Hardware of the ESP8266 Wireless Terminal

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1 Introduction

The purpose of this document is to describe the hardware of the Wireless Terminal module and give guidance on how to use it in an application circuit. It also provides a brief overview of the used WiFi chip and the intricacies of its power demands.

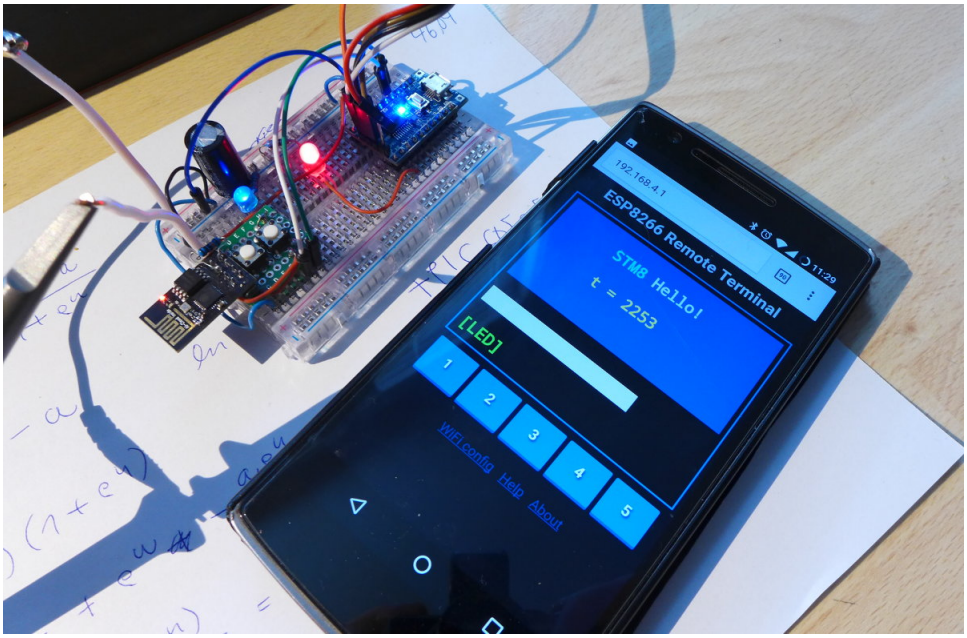

Figure 1: Wireless Terminal example setup with STM8 as the master controller. The white and green wires are the UART data connections. The on-screen white progress-bar is updated in real time by the STM8, and the red LED can be toggled by tapping the `[LED]` indicator, or pressing the blue button under it.

2 A look at the ESP8266 wireless SOC

The ESP WiFi modules provide an easy way to add connectivity to any project. Those modules (ESP-01, ESP-12 and others) can be—at the time of writing this document—purchased for about $2 (50 CZK) on eBay or AliExpress, which makes them an excellent choice for prototyping and hobby projects.

They are very capable and much-loved by the "hacker" community, despite their drawbacks, which include abysmal documentation. Thankfully there is a number of community-run projects attempting to rectify the situation.

Each module contains the ESP8266 SOC, which is a powerful microcontroller running at 80 or 160 MHz, with built-in WiFi driver and a range of unexpected, but useful peripherals. The chip is coupled with an external flash memory, typically about 1 MB large, that holds its program code.

This means the ESP8266 can be reprogrammed with custom firmware, which is what made this Wireless Terminal project possible. The generous amount of flash also makes it easy to embed an entire static website with images, stylesheets and JavaScript libraries straight into the module.

