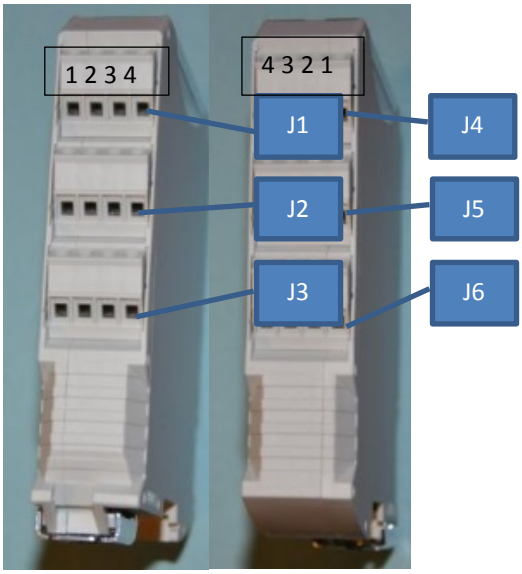
DRA004 Isolation Amplifier - Introduction.

Application Note 1.

Contents

DRA004 Generic Isolation Amplifier

The DRA004 is a DIN Rail mounting generic 3 channel isolation amplifier that can be configured during m ture. Standard options red with 3 types of inputs, Current Shunt, Internal Shunt and Internal Voltage Divider. It can also be offer customised unit with the input scaling and configuration defined by the user.



Inputs

1	2	3	4	Left Side
Current1 In	Current1 Out	Voltage1+	Voltage1-	J1
Current2 In	Current2 Out	Voltage2+	Voltage2-	J2
Current3 In	Current3 Out	Voltage3+	Voltage3-	J3

Outputs

4	3	2	1	Right Side
Vref	Channel2	Vref	Channel1	J4
NC	NC	Vref	Channel3	J5

Supplies

4	3	2	1	Right Side
-5.0V	Vref=0V	0V	5.0V	J6

The Reason for Isolation

The DRA004 isolation amplifier provides a means to measure signals without the signal ground and measurement ground being directly connected. This is desirable in a number of instances in industrial applications:

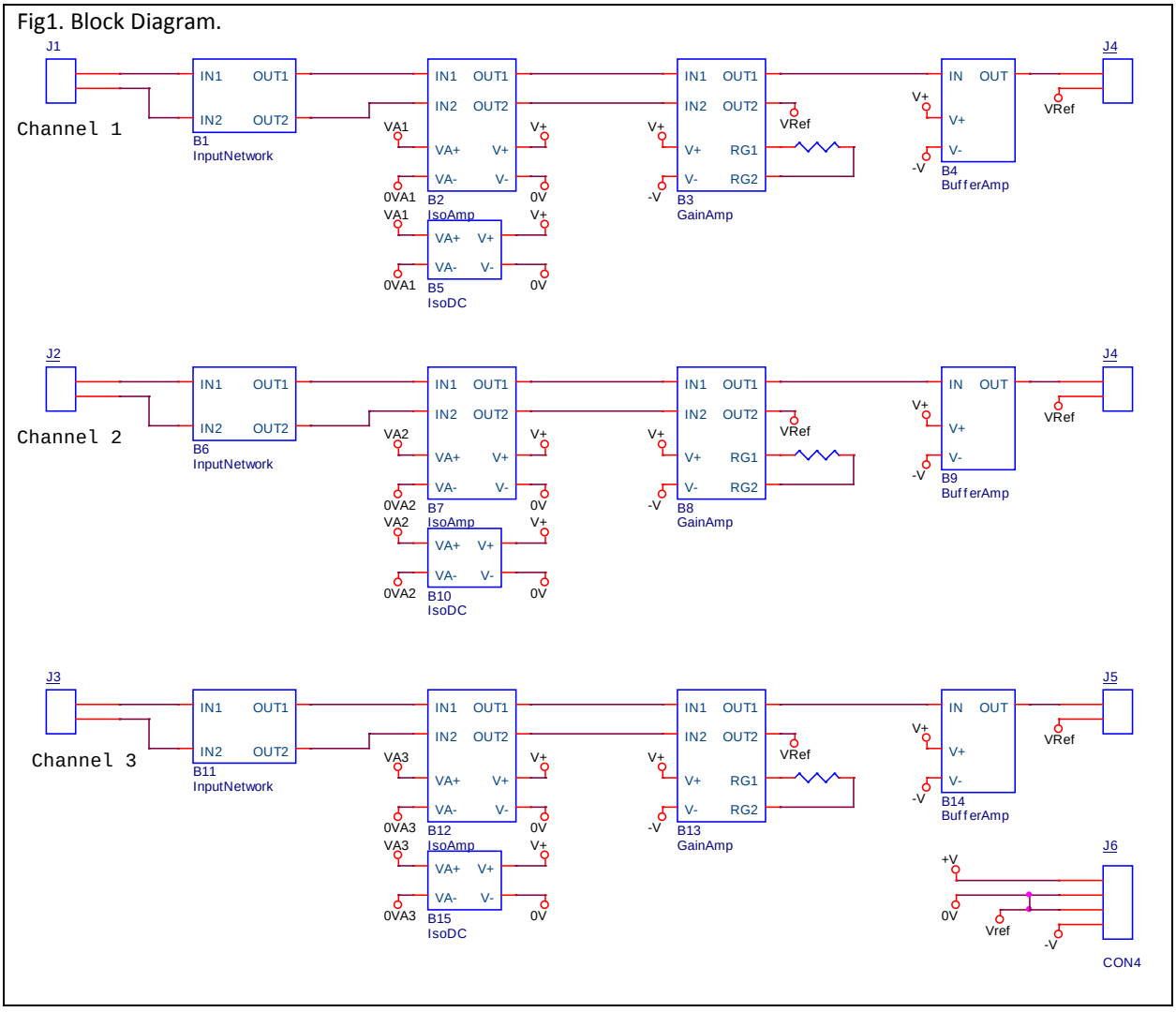
- The signal is referenced to a ground at a different potential to the measurement system ground.
- The signal has a large common mode swing relative to the measurement system, for example a current sense resistor in an electrical phase.
- Break ground loops so that leakage currents cannot flow in either direction between the signal and the measurement.

