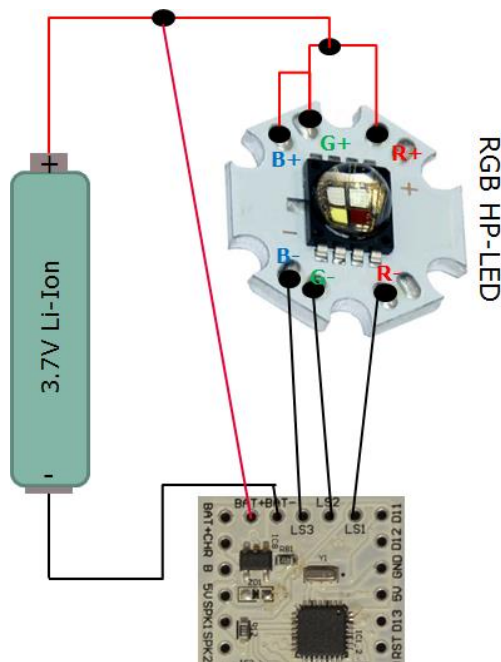


FIGURE 15: CONNECTION OF THE LOAD TO THE LOW-SIDE DRIVER PINS (LS1...LS6). EXAMPLE SHOWS WIRING OF AN RGB HIGH-POWER LED MODULE ON STAR PCB (I.E. CREE, LUXEON, ETC.). CURRENT LIMITING RESISTORS ARE NOT SHOWN FOR SIMPLICITY'S SAKE.

7.2.2 GESTURE- AND MOTION DETECTION WITH THE MPU6050 IMU

Link to Datasheet: <https://www.invensense.com/wp-content/uploads/2015/02/MPU-6000-Datasheet1.pdf>

Link to Register Map Description (for low level programming): <https://www.invensense.com/wp-content/uploads/2015/02/MPU-6500-Register-Map2.pdf>

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Link to MPU6050 Library for Arduino:

<https://github.com/jrowberg/i2cdevlib/tree/master/Arduino/MPU6050>

Link to MPU6050 Library for LSOS:

<https://github.com/neskweek/LightSaberOS/tree/master/Libraries/MPU6050>

Link to MPU6050 USaber MotionManager:

<https://github.com/JakeSoft/USaber/blob/master/motion/Mpu6050MotionManager.h>

7.2.3 WAV/MP3 DECODE CHIPSET AND AUDIO AMP

The DIYino Stardust v2 implements the chipset of the MP3-TF-16P Arduino Shield/MP3 module, which includes an YX6300-24SS MP3/Wav decoder chip, a 16Mbyte SPI Flash and a 3W high-fidelity audio amp („Boomer“).

Link to Datasheet of the sound module:

<http://www.dfrobot.com/image/data/DFR0299/DFPlayer%20Mini%20Manul.pdf>

Link to the 3W Audio Amp Datasheet: <http://www.ti.com/lit/ds/symlink/lm4871.pdf>

Link to simple Library: <https://github.com/DFRobot/DFPlayer-Mini-mp3>

Link to neskweek's improved Library:

<https://github.com/neskweek/LightSaberOS/tree/master/Libraries/DFPlayer>

8 UPLOAD SOFTWARE USING ARDUINO IDE: A STEP-BY-STEP WALKTHROUGH

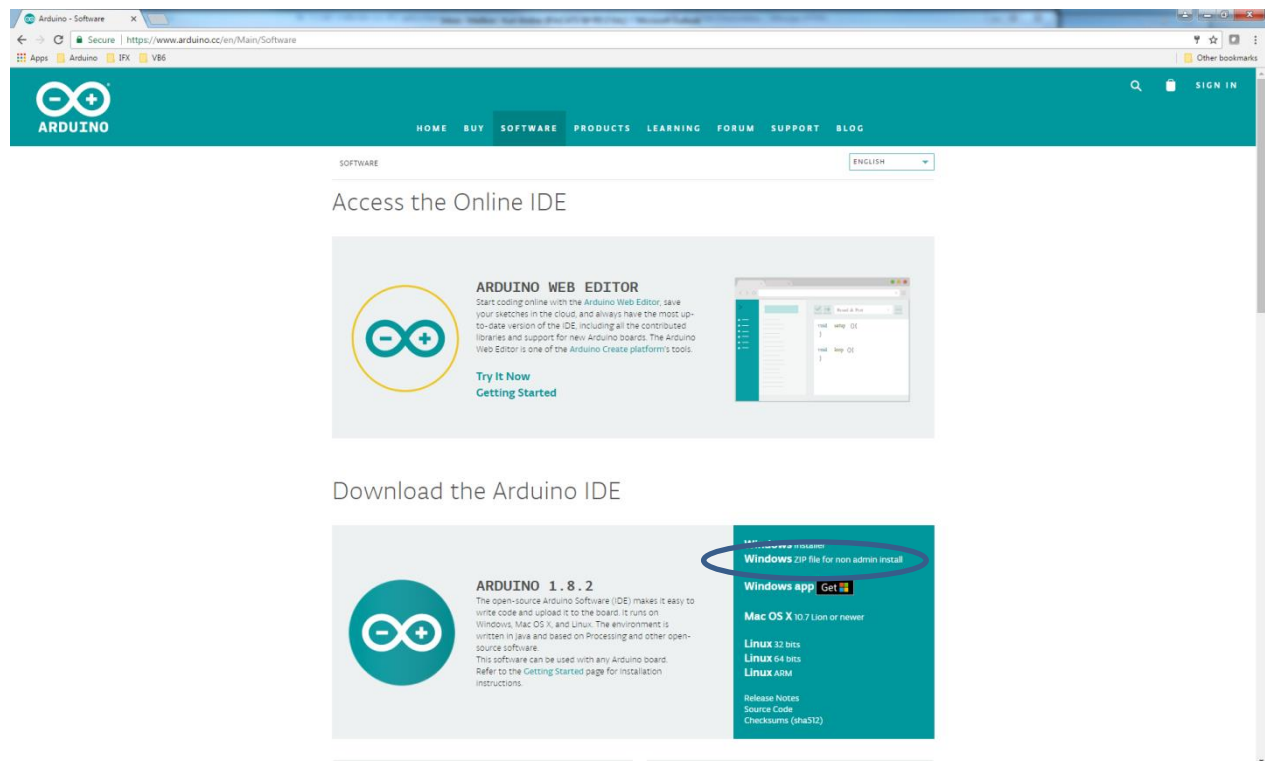
Please visit the Arduino Home Page for instructions how to install the Arduino IDE and upload code using it to your DIYino Stardust board:

<https://www.arduino.cc/en/Guide/Windows> (instructions are also available for Mac OS X and Linux)

The DIYino Stardust boards are configured as an Arduino/Genuino Uno compatible board, so when choosing your board please select Arduino/Genuino Uno.

