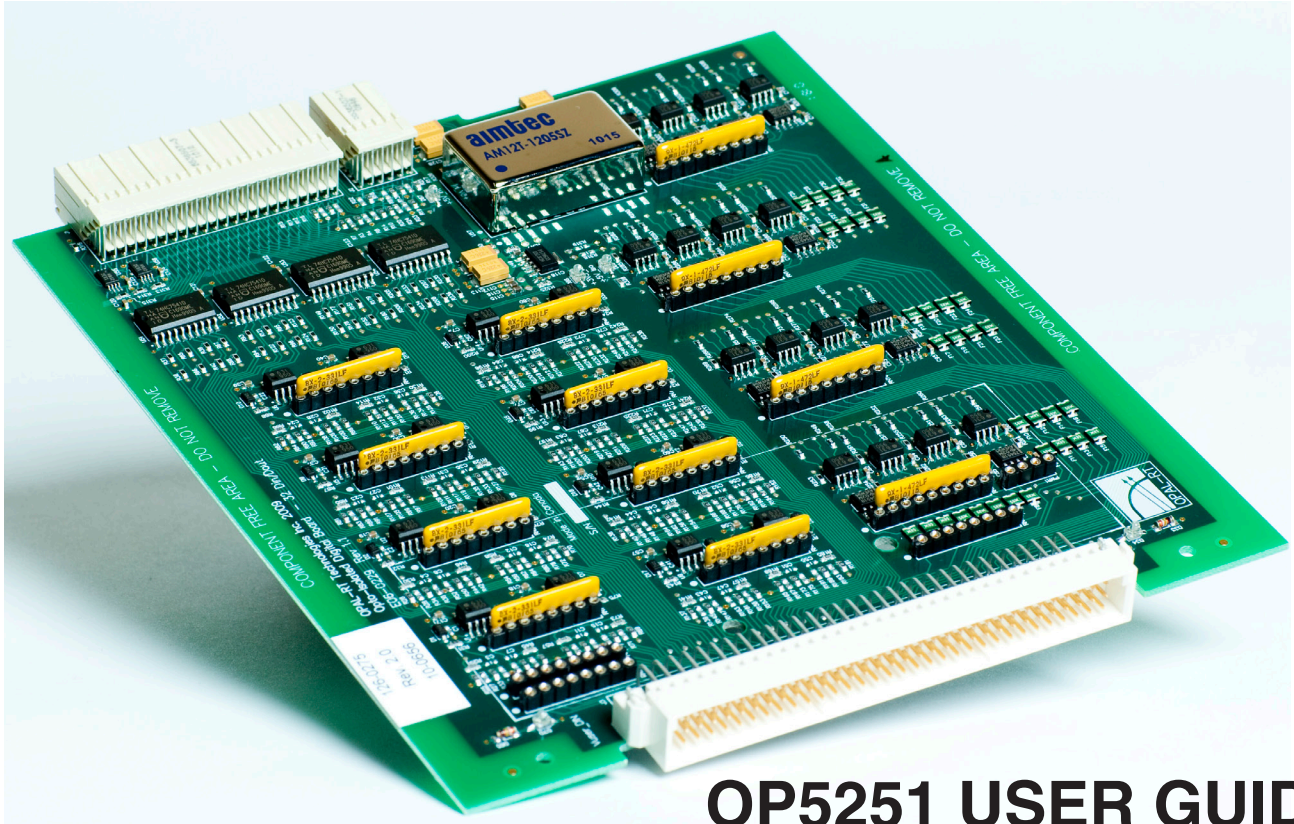




OPAL-RT



OP5251 USER GUIDE

Optically Isolated 32 Digital Inputs &
32 Digital Outputs Module

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GETTING STARTED

Before you begin, verify that your system meets the requirements of the OP5251 I/O board:

SOFTWARE REQUIREMENTS

- RT-LAB 8.4.0 and higher
- MATLAB 32 bits 6.5 and higher
- Windows XP and higher
- RT-XSG 1.3

HARDWARE REQUIREMENTS

- Opal-RT simulator:
 - Wanda box
 - Opal-RT I/O expansion box (only for use with Opal-RT simulators)

FEATURES

- 32 optically isolated input channels
- 32 optically isolated output channels
- All I/Os are sampled simultaneously for additional simulation accuracy. They can be sampled up to 5 MHz
- I/Os can be grouped in parallel for any size bus simulation
- Choice of sink or source inputs (Factory Options for Common Anode or Common cathode)
- All inputs accept sources from 4V to 30V and limit the current via user interchangeable resistors on sockets grouped in 4 input or 8 output channels.
- RS422 option (8 in, 8 out).

MODULE INSTALLATION

The OP5251 Digital Input Signal Conditioning Module must be inserted into the Opal-RT simulator using great care. Make sure that the card is properly aligned, using the guide tracks, before pressing into place.

INTRODUCTION

The OP5251 is a part of the OP5000 series - of optional, versatile signal conditioning modules for Opal-RT's state of the art HIL (hardware-in-the-loop) systems. Designed for Opal-RT's simulation systems, the OP5251 provides digital input and output signals with specific voltage conditioning. The optical isolation of the OP5251 I/Os make it ideal for environments where voltage isolation is required.

