SWITCHERGEAR
GEAR TO CONTROL YOUR POWER SWITCHES

Module N48501

Daisy-chain RS-485 transceiver interface
Isolated

REFERENCE MANUAL

Features

Standard module for SwitcherGear

RS-485 transceiver interface

Data rate up to 10 Mbit/s

Multi-drop communications

1/100 bus load

Duplicate terminal set for daisy-chain wiring

Power pass-through

Galvanic isolation

Signal lines are protected against short-circuit and ESD

12-way pluggable screw terminal

Applications

Fieldbus communications in industrial systems

PROFIBUS, modbus RTU

Custom serial communications

General Description

The N48501 module is a RS-485 interface that can be used to implement multi-drop serial communications.

Ordering Information

Order Code	***Description***
N48501	*SwitcherGear module, daisy-chain RS-485 transceiver interface, isolated*

Module Quick Start

1. **Set the configurable features.**

   Determine the feature settings that are required for the system under control. If necessary, change the default solder jumper settings. Refer to the Configuration section.

2. **Review the allocation of the MCU interface signals.**

   Confirm that the MCU interface signals connect to appropriate pins on the host MCU. Refer to your SwitcherGear configuration document and Table 3.

3. **Insert into the base slot.**

   Refer to your SwitcherGear configuration document for the location of modules.

4. **Connect the external wiring to the system connector.**

   Refer to Table 1 for the pin-out of the system connector.

Standard Interfaces

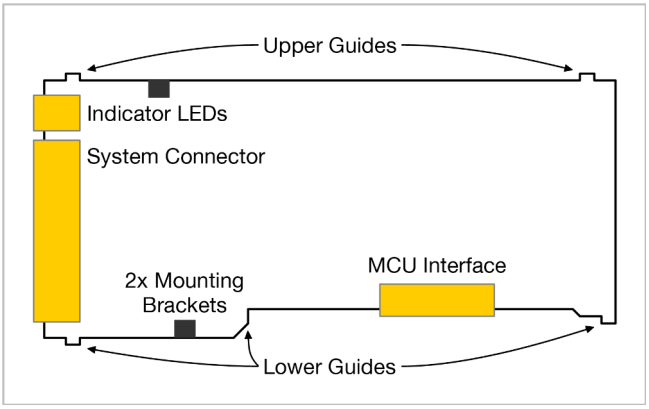

Figure 1: Parts of a SwitcherGear module.

System Connector

A 12-way pluggable screw terminal connector is used to connect system wiring to the N48501 module. Table 1 shows the pin-out of this connector.

The connector can be keyed by inserting the supplied red coding keys into the slots on the header. The corresponding moulded key on the plug must be removed to allow insertion into the header.

Denkinetic Pty Ltd
contact@denki.com.au

Table 1: System connector

Pin	Signal	Description
1 (Top)	A	Non-inverting bus input/output.
2	B	Inverting bus input/output.
3	-	-
4	VDC	Connection for power pass-through.
5	COM	0V of isolated transceiver circuitry, and connection for power pass-through.
6	FIELDGND	External field ground.
7	A	Non-inverting bus output.
8	B	Inverting bus output.
9	-	-
10	VDC	Connection for power pass-through.
11	COM	0V of isolated transceiver circuitry, and connection for power pass-through.
12 (Bottom)	FIELDGND	External field ground.

Table 2: Indicator LEDs

Appearance	Left Column		Right Column	
	Colour	Description	Colour	Description
	Green	Serial link TX active	Green	Serial link RX active
	Green	Green user indicator	Red	Red user indicator
	-	-	-	-
	-	-	-	-

Table 3: MCU interface

Pin	Signal	Description
D0	TXD	Serial link transmit data input signal.
D1	RXD	Serial link receive data output signal.
D2	TE/REn	Serial link transmit/receive enable signal. Transmit active-high, receive active-low.
D3	LEDGRN	Green user indicator input signal. Active-high.
D4	LEDRED	Red user indicator input signal. Active-high.
D5	-	-
D6	-	-
D7	-	-
D8	-	-
D9	-	-
D10	-	-
D11	-	-
A0	-	-
A1	-	-
A2	-	-
A3	-	-