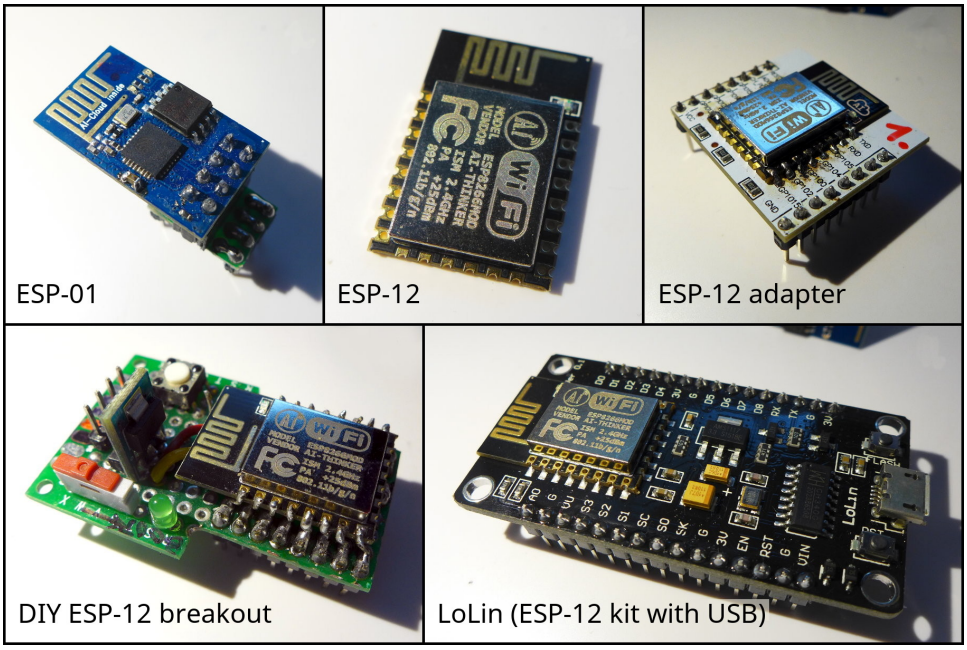

Figure 2: A selection of ESP8266 modules, commercial and home-made

2.1 ESP8266 power requirements

The ESP-xx modules are powered by 3.3 V and due to their high consumption, special care must be taken to ensure reliable operation. The static consumption could possibly be reduced using sleep modes, which can be useful e.g. for battery powered sensor modules.

The ESP8266 idle consumption with the WiFi peripheral enabled is around 70 mA, with frequent but very short 400 mA spikes. Those spikes can cause supply voltage disturbances in the rest of the circuit if the module is not blocked properly (by capacitors as close as possible to the ESP terminals). Additionally, shortly after startup there is a 40 ms long $>$ 300 mA current spike, which can cause even larger voltage drop.

Detailed current measurements can be found in this article.

2.1.1 Dangerous under-voltage fault state

If the ESP voltage drops below about 2 V, the chip can enter a dangerous fault state, continuously drawing 200 mA and after a few seconds suffering irreversible thermal damage.

This fault can be avoided using a voltage watchdog (LVD). Please note that thanks to Ohm's law, the voltage drop is most likely to occur with *long supply cables* or when using a *poor quality breadboard* with high contact resistance.

When this fault state occurs (observed as a sudden dimming of the indicator LED and the module getting hot), disconnect it from power as quickly as possible to

minimize the risk of damage. If you're using a module with the LVD chip on-board, it should take care of this issue.

3 Module schematic and recommended wiring

TODO: replace with an actual photo of the finalized module

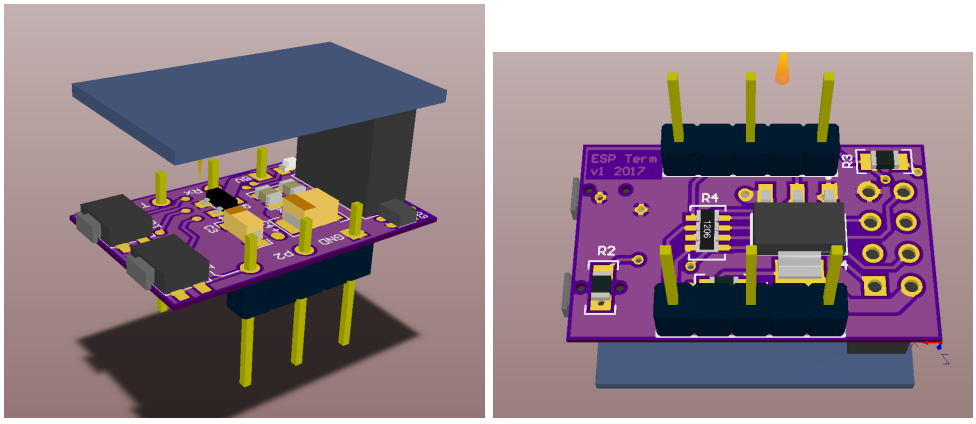

Figure 3: Renders of the breadboard adapter

The custom breadboard module schematic is depicted in Figure 4. The module is fitted with a voltage regulator in order to minimize the supply lines resistance and help provide stable voltage. Thus, the module needs to be powered by 5 V, possibly directly from USB.