DESCRIPTION

The OP5251 features 32 optically isolated input channels and 32 optically isolated output channels. All of these I/Os are sampled simultaneously for additional simulation accuracy. It is perfectly suited to interface real life environment signals to TTL or Differential for RT-LAB simulator, providing perfect electrical isolation and full short-circuit or discharge protection.

CIRCUIT LAYOUT DIAGRAMS

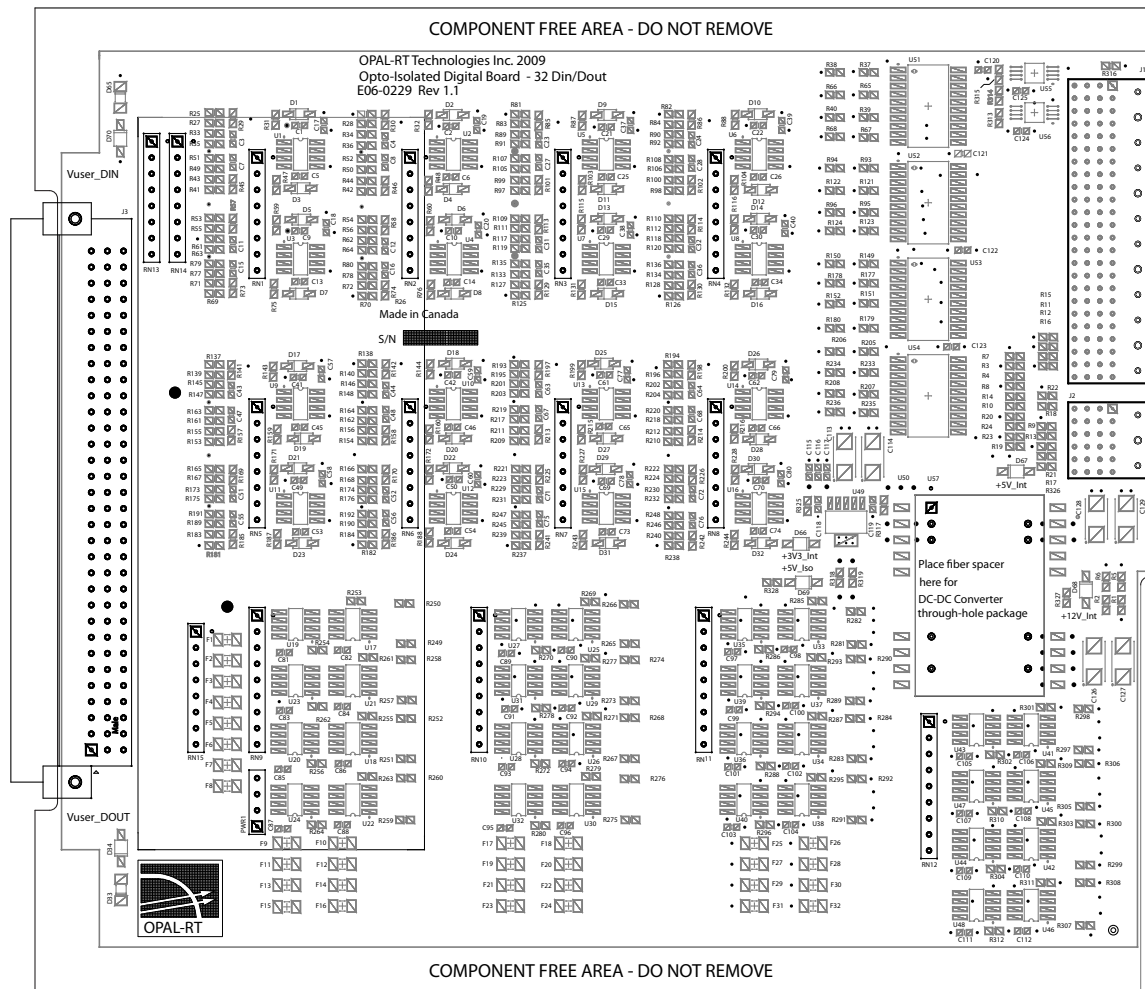


Figure 1: OP5251 Digital Signal Conditioning Module

INTRODUCTION

Circuit Layout Diagrams

RS-422 Communication Module

The communication module is offered as an option to convert the first 8 inputs and 8 outputs to differential I/Os, using an RS-422 cable.

The board is factory installed to user specifications. Its use requires a specific configuration that **MUST** be factory performed. Do not attempt to remove or modify the module in any way

Consult the “Pin Assignments” table for details on pin connections and channels for the RS-422 cable.