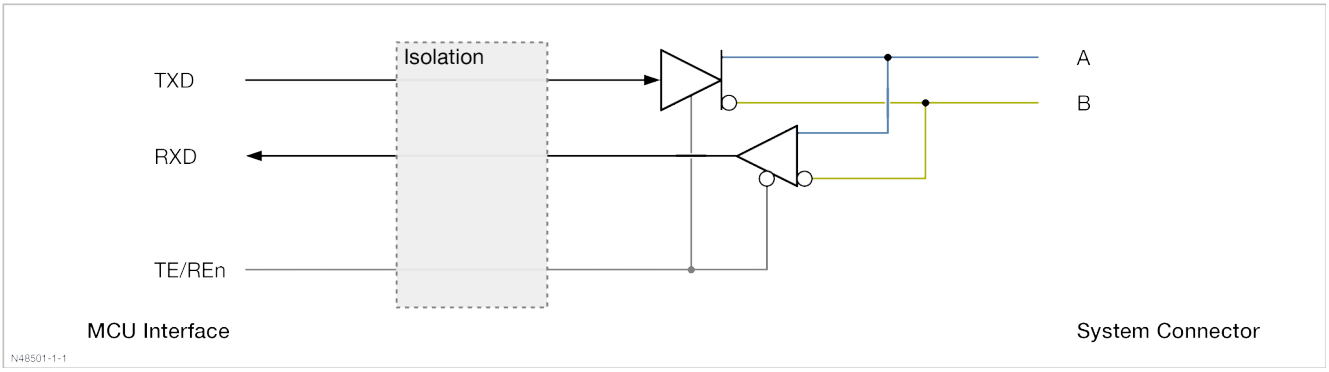

Figure 2: Functional block diagram of the N48501 module.

Indicator LEDs

Miniature indicator LEDs on the front panel show the status of the data lines and user status. Refer to Table 2 for details.

MCU interface

The MCU interface contains analogue and digital signals that allow interaction between the module and the host MCU. The MCU interface supports up to 12 digital inputs/outputs and up to 4 analogue outputs.

Refer to Table 3 for details of the signals provided by the N48501 module.

The signals in the MCU interface must be routed to appropriate pins of the host MCU. Refer to the SwitcherGear Configuration Document for your specific SwitcherGear unit for information on the routing of signals between the installed modules and the host MCU.

Configuration

The N48501 module has no user configurable hardware features.

Functional Description

The N48501 module is a RS-485 interface for use in multi-drop communication systems. As shown in Figure 2, the signal chain consists of an isolation barrier and transceiver circuits.

The TXD and RXD signals on the MCU interface are standard logic signals that should be routed to appropriate pins on the host MCU. Typically these would be routed to a UART resource on the MCU.

RS-485 is a half-duplex communications medium, where a node is either transmitting to the bus, or receiving from the bus. The TE/REn input signal controls the direction. The transmitter is enabled when the TE/REn signal is high, and the receiver is disabled. The receiver is enabled when the TE/REn signal is low, and the transmitter is disabled.

Tables 4 and 5 summarise the behaviour of the transmitter and receiver parts of the RS-485 transceiver. H is a logic high level, L is a logic low level, X is either logic high or low (don't care), Z is high-impedance output.

Table 4: Truth table for the bus transmitter.

Inputs		Bus Outputs	
TXD	TE/REn	A	B
H	H	H	L
L	H	L	H
X	L	Z	Z

Table 5: Truth table for the bus receiver.

Inputs		Output
Differential input voltage $\mathbf{V_{ID}} = (V_A - V_B)$	TE/REn	RXD
-10 mV ≤ $\mathbf{V_{ID}}$	L	H
-200 mV ≤ $\mathbf{V_{ID}}$ ≤ -10 mV	L	H or L[1]
$\mathbf{V_{ID}}$ ≤ -200 mV	L	L
X	H	H
Idle bus	L	H
Bus open-circuit	L	H
Bus short-circuit	L	H

The signals on the system connector meet the voltage specification for RS-485 signals and can be used for data rates up to 10 Mbit/s.

