

Dual Port Adapter Design Description

Purpose:

The Dual Port Adapter (DPA) is a two-channel interface board originally designed for the New Mooring Controller. The DPA's purpose is to provide Power control, switching, and monitoring, along with the physical layer communications interface, Galvanic Fault Isolation, and local CPU interface. The DPA can be used to interface to an instrument, a Gateway hierarchical above or an Instrument Concentrator (Icon) below. The basic communications path is a flexible serial interface capable of software reconfiguration between RS-232 and RS-485.

Power Control, Switching and Monitoring:

This section of the board provides the control of the power from the local CPU to an instrument or Icon connected Hierarchically below. The major function of this section is Solid State Power switching, Current and Voltage measurement, and Electronic Circuit breaker. Each of these functions is described in the following subsections. This section of the DPA has been designed to handle a continuous 12A current draw at no more than 5% loss.

Solid State Power switching:

This power switching function is implemented with the following parts: U8 (LTC1154), Q3 (IRF3205), and the RC network between U8 pin 6 and Q3 gate. U8 is an N-Channel High-Side MOSFET driver. Since the MOSFET is an N-channel requiring a positive switching voltage and that it is located on the positive side of the power supply a gate drive voltage higher than the power supply is required. This function is provided for by the LTC1154. Upon application of a voltage greater than 2.0V to pin 1, the LTC 1154 will begin to charge pump up the gate voltage above the positive rail at a rate of 100uA. The rate at which the MOSFET is turned-on is controlled by the RC network. This network slows the Gate voltage rise rate to provide a slow turn on to the attached instrument thus avoiding large capacitor in-rush currents. The IRF3205 is an N-channel HEXFET MOSFET chosen mainly for its low on resistance of 0.008 ohms. The diode in the RC network is to allow for fast turn off times, in the case of an over current. The LTC1154, will upon sensing a rising edge on pin 5, pull the gate voltage to ground, thus forward biasing the diode and allowing the gate charge to be depleted much faster. Along with shutting down the MOSFET the LTC1154 will pull low pin 3 signaling the local CPU interface of an over current condition. After an over current event Pin 1 must be cycled low and then back high to re-enable the switch.

Current, Voltage and temperature Monitoring.

The function of this section is to provide measurement of the current drain, voltage and heat sink temperature to the local CPU and Electronic Circuit breaker function. This section utilizes U4 (LT1494), U9 (MAX1291), U11 (LM61), and assorted resistors for scaling. The LT1494 performs the high side current sensing using resistor R11 as the current sensor. The transfer function of the current sense amplifier from Iload to Vout is:

$$V_{out} = I_{load} * R_{11} * R_{12} / R_{80}.$$

Which at maximum current level of 12 Amps gives an output of 2.46 volts which is slightly less than the maximum input voltage to the ADC. The voltage sense is provided and filtered by R16, R17 and C19, with a scaling of

$$V_{sense} = V_{supply}/6.$$

C19 provides a low-pass roll off of 5.5Hz.

The temperature monitoring function is performed by U11 (LM61) which monitors the heat sink temperature. The purpose of this function is to allow the Local CPU to detect any harmful increases in switch temperature. This allows the CPU the ability to shutdown the channel if an over temperature is occurring.

Electronic Circuit Breaker:

This function is implemented with U7 (X9317) and U6 (MAX919) controlling U5 (LTC1154). U7 is a Non-volatile Digital Potentiometer (DPOT) It operates as a voltage divider, dividing down the ADC

full scale reference voltage to a user defined level. This level then defines the trip point of the breaker. R15 and C18 to provide a Low-pass roll of 0.34Hz. The filtered voltage is then sent to the comparator U6 that compares the reference level to that of the current level sensed by U4. The comparator provides the shutdown signal to the switch controller in the case of an over current condition. To provide un-set-trip-level fault tolerance the DPOT uses the ADC reference to allow a maximum current trip point to be 12 Amps, as this is define by U4. The Electronic circuit breaker does not depend on software or the rest of the system for detection and switching, it only relies on the system for setting the actual trip level, which may be programmed. 12A slow blow fuses have been included in the current path to provide a back up to a primary breaker failure.

Physical Layer Communications Interface:

This section provides the physical layer interface of either RS-232 or RS-485. To accomplish this the DPA utilizes a dual mode transceiver (U17 MAX3160). The mode of the transceiver may be selected via software configuration. Each port provides 5 communications lines defined as Instrument Comm A-E. Their allocation is given in the table below:

Mode: RS-232

Instrument Comm	Function
A	Data Out
B	Handshake Out
C	Data In
D	Handshake In
E	Signal Common

Mode: RS-485 Half Duplex (Multi-drop)

Instrument Comm	Function
A	Data -
B	Data +
C	No Function
D	No Function
E	Signal Common

Mode: RS-485 Full Duplex

Instrument Comm	Function
A	Data Out –
B	Data Out +
C	Data In –
D	Data In +
E	Signal Common

The communications channel provided by the DPA may be electrically connected or isolated from the system power. This is the function of K6. K6 is a Dual coil Latching relay. To allow for isolation all signals must be passed through isolators. The data lines, as they may support high speed communications (1Mbit/s) utilize a capacitive digital isolator (U15, ISO150AP), while control signals use low power optical isolators (HCPL –0730). For a description of the control signals for the MAX3160 refer to that products data sheet. A long with the signal isolation, isolated power is generated by U21 (Lt1425). This configuration allows multiple use cases to be supported. The system can support instrument isolated and common communication lines, RS-232 and RS-485 signaling, along with shutting down communication for power saving and fault isolation.

Galvanic Fault Isolation:

In the event an instrument should leak and provide a fault connection to sea water the DPA supports complete galvanic isolation of the channel. Relays K1, K2, and K6 provide this ability. Relay K6, as described in the Communications section may be used to provide common communications in a required application. During Fault condition this relay may be opened to isolate communication lines.

Relay K1, and K2 is a power Relay used to Galvanically isolate the power lines to and instrument. Both of these relays my be used to help locate and isolate a Fault condition.

Local CPU interface:

This interface is a simple Serial Peripheral Interface (SPI), using Master in Slave Out, Master Out Slave In, Serial Clock and Channel Select, with a wired Or'd Interrupt. This interface is provided by a Low power Classical Programmable Logic Device (CPLD), U1, XCR3256. The actual software interface specification is still to be determined. This interface is the means of controlling the DPA's functions. To save lines and minimize Back plane lines the DPA's interrupt is a wired Or'd type. Although this requires the CPU to search all channels to find the interrupt, this should only be required during a fault, which should be at a minimum and would require the processor's intervention. Refer to DPA SPI interface specifications for more intrfomation.