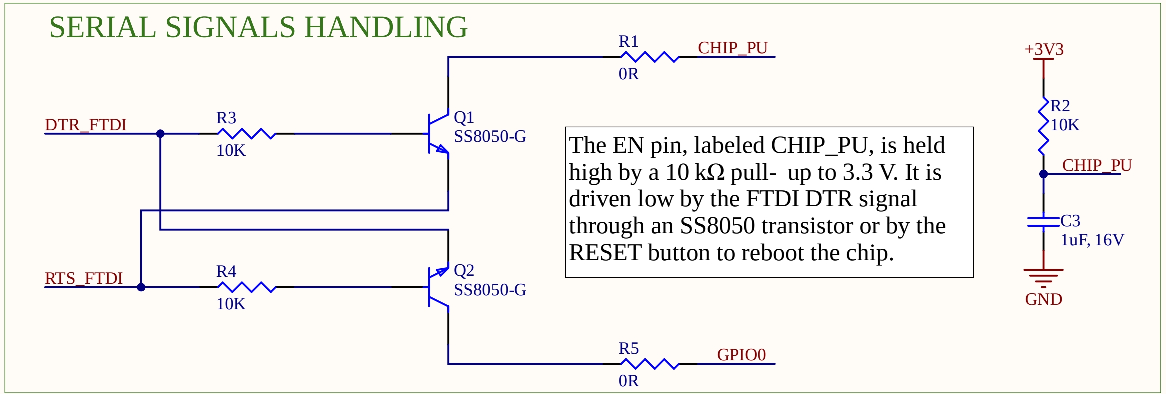
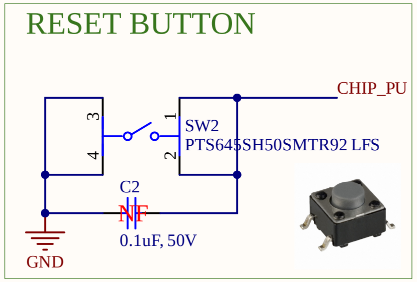
SERIAL SIGNALS HANDLING



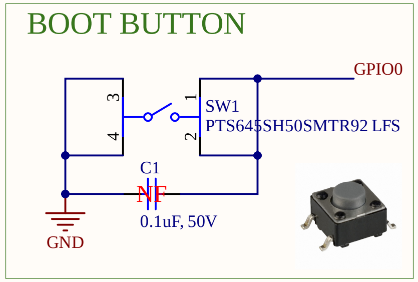
The EN pin, labeled CHIP_PU, is held high by a 10 kΩ pull- up to 3.3 V. It is driven low by the FTDI DTR signal through an SS8050 transistor or by the RESET button to reboot the chip.

RESET BUTTON



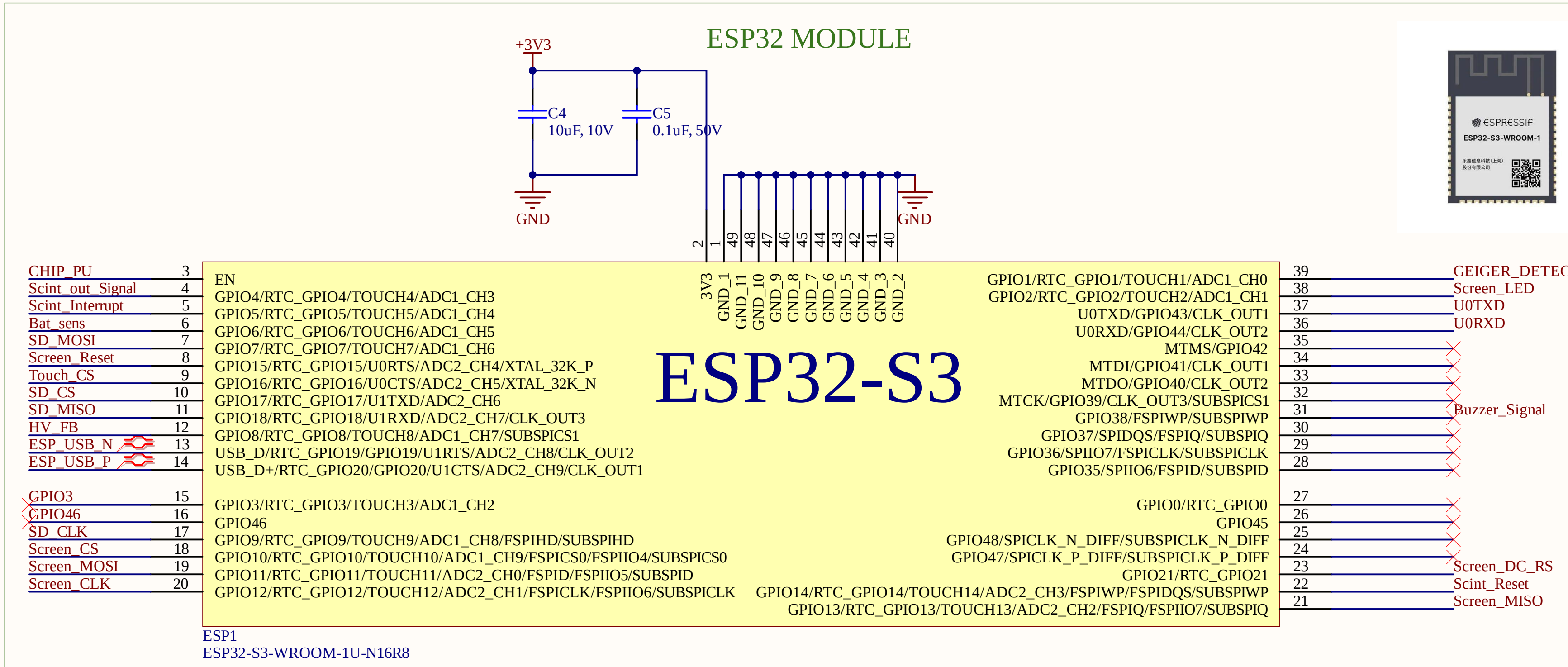
Pressing the RESET button grounds EN (CHIP_PU), forcing the ESP32- S3 to restart.

