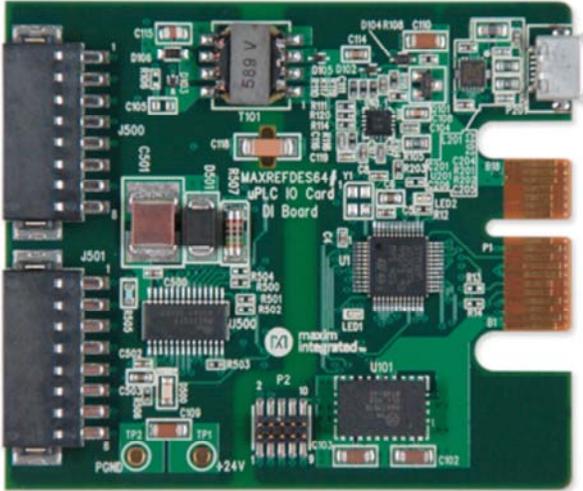MAXREFDES64# System Board

Enlarge+

Introduction

Industry 4.0[1] marks the fourth industrial revolution, characterized by distributed, intelligent control systems. Breaking from a past with large, centralized programmable-logic controllers, Industry 4.0 allows for highly configurable, highly modular factories, which accept an ever increasing number of sensor inputs while operating at a higher output than ever before. The ultra-small PLC, or Micro PLC, lies at the heart of the Industry 4.0 factory, providing high performance with ultra-low power consumption, in an ultra-small package. The MAXREFDES64# is Maxim's Micro PLC, octal-channel, digital input card.

The MAXREFDES64# reference design features 8-channel digital inputs with isolated power and data. The design integrates a $600V_{RMS}$ data isolator (MAX14850); a STM32F1 microcontroller; a FTDI USB-UART bridge; a high-efficiency DC-DC converter (MAX17515); and isolated/regulated +24V and +5V power rails (MAX17498C). The entire system typically operates at less than 140mW and fits into a space roughly the size of a credit card. A block diagram of the system is shown in **Figure 1**.
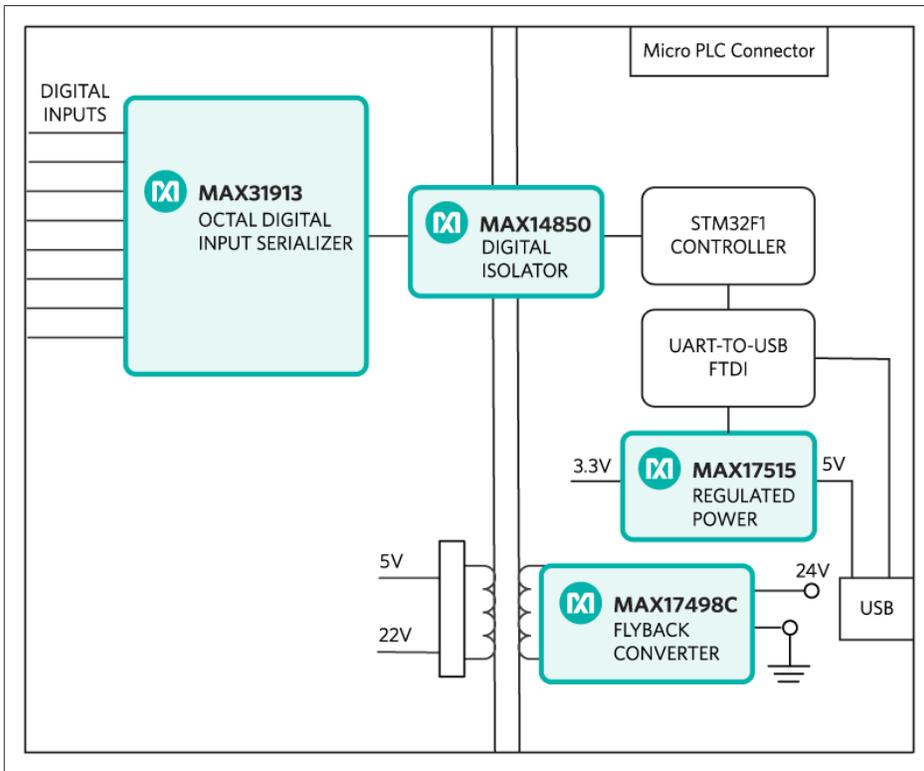
Figure 1. The MAXREFDES64# reference design block diagram.

