

## RAIN<sup>®</sup> (UHF) RFID reader evaluation kit

Data brief

### Features

- Based on ST25RU3993, a RAIN<sup>®</sup> (UHF) RFID reader IC, featuring:
  - ISO/IEC 18000-63:2015 / Gen2V2
  - GB/T 29768-2013
  - External and internal SW-controlled power amplifier (PA) options (30 and 17.5 dBm maximum TX power, respectively)
  - Configurable TX power level
  - Power detector to monitor TX power
  - Automatic carrier cancellation for improved RX sensitivity
  - Differential RX input
  - RX sensitivity: -80 dBm at 90% read success for one sideband of tag response (ISO18046-3: 2012), -77 dBm at 90% read success for both sidebands of tag response (ISO18046-3: 2020)
  - Adaptive / manual RX gain adjustment
  - Tunable radio frequency (from 840 to 960 MHz), 25 kHz minimum step
  - External frequency reference (20 MHz) assembly option
  - Adaptive / manual anti-collision slot options
- Continuous wave or Modulated RF output test modes
- Two antenna ports: SMB (M), with automatic / manual antenna port switching
- Carrier sense TX option (LBT)
- UHF Tag RSSI measurement
- Configurable SELECT command mask
- UHF transponder EPC Read / Write
- Transponder read based applications trigger
- Custom reader TX command editor tool
- Customizable Gen2 TX commands
- Direct TX modulation through MCU for proprietary protocol support
- Store / Recall reader configuration
- Register map
- Buzzer
- Host interface and supply
  - USB/UART bridge
  - USB receptacle: Micro, B-Type
  - Main supply: 6 V DC jack
- Controlled by STM32L476RGT6 MCU
- LED indicators, test points and buttons for easy debug / use



# 1 Description

The ST25RU3993-HPEV is a high-power RAIN® (UHF) RFID reader system based on the ST25RU3993 device.

Its purpose is to provide a comprehensive RAIN RFID reader system that allows the user to evaluate the properties and the features of ST25RU3993. To achieve this goal the ST25RU3993-HPEV board, differently from a typical reference design approach, combines a high RF power and a low RF power RFID reader on a single PCB.

Additionally, the ST25RU3993-HPEV board is outfitted with several easy-to-access test points and measurement possibilities. With minor modifications it is possible to change the architecture of the reader, for example, it is possible to control the RF circuitry with external MCU or vice versa. Bypassing the external on-board power amplifier or alternate antenna configurations are additional possibilities.

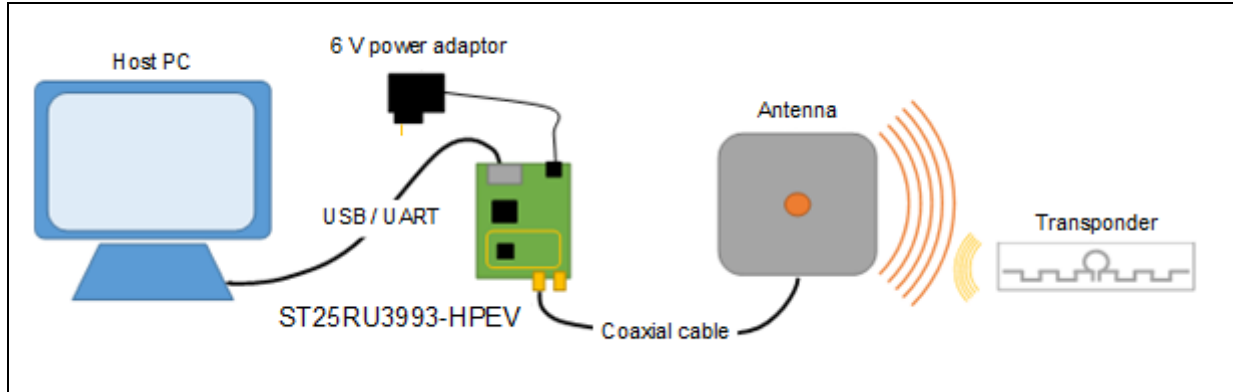
The ST25RU3993-HPEV is controlled by a graphical user interface (GUI) running on a host PC. The corresponding interface is a USB / UART bridge (requires driver installation). The GUI can be found in dedicated pages on [www.st.com](http://www.st.com).

