# STAR-Module Plus 910

*Preliminary*
*Rev 1.3*

***Integration Guide***

Author:

*Luciano Ruggiero*
*Pier Giorgio Peruzzi*

| Document History |
|---|
| **Rev 1.3** FW release 119 : New Radio Low Cost Plus version added |
| **Rev 1.2** FW release 118: Ddttl improvement, TX routine without byte stuffing |
| **Rev 1.1** FW release 117R: Calibration address bug fixed, CD improvement |
| **Rev 1.0** FW release 116F |

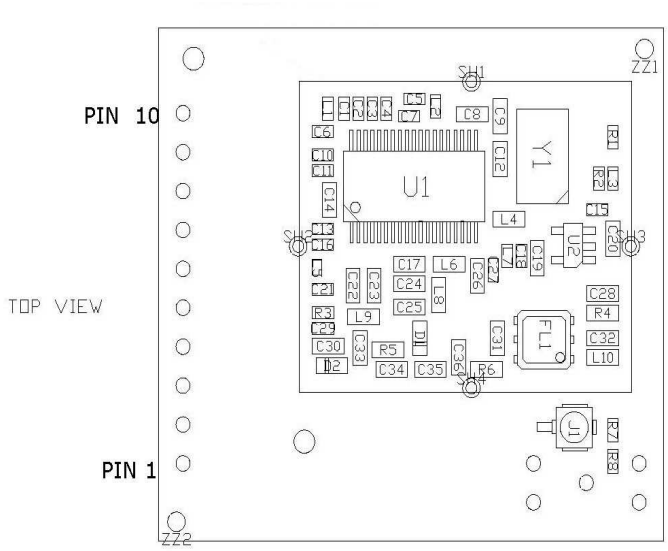


## Introduction

The STAR-Module 910 SLC is an FSK RF half-duplex transceiver working at 910 MHz.
Its main features are:

- UART baud rate of 38400 8 n 1bps
- Default RF baud of 36864bps Manchester encoded
- Extended 5.5 to 3.1 V power supply
- Temperature range –20℃ / +55℃
- High RF frequencies precision, due to utilization of a PLL synthesizer
- Factory calibration parameters saved on write protected flash block
- Factory pre-loaded unique 32 bit address for each module
- RF front-end with SAW filter for high out-of-band noise rejection and low spurius level emission
- On-board temperature sensor for compensation of frequency drift
- Bootloader for in circuit firmware upgrate
- Sub-milliampere sleep mode
- On-board EEPROM for configuration parameters

## Pinout




| Numbe | Direction | Description |
|---|---|---|
| J1 | - | RF CONNECTOR |
| 1 | - | GROUND |
| 2 | Input | TX_DATA |
| 3 | Output | CD# (active low) |
| 4 | Output | RX_DATA |
| 5 | - | not connected |
| 6 | - | GROUND |
| 7 | - | Vdc (3.1 to 5.5 V) |
| 8 | Input | IDLE |
| 9 | Input | RESET_ |
| 10 | - | GROUND |
| | | |