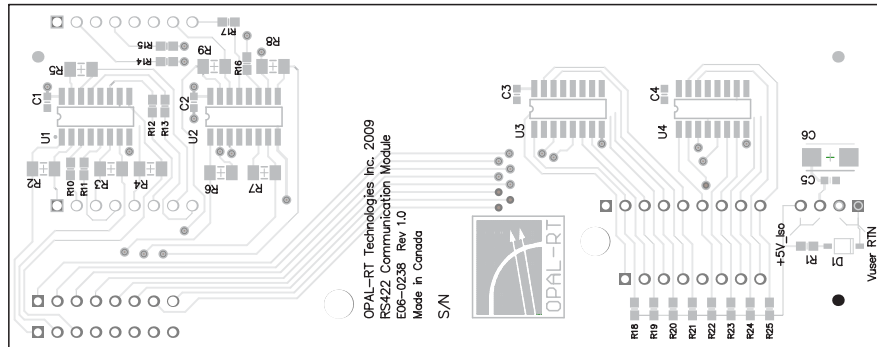


Figure 2: RS-422 Communication Module PCB Diagram



CAUTION - DO NOT remove the RS-422 Communication Module.

INTERFACES

Inputs

The optically isolated inputs accept a wide range of input voltage, ranging from 4 to 30 Volts, according to user's requirements. They have a low threshold current; typically 6 mA within the 5 to 15 mA range. The inputs are current limited by the interchangeable resistor array mounted on sockets. The resistor value may be changed by the user to enable higher input voltage.

By default, the module comes equipped with the resistor value set to 680 Ohms, which is recommended for 5 to 12 Volts input.

Each input has a reverse voltage protection of 5 Volts or more provided by a diode.

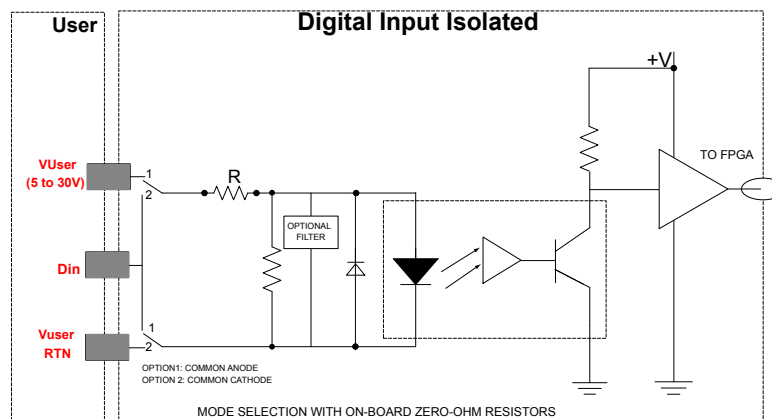


Figure 3: OP5251 Isolated Digital Input Drawing

The signal conditioning module inputs can be factory ordered to either common anode (default setting) or common cathode.



Figure 4: Common Anode (Push) mode and Common Cathode (Pull) mode

Each digital input channel is a positive logic circuit; a high input signal produces a high input state at the host data acquisition board. The source voltage (V_{user}^*) serves as the reference for the positive voltage level (see Voltage Range Selection).

* $V_{user} = 4 \text{ to } 30 \text{ V+}$; $V_{user} \text{ RTN} = 0 \text{ to } -30 \text{ V}$



Note that if the input is mounted in common cathode mode then the channel becomes a negative logic circuit

INTRODUCTION

Circuit Layout Diagrams

Outputs

Each optically isolated output has an open collector transistor. It can sink up to 100 mA continuous, and up to +30V according to user's requirements. It is current protected by resettable 150 mA fuse (PTC). The optical isolation circuitry is powered by an internal isolated DC supply.



CAUTION: If Vuser is connected to the simulator, the output of DOUT would be the same as Vuser Dout as long as no RT-LAB model is running (output transistor is open).

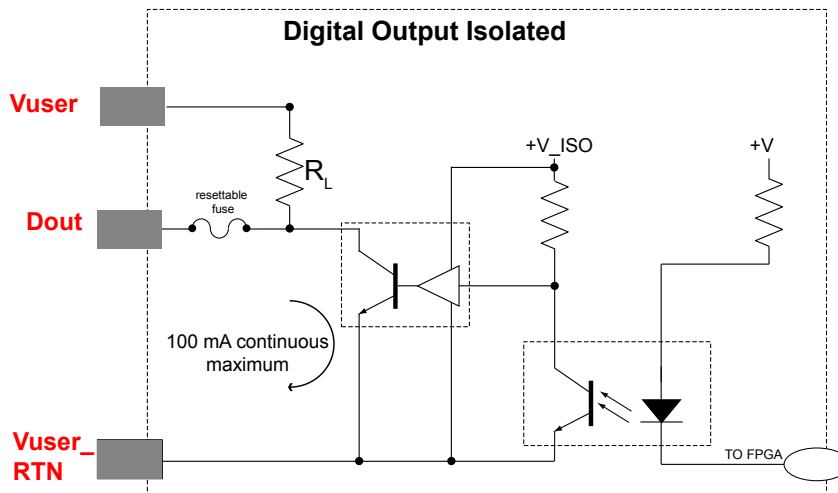


Figure 5: Isolated Digital Output Drawing (Pull only)

Interconnections

The OP5251 is a carrierless module. It fits directly into the hardware-in-the-Loop simulator without carriers. Up to four OP5251 modules can be positioned in a Wanda 4U and up to 8 in an OPAL-RT Expansion Box.