BOOT BUTTON



Pressing the BOOT button grounds GPIO0 through the 0.1 μF capacitor, placing the ESP32- S3 into the serial- bootloader on the next reset.

ESP32 MODULE



The design uses an Espressif ESP32- S3- WROOM- 1U module which integrates a dual- core 32- bit Xtensa® LX7 CPU running up to 240 MHz, 512 KB of SRAM, onboard QSPI flash and PSRAM, 2.4 GHz Wi- Fi (802.11 b/g/n) and Bluetooth 5 LE radios, USB OTG support, 43 GPIOs (with ADC, SPI, I²C, UART, I²S, RMT, PWM and capacitive- touch interfaces), and hardware cryptographic accelerators (AES, SHA).

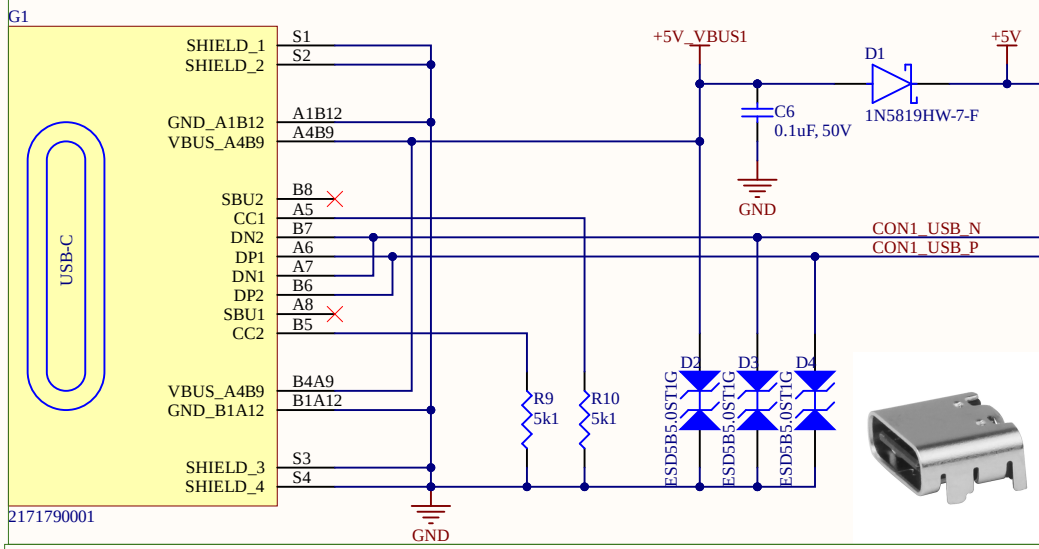
ESP32-S3 microcontroler unit

ESP32-S3: Dual-core Xtensa® LX7 MCU with 2.4 GHz Wi-Fi & Bluetooth 5 LE.

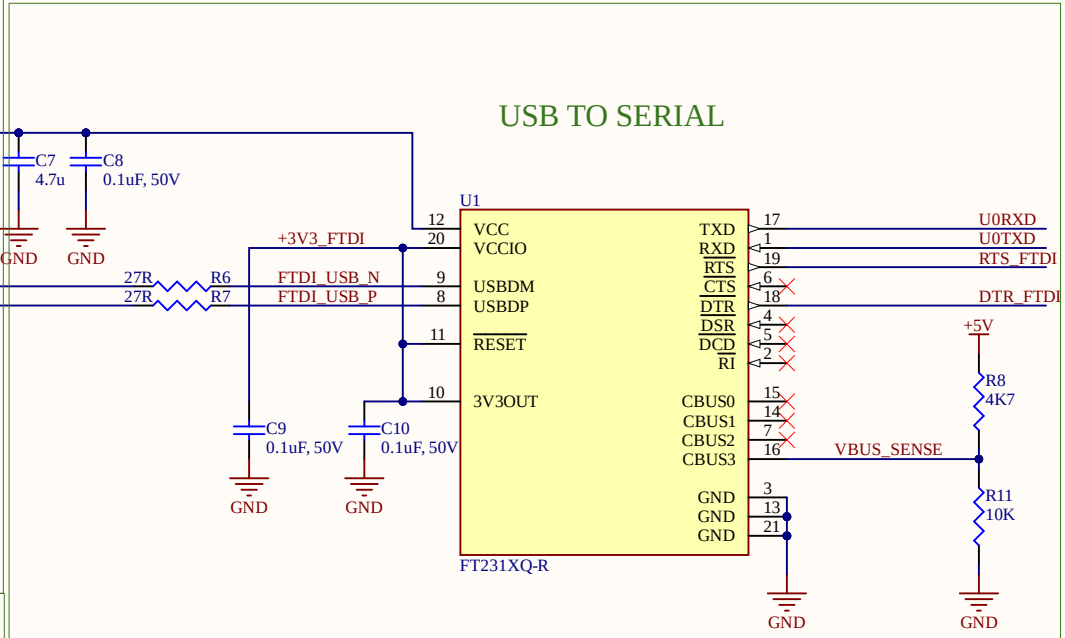
Sheet title: Microcontroller_Unit.SchDoc	
Project title: RadiationDetector.PrjPcb	
Author: Pablo Morán Peña	**Size:** A4
Date: 27/07/2025 Revision: **1**	**Sheet:** 1 of 6

Supervisor: Sr. Andrés Roldán
Adress:
Avda. Madrid 28, Edif. I+D Josefina Castro Vizoso, 2ª planta 18012 - GRANADA, SPAIN
UNIVERSIDAD DE GRANADA