The UART pins are not explicitly TTL compatible, but appear to work without problems with a 5 V USB-serial adapter. For added protection, the module is fitted with 1 k serial resistors.

The on-board LVD, if populated, will take care of the under-voltage fault state should it occur, and hold the ESP in shutdown, thus avoiding any potential damage. This is indicated by an LED on the adapter board, marked "LVD".

Debug messages can be listened to on GPIO2 (labeled "DBG"), and the RESET pin is also available for resetting the ESP by the master controller, should the need arise.

3.1 Alternate PCB populating options

The LDO can be omitted (replaced with a 0805 short) if a 5 V supply is not available or desired, then an external 3.3 V supply can be used directly. Note that the 100 uF blocking capacitor may not be sufficient in this case, so a larger external capacitor across the supply pins, close to the module, is recommended.

Please ensure the power supply is capable of delivering the required current safely (peak 450 mA, continuous 80 mA) without larger fluctuations.

Likewise, the polarity reversal protection PMOS can be replaced with a short.

The LVD and the LED can be left out if needed, but the pull-up resistor is mandatory to prevent the SOC entering sleep state spuriously.

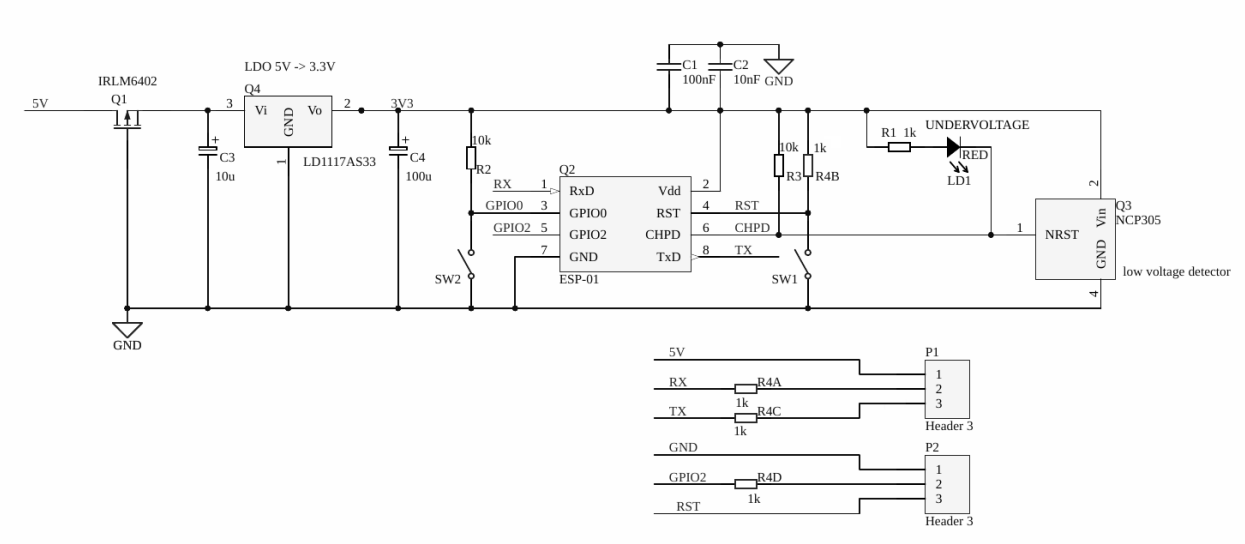

Figure 4: Breadboard adapter schematic

4 Useful links

- The Wireless Terminal Git repository & bugtracker
  https://github.com/MightyPork/esp-vt100-firmware
- ESP8266 current measurements
  https://www.ondrovo.com/a/20170207-esp-consumption/
- ESP8266EX official datasheet
  http://espressif.com/sites/default/files/documentation/0a-esp8266ex_datasheet_en.pdf