VUSER POWER CONFIGURATION

The digital input circuit needs a 5 V supply source to power the onboard circuitry. This source is connected to the computer's 5 VDC.

The digital outputs use an isolated DC-DC converter to power onboard circuitry.

The following resistors are used for the OP5251. The part numbers provided are for reference purposes only. Part numbers may differ according to supplier or country:

	Voltage range (Volts - continuous)	Resistor value (Ω)	Resistor Network Bourns Part Number
Digital Input	4-9	470	4608X-102-471 LF / 4308X-102-471 LF
	5-12	680 (default)	4608X-102-681LF / 4308X-102-681 LF
	6-16	1000	4608X-102-102 LF / 4308X-102-102 LF
	12-30	2200	4608H-102-222 LF / 4308H-102-222 LF
Digital Output	0-8	270	4609H-101-271 LF / 4309H-101-271 LF
	0-15	1000	4609H-101-102 LF / 4309H-101-102 LF
	0-30	4700 (default)	4609H-101-472 LF / 4309H-101-472 LF

Table 1: Digital Input/Output Voltage and Resistor Values



WARNING: ensure that the proper resistor is installed to obtain desired operating voltage. Failure to do so may result in damage to the OP5251 board or host setup.

VOLTAGE RANGE SELECTION

Inputs: Changing the value of resistor network RN1 to RN8 will configure the digital input voltage range in groups of 4. Using a DIP-8 isolated resistor network, make sure you match the pin 1 indicator with pin 1 on the module. If needed, you can add an additional resistor in series with the input circuit to increase the supply voltage.

Outputs: Changing the value of resistor network RN9 to RN12 will configure the output voltage range in groups of 8. Using a DIP-9 isolated resistor network, make sure you match the pin 1 indicator with pin 1 on the module. If needed, you can add an additional resistor in series with the input circuit to increase the supply voltage.

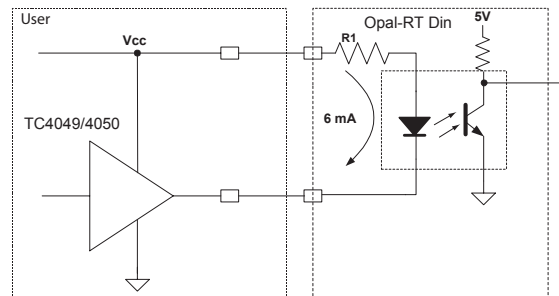
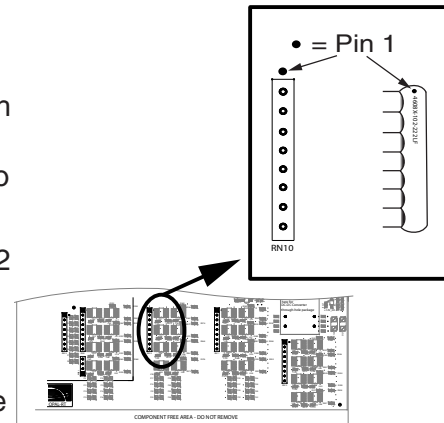


Figure 6: Digital input circuit

Each input resistor network contains 4 digital input channels. Refer to the “Resistor Network” table below for the relationship between the resistor network and input channels. To work properly, the Opal-RT digital input optical isolator needs a minimum current of 5 mA and a maximum current of 15 mA. Use the following formula to ensure safe power dissipation: $(V_{user} - 1.5 [V]) / \text{resistor } (\Omega) = \text{current (A)}$

Resistor network	Channel bank
RN1	Din 00-03
RN2	Din 04-07
RN3	Din 08-11
RN4	Din 12-15
RN5	Din 16-19
RN6	Din 20-23
RN7	Din 24-27
RN8	Din 28-31

Table 2: Din Resistor Network by Channel Bank

Each output resistor network contains 8 digital input channels. Refer to the Resistor Network table below for the relationship between the resistor network and inputs channels. Use the following formula to ensure safe power dissipation: $V_{user} (V) / \text{resistor } (\Omega) = \text{current (A)}$.

Resistor network	Channel bank
RN9	Dout 00-07
RN10	Dout 08-15
RN11	Dout 16-23
RN12	Dout 24-31

Table 3: Dout Resistor Network by Channel Bank

All digital I/Os are accessible via a 96 pin, 3 x 32, DIN96 connector (part number 5650461-5 or 5650462-5).

Pay careful attention to the position diagram and Pin Assignment table to ensure proper and safe function.