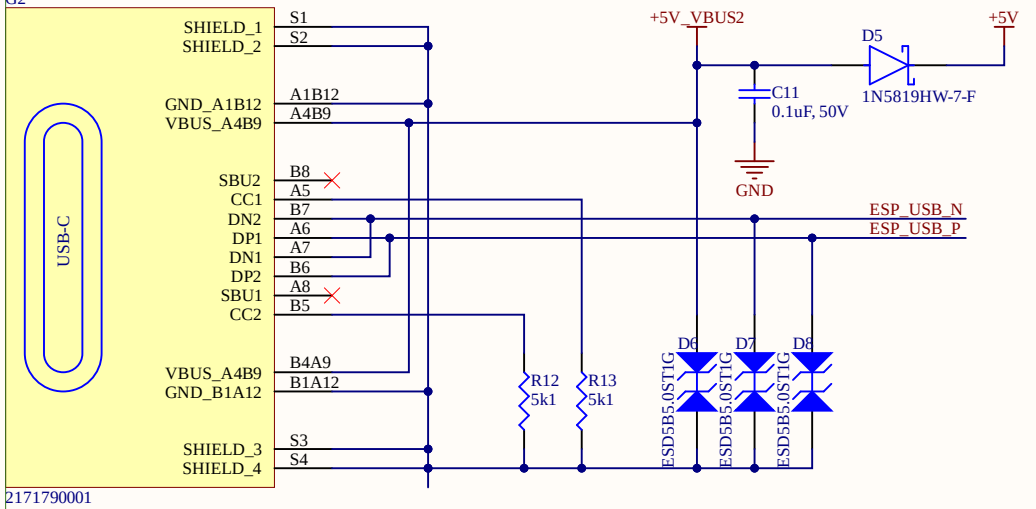
USB-C CONNECTOR 1



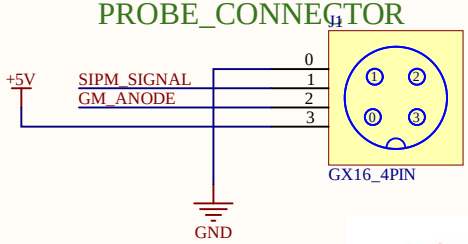
USB TO SERIAL



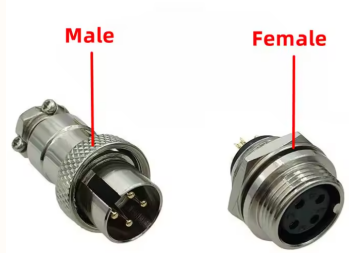
USB-C CONNECTOR 2



PROBE_CONNECTOR



The 4- pin GX16 probe connector brings the detector signals and power off- board:
- Pin 1: +5 V supply
- Pin 2: SiPM_SIGNAL (preamp output)
- Pin 3: GM_ANODE (high- voltage coupled pulse)
- Pin 4: GND



Input Output Ports

It includes two USB-C connectors, one for USB-to-UART and the other for native USB, and a 5-pin GX16 connector for interfacing with probes.

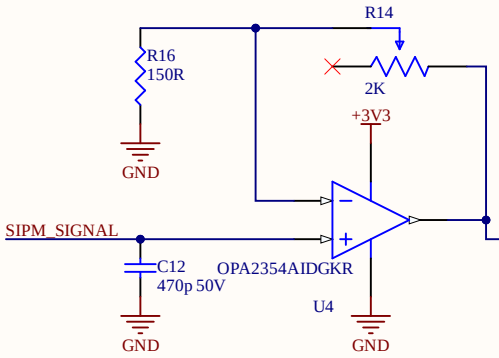
Sheet title: IO_Ports.SchDoc		
Project title: RadiationDetector.PrjPcb		
Author: Pablo Morán Peña		**Size:** A4
Date: 27/07/2025	Revision: **1**	**Sheet:** 2 of 6

Supervisor: Sr. Andrés Roldán

Adress:
Avda. Madrid 28, Edif. I+D Josefina Castro Vizoso, 2ª planta 18012 - GRANADA, SPAIN

