Operational description

A829US FULLY INTEGRATED UHF COMPACT READER (FCC part 15)

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1. Introduction

The A829US is a multi protocol fully integrated UHF low power short range reader designed specifically to be used in desktop or embedded RFID application. Currently the A829US Module supports the ISO18000-6 B, the Philips UCODE EPC 1.19 and EPC Class1 Gen2 protocols. Other future UHF protocols will be available by firmware upgrade. The A829US houses an integrated PIFA antenna, an A828US reader to perform RFID identification and protocol management and an USB service board for PC connection.

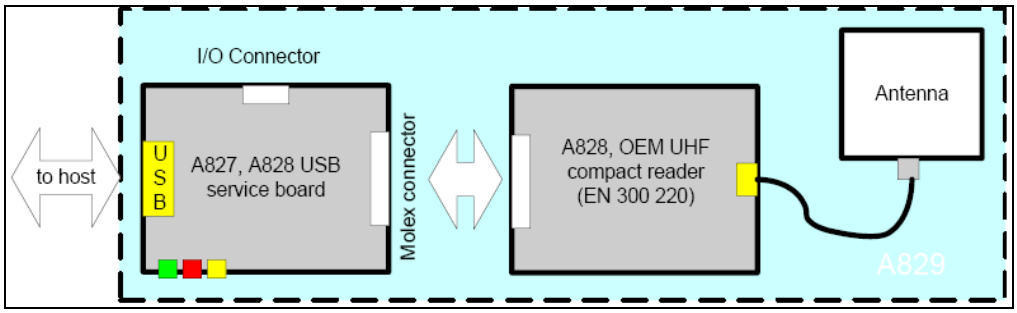

Figure 1: Mod. A829US Block Diagram

It is a bus powered USB device designed to operate as a stand alone PC peripheral communicating via an USB serial port.

Figure 2: A829US fully integrated UHF compact reader (FCC part 15)

2. Linear polarized 3db gain 915 MHz PIFA antenna

2.1. Principle of operation

This linear antenna is a quarter-wave patch (also known as planar inverted-F or PIFA) antenna that covers the USA UHF RFID band. It is linear polarized and houses a RG 178 cable equipped with a MMCX male connector.

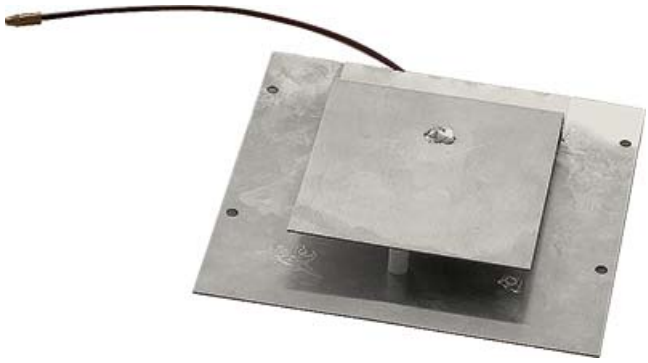

Figure 3: Linear polarized 3db gain 915 MHz PIFA antenna

2.2. Features

Table 1: Antenna electrical properties

Center Frequency	915 MHz
Impedance	50 Ω
VSWR	< 1.3 at center Frequency
Polarization	Linear
Gain	3.0 dBi
Connector	MMCX Straight Cable plugs (male)
Cable	RG 178 (40 cm)

Table 2: Antenna mechanical properties

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Dimensions	120 x 120 x 10 mm^3 (4,72 x 4,72 x 0,39 $inches^3$)
Weight	0.6 kg (1.32 lbs)
Material	Nickel silver

3. A828US Functional description

3.1. Principle of operation

The A828US reader is an RF transmit/receiver device suitable for RFID UHF operation.

It is based on the logic scheme depicted in figure 1 : a Microcontroller **LPC2106** from **Philips** (µc in the diagram) is used to control the analog RF front-end and to support the RFID protocol's management; the analog RF front end, driven by the Microcontroller, on one side generates the analog signal to be transmitted via the antenna and on the other provides all signal conditioning required for data reception.