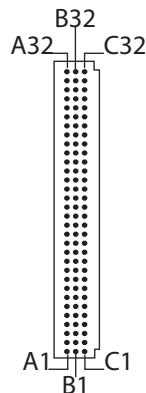


Figure 7: DIN96 Pin Assignment (male connector view)

OP5251 PIN ASSIGNMENTS

OP5251 126-0275	126-0274	Module pin assignment	OP5251 126-0275	126-0274	Module pin assignment
A32	A32	*RS422_IN_CH0-	A16	A16	OUT 00 / *RS422_OUT_CH0+
B32	B32	*RS422_IN_CH1-	B16	B16	OUT 01 / *RS422_OUT_CH1+
C32	C32	*RS422_IN_CH2-	C16	C16	OUT 02 / *RS422_OUT_CH2+
A31	A31	*RS422_IN_CH3-	A15	A15	OUT 03 / *RS422_OUT_CH3+
B31	B31	*RS422_IN_CH4-	B15	B15	OUT 04 / *RS422_OUT_CH4+
C31	C31	*RS422_IN_CH5-	C15	C15	OUT 05 / *RS422_OUT_CH5+
A30	A30	*RS422_IN_CH6-	A14	A14	OUT 06 / *RS422_OUT_CH6+
B30	B30	*RS422_IN_CH7-	B14	B14	OUT 07 / *RS422_OUT_CH7+
C30	C30	*RS422_OUT_CH0-	C14	C14	OUT 08
A29	A29	*RS422_OUT_CH1-	A13	A13	OUT 09
B29	B29	*RS422_OUT_CH2-	B13	B13	OUT 10
C29	C29	*RS422_OUT_CH3-	C13	C13	OUT 11
A28	A28	*RS422_OUT_CH4-	A12	A12	OUT 12
B28	B28	*RS422_OUT_CH5-	B12	B12	OUT 13
C28	C28	Vuser-DIN	C12	C12	OUT 14
A27	A27	Vuser-DIN	A11	A11	OUT 15
B27	B27	IN 00 / *RS422_IN_CH0+	B11	B11	Vuser-DOUT
C27	C27	IN 01 / *RS422_IN_CH1+	C11	C11	Vuser-DOUT
A26	A26	IN 02 / *RS422_IN_CH2+	A10	A10	Vuser-DOUT
B26	B26	IN 03 / *RS422_IN_CH3+	B10	B10	Vuser-DOUT
C26	C26	IN 04 / *RS422_IN_CH4+	C10	C10	Vuser_RTN
A25	A25	IN 05 / *RS422_IN_CH5+	A09	A09	Vuser_RTN
B25	B25	IN 06 / *RS422_IN_CH6+	B09	B09	Vuser_RTN
C25	C25	IN 07 / *RS422_IN_CH7+	C09	C09	Vuser_RTN
A24	A24	IN 08	A08	A08	Vuser_RTN
B24	B24	IN 09	B08	B08	Vuser_RTN
C24	C24	IN 10	C08	C08	Vuser_RTN
A23	A23	IN 11	A07	A07	Vuser_RTN
B23	B23	IN 12	B07	B07	Vuser_RTN
C23	C23	IN 13	C07	C07	Vuser_RTN
A22	A22	IN 14	A06	A06	*RS422_OUT_CH6-
B22	B22	IN 15	B06	B06	*RS422_OUT_CH7-
C22	C22	IN 16	C06	C06	OUT 16
A21	A21	IN 17	A05	A05	OUT 17
B21	B21	IN 18	B05	B05	OUT 18
C21	C21	IN 19	C05	C05	OUT 19
A20	A20	IN 20	A04	A04	OUT 20
B20	B20	IN 21	B04	B04	OUT 21
C20	C20	IN 22	C04	C04	OUT 22
A19	A19	IN 23	A03	A03	OUT 23
B19	B19	IN 24	B03	B03	OUT 24
C19	C19	IN 25	C03	C03	OUT 25
A18	A18	IN 26	A02	A02	OUT 26
B18	B18	IN 27	B02	B02	OUT 27
C18	C18	IN 28	C02	C02	OUT 28
A17	A17	IN 29	A01	A01	OUT 29
B17	B17	IN 30	B01	B01	OUT 30
C17	C17	IN 31	C01	C01	OUT 31

Table 4: Pin Assignments

* Only available with RS-422 option installed

OP5251 Pin Assignments for 126-0292 64 D I/O DIN96 4 x 50 adapter

		OP5251	126-0292 (64 DI/O DIN96 4x50)	
I/O Type	Module pin assignment	Din 96 IO	Connector	Pin #
Din	IN00	B27	P1	1
Din	IN01	C27	P1	3
Din	IN02	A26	P1	5
Din	IN03	B26	P1	7
Din	IN04	C26	P1	9
Din	IN05	A25	P1	11
Din	IN06	B25	P1	13
Din	IN07	C25	P1	15
Din	IN08	A24	P1	17
Din	IN09	B24	P1	19
Din	IN10	C24	P1	21
Din	IN11	A23	P1	23
Din	IN12	B23	P1	25
Din	IN13	C23	P1	27
Din	IN14	A22	P1	29
Din	IN15	B22	P1	31
Din	IN16	C22	P2	1
Din	IN17	A21	P2	3
Din	IN18	B21	P2	5
Din	IN19	C21	P2	7
Din	IN20	A20	P2	9
Din	IN21	B20	P2	11
Din	IN22	C20	P2	13
Din	IN23	A19	P2	15
Din	IN24	B19	P2	17
Din	IN25	C19	P2	19
Din	IN26	A18	P2	21
Din	IN27	B18	P2	23
Din	IN28	C18	P2	25
Din	IN29	A17	P2	27
Din	IN30	B17	P2	29
Din	IN31	C17	P2	31
Digital Power	Vuser_DIN	C28	P1-P2	41
Digital Power	Vuser_DIN	A27	P1-P2	42
Digital Power	Vuser_RTN	C10	P1-P2	43
Digital Power	Vuser_RTN	A09	P1-P2	44
Digital Power	Vuser_DIN	C28	P1-P2	45
Digital Power	Vuser_DIN	A27	P1-P2	46
Digital Power	Vuser_RTN	B09	P1-P2	47
Digital Power	Vuser_RTN	C09	P1-P2	48
Digital Power	Vuser_RTN	A08	P1-P2	49
Digital Power	Vuser_RTN	B08	P1-P2	50