Voltage and Current Measurement.

The DRA004 isolation amplifier has been designed to measure voltage or current. It has 3 identical channels that can be configured to measure anything from millivolts full scale up to ±1000V full scale. The signal may be voltage from an electrical supply, the phase of a motor, a solenoid drive, or it may be a voltage derived from a sensor such as a current sense resistor.

Block Diagram

Fig1. Block Diagram.



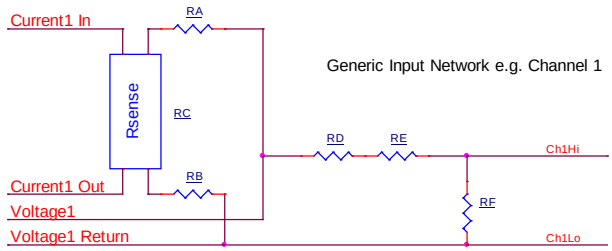
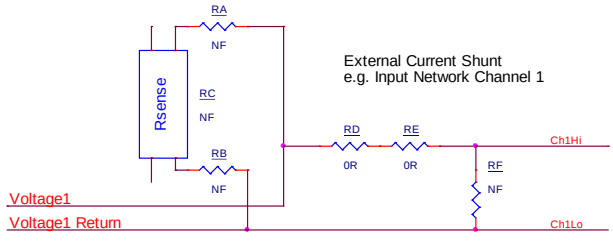
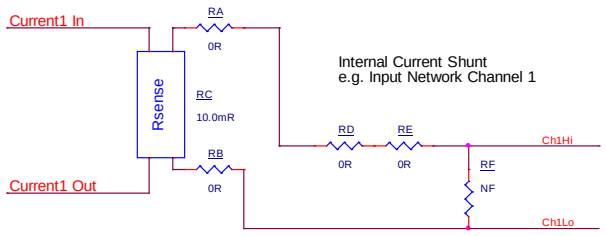
The block diagram shows 3 identical channels. The key components that confer the property of isolation are the IsoAmps and the IsoDCs. The IsoAmps components are integrated circuit isolation amplifiers with a fixed gain of 8.2 between the differential input and the differential output. The PCB has been designed to allow the maximum isolation voltage between input and output of 1410V. The IsoDC components are DC to DC power supplies that create an isolated 5V rail for the input stage of the IsoAmp component. The IsoDC parts have an isolation rating of 1500V so the overall rating of the DRA004 is 1410V between the input and the output. The input channels are isolated from each other and the PCB layout ensures that the 1410V isolation is maintained between channels on the input side. On the output side, the channels are referenced to Vref which is internally connected to the supply 0V. The outputs should be connected to a differential input of the data acquisition system.