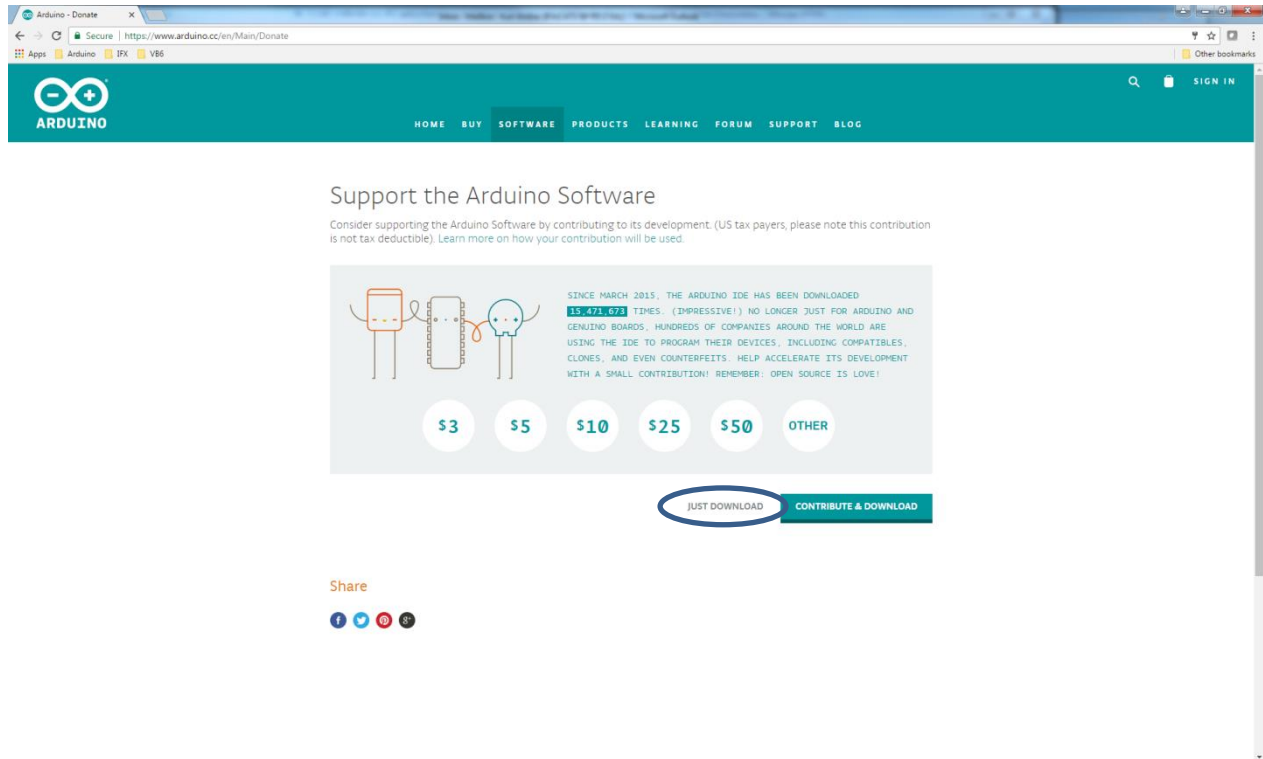
To upload open-source code to your Stardust board, follow the steps described here:

Step 1: Download Arduino IDE from <http://www.arduino.cc>. Go to Software and then to Download the Arduino IDE.

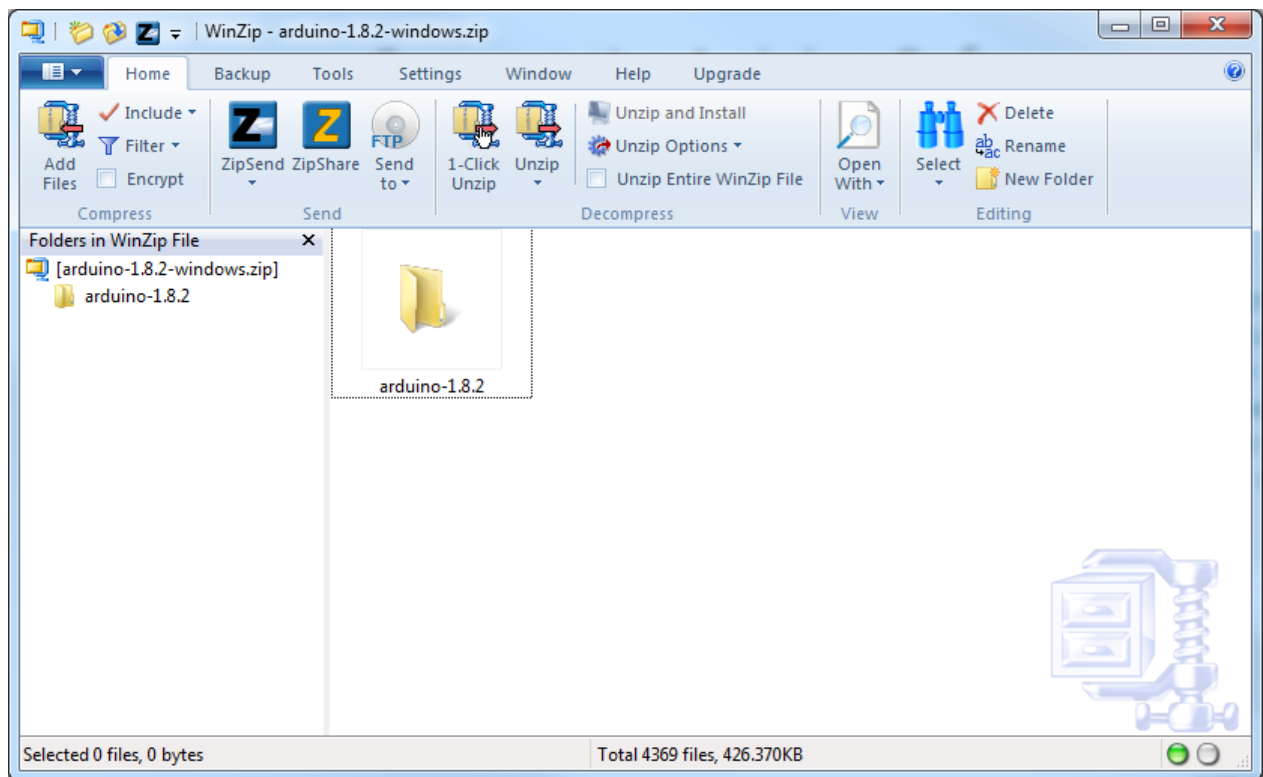


Step 2: From this page you will be redirected to another page where you can donate to the developers of the Arduino IDE. Optional, you can choose not to donate by clicking on Just Download.

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Step 3: The Arduino IDE will be downloaded. When download is completed, unzip the software anywhere you like to your PC.