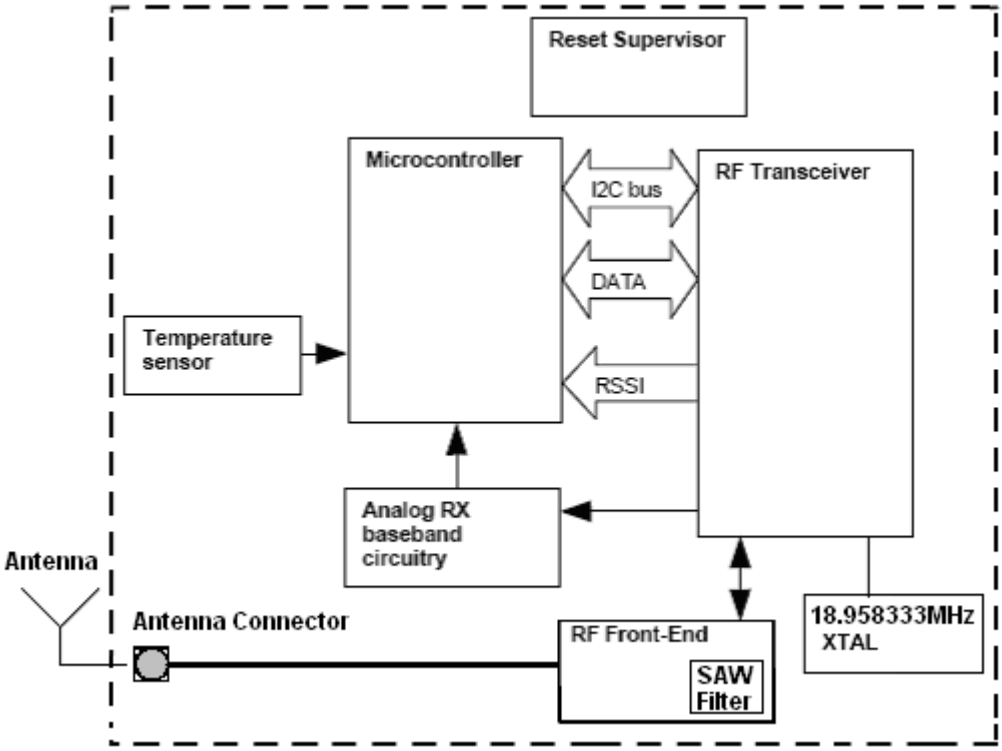
| IDLE/RX | Function |
|---|---|
| HIGH | Sleep |
| LOW | Rx mode<br>Receive data on TX_DATA, CD# asserted means RF channel is busy |

## Electrical characteristics

| Description | @ 3.3 V | @ 5 | Unit |
|---|---|---|---|
| TX mode current | 18 | 31 | mA |
| RX mode current | 16 | 21 | mA |
| IDLE mode current | 32 | 52 | uA |

## RF characteristics

| Description | Typ | Unit |
|---|---|---|
| TX/RX center frequency | 910 | MHz |
| FSK modulation frequency shift | +/- 75 | kHz |
| RX bandwidth | 300 | kHz |
| Output power (50 Ohm load) | -2.5 | dBm |
| RX Sensitivity (BER < 5% @36864 baud) | -106 | dBm |
| CD# threshold | -76 | dBm |
| RF in/out impedance | 50 | Ohm |
| Frequency drift from –25 to +55℃ | +/- 50 | ppm |

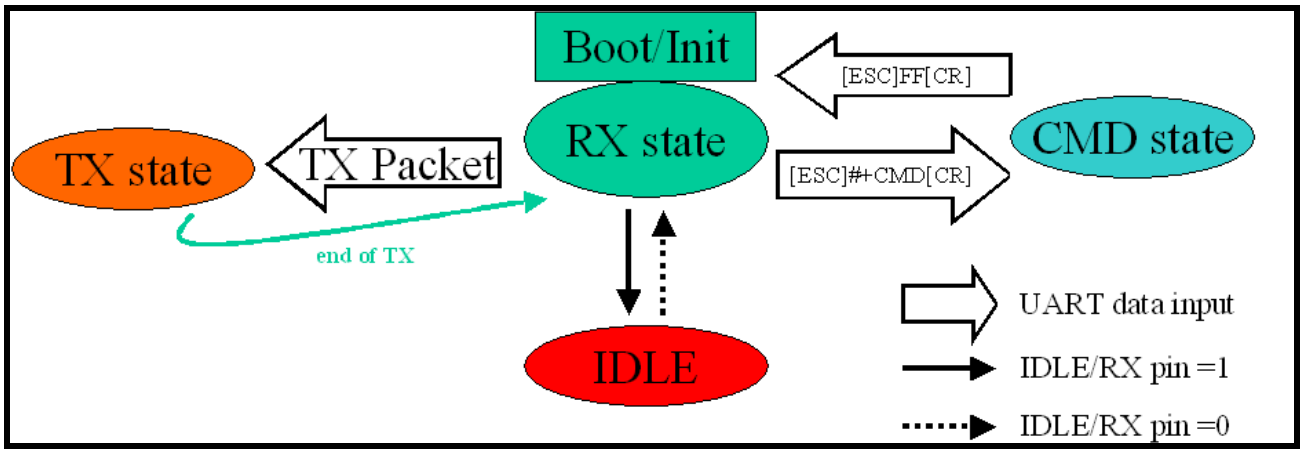



## Block diagram

Blocks description:

- Reset supervisor: the microcontroller is reset when power supply falls below 3V
- Temperature sensor: 10kOhm NTC
- Microcontroller: Atmel ATMega8L with RISC AVR core, 8kB Flash, 1kB SRAM, 512 B EEPROM, ADC, UART, I2C controller, 8MHz internal clock oscillator
- RF Transceiver: Infineon TDA5252 with PLL synthesizer (reference oscillator 18.958333MHz)
- Analog RX baseband circuitry: processing of analog signal from transceiver demodulator to uC ADC
- RF Front End: SAW filter, PIN-diode based RX-TX switch

## Basic module states




Different states explanation:

- IDLE: this state is entered when pin IDLE is set High. Power consumption is lowered to less than 100 uA. In idle state the radio module is unable to receive or transmit data packets.
- TX: RF power amplifier is active. This state can be entered from RX mode, sending to the module a formatted TX packet. Tx mode can't be hold active more than the maximum data packet (about 20 mS).
- RX:receiver is active. Data is sent out from RX_DATA pin and CD is set depending from presence or not of RF carrier.
- COMMAND: the module exits from normal functioning and is able to receive configuration commands from host. This state can be entered from RX mode, sending to the module the escape string [ESC]#+CMD[CR] @ 38400, 8, N, 1. To exit this state, the appropriate command must be sent.

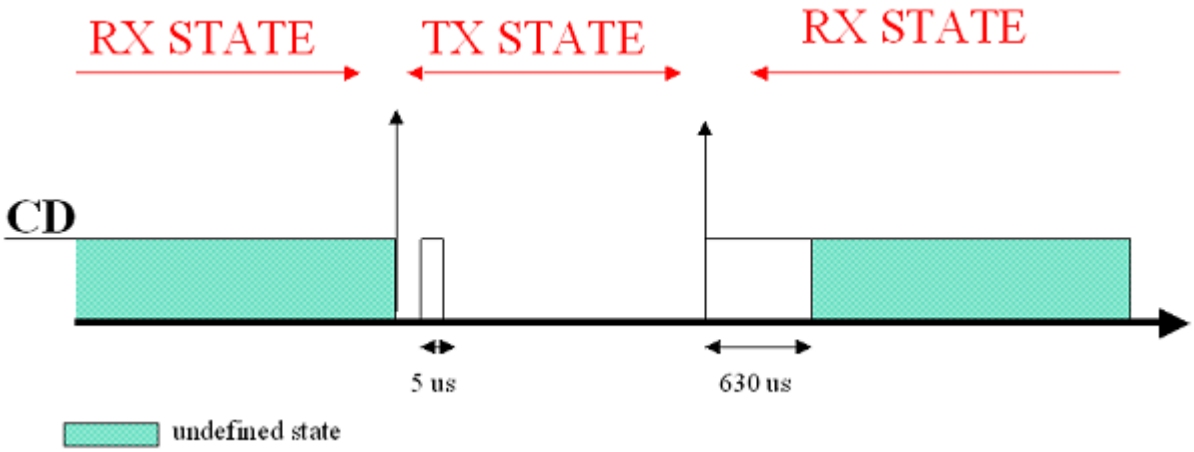



**Fig. 1**

## RX mode

Received RF signal is down-converted to baseband, demodulated and converted to a bit stream presented on TX_DATA pin. Also CD# is driven, asserting presence or lack of carrier in the RF channel as in Fig 1.