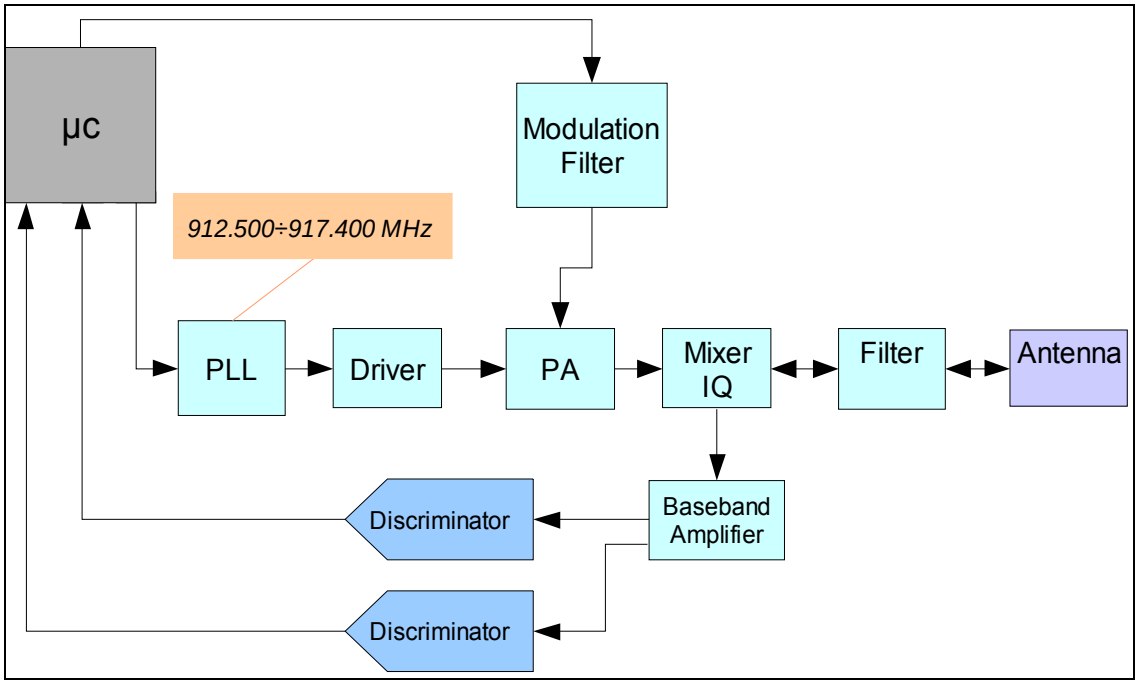

Figure 4: A828US block diagram

The transmit chain begins with the PLL block tuned for the frequency range from 912.45 MHz to 917.45 MHz; this band is divided into 50 channels spaced equally by 100 KHz and the centre frequency of each channel is selected randomly by the Microcontroller to be the carrier frequency of each transmission phase.

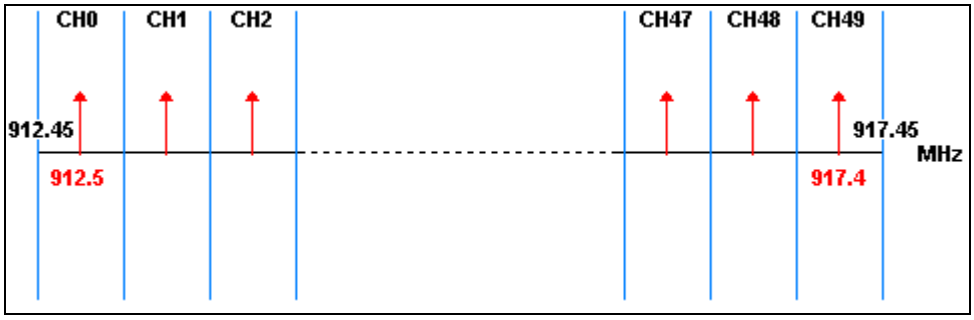

Figure 5: Frequency occupancy

More specifically, at boot time a random sequence of numbers comprised between 0 and 49 is generated by the Microcontroller using the C rand() function with an initial seed derived from the reader Serial Number (SN).

