

AN1047

2.5Mb/s Isolated RS485 Communication Interface With up to 500 mW Supplementary Power

Applications:

- Motor drives
- Industrial PLC
- Network Hubs, bridges and Routers
- Point Of Sale equipment
- Multi-port distributed systems

Most industrial serial communication schemes evolved from the RS485 standard. It is used for critical communications in multi drop networks as well as point to point communication with peripheral devices. Both integrated and discrete versions of this solution are available. The key advantages of a discrete solution are lower cost and the flexibility in your design. With drop in part substitutions the design can be customized to satisfy additional requirements. The high power DC/DC converter design provides functional flexibility for a wide variety of applications. Transceivers that comply with the RS485 and RS422 standards have been available for many years. Optical isolation is also required for many applications. Isolation ensures proper operation of the communications bus in challenging environments noted below.

First, is the formation of ground loops, which are created when long Communications cables bridge two or more branch circuits in the electrical distribution system. This can allow ground current to flow along the cabling causing noise or damaging equipment. Optocouplers in the transceiver section, combined with the transformer and optocoupler in the power supply section provide complete galvanic isolation, breaking any potential ground loops. Second is the isolation of control equipment from high voltage devices or noise generators such as motors. This is a growing problem in today's inexpensive motor controllers. The communications interface is the only isolation barrier between the high voltage, high inductance motor windings and the Programmable Logic Controller (PLC)

that controls it. However the high common mode noise immunity provided by the data interface optocouplers effectively blocks inductive noise while also providing safety isolation.

This application note will provide an overview of a new solution from CEL and National Semiconductor offering discrete isolated RS485 reference design that is both high power and flexible.

Features:

- ANSI standard RS485-A and RS422-B
- Wide input power range 3.3-5V
- Low Power sleep mode
- 2.5Mb/s data rate
- 500mW of additional power
- Fully isolated DC/DC converter
- 2500V isolation
- Gerber files available

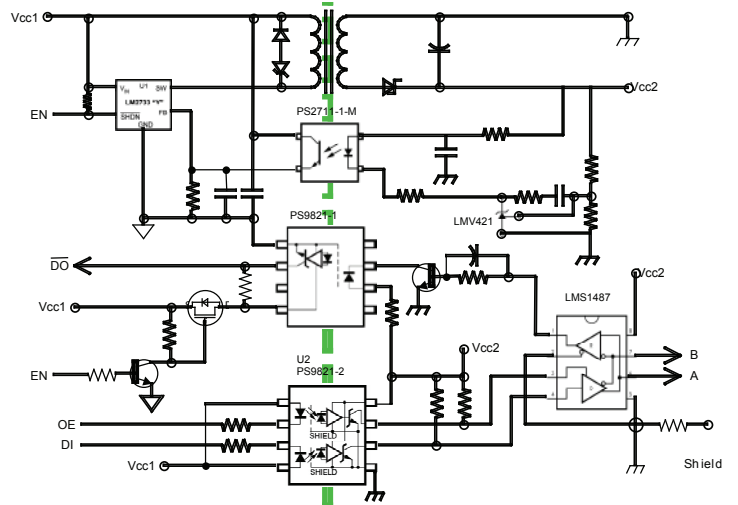


Figure 1

Solution Criteria

Implementation of an isolated communications interface requires the following considerations:

- 1) Selecting the appropriate transceiver for the design
- 2) Transmission of digital data across the isolation boundary
- 3) Providing isolated power for operation of the transceiver

In order to utilize the existing host power, the isolated interface power supply must work with input power between 3.3V and 5V. Many host applications have eliminated a 5V power supply altogether, requiring lower voltage operation for compatibility. No need for additional supply rails in the host application is required.

Well regulated output power allows use of industry standard 5V transceivers with high noise margin, as apposed to 3.3V interfaces that have sacrificed noise margin to accommodate the lower available voltage. The interface power supply must produce regulated 5V on the output side.

Adequate output power provides you the option of driving external loads, opening up a wide variety of possible applications. For example the additional power can be used for running other transceiver nodes in a network, A/D converters, card readers in POS applications, RFID scanners, and more. Since the power is derived from the host hardware, the external power supplies and external power infrastructure can be eliminated reducing your system cost significantly.

Please note that running peripherals with the interface power supply requires control of the power to the peripheral. Power Management functionality allows peripheral reset, or simple control for low power or battery operated systems.

The data interface components chosen must be fully compatible with the 3.3 to 5V input power range. This is achieved through selection of proper interface optocouplers. The timing requirements of the ANSI standard combined with the optocoupler performance sets the maximum data rate.

Additional factors to consider are footprint, cost, converter efficiency and power.

