Blackboard WR5000 Reader Circuit Description

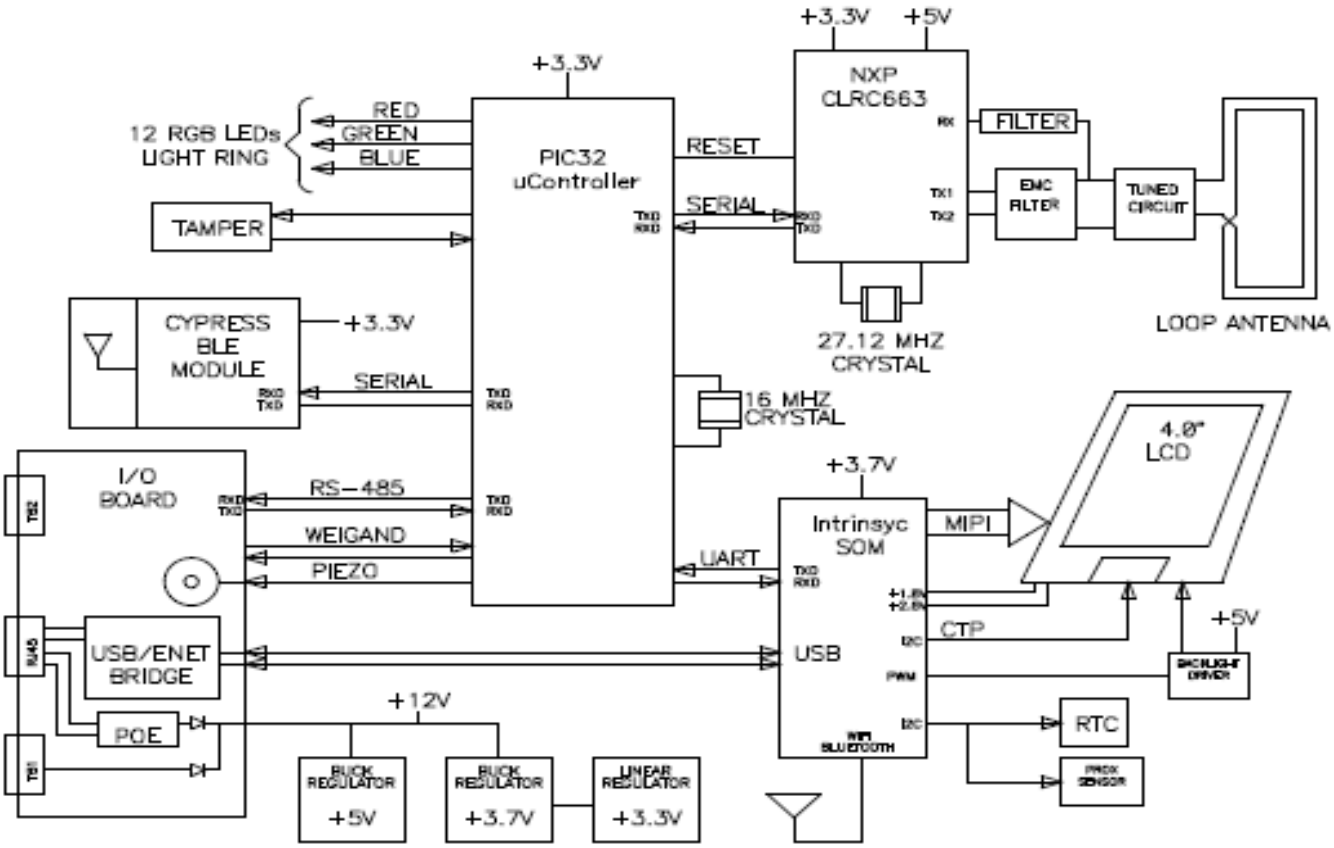
The Blackboard model WR5000, is a device for reading Blackboard contactless cards and other credentials that use Near Field Communications (NFC) technology. It supports two modes of operation; a Door reader that interfaces to either the Blackboard Security Access system or a Third-party Control panel using a Wiegand interface. A second mode of operation is as an Attendance reader.