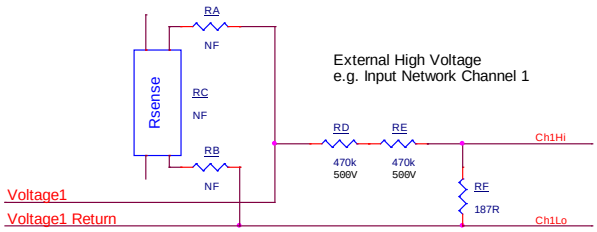
In the block diagram, the GainAmps are instrumentation amplifiers that set the overall scaling of the DRA004. The supply voltage is ±5V and the output can be scaled within that range; however for the standard variants the output range is ±2V to be compatible with a standard range of National Instruments DAQ sub-systems. Also ±2V can be configured for a 5V ADC on a microcontroller. Nevertheless, the output can be configured for other customised scaling levels within the ±5V limit. Note that the isolated 5V supplies for IsoAmp components are derived from the +5V input rail.

The BufferAmp components have a gain of 1 and provide the drive for output cables and short circuit tolerance.

Input Network Standard Variants

Fig 2. Input Network Variants.

Type	Network	Note
Generic		These 6 resistors can be fitted in different combinations for the 3 channels of DRA004. Standard arrangements are described below based on ±50mV and ±200mV at the input to IsoAmp.
A		This network is compatible with external current shunts with a 50mV full scale rating such as Murata/Datel 3020 series.
B		This network uses the internal RSense resistor to measure current. The resistor value is scaled to 200mV full scale at 20A peak and 14.1A continuous operation.

C		This network scales a ±1000Vpeak input to ±200mV at the IsoAmp input.

Customisation

The input network can be factory built to suit the user on request. The PCB has the following limitations:
Fig 3. Custom input network.

	RA	RB	RC	RD	RE	RF
Footprint	2512	2512	2512	2512	2512	0805
Power	100mW	100mW	3W max.	0.6W	0.6W	100mW
Voltage				500V	500V	200mV
Normal Range	0R link	0R link	2.5mR min. 14.1Arms continuous. 20A peak.	Note: Power and volts max limits.	Note: Power and volts max limits.	Note: *

The network on the input of each channel can be defined to provide an input to the IsoAmp of up to ±200mV. The IsoAmp has a fixed gain of 8.2 and the gain of GainAmp, see Fig 1, can be set by RG on each channel according to gain = (1+(100k/RG)).
The bandwidth is set by an RC network at 80kHz. This can be set to any bandwidth up to 200kHz – see below.
* ±200mV is the maximum measurable input to the isolation amplifier. ±2V is the maximum without damage and ±6V is maximum transient for 2secs.

Offset Trim

There is an offset adjustment potentiometer on each channel that is accessible by lifting the top cover of the DIN Rail case.

Bandwidth and Noise

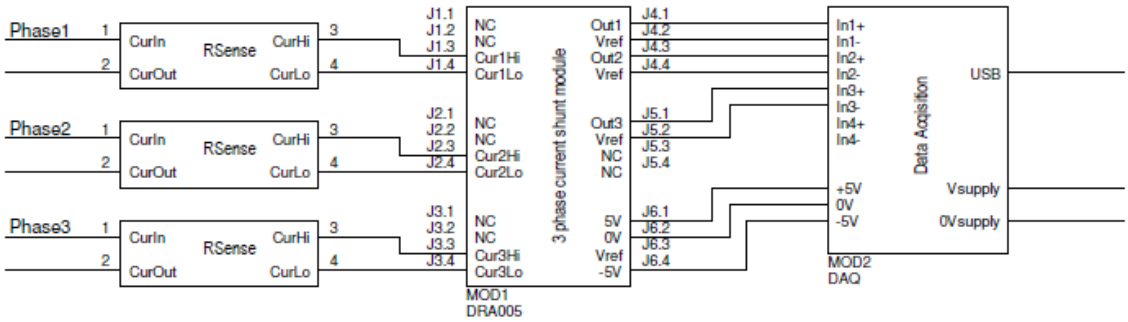
The standard variants have a simple RC limit to the bandwidth set to 80kHz. The maximum bandwidth is limited by the IsoAmp at 200kHz and by the GainAmp as a function of frequency (500kHz at G=4, 100kHz at G=10, 80kHz at G=20).

