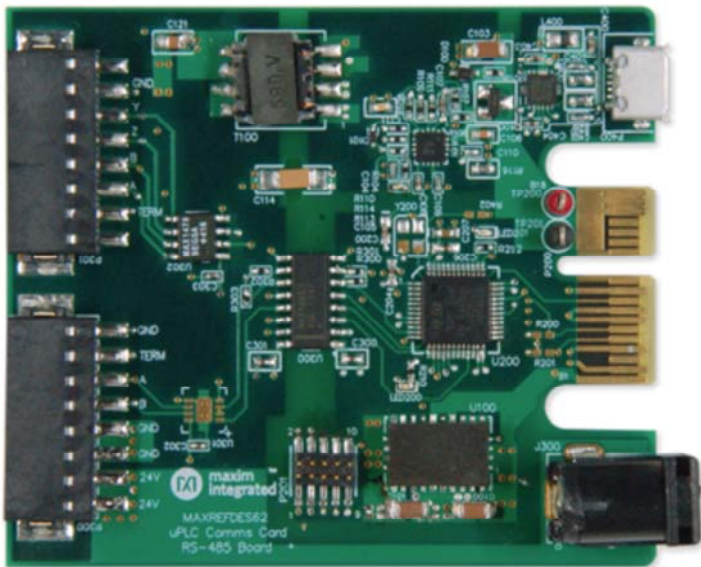System Board 5984

MAXREFDES62#: RS-485 COMMUNICATIONS MICRO PLC CARD

| DETAILS |

MAXREFDES62# 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 that accept an ever-increasing number of sensor inputs and operate at a higher output than 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 MAXREFDES62# is Maxim's micro PLC RS-485 communications card.

The MAXREFDES62# features two RS-485 transceivers (one full duplex and one half duplex) with isolated power and data. Each driver output has a selectable 120Ω termination resistor. The MAXREFDES62# design integrates one half-duplex RS-485 transceiver (MAX14783E); one full-duplex RS-485 transceiver (MAX14789E); 600V$_{RMS}$ data isolation (MAX14850); a STM32F1 microcontroller; a FTDI USB-UART bridge; and isolated/regulated +3.3V power rails (MAX17498C/MAX17515). The entire system typically operates at less than 500mW and fits into a space roughly the size of a credit card. While targeted for industrial and micro PLC applications, the MAXREFDES62# can be used in any application that requires high RS-485 data rates and ESD protection. A block diagram is shown in **Figure 1**.
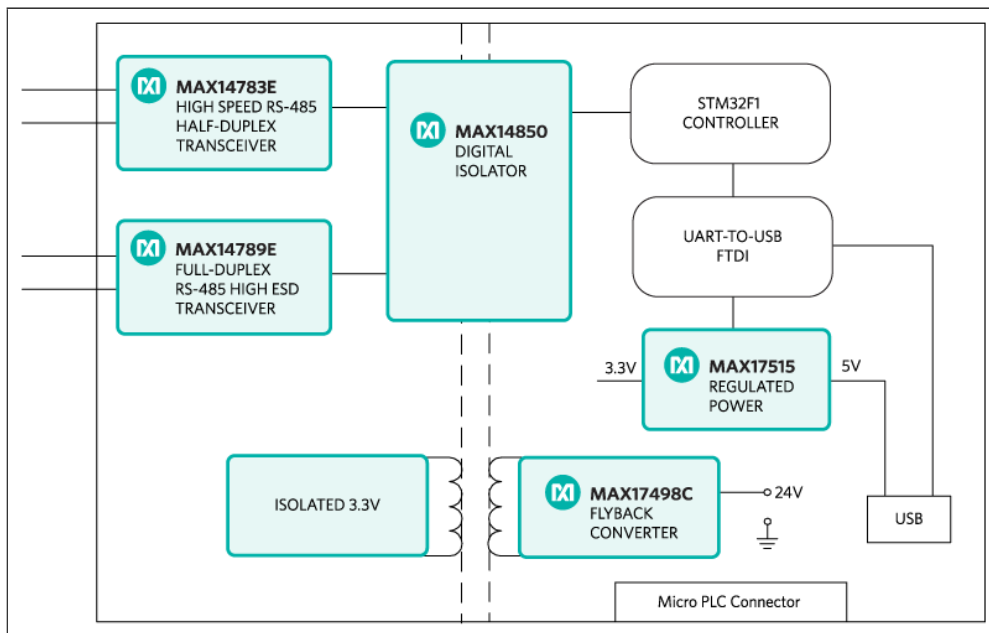