Features of the WR5000 include:

4.0” LCD (480 x 800) with capacitive touch panel
Configuration via touchscreen/display
NFC technology
RS-485 Serial interface
Communications 10/100 Base-T Ethernet (IP) or Wi-Fi 802.11b/g/n 2.4 GHz single band
Bluetooth 4.1
Snapdragon 410 quad core ARM® Cortex® A53 (64bit, 1.2GHz)
Qualcomm® Adreno™ 306 GPU
Qualcomm® Hexagon™ v5 DSP
Microchip PIC32 Microcontroller

The reader contains three circuit boards:

- Carrier board
- I/O board
- System on Module (SOM)



Carrier Board

The main circuit board which has both the I/O board and SOM plug into is referred to as the Carrier board. The I/O board uses a 40-pin connector and the SOM uses two 100-pin connectors. These connectors provide the electrical interface signals and DC power supply voltages between all three.

The Carrier board takes +12 Volt input and regulates it to DC voltages of +5V, +3.3V and +3.7V. These DC voltages are used by the I/O board and the SOM. The Carrier board contains a Microchip PIC32 microcontroller, an NXP CLRC663 NFC transceiver, a BLE module and voltage-level translators that allow interfacing to the +1.8V signals from the SOM. The Carrier board also provides a path for electrical signals from the SOM to the LCD, a real-time clock and a proximity sensor. In addition, USB signals from the SOM connect to the I/O board to provide an Ethernet connection via a bridge circuit.

The PIC32 controls twelve RGB LEDs that provide a lighted ring around the bezel. These are connected to three of the PIC32 pulse width modulators (PWMs). The PIC32 controls these signals to provide ambient lighting as well as annunciation of valid and denied reporting using green and red.

A GPIO signal from the PIC32 controls the frequency that drives a piezo speaker on the I/O board. This signal is controlled in a 1ms software interrupt for determining frequency and duration.

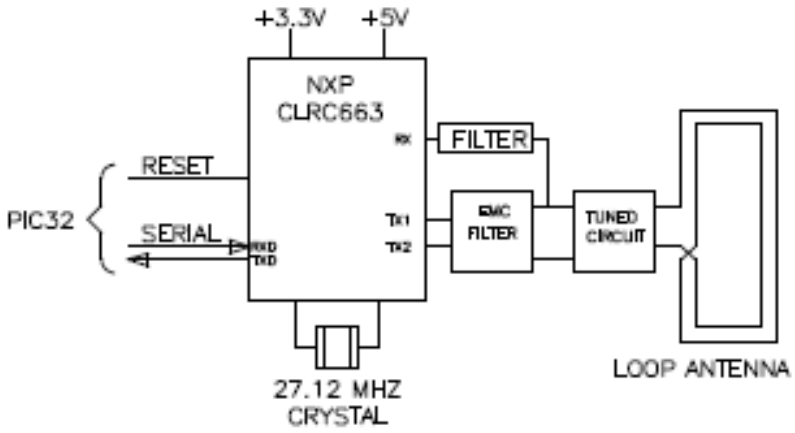
The reader can be powered from either a +12V input which must be connected to the terminal block, TB1-1 or it can be provided through Power-Over-Ethernet (POE) using the RJ-45 connector. The I/O board uses a POE module from Silvertel which provides a +12V output.

The PIC32 communicates to the SOM through a UART channel. Voltage level translators are used to interface the +3.3V referenced signals of the PIC32 to the +1.8V signals on the SOM.

A Tamper circuit provides detection if the reader is being removed from its mounting plate. This circuit uses a photo-transistor output and reflective photo-interrupter. If the reader is moved from its mounting position, this condition is measured by the PIC32 and thus an alert can be returned to the Access Control system.