Typically the output noise is 2.5mVrms at 0V input and is due mostly to the IsoAmp component.

There is a 100R resistor in the output that can be used to reduce the bandwidth by placing a capacitor across the output terminals or in the measurement equipment. As a customised feature the capacitor can be fitted on the PCB on through-hole pads.

Typical Connections

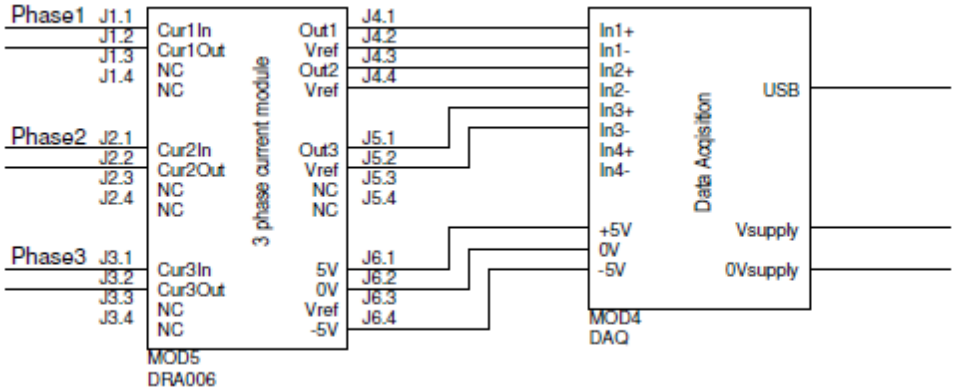
DRA005, 3 channel external current shunt.



The DRA005 module has 3 channels configured as Type A in Fig2 above. The current shunts are labelled RSense and fit in the phase connection. This could be an electrical supply phase or the phase supply of a motor. The DRA005 is scaled to accept ±50mV full scale to produce ±2.0V output. The Murata/Datel 3020 series of shunts are available in 50mV full scale and the correct model should be chosen to match the current to be measured. If say ±200A peak is chosen as the full scale then 1A will be the minimum current that can reasonably be measured. The bandwidth is DC to 80kHz so this arrangement could be used to measure the phase current of high speed motors, variable frequency aircraft supply systems, 50/60Hz electrical systems, DC solar power systems or DC solenoids, for example.

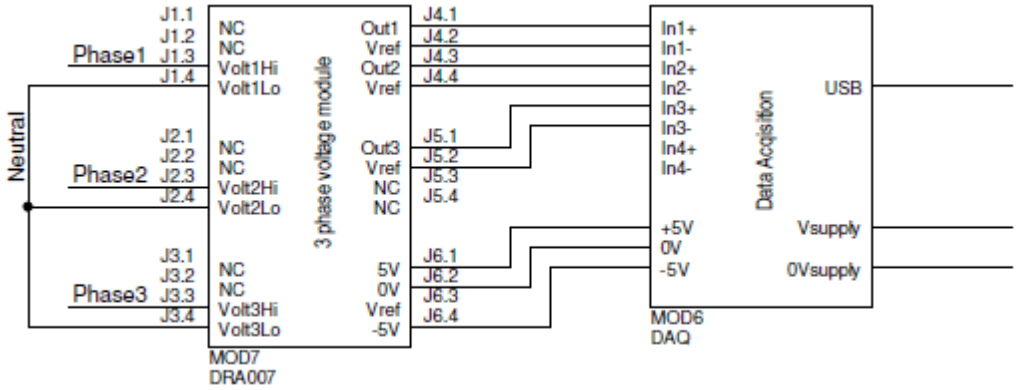
The 0V supply to the DRA005 and to the DAQ should be referenced to a star point in the measurement rack and can be earthed at the star point.

DRA006, 3 channel internal current shunt.