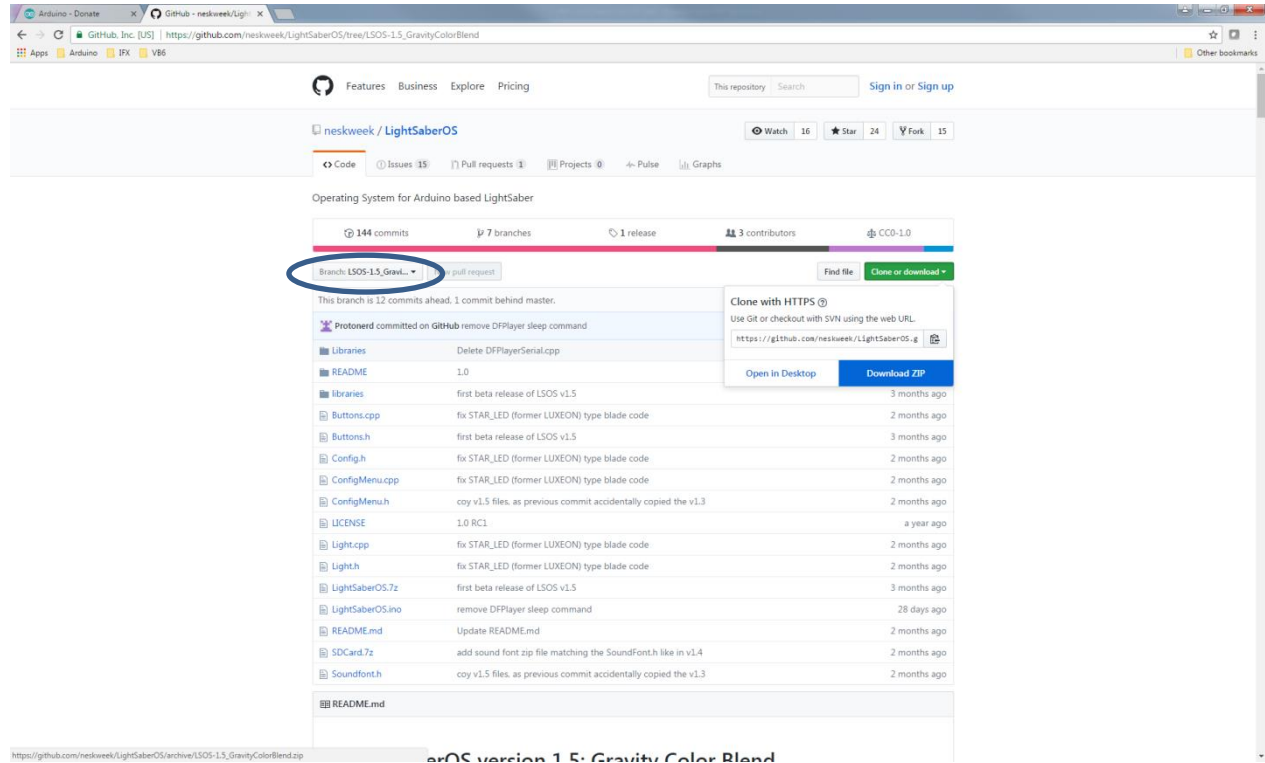
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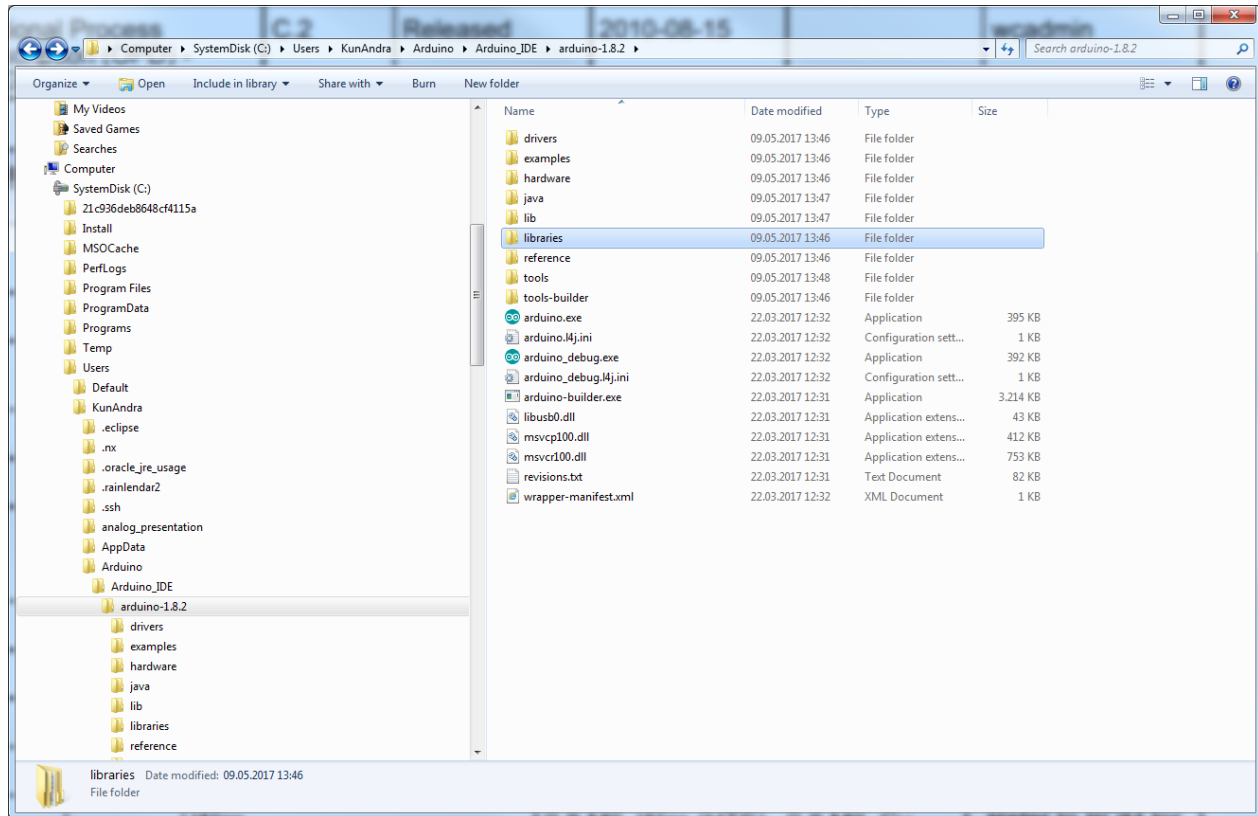
Step 4: Download the lightsaber code of your choice, from example from GitHub:

https://github.com/neskweek/LightSaberOS/tree/LSOS-1.5_GravityColorBlend



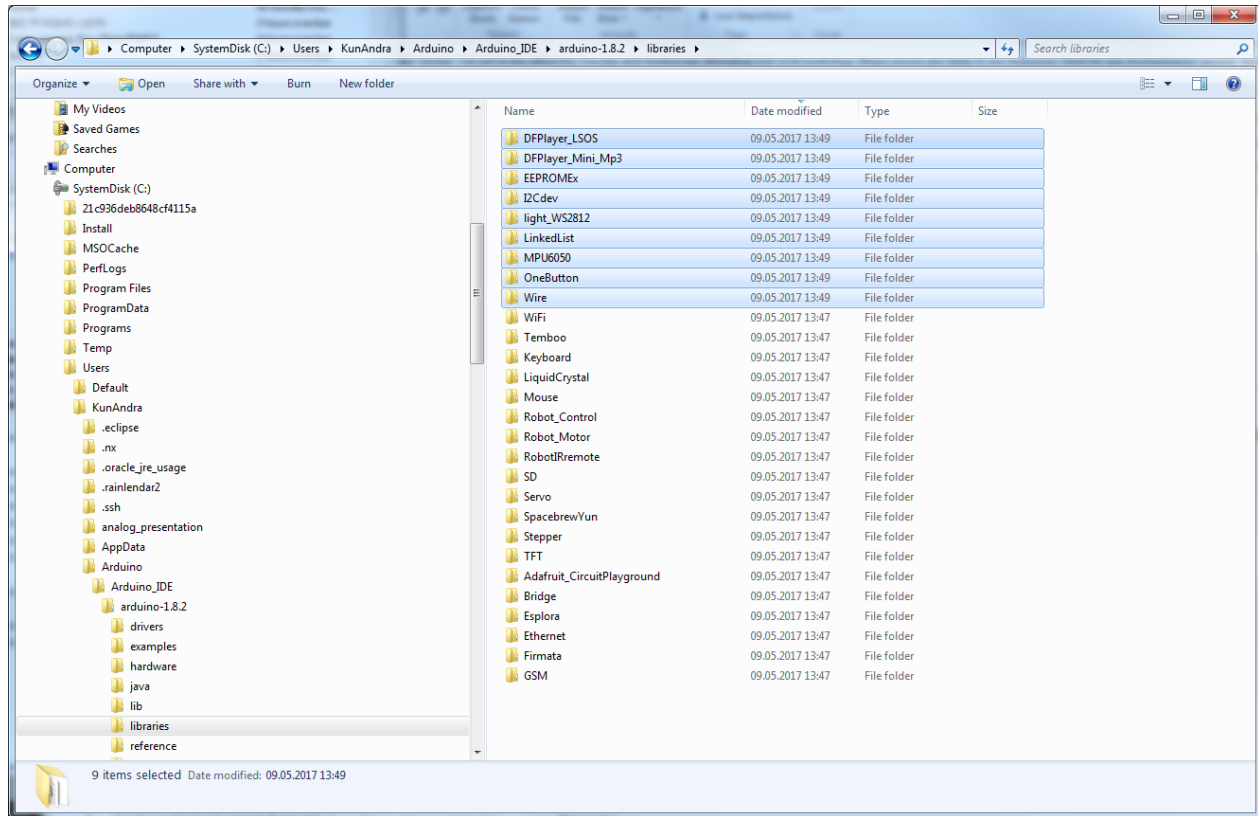
Step 5: Navigate to the folder you unzipped the Arduino IDE and go to the libraries folder.

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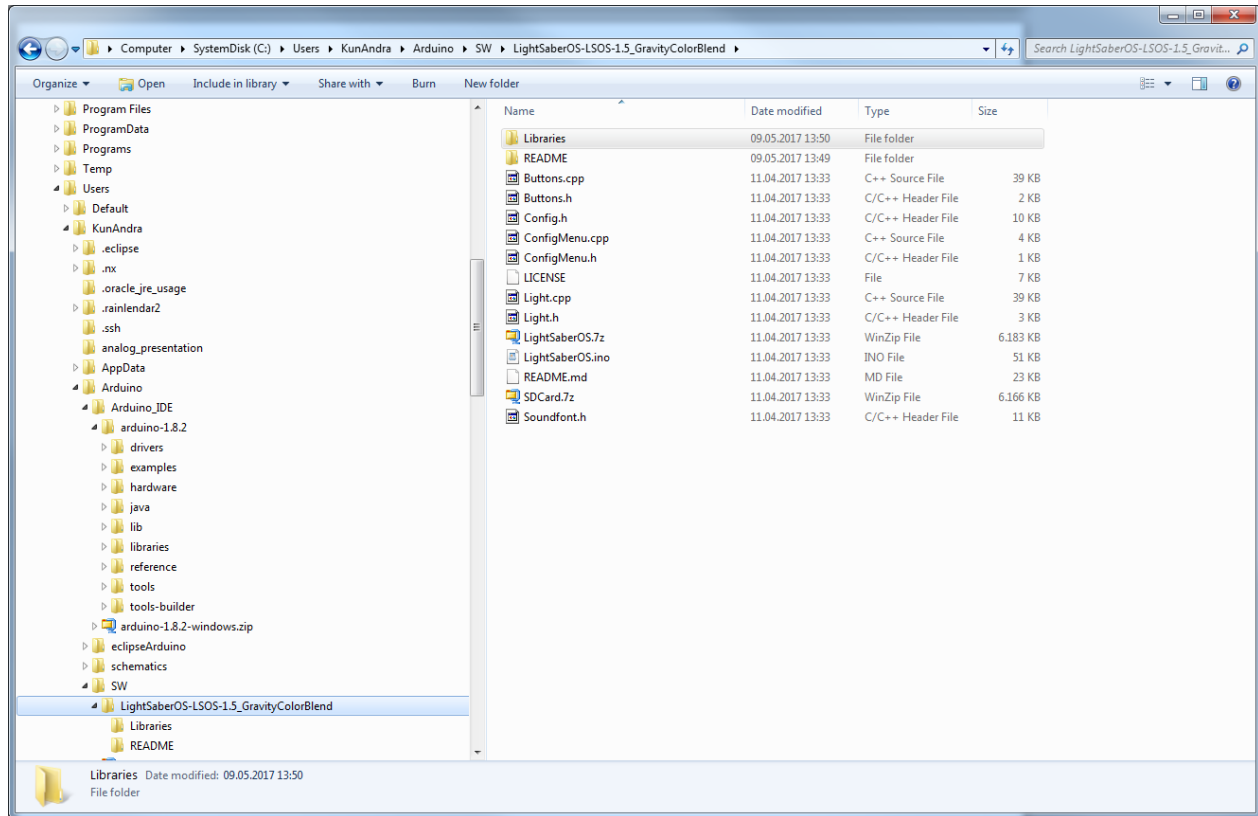
Step 6: This libraries folder contains basic libraries for Arduino. For the IDE to find the libraries necessary to compile your downloaded lightsaber code, you must copy all folders located in libraries folder of the lightsaber software ZIP file to this folder. Sounds more difficult than it really is, look at the next picture which clearly explains what is to be done:

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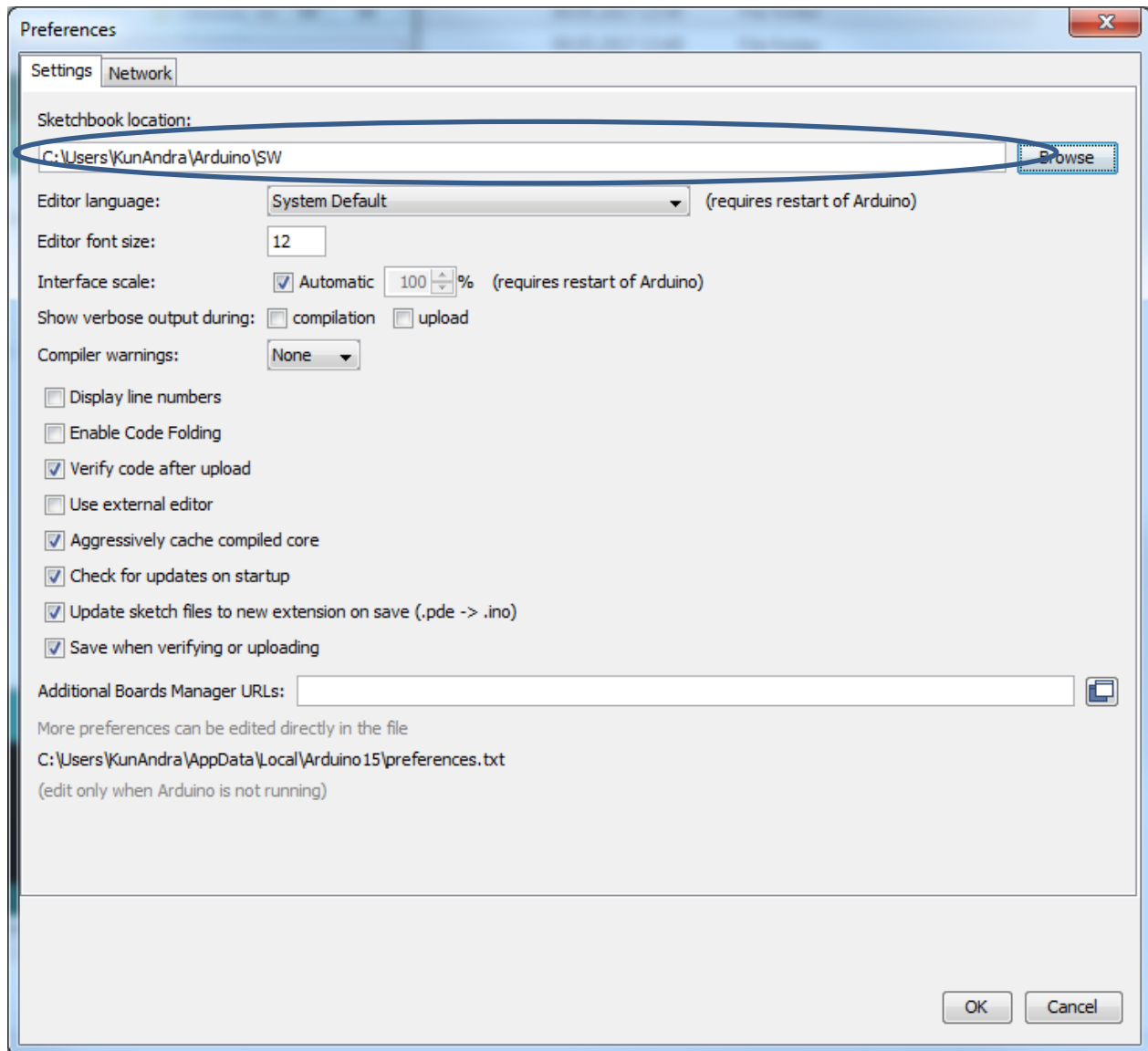
And in the next picture you can see where the libraries of the lightsaber software can be found:

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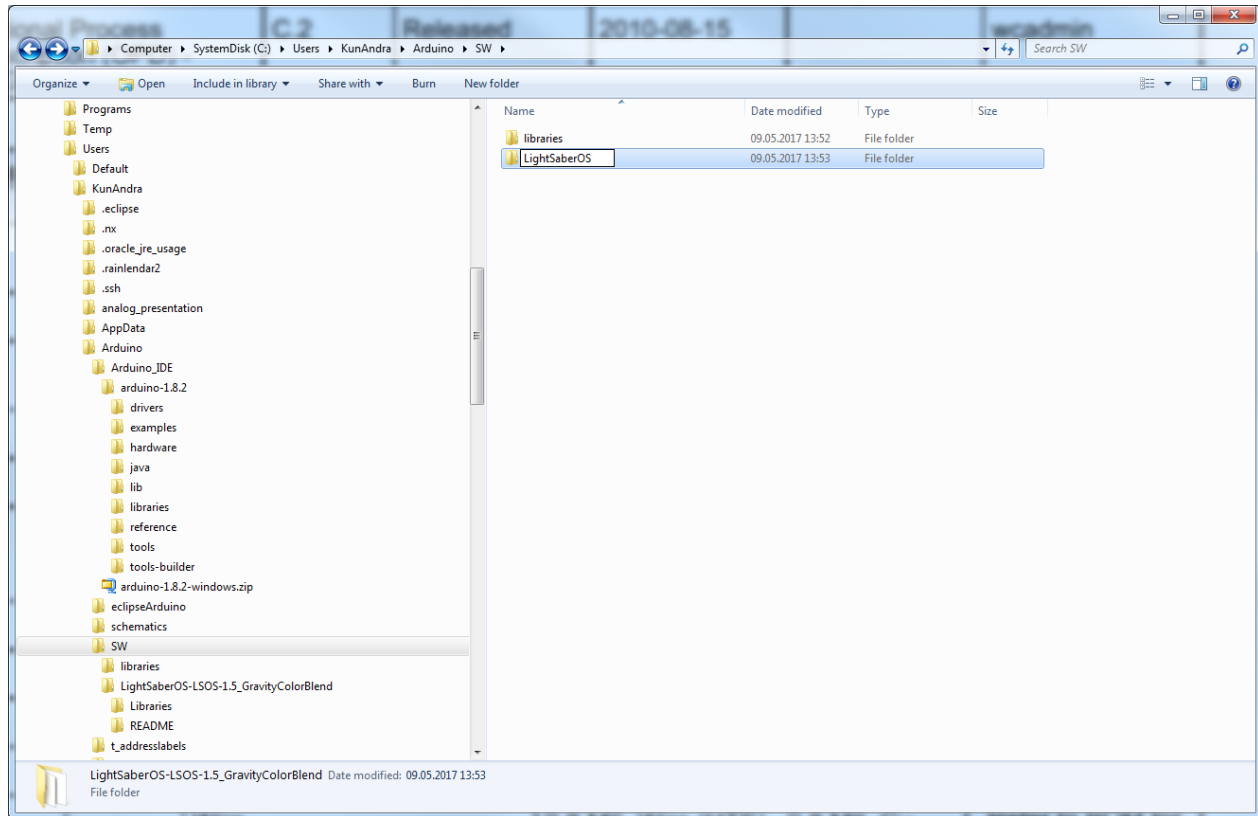
Step 7: Now it's time to start the Arduino IDE. Simply start the arduino.exe. Then go to File/Preferences and specify the folder containing the lightsaber code folder you downloaded (see path in the pic above and compate it to the path indicated under Sketchbook location):

