ESP32 IoT board — pre-fabrication review

Olimex ESP32-DevKit-LiPo, hardware revision D (ESP32-WROOM-32D, LiPo charger, CH340X USB-UART)

Design files	KiCad 5 schematic, PCB, BOM (Rev D, 2023-10-02)	Design owner	Olimex Ltd. (open-source design)
Board	2 layers, 27.9 × 48.3 mm, 56 parts	License	Hardware: Apache 2.0 (Olimex Ltd.)
Review scope	PCB review: schematic, layout, BOM	Intended use assumed	Battery-powered IoT product base

READINESS STATUS

READY WITH ACTIONS

Suitable to build as a development board. The significant findings should be assessed before using it as the base of a battery-powered product.

0	4	2	3
CRITICAL	SIGNIFICANT	VERIFICATION	IMPROVEMENT
Blocks fabrication	Address before pilot	Measure on prototype	Robustness & DFM

Findings summary

ID	SEVERITY	FINDING	AREA
F-01	SIGNIFICANT	3.3 V output labelled 600 mA, but the regulator is rated 500 mA and the ESP32 alone needs that much	Power
F-02	SIGNIFICANT	On battery, LDO dropout can pull 3.3 V below the module's 3.0 V minimum during Wi-Fi bursts	Power / battery
F-03	SIGNIFICANT	No reverse-polarity protection on the LiPo connector	Protection
F-04	SIGNIFICANT	3.3 V bulk capacitance ≈ 2 µF effective after DC bias; Espressif asks for ≥ 10 µF	Power integrity
F-05	VERIFICATION	UART RX (GPIO3) has no fitted pull-up; check 921600-baud flashing and battery-only leakage	USB-UART
F-06	VERIFICATION	Strapping pin GPIO12 (MTDI) exposed without guidance; a pull-up at boot breaks flash access	Boot / strapping
F-07	IMPROVEMENT	No ESD protection on the USB connector or external power entry	Protection
F-08	IMPROVEMENT	No series resistor on U0TXD (Espressif recommends 499 Ω)	EMC
F-09	IMPROVEMENT	Linear charger dissipates ≈ 0.45 W in SOT-23-5 at 455 mA	Thermal

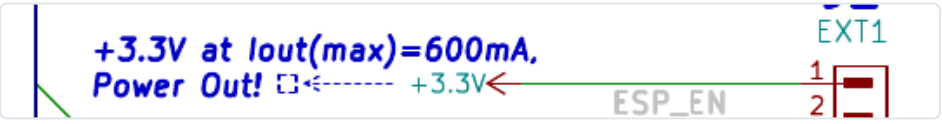
Detailed findings

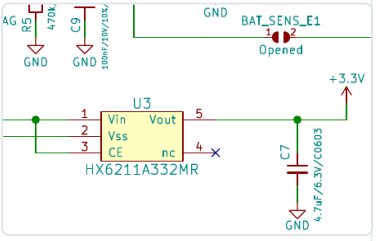
SIGNIFICANT F-01 **3.3 V output rating overstated for the Rev D regulator**

EVIDENCE — Header note on EXT1 reads "+3.3V at Iout(max)=600mA, Power Out!". Rev D uses U3 HX6211A332MR, an LDO listed at 500 mA maximum output. The ESP32 itself needs a supply able to deliver ≥ 500 mA for Wi-Fi transmit peaks.

IMPACT — Loads powered from the 3.3 V header pin share a regulator that is already at its rating during radio peaks. Exceeding it can cause brown-out resets or regulator current limiting.

REFERENCE — Espressif ESP32 schematic checklist: 3.3 V supply "output current is no less than 500 mA" · HX6211A332MR part data (500 mA, LDO).





SIGNIFICANT F-02 **Battery operation: LDO dropout limits usable LiPo capacity**

EVIDENCE — On battery, VBAT (3.0–4.2 V) feeds U3 through FET1. The LDO's dropout is listed as 260 mV at 200 mA and increases with load. During Wi-Fi transmit peaks of several hundred mA, the 3.3 V rail follows VBAT minus the dropout once VBAT falls below roughly 3.6 V.

IMPACT — ESP32-WROOM-32D modules are specified from 3.0 V. Below roughly 3.4–3.5 V on the cell, radio bursts can drop VDD33 under 3.0 V, causing brown-out resets while a meaningful share of battery capacity remains.

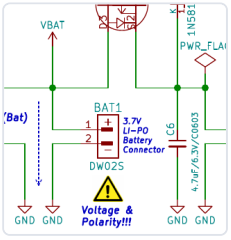
VERIFY — VDD33 during Wi-Fi TX with VBAT at 3.6, 3.5 and 3.4 V. Values above are calculated estimates, not measurements.

REFERENCE — HX6211A332MR part data (dropout 260 mV @ 200 mA) · ESP32-WROOM-32D datasheet operating voltage 3.0–3.6 V.

SIGNIFICANT F-03 **No reverse-polarity protection on the battery connector**

EVIDENCE — BAT1 (DW02S) connects directly to VBAT, the charger BAT pin and FET1. The only safeguard is a "Voltage & Polarity!!!" note on the schematic.

IMPACT — Off-the-shelf LiPo packs with 2-pin connectors are supplied with either polarity. A reversed pack drives current through the charger and FET body diode, typically destroying parts and risking the cell.



SIGNIFICANT F-04 **3.3 V bulk capacitance below Espressif guidance after DC-bias derating**

EVIDENCE — The board-level 3.3 V rail has one bulk capacitor: `C7 4.7 µF / 6.3 V / X5R / 0603`. At 3.3 V (52 % of rating) a part of this size and value typically retains well under half its capacitance; PreBuild's DC-bias estimate is ≈ 2 µF effective.