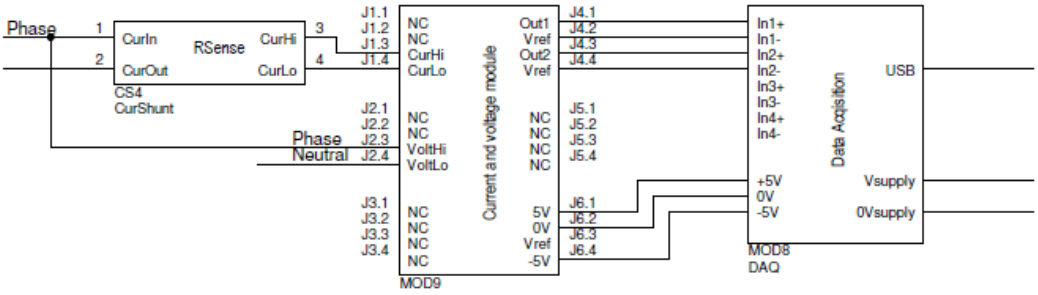
The DRA006 module has 3 channels configured as Type B in Fig2 above. The current sense resistor is internal and is in the phase connection. This could be an electrical supply phase or the phase supply of a motor. The DRA006 is scaled to ±20A full scale to produce ±2.0V output. The bandwidth is DC to 80kHz so this arrangement could be used to measure the phase current of high speed motors, variable frequency aircraft supply systems, 50/60Hz electrical systems, DC solar power systems or DC solenoids, for example. The 0V supply to the DRA006 and to the DAQ should be referenced to a star point in the measurement rack and can be earthed at the star point.

DRA007, 3 channel voltage.



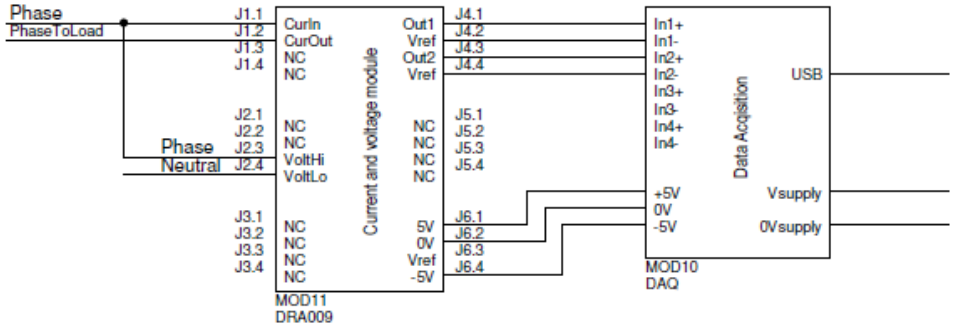
The DRA007 module has 3 channels configured as Type C in Fig2 above. The voltage divider resistors are internal and connect to the phases. This could be an electrical supply phase or the phase supply of a motor. The DRA007 is scaled to ±1000V full scale to produce ±2.0V output. The bandwidth is DC to 80kHz so this arrangement could be used to measure the phase current of high speed motors, variable frequency aircraft supply systems, 50/60Hz electrical systems, or DC solar power systems for example. The 0V supply to the DRA007 and to the DAQ should be referenced to a star point in the measurement rack and can be earthed at the star point.

DRA008, Single phase voltage and external current shunt.



The DRA008 module has 1 channel configured as Type A and 1 as Type C in Fig2 above. The voltage divider resistors are internal and connect to the phase. The current shunt is labelled RSense and fits in the phase connection. The bandwidth is DC to 80kHz so this arrangement could be used to measure the phase current of high speed motors, variable frequency aircraft supply systems, 50/60Hz electrical systems, or DC solar power systems for example. The 0V supply to the DRA008 and to the DAQ should be referenced to a star point in the measurement rack and can be earthed at the star point.

DRA009, Single phase voltage and internal current shunt.



The DRA009 module has 1 channel configured as Type B and 1 as Type C in Fig2 above. The voltage divider resistors are internal and connect to the phase. The current sense resistor is internal and is in the phase connection. The bandwidth is DC to 80kHz so this arrangement could be used to measure the phase current of high speed motors, variable frequency aircraft supply systems, 50/60Hz electrical systems, or DC solar power systems for example. The 0V supply to the DRA009 and to the DAQ should be referenced to a star point in the measurement rack and can be earthed at the star point.