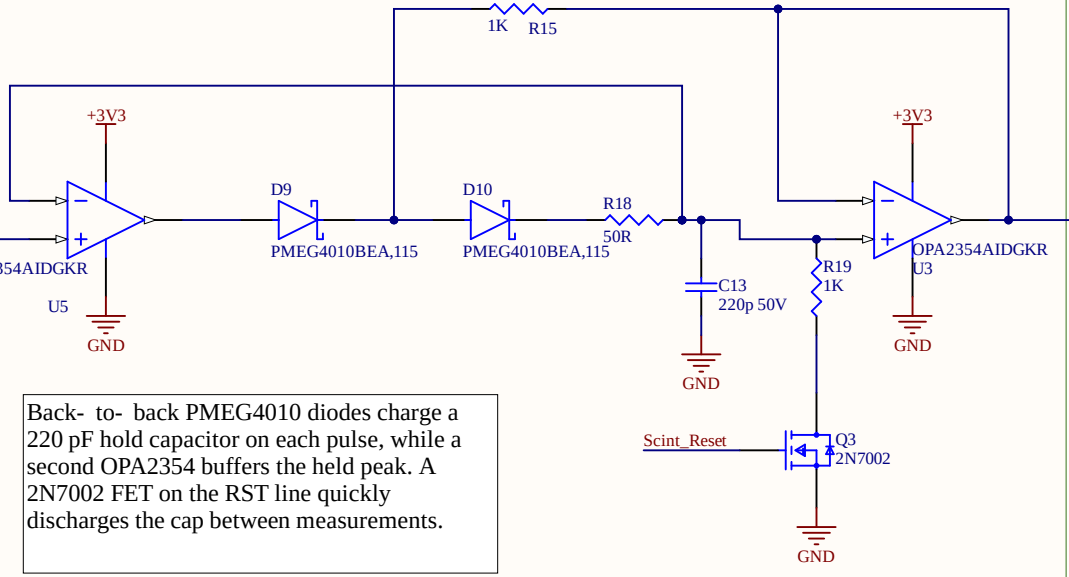
UNIVERSIDAD DE GRANADA

Preamplifier



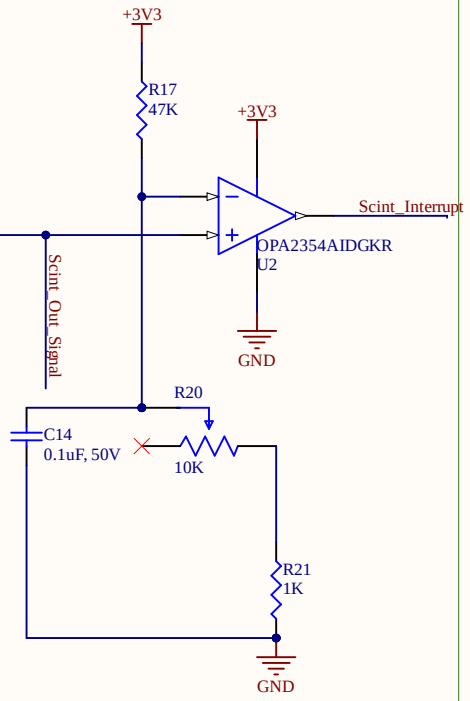
An OPA2354 configured as a low- noise non- inverting amp boosts the SiPM pulses. A 2 kΩ feedback potentiometer with a 150 Ω resistor to ground sets the gain, and a 47 pF input cap ensures stability and bandwidth limiting.

Sample & Hold / Peak Detector

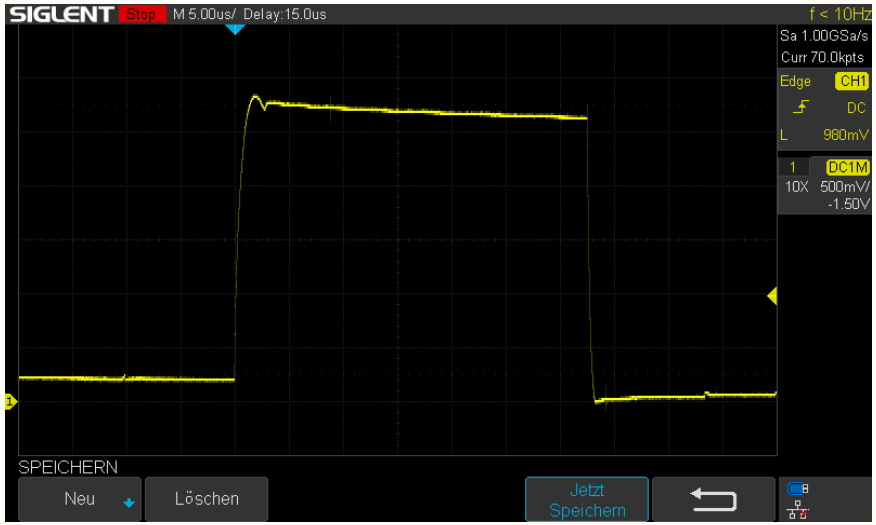


Back- to- back PMEG4010 diodes charge a 220 pF hold capacitor on each pulse, while a second OPA2354 buffers the held peak. A 2N7002 FET on the RST line quickly discharges the cap between measurements.

Pulse Discriminator



The OPA2354 is configured as a comparator: its non- inverting input is tied to the buffered signal, and its inverting input is set by a 10 kΩ/1 kΩ divider with a 0.1 µF filter. A 47 kΩ pull- up on the output drives GPIO5, generating a clean interrupt to trigger the ADC measurement.



Credit: mkgeiger / gamma- spectroscopy (MIT License)

Scintillator signal conditioning circuit

It amplifies the SiPM signal, holds its value, and generates an interrupt so the ADC can sample it.

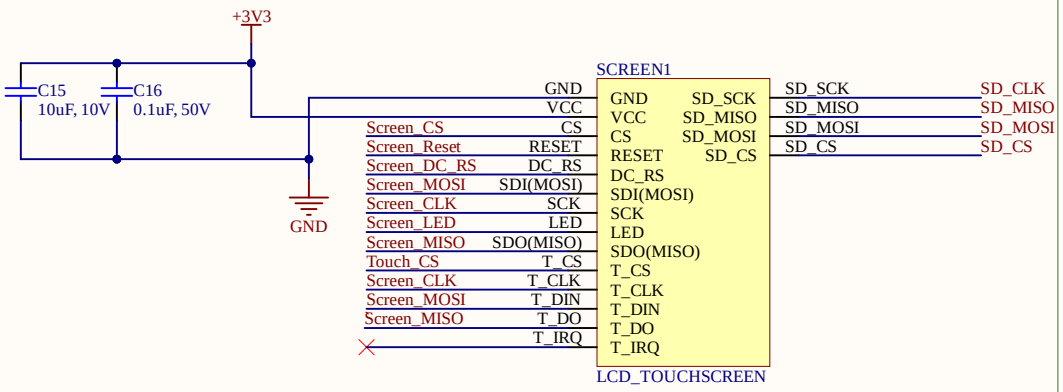
Sheet title: Scintillator_Circuit.SchDoc		
Project title: RadiationDetector.PrjPcb		
Author: Pablo Morán Peña		**Size:** A4
Date: 27/07/2025	Revision: **1**	**Sheet:** 3 of 6

Supervisor: Sr. Andrés Roldán

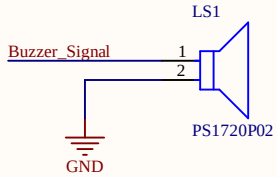
Adress:
Avda. Madrid 28, Edif. I+D Josefina Castro Vizoso, 2ª planta 18012 - GRANADA, SPAIN