Isolation

The bus terminals (A, B, COM, VDC) are galvanically isolated from the SwitcherGear controller.

The purpose of the isolation in the N48501 module between the RS-485 signal lines and the SwitcherGear controller is to prevent ground loops that may introduce electrical interference. In this scenario, the working voltage across the isolation barrier is typically no more than 10 V. The isolation barrier must not be used to isolate mains supplies.

The module includes an on-board isolated power supply to power the isolated transmitter and receiver circuitry.

1 *Due to input hysteresis, the output level for this intermediate input voltage range depends on the exact threshold voltages and the direction of the signal (positive-going or negative-going).*

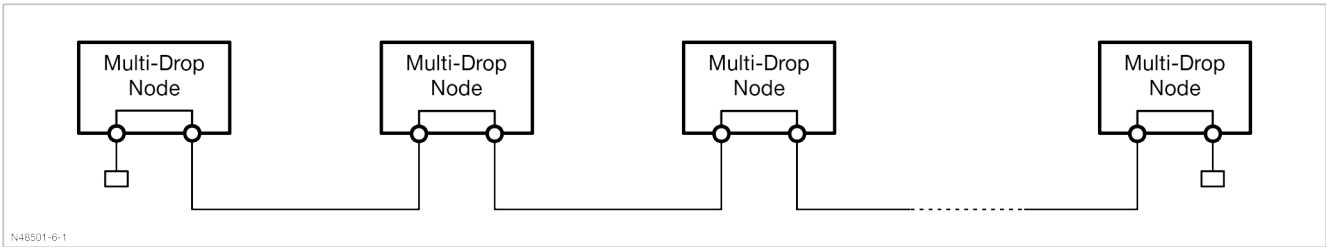

Figure 3: Daisy-chain wiring of nodes in a linear bus. Termination resistors are fitted to the terminals of the two end nodes.

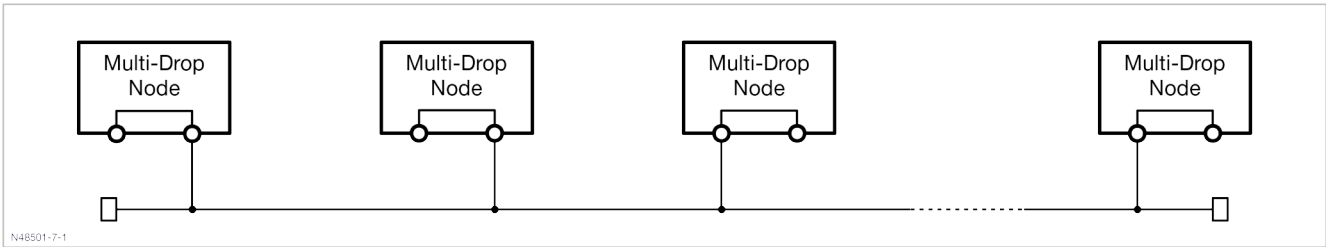

Figure 4: Stub wiring of nodes in a linear bus. Termination resistors are fitted to both ends of the bus cable.

Applications Information

RS-485 is a physical layer specification that is used for many common industrial communication protocols, e.g. PROFIBUS, modbus RTU, etc. It uses differential signalling on a pair of wires – the voltages on the wires are complementary. RS-485 defines only the voltages on the comms bus. How data is transmitted using the physical layer depends on higher level protocols.

RS-485 is commonly used in a linear bus topology, which consists of a single, straight communications bus that is terminated at both ends. Communications devices, or nodes, are connected to the linear bus at various positions along its length. This arrangement is known as multi-drop or multi-point. Only one node transmits data onto the bus at any time, while all other nodes receive the data. A transmitter can target a specific other node by the use of addresses embedded into the data frame.

Figures 3 and 4 show how communications nodes are connected into a linear bus using daisy-chain wiring and stub wiring. Daisy-chaining creates an electrically clean bus that is simple to wire, but requires the nodes to have duplicate terminates to enable the pass-through wiring of the bus. Stub wiring requires a three-way junction on the bus, and the length of the stubs must be minimised to reduce signal reflections on the bus.