The board supports tuning the radio frequency from 840 to 960 MHz. and provides two SMB (male) antenna connectors that can be controlled via the GUI. To enable scanning for RAIN RFID transponders connect a suitable 50  $\Omega$  UHF antenna for the targeted frequency range.

## 2 Standard connection setup and block diagram

The typical reader setup is shown in [Figure 1](#).

**Figure 1. Standard connection setup**



The host PC running the GUI is connected via a Micro-USB cable. The external power amplifier on the ST25RU3993-HPEV board is powered through the 6 V power adaptor and must be connected when the external PA TX option is used. The antenna is connected to the active antenna port through a coaxial cable. A transponder is within the antenna range.

The board is controlled by means of the STM32L476RGT6 microcontroller (featuring an Arm<sup>®(a)</sup> 32-bit Cortex<sup>®</sup>-M4 core operating at 64 MHz), with 128-Kbyte RAM, 1-Mbyte Flash memory, SPI Mode 1 (5 MHz), firmware programmable through USB/UART and SWD debug interface. The block diagram is shown in [Figure 2](#).

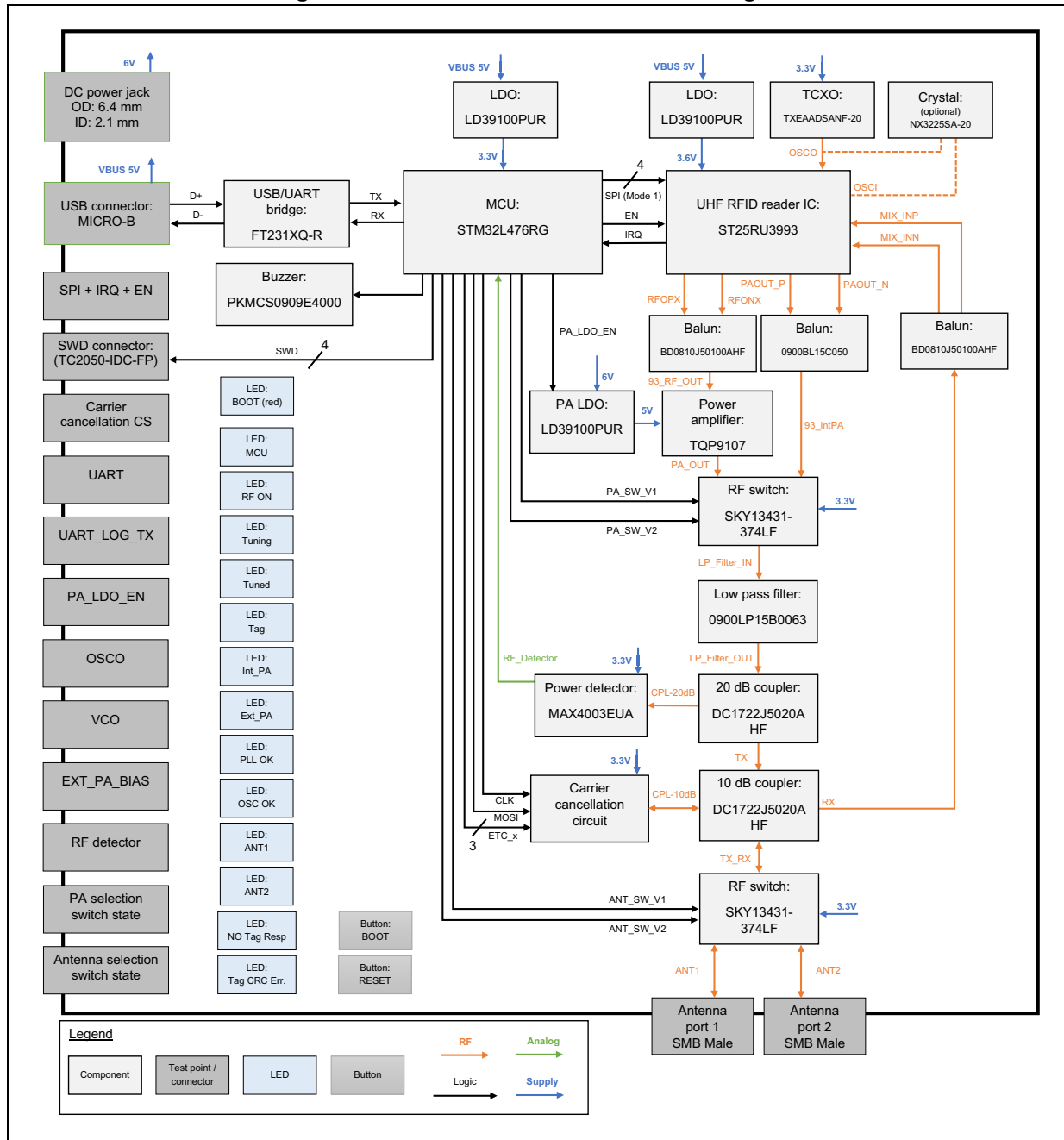
arm

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The board features:

- LED indicators
  - Power amplifier selection
  - Carrier cancellation tuning activity
  - Carrier cancellation tuning OK
  - OSC OK (20 MHz external reference)
  - PLL OK
  - RF ON
  - No tag response
  - Tag CRC error
  - Tag found
- Test points
  - In-circuit RF power levels and signals
  - RFID communication TX and RX
  - UART and SPI signal lines
  - UART\_LOG for debugging purposes
  - Control voltage of internal VCO
  - RF power detector output voltage
  - 20 MHz reference signal
  - External PA BIAS voltage
  - LDO output voltages
  - LDO outputs: jumpers for current consumption measurement
  - Main supply: jumper for current consumption measurement
  - Antenna switch state
  - Power amplifier selection switch state
- Buttons:
  - MCU reset
  - MCU boot mode