UNIVERSIDAD DE GRANADA

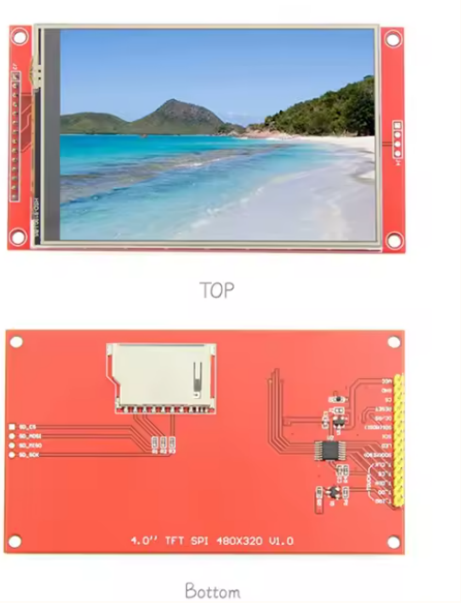
Touch Screen & SD Card



Buzzer



A PS1720P02 piezo buzzer is driven directly from GPIO38, with its other terminal tied to GND for simple audible notifications.



The project uses a 4 " 480 × 320- pixel color TFT module driven by an ST7796S over SPI at 40MHz. It runs from a single 3.3 V rail (with 10 µF + 0.1 µF decoupling), has an onboard LED- backlight pin for brightness control. Touch input is handled by an XPT2046 resistive- touch controller Sharing the same SPI interface as the screen. SD Card access is managed via a different SPI interface

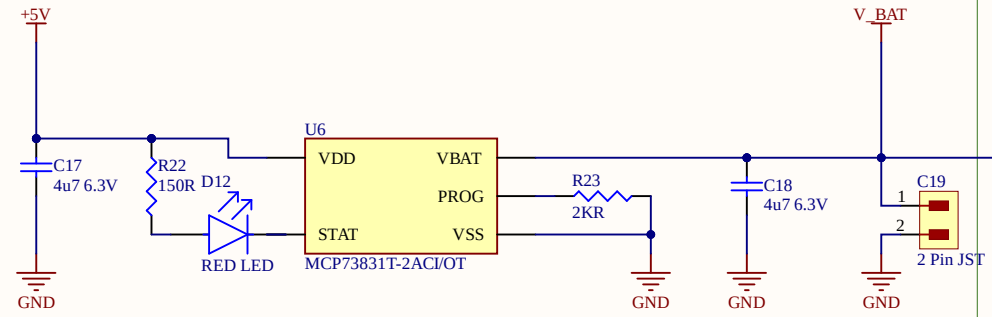
Peripherals

SPI Touch Screen, SPI SD Card and buzzer

Sheet title: Peripherals.SchDoc		**Supervisor:** Sr. Andrés Roldán
Project title: RadiationDetector.PrjPcb		**Adress:** Avda. Madrid 28, Edif. I+D Josefina Castro Vizoso, 2ª planta 18012 - GRANADA, SPAIN
Author: Pablo Morán Peña	**Size:** A4	
Date: 27/07/2025	Revision: **1**	**Sheet:** 4 of 6

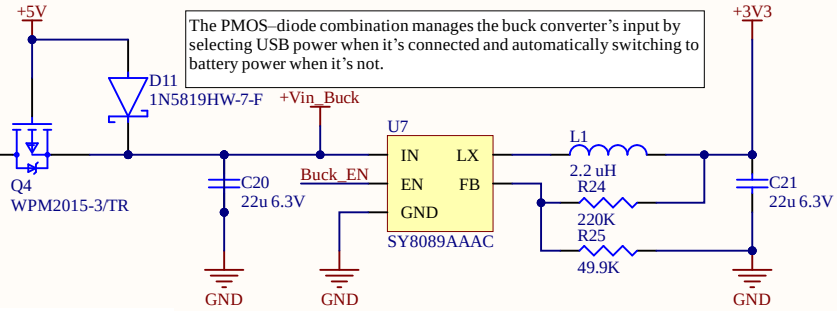
UNIVERSIDAD DE GRANADA

Battery Charging Circuit



The MCP73831T- 2ACI/OT is a battery- charging IC from Microchip that provides a constant charge current set by the RPROG resistor; here, a 2 kΩ resistor programs the charging current to 500 mA.

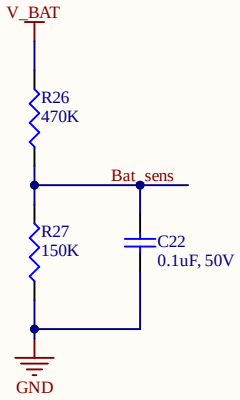
3.3V Generation



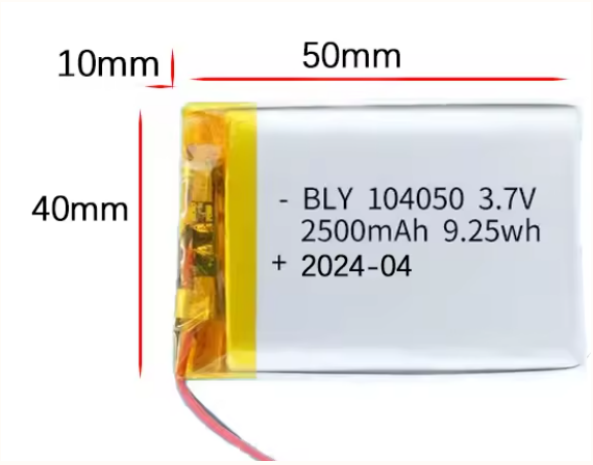
The PMOS–diode combination manages the buck converter's input by selecting USB power when it's connected and automatically switching to battery power when it's not.