**Absence of RF: high level.**
**Presence of RF: low level.**

The RF down conversion starts with the reception of the 0xB2 (old protocol) or 0x96 (new protocol) byte, followed by the packet length byte. According to this value the conversion goes on receiving length number bytes plus the two CRCs.
Thus the byte stream presented on TX_DATA (output) UART starts with 0xFF, 0xB2 or 0x96, the packet length byte and so on sending the number of length byte to complete the packet reception plus the CRCs bytes.

Active blocks are:
- Receiver part of transceiver
- ADC conversion of RSSI signal
- DSP of the analog demodulated signal in order to decide the best RX frequency out of the 2 available
- Analog signal conditioning block, prior to ADC conversion
- ADC conversion of temperature indication and compensation
- UART to receive command strings from the host @38400, N, 8, 1 on pin Data In.

The reception of the enter test string **[ESC]#+CMD[CR]** causes the exit from RX mode and the entering of CMD mode, while the reception of the TX command **[STX] [DATA]** causes the exit from RX mode and the entering in TX mode transmitting data.

**Enter Test: [ESC]#+CMD[CR]** to enter in CMD mode
**TX Packet: [STX] [DATA]** to transmit [DATA]

## TX mode

Frame sent by the host on pin RX_DATA is up-converted to RF, modulated and power-amplified.
During TX mode CD# line is shown in Fig. 2 during the TX state.

Active blocks are:
- Transmitter part of transceiver
- Power amplifier

### *TX Packet Formatting*

Transmission starts only sending a data packet with a specific data format and without delay between one byte to the next one of the data packet. Transmission ends when is transmitted the last byte received from the host (max 96 bytes). At least transmision ends as soon as sent the 96th byte from the first byte of the packet.
The [DATA] frame to be transmitted has to be formatted as follows :
The first byte must be [STX] (0x02) : this is the TX key char. As soon as received th STX byte the radio module start to send a 12 bytes preamble. The preamble is followed from the bytes of the data packet up to the last one.
The second byte must be the SOF (start of frame byte depending from the protocol used. Now are supported 0xB2 or 0x96 only)
The third byte must be the frame length (from length byte itself to the CRC field excluded).
Follows all other bytes of the packet to be transmitted.

Example:
to transmit the data packet : “0x25 0x10 0x25 0x40 0x11” – 5 bytes,
the packet to be sent to the radio has to be :
[0x02] [0x96] [0x06] [0x25] [0x10] [0x25] [0x40] [0x11] [CRC1] [CRC2].
Number of TX bytes sent = length (0x06) + 3. [STX], the TX key char, is not sent.
The transmitted preamble is 12 bytes length.

The module returns in RX state after transmitting all the bytes of the packet.