Near Field Communication (13.56 MHz) Circuitry

The circuit for the Near Field Communication consists of an NXP CLRC663 transceiver, a 27.12 MHz crystal, an EMC filter, an impedance matching circuit and a loop antenna. The CLRC663 divides the crystal frequency of 27.12 MHz to generate the 13.56MHz carrier frequency. Two DC voltages are connected to the CLRC663. The I/O interface signals are supplied by +3.3V and the transmit driver voltage input (TVDD) is supplied by +5V.



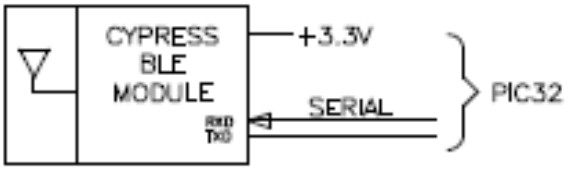
The signal driven on pins TX1 and TX2 is the 13.56 MHz energy carrier modulated by an envelope signal. The data signal on the 13.56 MHz carrier uses 8% - 14% Amplitude-Shift-Keying (ASK) and is Manchester encoded at a baud rate of 106 or 212 Kbits/second, based on credential type. The signal to the receiver is AC-coupled and filtered at the RX pin.

Series inductors on the TX1 and TX2 pins and parallel capacitors, provide an EMC filter. Additional series and parallel capacitors are used for tuning and impedance matching the loop antenna. Series resistors are used to control the quality factor of the antenna and control the minimum resistance. The capacitors and resistors achieve the appropriate signal shaping in accordance to ISO/IEC 14443.

The loop antenna is integrated in the PWB and was designed to be on the outside of the LCD profile. This provides adequate loop area for the reader form factor. The dimensions of the antenna are 2.6” x 4.3” and the read range is approximately 2 inches. To reduce eddy currents which diminishes the read range, the metal back of the LCD is covered with ferrite. In addition, an approximate .30” strip of ferrite is adhered along the entire perimeter on the backside of the carrier board.

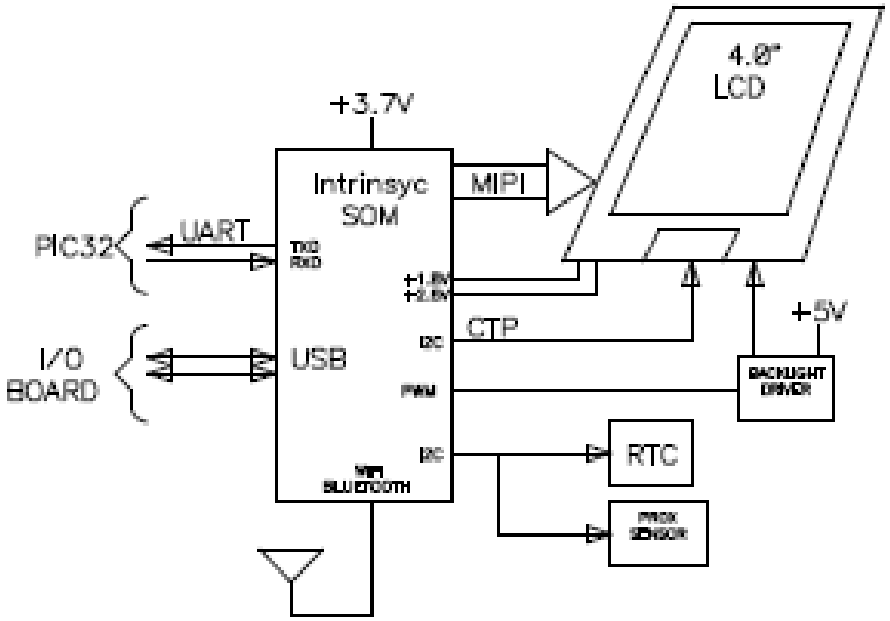
Bluetooth Low Energy (BLE) Module

The PIC32 interfaces to a Cypress BLE module over a serial UART interface. The Cypress CYBLE-222014-01 is a fully certified and qualified module supporting Bluetooth Low Energy (BLE) 4.2 wireless communication. The CYBLE-222014-01 is a turnkey solution and includes onboard crystal oscillators, chip antenna, passive components, and Cypress PRoC™ BLE.