The random sequence is inserted into an array (named CHlist in the firmware code) of 50 elements : the first element of the array is the first random number of the sequence, the last element is the latter. Each element (named CH) represents a different RF channel; each channel is related to the carrier wave frequency by the following formula:

$$Fcw = 912.5 + 0.1*CH \quad MHz$$

Every time a continuos wave is switched on, an array index (called CHindex) is incremented by one and the element value of the CHlist array whose index is equal to CHindex is extracted from the array. This would be the channel selected for the next transmission phase.When the array index equals 49 the next selected index will be 0. In the firmware code a timeout is set to check if the currently selected channel has been in use for more than 400 msec in a 20 sec period starting from the first time the channel was selected. When the timeout is reached the next index channel whose dwell time is less than 400 msec will be selected for continuing the transmission cycle.

The output from the PLL is fed first into the driver block, constituted by a VNA-28 chip from MinicircuitsÒ (a low noise - wideband amplifier with 1-db compression point of 11 dBm) and then to the PA (VNA-25 from MinicircuitsÒ) to raise the output power from 1 mW to 50 mW ca. The PA power supply is modulated by the Microcontroller through the Modulation filter block following a supply modulation scheme which results in a high noise immunity. The final output signal is properly shaped by the filter block to meet protocol's spectral mask requirements.

The receiver's architecture is based on a direct conversion scheme (zero IF) with local oscillator derived from the transmit chain, so the reception frequency is automatically

synchronized to the transmission frequency during frequency hopping sequence (Mixer I/Q block).

A baseband amplifier, whose 3dB bandwidth is 100 KHz (i.e. equal to the channel spacing), amplifies the outputs from the Mixer I/Q block to a level that can be discriminated by two comparators (referred as discriminator in the picture of Figure 1).

Note that the receiver input bandwidth is determined by the baseband filter at the output of I/Q Mixer block. As this filter has a 3dB bandwidth of 100 KHz it automatically matches the channel spacing.

The discriminator outputs represent the I/Q digital channels that must be passed to the Microcontroller to extract the tag's reply data.

3.2. Connectors

The A828US connects to antennas via a MMCX connector from Huber-Shuner (82 MMCX-S50-0-2/111_K) and to the host equipment through a serial interface available on pins 9-10 of a 12 poles Molex connector (type 53261-1290).

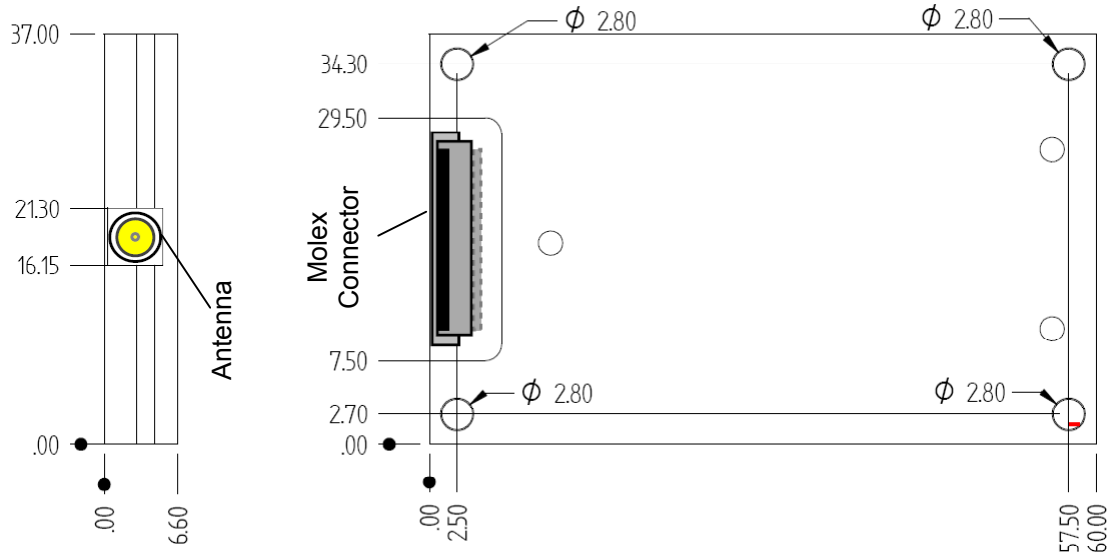

Figure 6: A828US Mechanical drawings

The Molex connector carries also the ground and power supply signals and the reset and general purpose input/outputs as can be derived from the pin-out in table 1.