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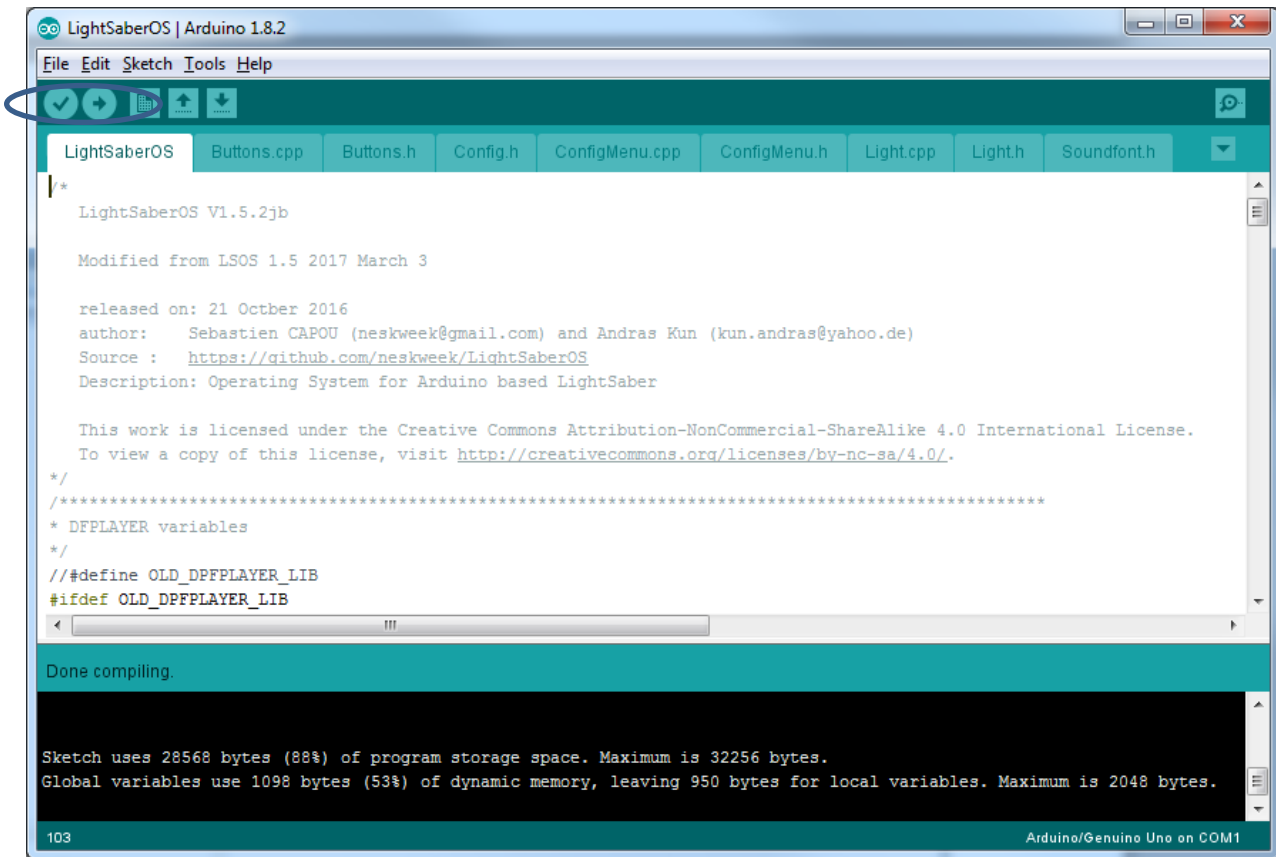
Step 8: It is crucial that the name of the lightsaber code folder be the same as the .ino file in that folder, see in the next picture. I.e. if the ino file name is LightsaberOS.ino, the folder containing the .ino file also must be named LightsaberOS. Rename the folder accordingly.

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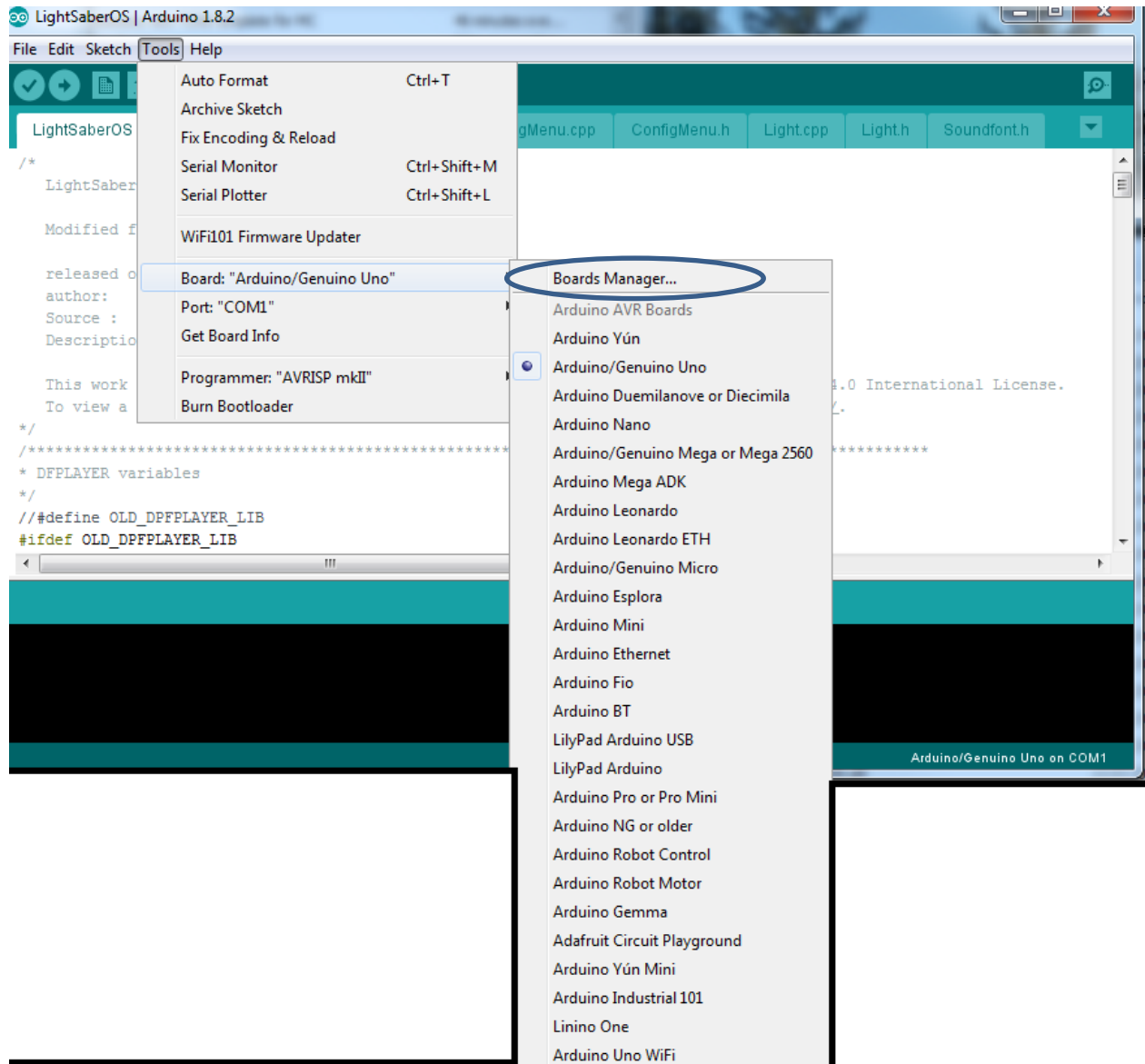
Step 9: Once everything is settled, go to File -> Open -> `./../<lightsaber code .ino file name>`. See next picture how it should look like once the code is opened. The Check and Arrow buttons can be used to compile or compile/download the code to your Arduino compatible board.