Intrinsyc System on Module (SOM)

The Intrinsyc Open-Q 410 System on Module (SOM) is a compact, production ready module based upon Qualcomm’s Snapdragon 410 processor quad core ARM® Cortex® A53 (64bit, 1.2GHz). Memory consists of 1GB LPDDR3 RAM (533MHz) and 8GB eMMC 5.0 Flash. It includes the PM8916 PMIC that provides different external DC voltage levels to interface to peripheral devices. Also included is a U.FL coaxial connector on the top side, which provides a connection to the single band WiFi / BT antenna feed from a WCN3620. The SOM connects to the Carrier Board with two 100-pin board to board connectors.



The SOM communicates with the PIC32 through a dedicated UART channel. Voltage level translators are used to interface the +3.3V referenced signals on the PIC32 to the +1.8V signals on the SOM. In addition, USB signals from the SOM connect to the I/O board which interface to a USB-to-Ethernet bridge. This provides a means of connecting the reader to a wired network.

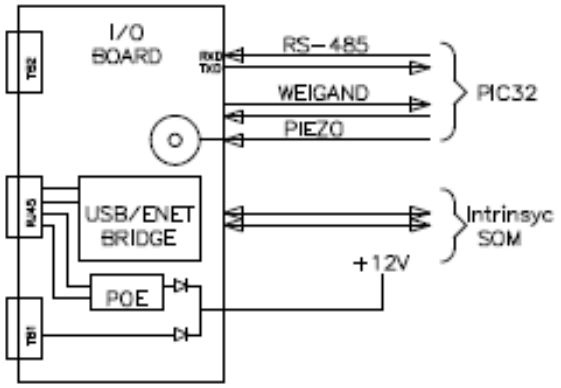
The SOM provides a four lane MIPI bus interface. The Display Serial Interface (DSI) lanes provide an interface to display controllers typically found in mobile devices. Each lane is a high-speed differential signaling point-to-point serial bus. On the reader design, only 2 lanes are used to control the Tianma LCD. The SOM also interfaces to the capacitive touch panel through a dedicated I2C bus.

A real-time clock circuit and Proximity sensor are located on the carrier board. These circuits are controlled by the SOM using a shared I2C bus. The devices use different bus addresses.

There are two U.FL coaxial connectors on the top side of the SOM. One connector provides an antenna feed from the WCN3620 to the single band WiFi/Bluetooth. The second connector is for GPS and is not used. A U.FL coaxial cable is installed in the WiFi/BT connector. The cable is connected to a U.FL connector on the carrier board which has a trace connecting to a surface mount chip antenna manufactured by Johanson Technologies, part number 2450AT18A100E.

I/O Board

With limited space and the required form factor, a mezzanine board was necessary. This is referred to as the I/O board since it provides the connection points to the outside world. There are two 4-pin terminal blocks and an RJ-45 jack. Circuitry on the board consists of a Power-Over-Ethernet (POE) module. The POE module is manufactured by Silvertel, model Ag9800M, and is IEEE802.3af compliant. It provides short circuit protection and provides 1500V of isolation.



The I/O board has a Microchip LAN9500A, USB 2.0 to 10/100 Ethernet Controller bridge. It has an integrated MAC and PHY and supports 10BASE-T and 100BASE-TX. It is fully compliant with IEEE802.3/802.3u and supports full and half-duplex modes.

A Piezo speaker is controlled by a GPIO from the PIC32 on the Carrier board. This provides an audible noise for feedback to the User.

In addition, the Serial UART signals from the PIC32 are connected to an RS-485 transceiver. These signals connect to the TB1, terminal block. Circuitry to support Wiegand is included on the I/O board. These are connected to both the TB1 and TB2 terminal blocks. The PIC32 drives the open collector output signals D0 and D1, and monitors the inputs for Green LED, Red LED and BEEPER. A Tamper signal is driven low based on the tamper circuit being monitored by the PIC32.