IMPACT — Wi-Fi transmit current steps cause droop and ripple on VDD33; limited local bulk capacitance compounds F-01 and F-02 and can affect RF performance or cause resets.

VERIFY — VDD33 ripple during transmit bursts; the LDO's output-capacitor stability range in its datasheet.

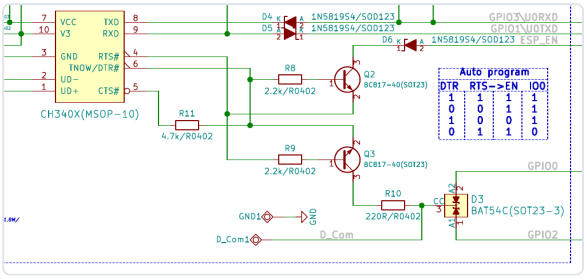
REFERENCE — Espressif ESP32 schematic checklist: "at least 10 µF capacitor at the main power entrance" · PreBuild MLCC DC-bias calculator (prebuild.in/tools/mlcc-dc-bias-calculator/).

VERIFICATION F-05 **UART RX pull-up not fitted (R7 = NA)**

EVIDENCE — CH340X TXD drives ESP32 GPIO3 (U0RXD) through Schottky D4 (cathode toward the CH340X). The high level on GPIO3 therefore comes only from the ESP32's internal pull-up; R7 to 3.3 V is not fitted.

IMPACT — A weak internal pull-up plus diode capacitance slows rising edges; uploads at 921600 baud (a common default) can become unreliable. With USB unplugged, the same pull-up forward-biases D4 into the unpowered CH340X, which may cause small battery drain.

VERIFY — GPIO3 rise time at 921600 baud; battery-only sleep current with USB disconnected.



VERIFICATION F-06 **GPIO12 (MTDI) strapping pin exposed without guidance**

EVIDENCE — GPIO12 is routed to header EXT1 pin 13 with no note. MTDI is sampled at reset to select flash voltage.

IMPACT — If an add-on circuit pulls GPIO12 high at boot, the chip selects 1.8 V for the flash; the WROOM-32D's 3.3 V flash then fails to boot.

VERIFY — Boot behaviour with each intended add-on connected; the flash-voltage eFuse state of production modules.

REFERENCE — Espressif ESP32 schematic checklist: strapping pins GPIO0, GPIO2, GPIO5, MTDI, MTDO; MTDI high selects 1.8 V VDD_SDIO.

IMPROVEMENT F-07 **No ESD protection on USB or power entry**

EVIDENCE — USB D+/D− and VBUS go straight from USB-UART1 to the CH340X and the power path; the BOM has no TVS or ESD devices. Espressif: "add an ESD protection diode" where external power enters the PCB.

IMPACT — Exposed connectors are the most common ESD entry point in handled products; field failures or failed ESD testing are possible.

IMPROVEMENT F-08 **No series resistor on U0TXD**

EVIDENCE — GPIO1 (U0TXD) drives D5 directly. Espressif ESP32 schematic checklist recommends a 499 Ω series resistor on U0TXD to suppress harmonics.

IMPACT — Fast UART edges can add radiated harmonics relevant to EMC compliance.

IMPROVEMENT F-09 **Charger dissipation at 455 mA**

EVIDENCE U1 BL4054B-42 runs from +5 V after D1 at I_{BAT} = 1000/2.2 kΩ ≈ 455 mA. In the constant-current phase it dissipates roughly (4.7 − 3.7 V) × 0.455 A ≈ 0.45 W in SOT-23-5.

IMPACT Expect thermal current fold-back and longer charge times, especially in enclosures.

Checks passed

CHECK	RESULT
EN (CHIP_PU) RC delay: R13 10 kΩ, C8 1 µF	PASS Matches Espressif's typical 10 kΩ / 1 µF
Auto-program circuit (DTR/RTS → EN, GPIO0; GPIO2 held low via D3)	PASS Correct download-mode sequencing
Antenna keep-out	PASS Antenna region overhangs the board edge; no tracks or vias beneath it
Ground reference	PASS GND pours on both layers, 56 GND vias
Battery measurement (R2/R5 470 kΩ, C9 100 nF → GPIO35)	PASS On ADC1, usable while Wi-Fi is active; solder-jumper isolated
CH340X powered from USB only	PASS Avoids battery drain (see F-05 for leakage check)
Charge current setting (R4 2.2 kΩ)	PASS ≈ 455 mA, ≈ 0.33 C for the recommended 1400 mAh cell

Method and limitations

Reviewed against the published Rev D KiCad schematic, PCB and BOM, Espressif's ESP32 hardware design guidelines and manufacturer part data. Electrical values under "Verify" are estimates that require bench measurement. Findings identify risks and their basis; PreBuild does not prescribe design changes. Any design change, and its validation, remains the responsibility of the design owner. This review does not cover firmware, RF performance, EMC compliance testing or enclosure fit. No review can guarantee a working board; bench bring-up and testing remain essential.

About this sample. This is an independent example review prepared by PreBuild Engineering to show the format of a Design Assurance Report. It uses the open-source Olimex ESP32-DevKit-LiPo design files (Rev D), © Olimex Ltd., licensed under the Apache License 2.0. Schematic excerpts are reproduced from those files. Olimex Ltd. has not reviewed or endorsed this report. The ESP32-DevKit-LiPo is a mature, production development board; findings reflect PreBuild's checklist for using the design as the base of a battery-powered product. ESP32 and Espressif are trademarks of Espressif Systems.

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