Figure 1. The MAXREFDES62# reference design block diagram.

Features

- High-speed RS-485 communication
- Isolated power and data
- Micro PLC form factor
- Extended Protection with TVS on RS-485 Lines
- Device drivers
- Example C source code
- Test data

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 MAXREFDES62# Reference Design

Power Type	Input Voltage (V)	Input Current (mA, typ)
On-board isolated power	24	20

Note: STM32F1 and FTDI are powered by USB separately.

The MAXREFDES62# uses the ultra-efficient MAX17498C (U101) to generate the isolated +3.3V that powers the RS-485 transceivers from a 24V supply. This circuit is designed to maintain at least 3.0V of isolated power if one of the RS-485 drivers becomes shorted.

The MAX14850 (U300) digital data isolator provides data isolation between the SMT32F1 microcontroller and the MAX14783E and MAX14789E transceivers. The combined power and data isolation achieved is $600V_{RMS}$.

The MAXREFDES62# uses the ultra-efficient MAX17498C (U501) to generate the isolated +17.5V, +7.5V, and -5V rails from a 24V supply. The MAX8719 (U102), MAX1659 (U103), and MAX1735 (U104) provide post-regulated +15V, +5.5V, and -3V rails. The MAX14850 (U301) digital data isolators provide data isolation. The combined power and data isolation achieved is $600V_{RMS}$.

The MAX17515 (U100) step-down DC-DC converter converts the +5V supply from the USB to +3.3V and powers the STMicroelectronics STM32F1 (U200) microcontroller and FTDI (U400) USB-UART bridge.