The SY8089AAAC is a synchronous buck converter IC from Silergy that delivers up to 1 A of load current at 1.5 MHz switching frequency, with input undervoltage lock- out and thermal- shutdown protection; the output voltage is set by an external resistor divider—e.g. a 220 kΩ/49.9 kΩ feedback network programs V_{out} to about 3.3 V.

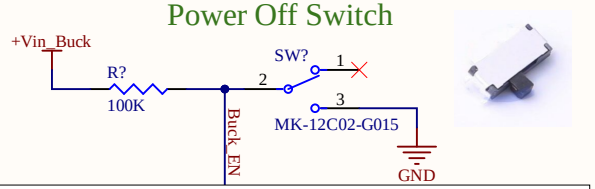
V_BAT Sampling



The 470 kΩ/150 kΩ resistor divider scales V_BAT down to ~0.24 × V_BAT for ADC sensing, while the 0.1 µF cap provides high- frequency noise filtering.



Power Off Switch



A switch sets the buck enable pin to ground, thus turning off the 3v3 generation and the device

The project uses a BLY 104050 single- cell Li- Po pouc battery rated 3.7 V nominal and 2500 mAh (≈9.25 Wh). It measures 50 × 40 × 10 mm, weighs about 50 g, and has no built- in protection, so we pair it with an external MCP73831- based charger. The manufacturer recommends charging it at 0.2–0.5 C (500–1250 mA) up to 4.20 V and avoiding discharge below 3.0 V to maximize life and safety.

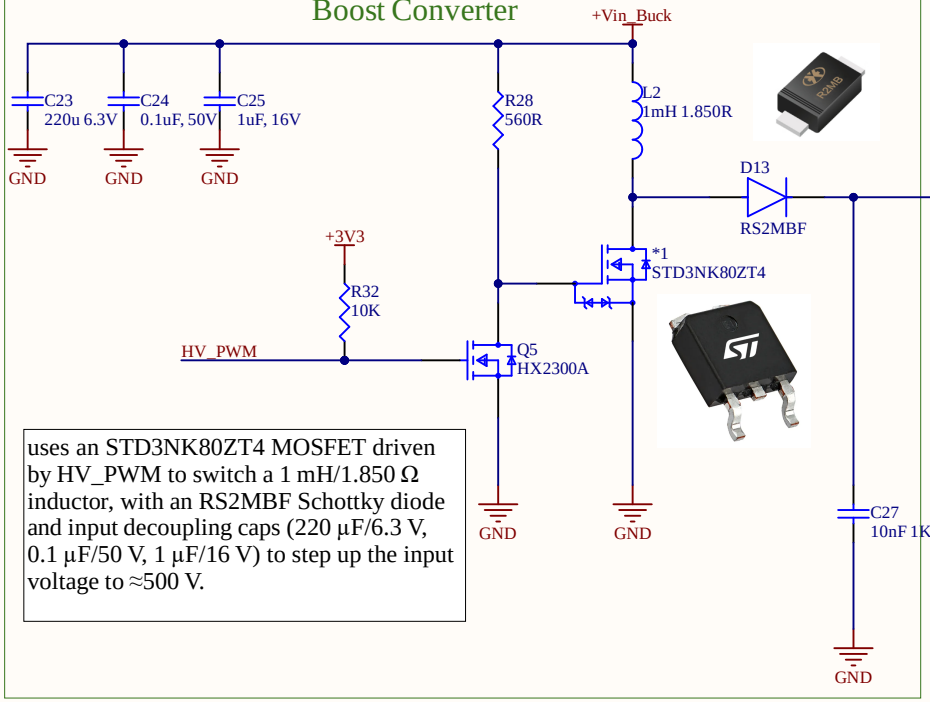
Power Management

Battery charging circuitry, and 3v3 generation

Sheet title: Power.SchDoc			**Supervisor:** Sr. Andrés Roldán
Project title: RadiationDetector.PrjPcb			**Adress:** Avda. Madrid 28, Edif. I+D Josefina Castro Vizoso, 2ª planta 18012 - GRANADA, SPAIN
Author: Pablo Morán Peña		**Size:** A4	
Date: 27/07/2025	Revision: **1**	**Sheet:** 5 of 6	

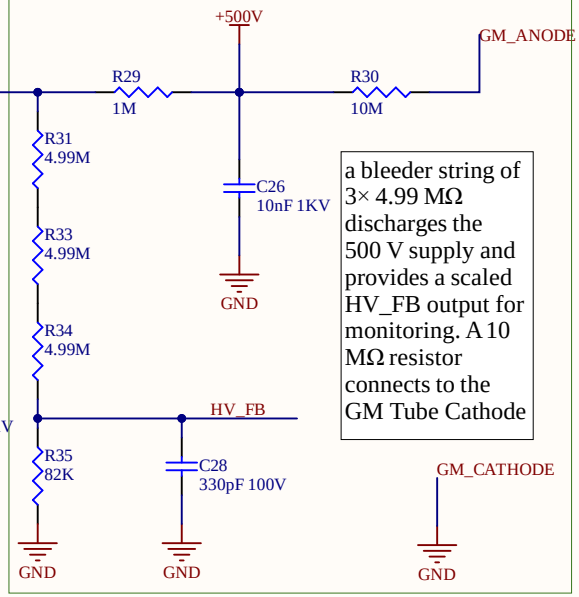
UNIVERSIDAD DE GRANADA

Boost Converter



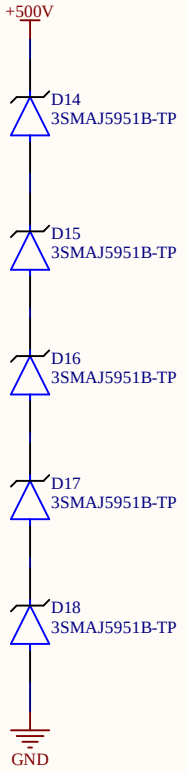
uses an STD3NK80ZT4 MOSFET driven by HV_PWM to switch a 1 mH/1.850 Ω inductor, with an RS2MBF Schottky diode and input decoupling caps (220 µF/6.3 V, 0.1 µF/50 V, 1 µF/16 V) to step up the input voltage to ≈500 V.