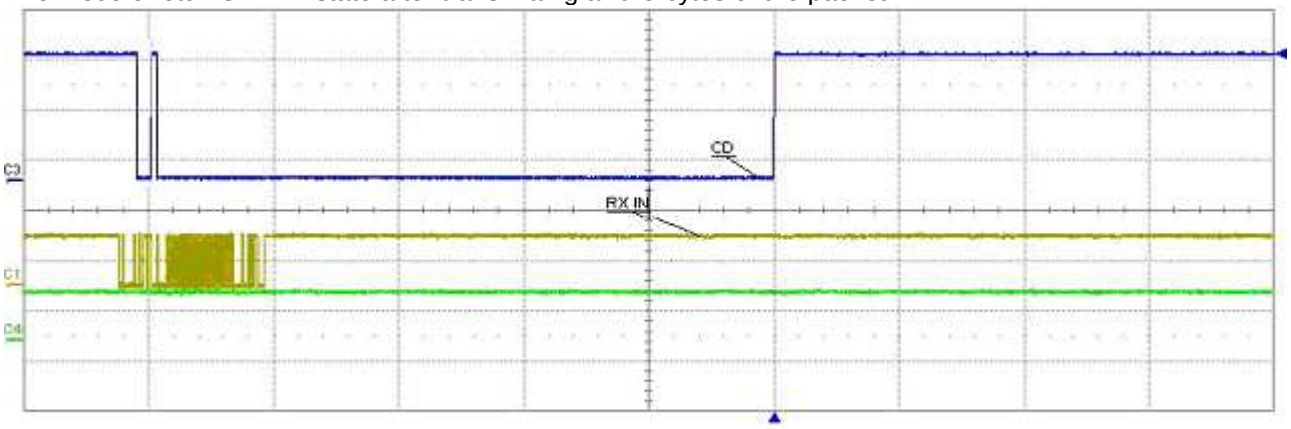



**Fig. 2**

## IDLE mode

In order to maximize battery duration on portable devices a low-consumption state is used.
In this state with IDLE/RX_ pin asserted, all hardware blocks swith to power-down mode or switched off.
To wake up the module, the host must deasserted IDLE/RX pin (Set RTS). In IDLE mode CD# has **low level** (shown in fig. 3)**.**

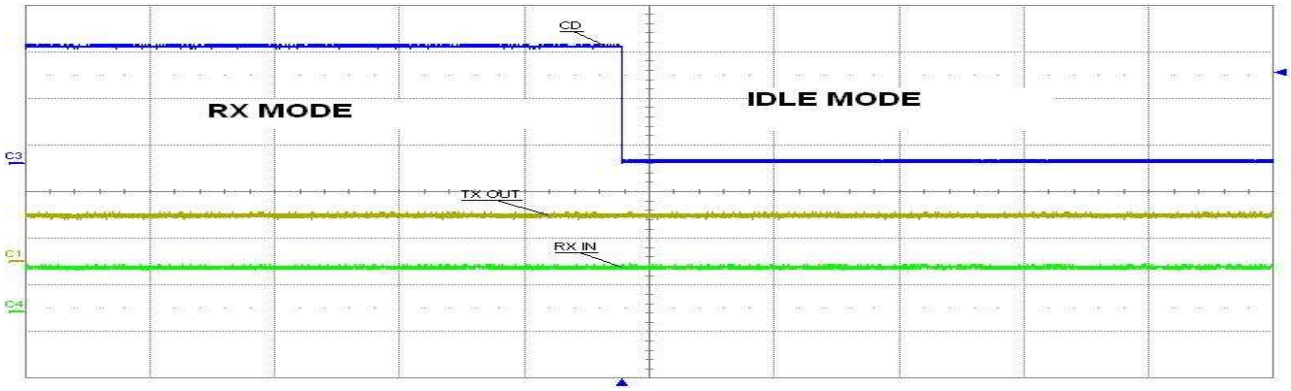



**Fig. 3**

## COMMAND mode

When the host puts the module in RX mode and then sends the escape string [ESC]#+CMD[CR], COMMAND mode is entered.
To confirm COMMAND mode, STAR-Module answers to the host the string [STX][CR] using TX_DATA pin.
In this state normal functioning is disabled, but it is possible to send configuration commands to the module, in order to change the settings loaded on its configuration EEPROM.
Command must be sent using RX_DATA pin @38400, N, 8, 1 in the form: [ESC]xxxx[CR].
While answers from the module are in the form: [STX]xxx[CR].
If an incorrect command is sent, the answer is: [STX][NAK][CR].
In Command mode CD# has **low level.**
The state is exited using the exit command: [ESC]FF[CR] causing the reset of the module and activating the new configuration saved on EEPROM.
NOTE: commands are case sensitive.

**RF interface**

StarModulePlus910 has 50 Ohm impedance on RF out in TX and RX mode, therefore impedance matching is required for antenna system of host.
Care must be taken for the proximity of conductive materials or the user's hand that will cause a mismatch of the antenna, decreasing the transceiver RF characteristics.
Moreover, care must be taken to ensure that the host system doesn't have spurious emissions in the range 910MHz+/-200kHz, that could cripple receiver sensitivity: it is advised to put a ground plane under the RF module and to filter the power supply.
Noisy parts, like system buses, must be shielded in order not to irradiate spurious fields.

**This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:**
**1) This device may not cause harmful interference, and**
**2) This device must accept any interference received, including interference that may cause undesired operation.**

**Any change or modification to the product not expressly approved by Datalogic Scanning Group S.r.l. could void the user's authority to operate the device.**