Detailed Description of Firmware

The MAXREFDES62# uses the on-board STM32F103 microcontroller to communicate with the RS-485 transceivers. The user transmits and receives data through the RS-485 transceivers using a terminal program. The simple process flow is shown in **Figure 2**. The firmware is written in C using the Keil® µVision5® tool.
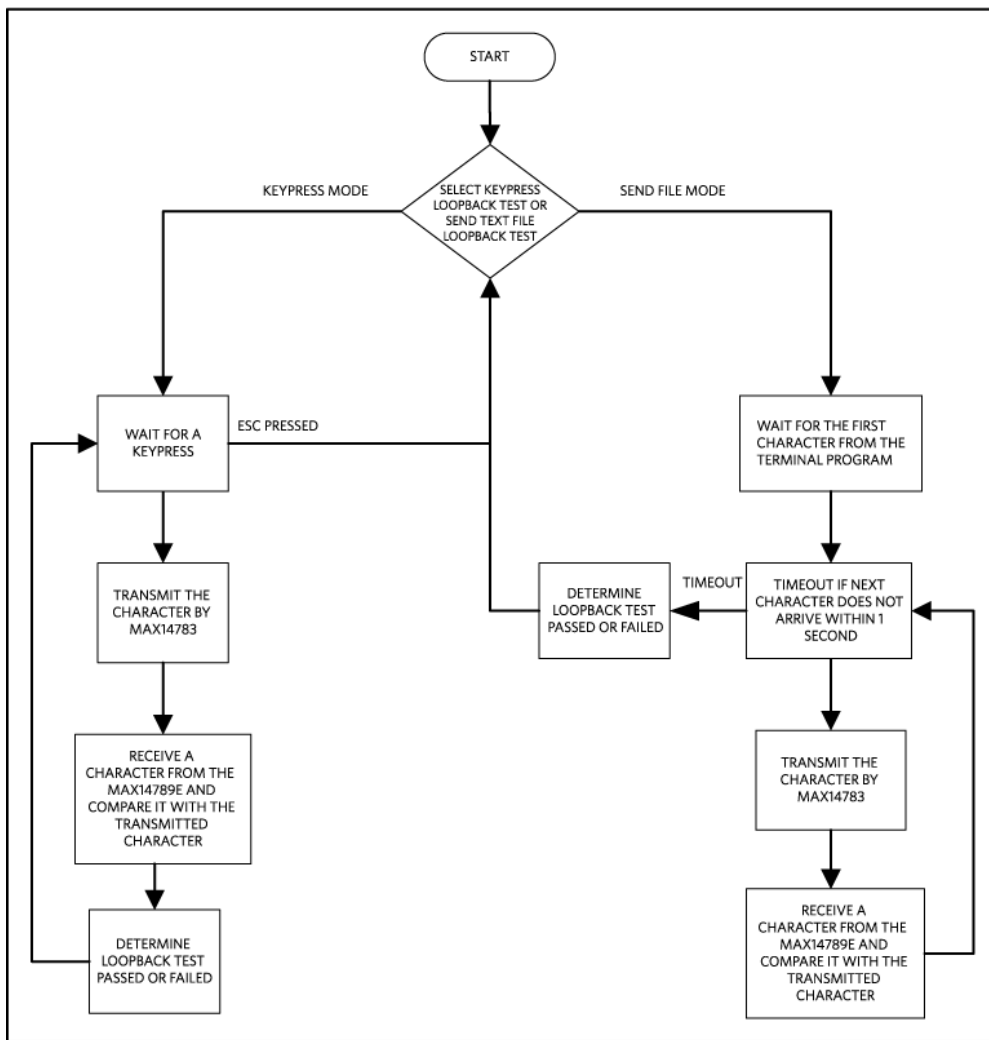
Figure 2. The MAXREFDES62# firmware flowchart.

The firmware accepts commands and transmits characters or text files through the MAX14783E. Connected in loopback, the transmitted data is received through the MAX14789E and compared to the original data that was sent. 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
- MAXREFDES62# board
- 24V power supply

Procedure

The reference design is fully assembled and tested. Verify board operation using the following steps:

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

1. Turn or keep off the 24V power supply.
2. The MAXREFDES62# 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 (TP201) connector on the MAXREFDES62# board. Connect the positive terminal of the 24V power supply to the +24V (TP200) connector on the MAXREFDES62# board.
4. Turn on the 24V power supply.
5. Connect the USB cable from the PC to the MAXREFDES62# board.
6. Open the 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). The MAXREFDES62# software displays a menu (Figure 3).
7. For immediate signal testing, configure the RS-485 transceivers in loopback mode as follows: Use a wire to connect the A terminal of the P300 terminal bock to the A terminal of the P301 terminal block. Use a wire to connect the B terminal of the P300 block to the B terminal of the P301 terminal block.
8. Press 0 in the terminal program to start the keypress loopback test.
9. Enter a character.
10. Verify that the character received is the same as the character sent.
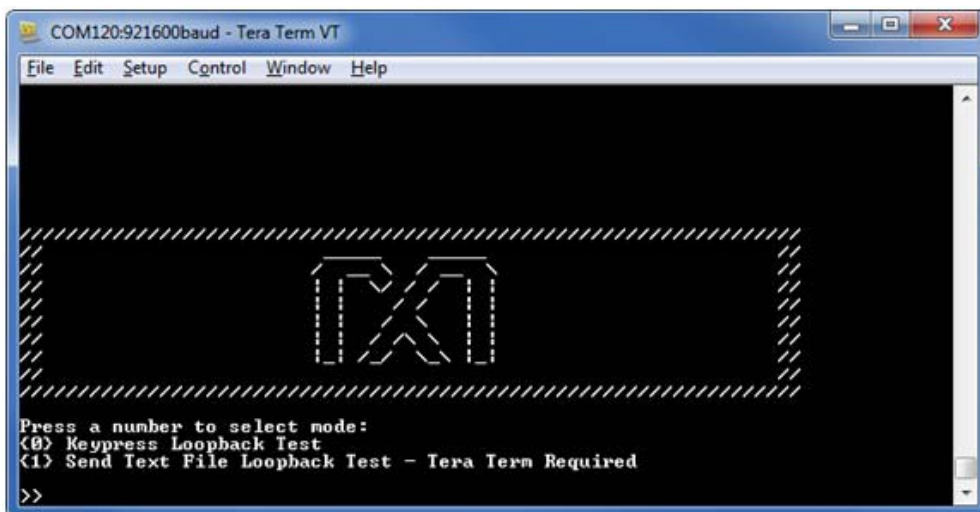