The N48501 module provides a duplicate set of terminals for daisy-chain wiring as shown in Table 1 and Figure 5. The bus comms and power are passed-through the module terminals in a daisy-chain implementation. The module can also be wired to a stub, in which case one set of terminals is unused.

The COM terminal is internally connected to the power supply of the isolated transceiver circuitry. It should be wired using a third conductor to the COM or 0V terminals of the other nodes in the system to reduce common-mode noise at the A/B terminals.

RS-485 uses differential voltage signalling, which greatly improves performance in noisy environments compared to single-ended signalling (e.g. as used in RS-232). The comms bus comprises a pair of conductors that are twisted together. This construction gives a defined coupling between the conductors – the characteristic impedance. It also helps to reject coupling of external fields onto the signal conductors.

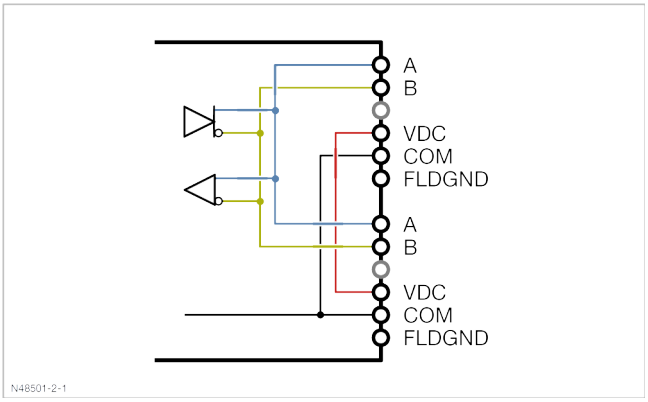

Figure 5: Pass-through connections on the system connector for daisy-chain wiring.

The twisted-pair conductors are connected to the system connector terminals as shown in Figure 6. The A and B signals from the N48501 module must be connected to the respective terminals of the other nodes. Swapped A/B signals will cause bus communications to fail.

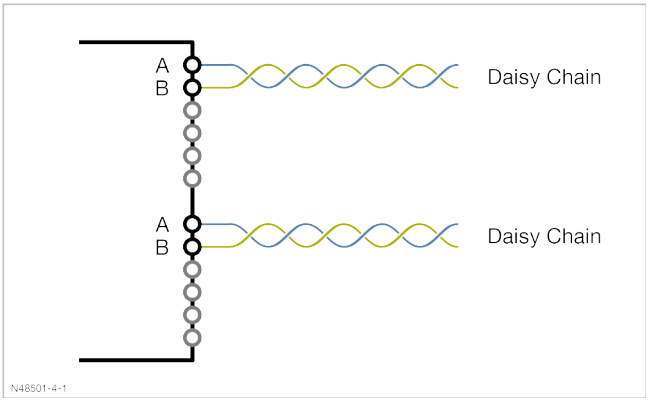

Figure 6: Daisy-chain wiring for a node in the middle of a linear comms bus.

Termination Resistors

The two ends of the linear bus must be terminated with a resistor to prevent signal reflections. The value of the resistor should be equal in value to the characteristic impedance of the twisted-pair cable that is used. A typical value for communications cable is 120 Ω. The termination resistor can be fitted to the second set of A/B terminals of the N48501 module, as shown in Figure 7.

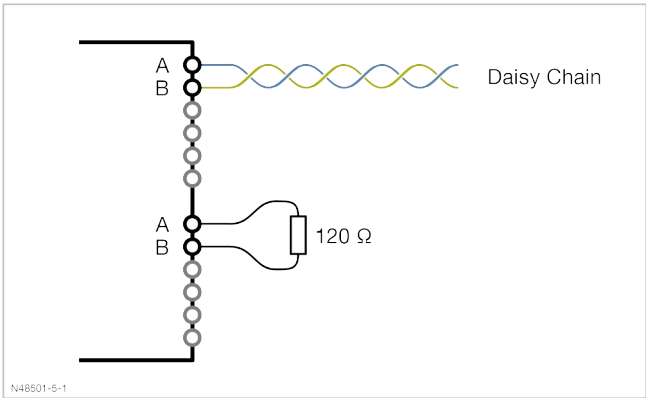

Figure 7: Daisy-chain wiring for a node at the end of a linear comms bus, showing termination resistor.