Features

- Isolated power and data
- Micro PLC form factor
- Device drivers
- Example C source code

Applications

- Industrial control and automation
- Process control
- PLC

Detailed Description of Hardware

The power requirement is shown in **Table 1**.

Table 1. Power Requirement for the MAXREFDES64# Reference Design

Power Type	Input Voltage (V)	Input Current (mA, typ)
On-board isolated power	24	5.6

Note: STM32 and FTDI are powered by USB separately.

The MAX31913 (U500) is an octal digital input serializer.

The ultra-efficient MAX17498C (U102) generates the isolated +24V, and +5V rails from a 24V supply. The MAX14850 (U301) digital data isolators provide data isolation. The combined power and data isolation achieved is 600V$_{RMS}$.

The MAX17515 (U101) step-down DC-DC converter converts the +5V supply from the USB to +3.3V and powers the STM32 (U1) microcontroller and FTDI (U201) USB-UART bridge.

Detailed Description of Firmware

The MAXREFDES64# uses the on-board STM32F1 microcontroller to communicate with the octal digital input serializer. The user can read the digital inputs status through a terminal program. The simple process flow is shown in **Figure 2**. The firmware is written in C using the Keil µVision5 tool.
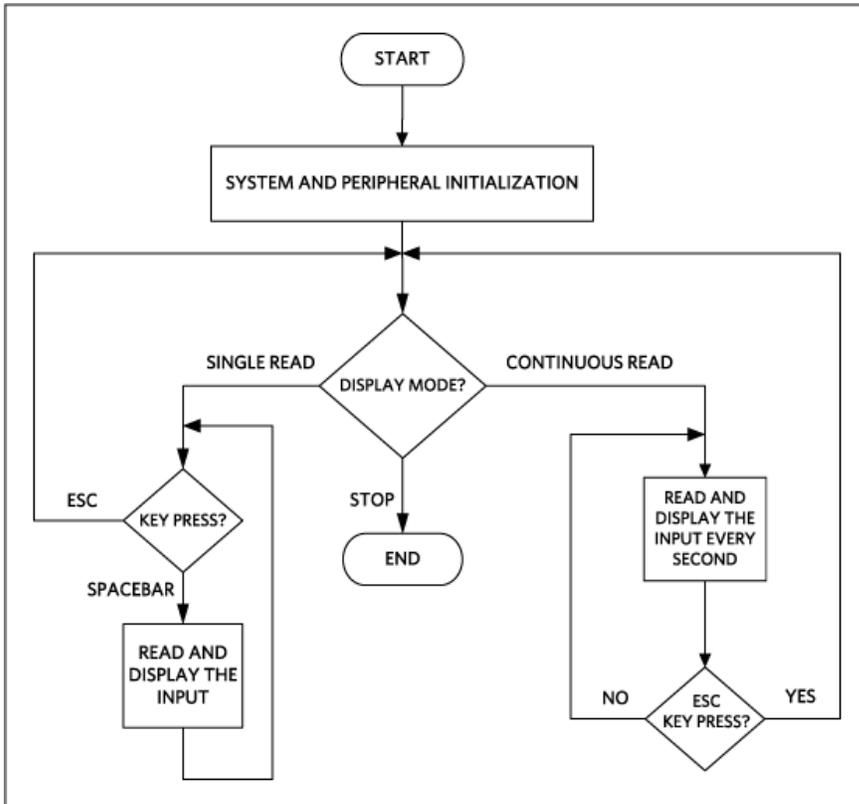

Figure 2. The MAXREFDES64# firmware flowchart.

The complete source code is provided to speed up customer development. Code documentation can be found in the corresponding firmware platform files.

Quick Start

Required equipment:

- Windows® PC with a USB port
- MAXREFDES64# board
- 24V power supply

Procedure

The reference design is fully assembled and tested. Follow the steps to verify board operation:

Always disconnect and reconnect the USB cable before using the terminal program.

1. Turn off, or keep off, the 24V power supply.
2. The MAXREFDES64# utilizes the FTDI USB-UART bridge IC. If Windows cannot automatically install the driver for the FTDI USB-UART bridge IC, the driver is available for download from www.ftdichip.com/Drivers/D2XX.htm.
3. Connect the negative terminal of the 24V power supply to the PGND connector on the MAXREFDES64# board. Connect the positive terminal of the 24V power supply to the +24V connector on the MAXREFDES64# board.