Figure 3. Terminal program main menu.

Lab Measurements

Equipment used:

- Windows PC

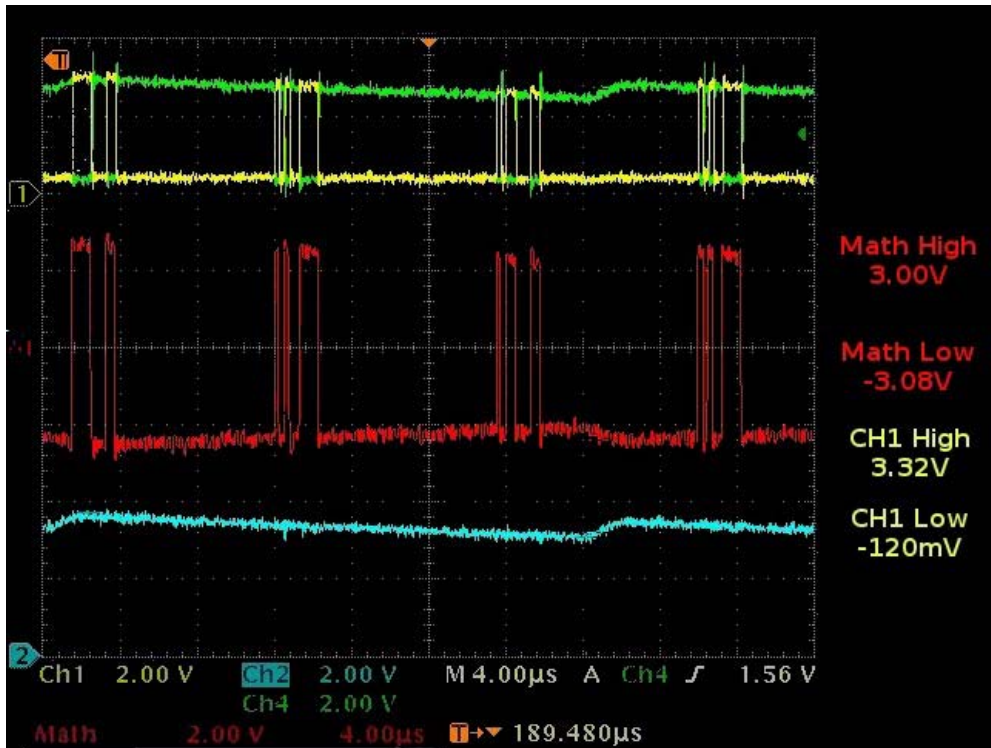- Oscilloscope
- MAXREFDES62# board
- +24V power supply

Figure 4. Loopback functionality (text file transfer), cable = 0m, termination
enabled on both transceivers (CH1 = A, CH4 = B, MATH = A-B, CH2 = V_{ISO}).

Figure 5. Loopback functionality (text file transfer), cable = 30m, Cat5e, termination enabled on both transceivers (CH1 = A, CH4 = B, MATH = A-B, CH2 = V_{ISO}).

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.