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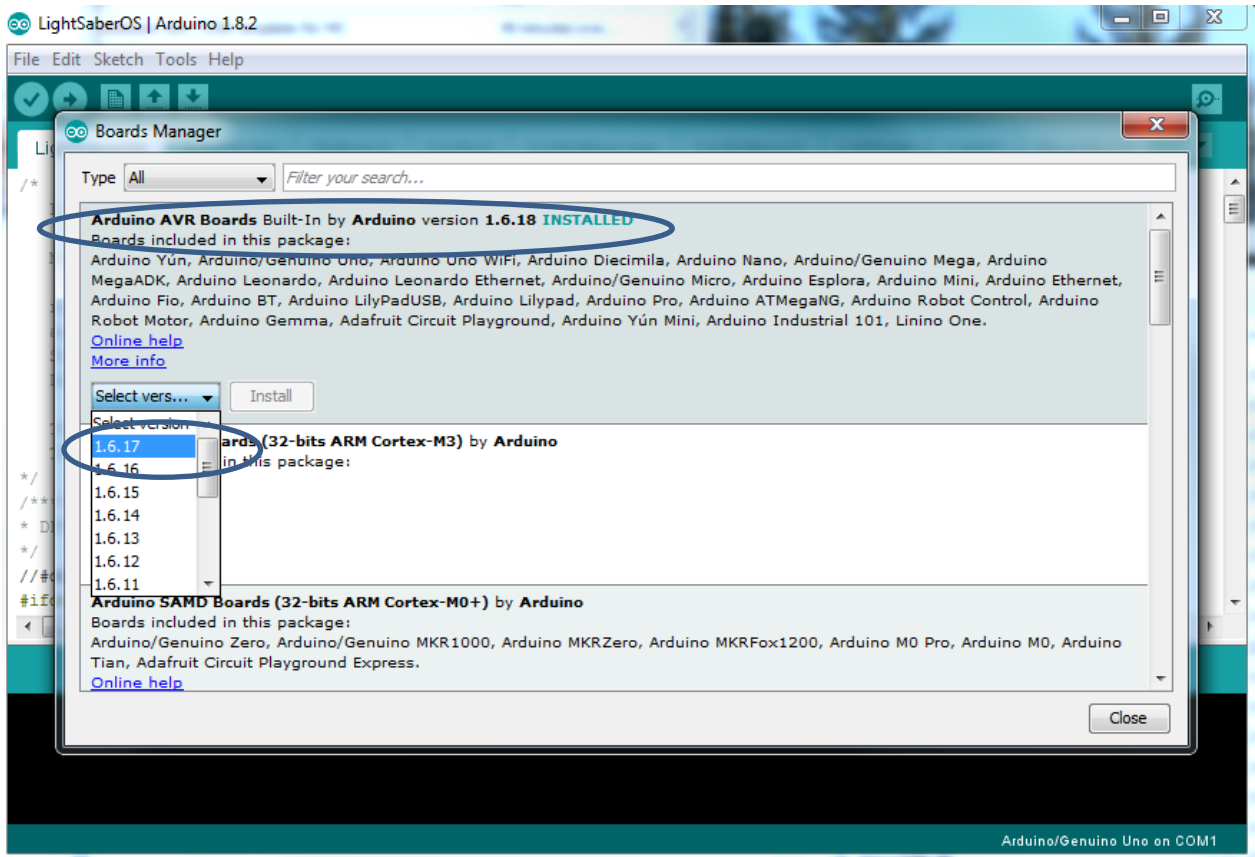
Step 10: Prior to downloading the code to your board, the type of your microcontroller needs to be specified. To do this, enter the Boards Manager as depicted on the following picture:

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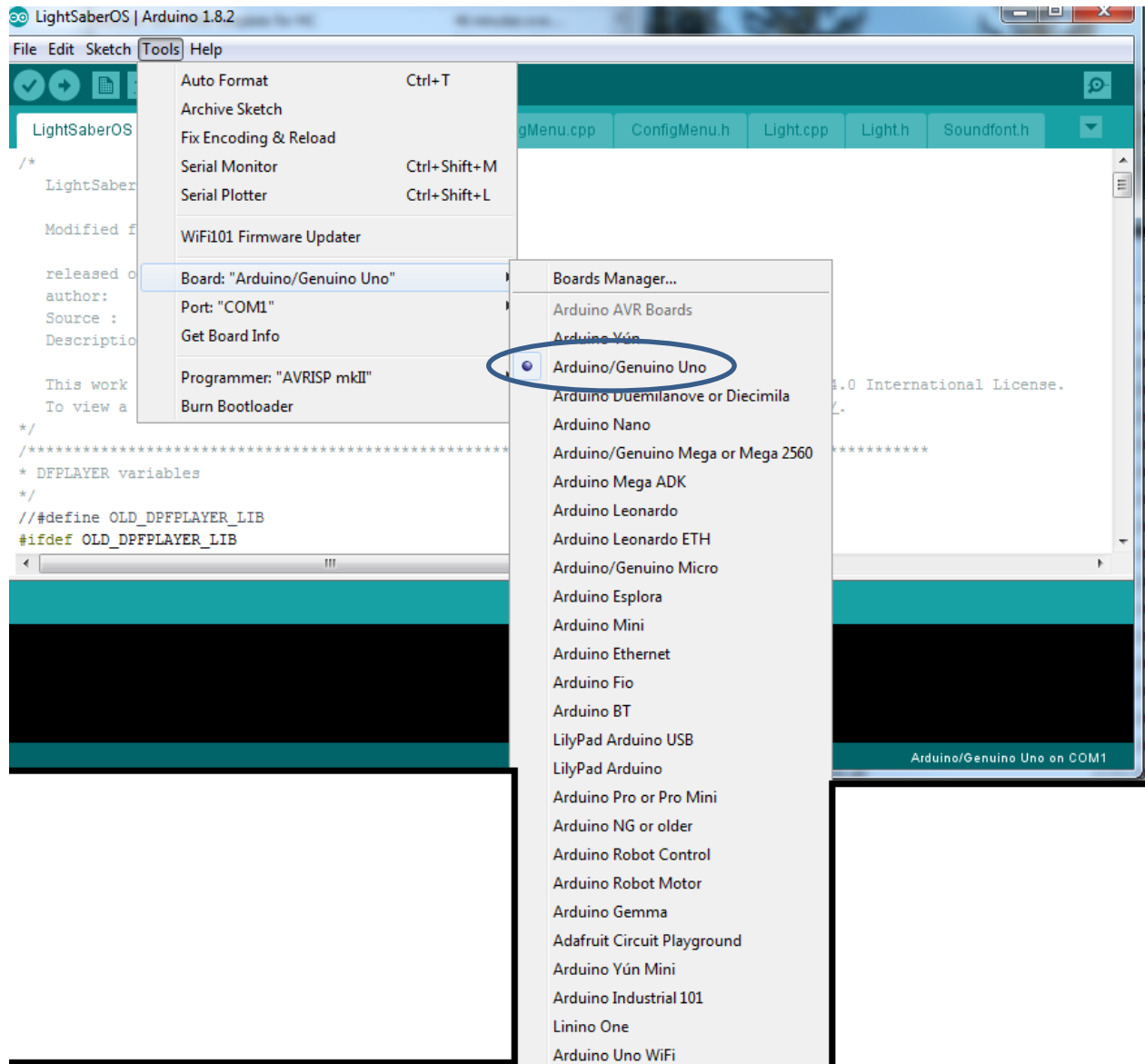
Once the Boards Manager starts, choose Arduino AVR Board, select the version 1.6.17 from the Select Version drop-down menu and click on install.