Powered Bus

Some implementations of RS-485 communications busses include a second pair of conductors for power, as shown in Figure 8. The power is available to the nodes for powering of the node's communications transceiver or of the entire node.

The N48501 module is powered from the 24 VDC of the MCU interface, so does not use power from the COM and VDC terminals. As for the communications signals, the power connections on the N48501 module are duplicated to allow daisy-chain wiring of powered busses.

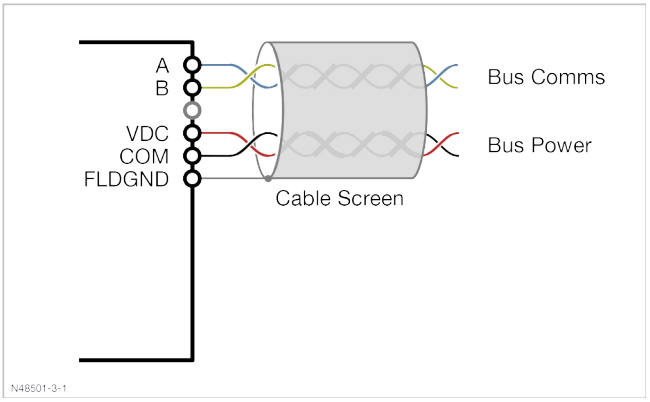

Figure 8: Wiring of bus comms and power cable to one set of bus terminals in the system connector.

Speed versus Length

It is recommended that the speed of a RS-485 bus should be limited to 10 Mb/s. This speed can be typically used with bus lengths up to 12 m.

It is also recommended that the length of a RS-485 bus should be limited to 1200 m. This length can be typically used with a bus speed up to 100 kb/s.

Between these extremes, the bus speed and length must be traded-off.

The maximum speed ultimately depends on the signal integrity in the network. It is critical to correctly terminate the ends of the bus and to minimise the length of stub connections. You should make your own measurements to confirm that the communications network is performing correctly for your system conditions.

Host MCU

Texas Instruments C2000

When using a C2000 microcontroller, the serial data signals of the module should be connected to a SCI peripheral. The TE/REn and LED signals should be connected to GPIO data pins.

SwitcherWare Library

The SwitcherWare Library from Denkinetic includes code resources to handle the low-level hardware configuration and provide a simple-to-use interface for the N48501 module. See the SwitcherWare documentation for the classes `SerialPort`, `GpioPin`, `GpioPinActiveHigh` and `GpioPinActiveLow` for more information. The SwitcherWare library also includes examples for serial communications and many others.

Warnings

The bus terminals of the system connector (A, B, COM, VDC) must not be connected to a mains supply or circuits connected to a mains supply.

The user is responsible to ensure that the cables and connectors used for external wiring have insulation and/or separation distances that provide isolation from live parts and from earth.

Electrical Characteristics

The following specifications apply for T_A = 25 °C, unless otherwise noted.

Parameter	Conditions	Min	Typ	Max	Unit
RECEIVER					
Input Voltage	Voltage on either bus terminal	-7		12	V
Positive-Going Differential Threshold			-80	-10	mV
Negative-Going Differential Threshold		-200	-120		mV
Input Hysteresis			40		mV
Differential Input Resistance		48			kΩ
TRANSMITTER					
Differential Output Voltage Magnitude	R_L = 54 Ω	2.1			V
Short-Circuit Output Current			±135		mA

Timing Characteristics

The following specifications apply for T_A = 25 °C, unless otherwise noted.

Parameter	Conditions	Min	Typ	Max	Unit
Transmitter data rate				10	Mbit/s
Transmitter propagation delay time				35	ns
Transmitter pulse skew			2	5	ns
Receiver propagation delay time				50	ns
Receiver pulse skew			2	5	ns

Revision History

Revision	Date	Changes From Previous Release
1	23 Feb 2021	▪ Original release.