Bleeder + Feedback



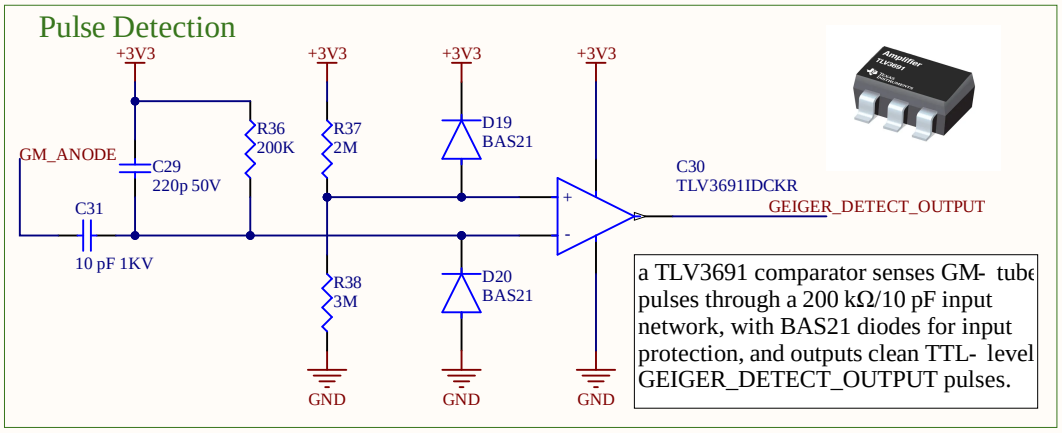
a bleeder string of 3× 4.99 MΩ discharges the 500 V supply and provides a scaled HV_FB output for monitoring. A 10 MΩ resistor connects to the GM Tube Cathode

HV Clamp



a series chain of five 3SMAJ5951B-TP diodes with a zenner voltage of 120v clamps the high- voltage rail at ~500 V to protect against over- voltage transients.

Pulse Detection



a TLV3691 comparator senses GM- tube pulses through a 200 kΩ/10 pF input network, with BAS21 diodes for input protection, and outputs clean TTL- level GEIGER_DETECT_OUTPUT pulses.

The tube's anode is held at +500 V through a high- value bleeder resistor, and a coupling capacitor (e.g. 10 nF/1 kV) blocks that DC while passing the fast voltage drop when the tube fires to the pulse- detector input.
The project uses a Philips 18504 Geiger–Müller tube.

GM Tube conditioning circuit

It generates the required 500 V for the GM tube and includes a simple pulse-generating circuit.

Sheet title: Geiger_Circuit.SchDoc			**Supervisor:** Sr. Andrés Roldán
Project title: RadiationDetector.PrjPcb			**Adress:** Avda. Madrid 28, Edif. I+D Josefina Castro Vizoso, 2ª planta 18012 - GRANADA, SPAIN
Author: Pablo Morán Peña		**Size:** A4	
Date: 27/07/2025	Revision: **1**	**Sheet:** 6 of 6	