4. Turn on the 24V power supply.
5. Connect the USB cable from the PC to the MAXREFDES64# board.
6. Open Hyperterminal or a similar Terminal program on the PC. Find the appropriate COM port, usually a higher number port, such as COM4, or COM6, and configure the connection for 921600, n, 8, 1, none (flow control).
7. The MAXREFDES64# software will display a menu (**Figure 3**).
8. For immediate signal testing, connect the positive terminal of the 24V voltage source to any digital input terminal (DI_FIN1 to DI_FIN8) of the J500 and J501 terminal blocks. Pay close attention and avoid connecting 24V to the ground terminals. Since the digital input terminals and the ground terminals alternate on the terminal block and are so close to each other, special care must be taken.
9. Press 0 in the terminal program to start the continuous read mode.
10. Verify that the digital value read (hex and binary) matches the digital input status of J500 and J501 terminal blocks.
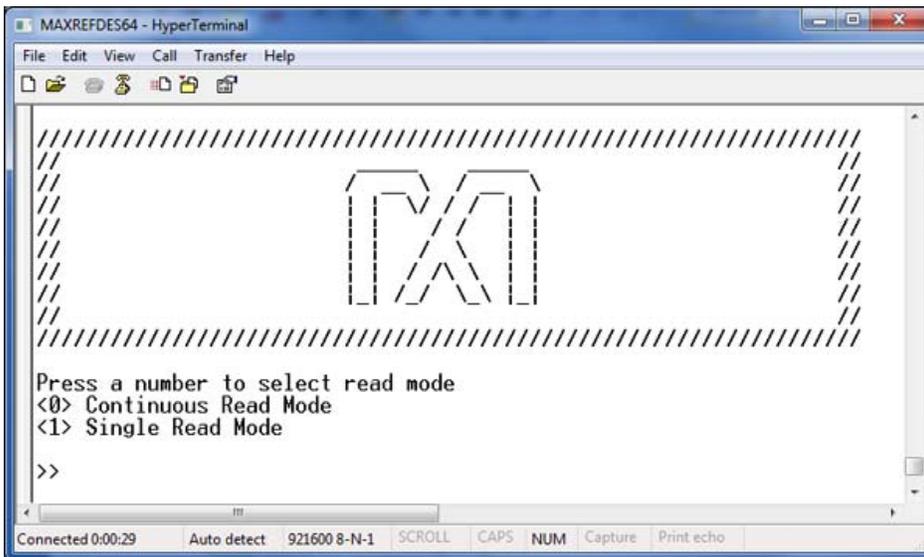

Figure 3. Terminal program main menu.

Lab Measurements

Figure 4 and **Figure 5** show the digital inputs of hex value 0x55 and also the result read by the Terminal program.

Figure 4. Test setup.

Figure 5. Test outputs.

Reference

1. The new generation of manufacturing production is called Industry 4.0 in Germany and Smart Manufacturing System elsewhere. See, **Securing the future of German manufacturing industry, Recommendations for implementing the strategic initiative INDUSTRIE 4.0, Final report of the Industrie 4.0 Working Group**,

Industry 4.0 Working Group, Acatech National Academy of Science and Engineering, April 2013, www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/ Industrie_4.0/Final_report__Industrie_4.0_accessible.pdf. Henceforth cited as **Industrie 4.0**. Although the Industrie 4.0 report is focused on Germany, the implications of the German research and findings are recognized for industry in other countries. See also Ferber, Stefan, "Industry 4.0 – Germany takes the first steps toward the next industrial revolution," Bosch Software Group, **Blogging the Internet of Things**, October 16, 2013, http://blog.bosch-si.com/industry-4-0-germany-takes-first-steps-toward-the-next-industrial-revolution/.

There are many sources for Smart Manufacturing Leadership. An interesting summary report of issues and topics can be found at the **Smart Manufacturing Leadership Coalition Committee Working Meeting**, Minneapolis, MN, U.S., Thursday, October 20, 2011, https://smart-process-manufacturing.ucla.edu/workshops/2011-workshop/presentations/SMLC%2010-20-11v3.pdf. Also see, **Implementing 21st Century Smart Manufacturing, Workshop Summary Report**, Smart Manufacturing Leadership Coalition, June 24, 2011, https://smart-process-manufacturing.ucla.edu/about/news/Smart% 20Manufacturing%206_24_11.pdf. A simple web search on the topic will reveal considerably more references.

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