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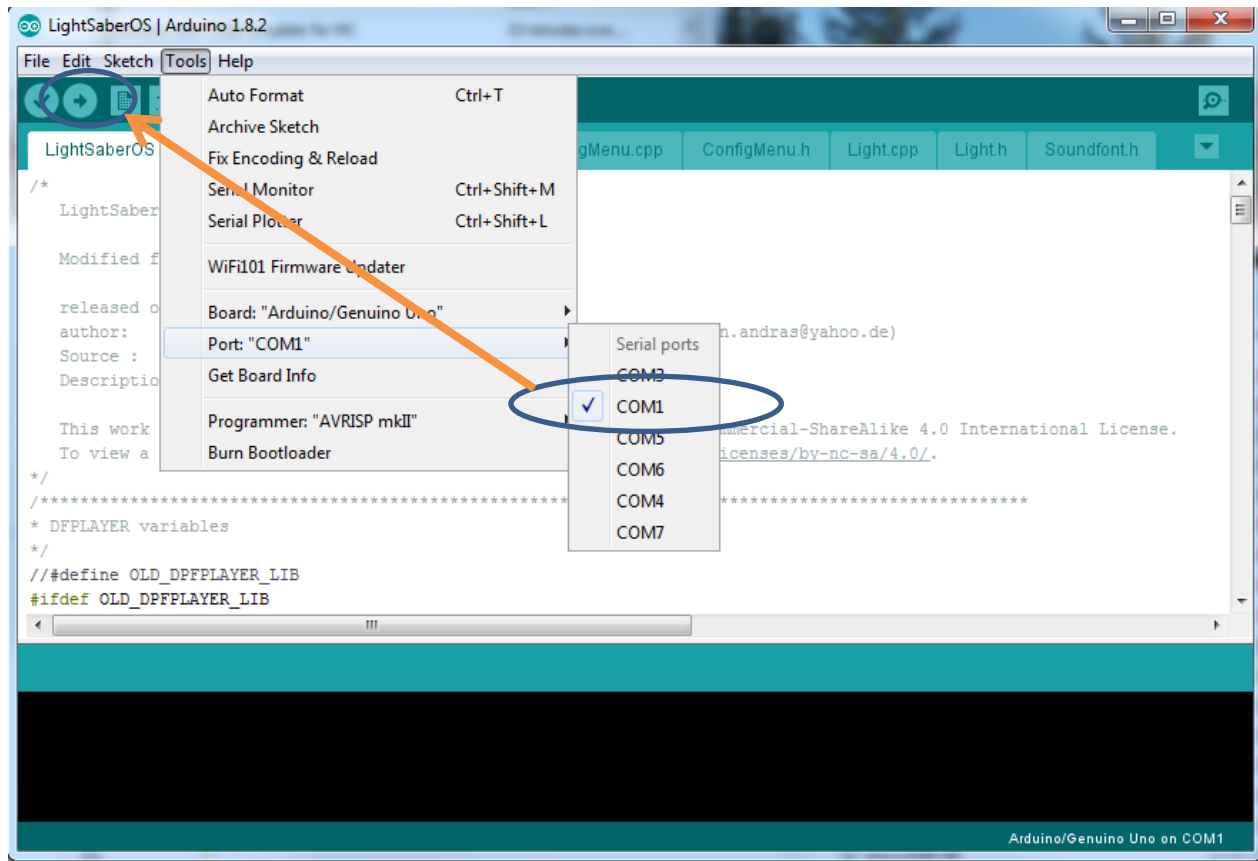


Step 11: Once installation of the Boards Manager is done, specify your board by selecting Arduino/Genuino Uno from Tools/Boards (DIYino Stardusts v2 boards are all configured as Arduino/Genuino Uno, as well as newer runs of DIYino Prime boards. Some older runs from the Prime configured the boards as Arduino Nano, since the original Prime was based on the Nano. Later on it was decided to configure the boards uniformly as Uno to benefit from the additional 1.5k code space)

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Step 12: Connect the Stardust board to your PC using a USB cable. Once done, a new COM port shall appear under Tools/Port, which corresponds to your board. Select this COM port and start uploading code with the Arrow button.



9 QUICK-START GUIDE TO FX-SABEROS

FX-SaberOS (<https://github.com/Protonerd/FX-SaberOS>) is the world's most popular open source saber operating system, evolving out of the world's first such system, the LightSaberOS written by Sebastien Capou (neskweek) and Andras Kun (Protonerd). In this Chapter you can learn how to quickly set up the most important parameters of the saber code for a first upload.

First of all you need to upload so called sound fonts to your Stardust board. You can use your own sound fonts (see Chapter 2.2 for uploading sound files and Chapter 4.6 for preparing your own sound fonts for upload to the Stardust board). There are excellent free-to use sound fonts from Darth PJs (Trinity Force Sabers) on GitHub (https://github.com/Protonerd/FX-SaberOS/blob/master/soundfonts/DIYino_Stardust_SPIFlash_image.7z), the contents of the zip file can be directly moved to the SPI flash following the instructions in Chapter 4.5. Afterwards you can download and open FX-SaberOS in your Arduino IDE.

On the Config_HW.h tab, you can configure your hardware and peripherals:

Make sure you select Stardust as board:

```
//#define DIYINO_PRIME
#define DIYINO_STARDUST
```

You can select between single and 2-buttons modes by commenting out or leaving following line uncommented:

```
#define SINGLEBUTTON -> single button setup
```

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```
//#define SINGLEBUTTON -> 2- buttons setup
```

Now it's time to define your blade type, leave your blade type uncommented and the other two commented. For instance to select a neopixel blade:

```
//#define LEDSTRINGS -> defaults to 6 segments, DIYino Prime recommended
```

```
//#define STAR_LED -> defaults to Red to LS1, Green to LS2 and Blue to LS3
```

```
#define PIXELBLADE -> neopixel blade
```

And finally if you are using neopixel blade, define the length of your blade in pixels:

```
#define NUMPIXELS 115
```

For basic setup that's all. If you want to understand how the code works, visit the GitHub Wiki. Have fun and May The Force Be With You! Always!

10 RELATED LINKS

FX-SaberOS: <https://github.com/Protonerd/FX-SaberOS>

LSOS: <https://github.com/neskweek/LightSaberOS>

USaber: <https://github.com/JakeS0ft/USaber>