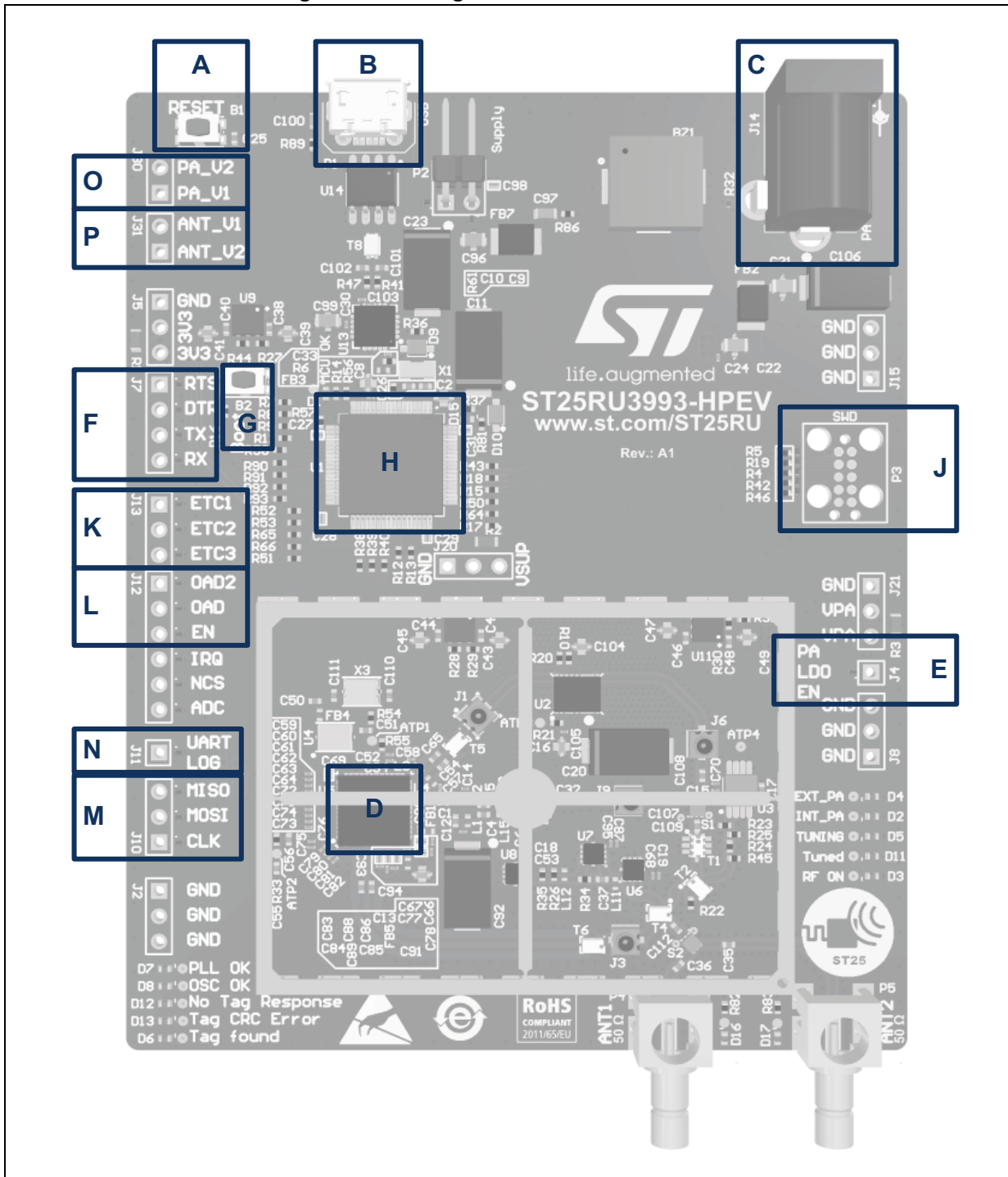
Figure 2. ST25RU3993-HPEV functional diagram



**Table 1. MCU interfaces and buttons (see [Figure 3](#))**

A	MCU reset button
B	USB receptacle: Micro, B-Type
C	6 V DC power connector: 5 mm barrel connector
D	ST25RU3993 Rain (UHF) RFID reader IC
E	Enable line connection of power amplifier LDO
F	UART interface connections
G	MCU boot mode button
H	STM32L476RGT6 (Arm <sup>®</sup> 32-bit Cortex <sup>®</sup> -M4)
J	SWD debug interface connections
L, M	SPI bus interface connections
N	UART_LOG connection for debugging purposes
K	Carrier cancellation circuit (CCC) SPI chip select lines
O	PA output selection switch state
P	Antenna port selection switch state

Figure 3. Main digital interfaces and buttons



### 3 Kit content

- ST25RU3993-HPEV UHF RFID reader printed circuit board (PCB)
- FCC far field patch antenna (Times-7: A5020)
- ETSI far field patch antenna (Times-7: A5020)
- Near field loop antenna
- Wall-outlet power supply (CUI Inc.: SMI6B-6-4-P5)
- USB data cable (CNC Tech: 102-1092-BL-F0050)
- Coaxial antenna cable (MULTICOMP PRO: MC002990)
- Two UHF RFID sample tags, with tag info card (Alien: ALN-9840)
- Printed FCC note



## 4 Revision history

Table 2. Document revision history

Date	Revision	Changes
13-Aug-2020	1	Initial release.
11-Nov-2020	2	Updated <a href="#">Features</a> .
14-May-2021	3	Updated document title and image on cover page.
02-Aug-2021	4	Added <a href="#">Section 3: Kit content</a> .

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