PIN	Name	Function
1	Vdc (+5 V)	Power supply
2	/Reset	Reset signal
3	Gpio0	General Purpose IO
4	Gpio1	General Purpose IO
5	Gpio2	General Purpose IO
6	Gpio3	General Purpose IO
7	Gpio4	General Purpose IO
8	/Wakeup	Wakeup signal
9	Rxd	Serial Rx signal
10	Txd	Serial Tx signal
11	Gnd	Ground signal
12	Gnd	Ground signal

Table 3: Molex PIN OUT

4. A827 Functional description

4.1. Principle of operation

The Mod. A827 USB service board is a bus powered FT232BM chip based card which allows to manage the Mod. A828EU OEM UHF enhanced compact reader via USB.

Drivers for this device are freely available at: http://www.ftdichip.com/Drivers/VCP.htm

Table 4: Mod. A827 Technical Specifications

Digital I/O	Six I/O lines 3.3 V out, 5 V tolerant
USB Port	USB B female connector Bus powered USB 2.0 device Must be connected to High-power Port (> 500 mA @ VBUS) It appears as USB serial port Virtual Com Port (VCP) drivers for - Windows 98/2000/ME/XP Windows CE 4.2, Linux 2.40 and greater
LED display	RED: Power GREEN: Identify TAG YELLOW: USB communication
Dimensions	85 x 55 x 8 mm^3 (3.35 x 2.17 x 0.32 $inches^3$)
Electrical Power	5 V DC bus powered (USB) Max 500 mA
Operating Temperature	-20 °C to 60 °C

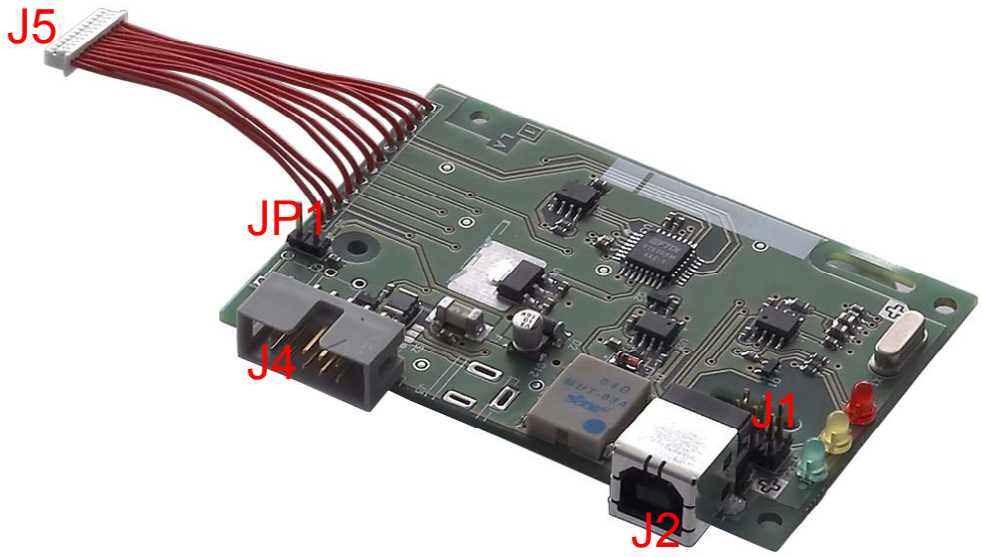

Figure 7: Mod. A827 USB service board

4.2. Technical drawings

The following drawing shows the Mod. A827 components position.