Solution Overview

Transceiver Section:

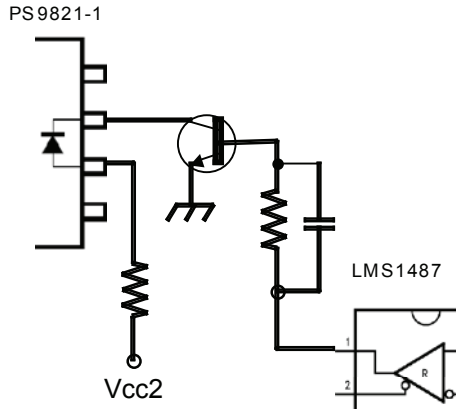
The transceiver chosen, shown in Figure 1, is the LMS1487 from National Semiconductor. This is a low cost transceiver with full ANSI, RS485-A and RS422-B standard compliance. This device will support data transfer rates of up to 2.5Mb/s, open circuit fail safe operation to prevent indeterminate bus states, short circuit protection and thermal shut down to handle fault conditions. Other footprint compatible transceivers are also available that offer additional features such as high ESD immunity and variable slew rate for EMI suppression. These transceivers can be substituted to achieve your specific design goals.

Isolated Data Interface:

To meet the requirements for 3.3V and 5V systems, the isolated data interface includes very flexible optocouplers. NEC PS9821 optocouplers operate at data rates as high as 15Mb/s over the full 3.3-5V nominal voltage range of the power supply. These couplers support 4mm creepage and 2500V isolation needed for almost all communications interface requirements. It is offered in both single and dual SO8 packages.

With only the change of two current limit resistors, the interface can be optimized for efficient operation at either 3.3 or 5V supply voltages. The input LED of the PS9821 optocoupler has a forward voltage of approximately 1.8V. To guarantee proper operation over the life of the application, NEC recommends 6.3mA minimum forward diode current (I_f). Since the forward voltage of the diode is a large portion of the available drive voltage, matching the value of the current limit resistors to the available power supply voltage is highly recommended. In addition, the digital interface to the system must be capable of sourcing 8mA.

Due to the limited current capability of the Data Output (DO) pin of the transceiver, additional circuitry between the transceiver's DO pin and the input of the optocoupler has been implemented as shown in Figure 2.



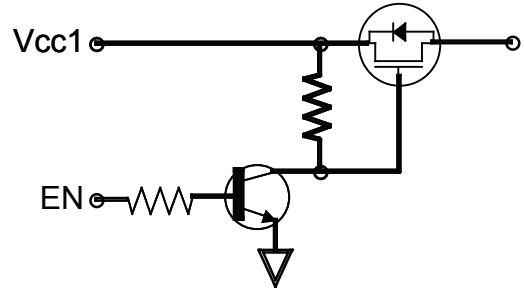
This enables the diode to be driven at proper input current levels without stressing the 4mA DO output from the transceiver.

Power Section:

The DC/DC converter is designed with several features in mind. It is implemented with isolated precision referenced feedback which allows for a wide range of input and stable output voltages. The supply will operate at up to 80% efficiency from 3.3V to 5V inputs. The output is always well regulated at 5V, therefore eliminating the need for using 3.3V transceivers with their associated lower noise margin.

Output supply power is rated at 180mA and 5V. This is significantly higher than the 70mA required to run the transceiver at full load. This additional power can be used for a wide range of possible applications. Point to point power schemes can be implemented where the peripheral device and its communications interface are powered by the host equipment. This application is very useful for RFID readers or card readers where a separate supply for these peripherals would be expensive, bulky and require additional wiring. It might also be used to power several nodes in a multi drop network from single master interface.

A sleep mode is also provided that completely shuts down the interface power by stopping the pulse width modulator. In lower power, battery powered, or intermittently operated systems power management can be easily accomplished. To implement a very low power sleep mode, additional functionality is provided to shut down the output stages of the DO optocoupler which draws quiescent current. This is optional if power management at this level is not required.



Summary

The solution in Figure 1 meets all of the fundamental requirements for ANSI standard RS485 and RS422. The design goals of high voltage isolation, speed and output voltage flexibility are fully met with the choice of the NEC PS9821 family of optocouplers. The fully isolated DC/DC Boost converter design is efficient with robust power and large input operating range, allowing the interface to perform functions far above simple cable transceiver applications. The well regulated output provides you with a stable high noise margin supply for the transceiver that can also power a host of external applications. The low power shutdown feature makes this design ideal for battery operated devices. The compact size of the interface is comparable to available modular solutions, at significantly lower cost, and vastly improved flexibility for your design.

California Eastern Laboratories

Exclusive Agents for NEC RF, Microwave and Optoelectronic semiconductor products in the U.S. and Canada
 4590 Patrick Henry Drive, Santa Clara, CA 95054-1817
 Telephone 408-919-2500 • FAX 408-988-0279 • Telex 34/6393
 Internet: <http://www.cel.com>

Information and data presented here is subject to change without notice. California Eastern Laboratories assumes no responsibility for the use of any circuits described herein and makes no representations or warranties, expressed or implied, that such circuits are free from patent infringement.