UNIVERSIDAD DE GRANADA

Comment	Description	Designator	Footprint	LibRef	Quantity
STD9NK80ZT4	MOSFET N-CH 800V 2.5A DPAK	*1		STD9NK80ZT4	1
0.1uF, 50V	CAPCER0.1UF 50V X7R 0402	C1, C2, C5, C6, C8, C9, C10, C11, C14, C16, C22, C24		C1005B104KB5NNNC	12
1uF, 16V	CAPCER1UF16V X5R 0402	C3, C25		C1005A105KD5NNNC	2
10uF, 10V	CAPCER10UF 10V X5R 0402	C4, C15		C1005A106MP5NUB8	2
4.7u	CAPCER4.7UF6.3V X5R 0402	C7		C1005A475KQ5NRNC	1
470p 50V	CAPCER470PF50V X7R 0402	C12		C1005B471KB5VPNC	1
220p 50V	CAPCER220PF50V X7R 0402	C13, C29		C1005B221KB5NNNC	2
4u7 6.3V	CAPCER4.7UF6.3V X5R 0402	C17, C18		C1005A475KQ5NRNC	2
2 Pin JST	Board Connector, 2 Contact(s), 1 Row(s), Male, Straight, 0.079 inch Pitch, Solder Terminal, Locking, Natural Insulator	C19		B2B-PH-K-S(LF)(SN)	1
22u 6.3V	CAPCER22UF6.3V X5R 0603	C20, C21		CL10A226MQ8NRNC	2
220u 6.3V	CAPCER220UF6.3V X5R 1210	C23		CL32A227MQVNNNE	1
10nF 1kV	CAPCER10000PF 1kV X7R 1206	C26, C27		CC1206KKX7R3BB103	2
330pF 100V	CAPCER330PF 100V C0G/NPO 0805	C28		CC0805JRNPO9BN331	1
TLV3691IDCKR	IC COMPARATOR 1 GEN PUR SC70-5	C30		TLV3691IDCKR	1
10 pF 1kV	CAPCER10PF 1kV C0G/NPO 1206	C31		CC1206JNNPO3BN100	1
1N5819HW-7-F	DIODE SCHOTTKY 40V 1A SOD123	D1, D5, D11		1N5819HW-7-F	3
ESD5B5.0ST1G	TVS DIODE 5VWM SOD523	D2, D3, D4, D6, D7, D8		ESD5B5.0ST1G	6
PMEG4010BEA,115	DIODE SCHOTTKY 40V 1A SOD323	D9, D10		PMEG4010BEA,115	2
RED LED	LED RED CLEAR SMD	D12		LTST-C171KGKT	1
RS2MBF	2A 1000V 1.3V SMB-FL Diodes - General Purpose ROHS	D13		RS2MBF	1
3SMAJE6951B-TP	DIODE ZENER 120V 3W DO214AC	D14, D15, D16, D17, D18		3SMAJE6951B-TP	5
BAS21	DIODE STANDARD 250V 200MA SOT233	D19, D20		BAS21	2
ESP32-S3-WROOM-1U-N16R8	SMD Module, ESP32-S3R8 With 8 mb	ESP1		ESP32-S3-WROOM-1U-N16R8	1
2171790001	CONN RCPT USB2.0 TYP C 24P SMD RA	G1, G2		2171790001	2
GX16_4PIN	GX16_4PIN	J1		GX16_4PIN	1
2.2 uH	1.35A 2.2uH ±20% 1.35A SMD 3x3mm Power Inductors ROHS	L1		VLS3015ET-2R2M	1
1mH 1.85OR	FIXED IND 1MH 520MA 1.85 OHM SMD	L2		46102SC	1
PS1720P02	Data Line Filter, 1 Function(s)	LS1		PS1720P02	1
SS8050-G	Transistores - Bipolar (BJT) - Simple NPN 25 V 1.5 A 100MHz 300 mW Montaje en superficie SOT-23-3	Q1, Q2		SS8050-G	2
2N7002	MOSFET SOT23 N 60V 5OHM 150C	Q3		2N7002	1
WPM2015-3/TR	20V 2.4A 110mΩ@4.5V,2.7A 1.1W 1V@250uA 1 P-Channel SOT-23-3 MOSFETs ROHS	Q4		WPM2015-3/TR	1
HX2300A	20V 2.5A 46mΩ@4.5V,2.5A 650mV 1 N-channel SOT-23 MOSFETs ROHS	Q5		HX2300A	1
0R	RES 0 OHM JUMPER 1/16W 0402	R1, R5		RC0402JR-070RL	2
10K	RES SMD 10K OHM 1% 1/16W 0402, TRIMMER 10K OHM 0.25W GW TOP ADJ	R2, R3, R4, R11, R20, R52		AC0402FR-0710KL, TBS3YL103MR10	6
27R	RES SMD 27 OHM 1% 1/16W 0402	R6, R7		AC0402FR-0727RL	2
4k7	AC0402FR-074K7L	R8		AC0402FR-074K7L	1
5k1	RES SMD 5.1K OHM 1% 1/16W 0402	R9, R10, R12, R13		AC0402FR-075K1L	4
2K	TRIMMER 2K OHM 0.25W 3LEAD TOP	R14		3314J-1-202E	1
1K	RES SMD 1K OHM 5% 1/16W 0402	R15, R19, R21		AC0402JR-071KL	3
150R	RES SMD 150 OHM 1% 1/16W 0402	R16, R22		AC0402FR-07150RL	2
47K	RES SMD 47K OHM 1% 1/16W 0402	R17		AC0402FR-0747KL	1
50R	RES SMD 50 OHM 0.1% 1/16W 0402	R18		RT0402BRE0750RL	1
2KR	RES 2K OHM 1% 1/16W 0402	R23		AC0402FR-132KL	1
220K	RES 220K OHM 5% 1/16W 0402	R24		RC0402JR-07220KL	1
49.9K	RES 49.9K OHM 1% 1/16W 0402	R25		RC0402FR-0749K9L	1
470K	RES 470K OHM 5% 1/16W 0402	R26		RC0402JR-07470KL	1
150K	RES 150K OHM 5% 1/16W 0402	R27		RC0402JR-07150KL	1
560R	RES SMD 560 OHM 1% 1/16W 0402	R28		AC0402FR-07560RL	1
1M	RES SMD 1M OHM 1% 1/16W 0402	R29		AC0402FR-071ML	1
10M	Fixed Resistor, Metal Glaze/thick Film, 0.0625W, 10000000ohm, 50V, 1% +/-Tol, 100ppm/Cel, Surface Mount, 0402	R30		AC0402FR-0710ML	1
4.99M	RES 4.99M OHM 1% 1/4W 1206	R31, R33, R34		RC1206FR-074M99L	3
82K	RES SMD 82K OHM 1% 1/16W 0402	R35		AC0402FR-0782KL	1
200K	RES SMD 200K OHM 1% 1/16W 0402	R36		AC0402FR-07200KL	1
2M	RES SMD 2M OHM 1% 1/16W 0402	R37		AC0402FR-072ML	1
3M	RES SMD 3M OHM 5% 1/16W 0402	R38		AC0402JR-073ML	1
100K	RES SMD 100K OHM 1% 1/16W 0402	R7		AC0402FR-07100KL	1
LCD_TOUCHSCREEN	Data Line Filter, 1 Function(s)	SCREEN1		LCD_TOUCHSCREEN	1
PTS645SH50SMTR92 LFS	SWITCH TACTILE SPST-NO 0.05A 12V	SW1, SW2		PTS645SH50SMTR92LFS	2
MK-12C02-G015	Surface Mount, Right Angle 1A SPDT 6V Black 10,000 Cycles SMD Slide Switches ROHS	SW?		MK-12C02-G015	1
FT231XQ-R	IC USB SERIAL FULL UART 20QFN	U1		FT231XQ-R	1
OPA2354AIDGKR	IC OPAMP VFB 2 CIRCUIT 8VSSOP	U2, U3, U4, U5		OPA2354AIDGKR	4
MCP73831T-2ACI/OT	Power Supply Support Circuit, Adjustable, 1 Channel, PDSO5	U6		MCP73831T-2ACI/OT	1
SY8089AAAC	Buck Adjustable 2A 2.7V~5.5V SOT-23-5 DC-DC Converters ROHS	U7		SY8089AAAC	1