Table 5: Din Pin assignments for 126-0292



NOTE: Even numbered pins (2, 4, 6, 8, 10, 12, ...32) on connectors P1 to P4 are all tied to Vuser_RTN

OP5251 Pin Assignments for 126-0292 64 D I/O DIN96 4 x 50 adapter (cont'd)

		OP5251	126-0292 (64 DI/O DIN96 4x50)	
I/O Type	Module pin assignment	Din 96 IO	Connector	Pin #
Dout	OUT00	A16	P3	1
Dout	OUT01	B16	P3	3
Dout	OUT02	C16	P3	5
Dout	OUT03	A15	P3	7
Dout	OUT04	B15	P3	9
Dout	OUT05	C15	P3	11
Dout	OUT06	A14	P3	13
Dout	OUT07	B14	P3	15
Dout	OUT08	C14	P3	17
Dout	OUT09	A13	P3	19
Dout	OUT10	B13	P3	21
Dout	OUT11	C13	P3	23
Dout	OUT12	A12	P3	25
Dout	OUT13	B12	P3	27
Dout	OUT14	C12	P3	29
Dout	OUT15	A11	P3	31
Dout	OUT16	C06	P4	1
Dout	OUT17	A05	P4	3
Dout	OUT18	B05	P4	5
Dout	OUT19	C05	P4	7
Dout	OUT20	A04	P4	9
Dout	OUT21	B04	P4	11
Dout	OUT22	C04	P4	13
Dout	OUT23	A03	P4	15
Dout	OUT24	B03	P4	17
Dout	OUT25	C03	P4	19
Dout	OUT26	A02	P4	21
Dout	OUT27	B02	P4	23
Dout	OUT28	C02	P4	25
Dout	OUT29	A01	P4	27
Dout	OUT30	B01	P4	29
Dout	OUT31	C01	P4	31
Digital Power	Vuser_DOUT	B11	P1-P2	41
Digital Power	Vuser_DOUT	C11	P1-P2	42
Digital Power	Vuser_RTN	C10	P1-P2	43
Digital Power	Vuser_RTN	A09	P1-P2	44
Digital Power	Vuser_DOUT	A10	P1-P2	45
Digital Power	Vuser_DOUT	B10	P1-P2	46
Digital Power	Vuser_RTN	B09	P1-P2	47
Digital Power	Vuser_RTN	C09	P1-P2	48
Digital Power	Vuser_RTN	A08	P1-P2	49
Digital Power	Vuser_RTN	B08	P1-P2	50

Table 6: Dout Pin assignments for 126-0292



NOTE: Even numbered pins (2, 4, 6, 8, 10, 12, ...32) on connectors P1 to P4 are all tied to Vuser_RTN

SPECIFICATIONS

Product Name	OP5251
Part Number	126-0275
INPUT SECTION	
Number of Inputs	32
Isolation	Optical isolator
Connection mode	Common anode or Common cathode (factory configured, on request)
Input current	Minimum: 5 mA Maximum: 15 mA
Input current resistor network	Socket mounted
Detection threshold	Separate Schmitt Trigger
Voltage range	4 to 30 Vdc
Delay Low-to-High	110 ns
Delay High-to-Low	60 ns
Rise/Fall times	6 ns/6 ns
OUTPUT SECTION	
Number of Outputs:	32
Isolation:	Optical isolator
Output Drive:	Open Collector Transistor
Output Current max:	100 mA continuous
Output Protection :	150 mA Resettable Fuse
Output Voltage range:	4 to 30 Vdc
Pull-Up Load resistor network:	Socket mounted
Delay Low-to-High:	100 ns with 1 k Ω R _L
Delay High-to-Low:	50 ns
Rise/Fall times:	R _L dependant / 6 ns
Power Isolation:	On-board DC to DC isolated converter