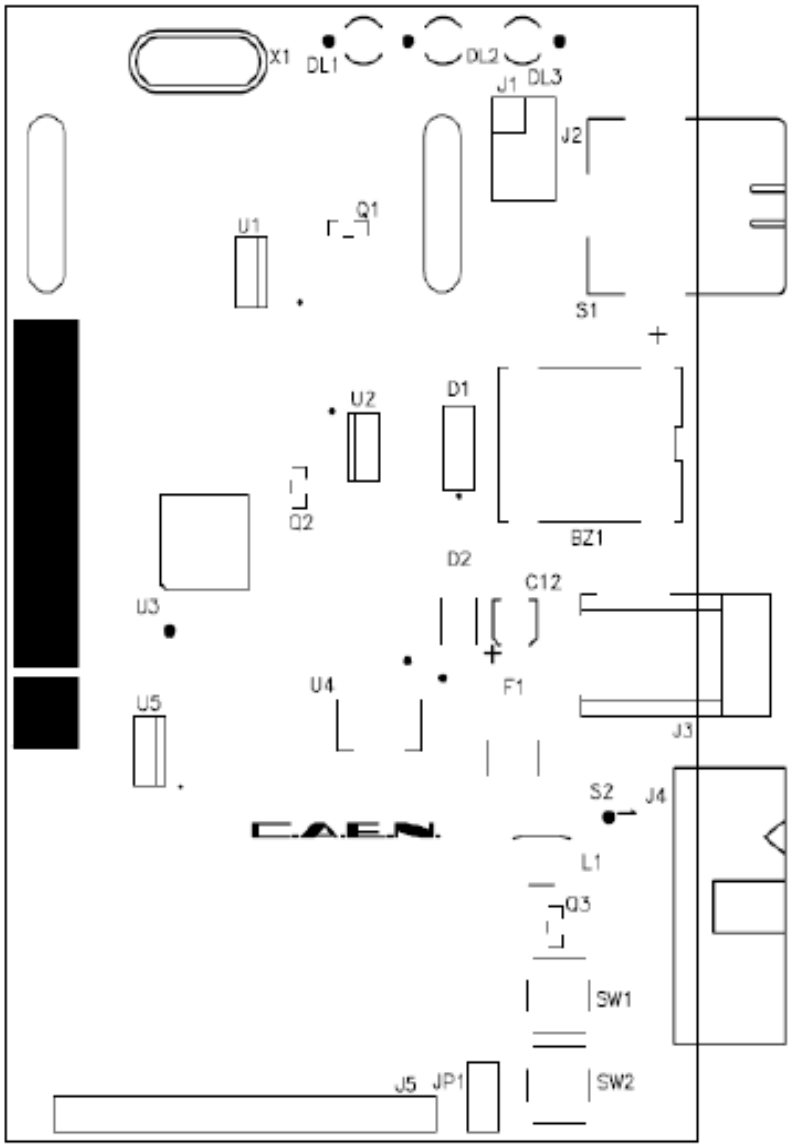

Figure 8: Mod. A827 technical drawings

4.3. Connectors

(Refer to **Figure 7** and **Figure 8)**

J1: male strip, double 2.54mm step, which carries LED signals and power supplies: LED control signals and board power supplies are provided on this connector.

- J1-1 = Led power supply (out)
- J1-2 = GND (in/out)
- J1-3 = Led serial communication (out)
- J1-4 = VCC (in/out)
- J1-5 = Led TAG Identify (out)
- J1-6 = 3.3 Volt (in/out)

J2: USB Type B port
J3: external power supply connector (*not yet implemented*)
J4: 3M-7610-5002-5+5 Connector; it provides the A828EU I/O ports and allows external power supply without using the USB port.

- J4-1 = external power supply +5V (in)
- J4-2 = external power supply +5V (in)
- J4-3 = GPIO3
- J4-4 = GPIO0
- J4-5 = GPIO4
- J4-6 = GPIO1
- J4-7 = /RESET
- J4-8 = GPIO2
- J4-9 = GND
- J4-10 = GND

J5: Molex Connector to be connected with A828EU
JP1: jumper for connecting the A828EU power supply with the A827 power supply. Default setting: jumper inserted = power supply connected.
S1: Switch for TAG identify Beep ON/OFF
S2: Switch for power supply selection: pin1 connected with pin2 = power supply via USB; pin3 connected with pin2 = power supply via J4 (pin 1 and 2 = +5V; pin 9 and 10 = GND)

4.4. Leds

(Refer to **Figure 7** and **Figure 8**)
DL1 (red) = TAG identify (active whenever a tag is detected)
DL2 (yellow) = Serial communication on USB line
DL3 (green) = Power supply

4.5. Switches

(Refer to **Figure 7** and **Figure 8**)
SW1 = RESET (*not yet implemented*)
SW2 = A828EU recovery after being in sleep mode (*not yet implemented*)

4.6. Miscellaneous

(Refer to **Figure 7** and **Figure 8**)
BZ1 = Buzzer, it beeps for 0.5 s (circa) whenever a tag is detected.