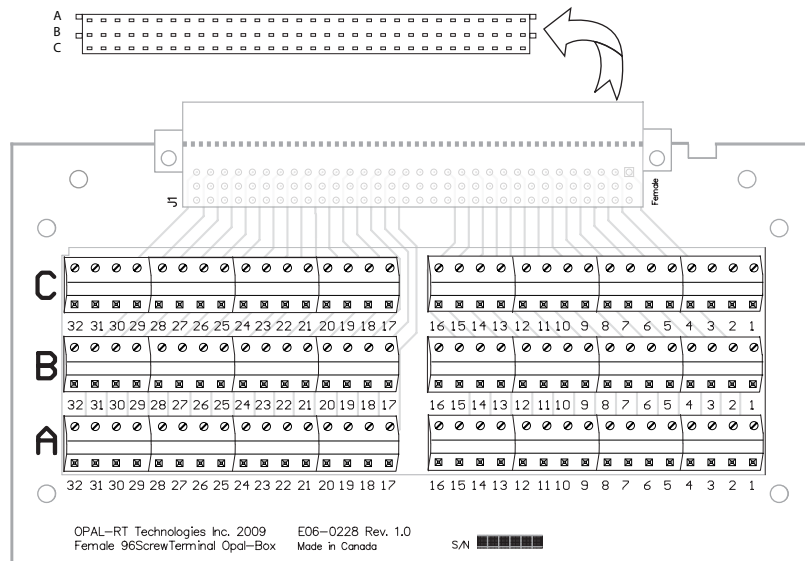
ACCESSORIES

The following accessories are available for use with the OP5251.

- 126-0284: (optional) RS422 board (shown in “RS-422 Communication Module PCB Diagram”)
- 126-0274: Female 96DIN screw terminal
- 126-0293: Din32/Dout32 loopback connector
- 126-0292: 64 D I/O DIN96 4 x 50 adapter
- 113-0374L (optional) 2 x 50-pins IDC50

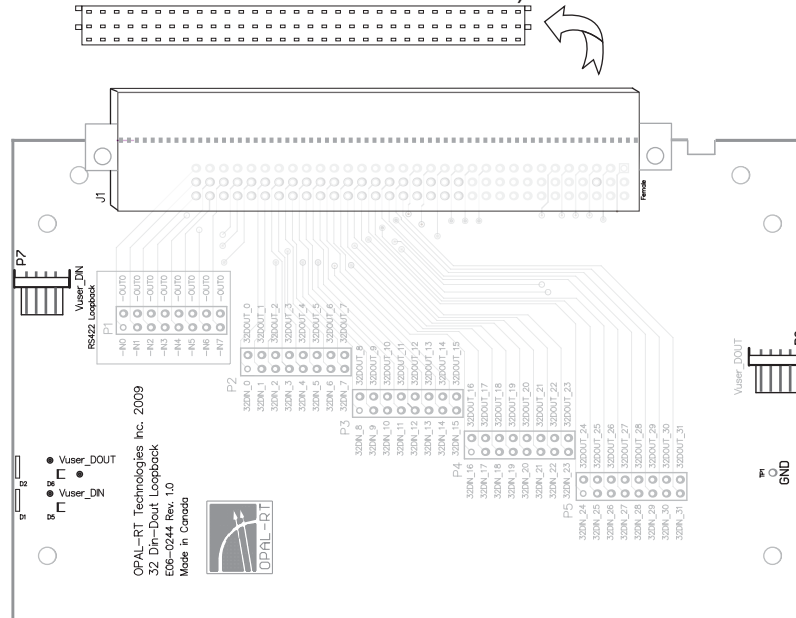
126-0274: Female 96DIN screw terminal

- Connecting directly into the OP5251, the 96DIN connectors allow quick and precise customized connections to specific pins (listed in Table 4).



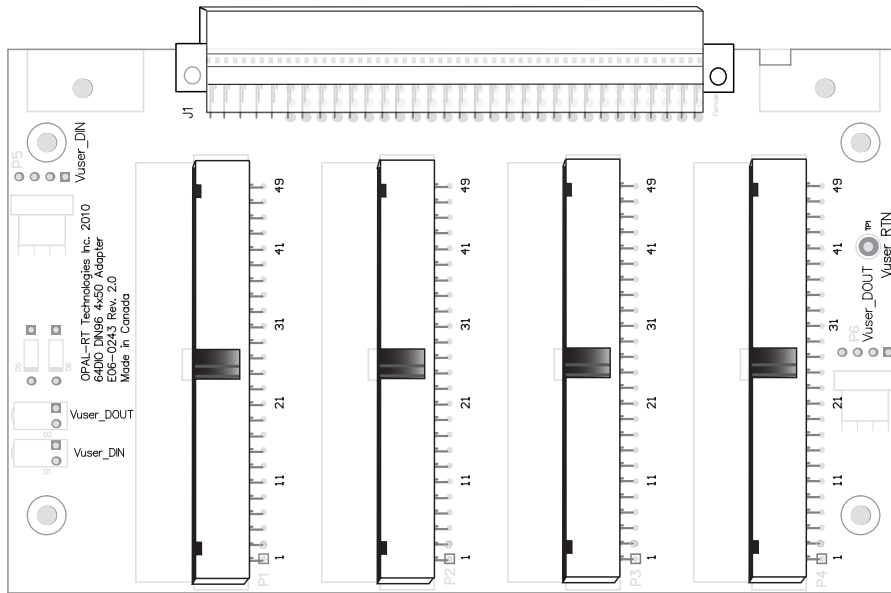
126-0293: Din32/Dout32 loopback connector

- Used for internal tests to connect the 32Din to the 32Dout)



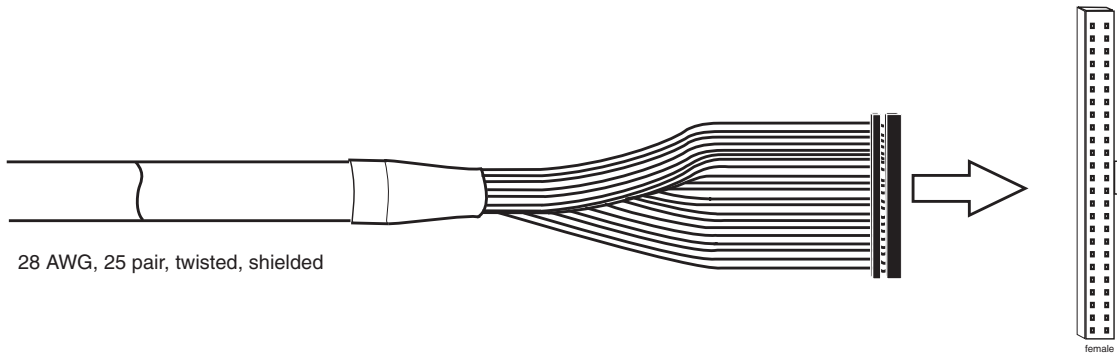
126-0292: 64 D I/O DIN96 4 x 50 adapter

This adapter is used to connect twisted pair flat cable and allows for quick connections to digital Input/Output boards using four 50-pin (2x25) connectors. (see Table 5 and Table 6 for pin assignments)



113-0374L 2 x 50-pins IDC50 cable

- Round shielded cable, 25 twisted pair (for use with part number 126-0292, 64 D I/O DIN96 4 x 50 adapter)



TYPICAL APPLICATIONS

The following drawing provide examples of typical application with high Dout and with low Dout.

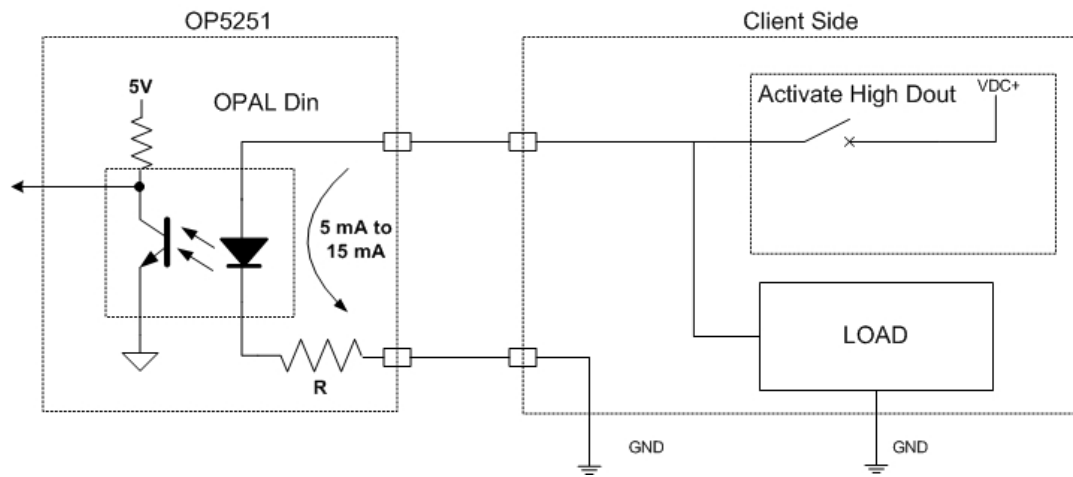


Figure 8: Typical high-side acquisition circuit

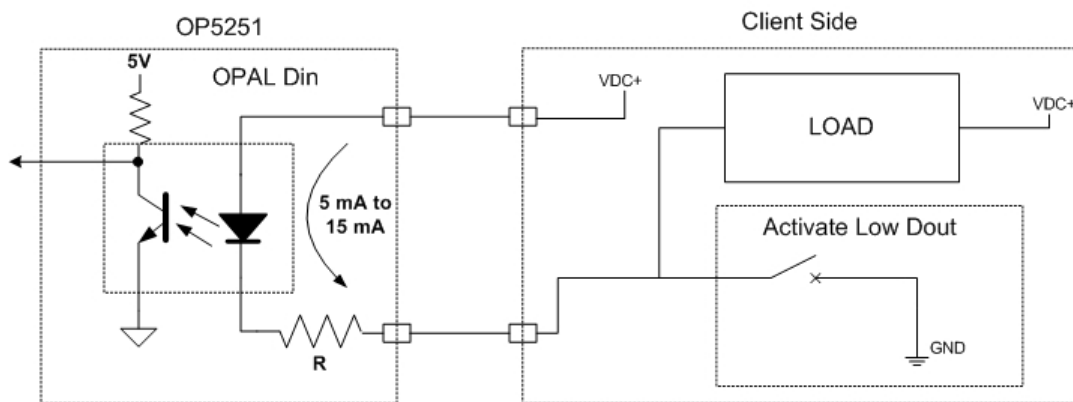


Figure 9: Typical low-side acquisition circuit

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