ICS
ICS ELECTRONICS
division of Systems West Inc.

IEEE 488

APPLICATION BULLETIN

USING THE 4861 OEM BOARD AS A POWER SUPPLY CONTROLLER

INTRODUCTION

This application note describes how to use the 4861 OEM Board to create a dual output power supply that can be controlled from the GPIB bus or from an RS-232/RS-485 serial link. The 4861's versatile firmware allows the user to customize the 4861's operation and responses so the board appears as an integral part of the power supply system.

PRODUCT DESCRIPTION

The end product is a power supply chassis with two narrow-range, + 5 and + 12 volt outputs that can be controlled from a GPIB bus or from an serial link. Each voltage output is to be controlled over a ± 10% range with a separate on/off control of each output. The output will also be prevented from exceeding a preset limit. Output voltage and current is to be measured and reported to the host computer. Figure 1 shows a block diagram of the power supply chassis.

The selected power supplies produce 5 ±10% and 12 ±10% VDC outputs at currents up to 100 amperes. The voltage levels of the power supplies can be controlled by varying a DC control input voltage and turned off and on with a logic input signal. Each supply provides a status output that indicates if its output is off or on.

The 4861 OEM Boards are available in various configurations with different analog output-input combinations. The board selected for this application, P/N 114584-04, has four isolated analog outputs, four analog inputs, and digital I/O capability. The board has both serial and GPIB interfaces. At power turn-on, the serial interfaces are enabled and remain enabled until the GPIB interface is addressed and put into the remote state.

CONTROLLING THE POWER SUPPLY OUTPUTS

The power supply control inputs are specified to be linear from +5 to 0 Vdc for a - 10% to + 10 % change in the nominal voltage output. The input for the nominal +5 or +12 volts output is 2.5 Vdc. The 4861's plus analog outputs are connected to the power supply's control inputs. The minus output is connected to the power supply's input return terminal as shown in Figure 2. In our example, analog output channel #1 will be used to control the + 5 volt supply and channel #2 will be used to control the + 12 volt supply.
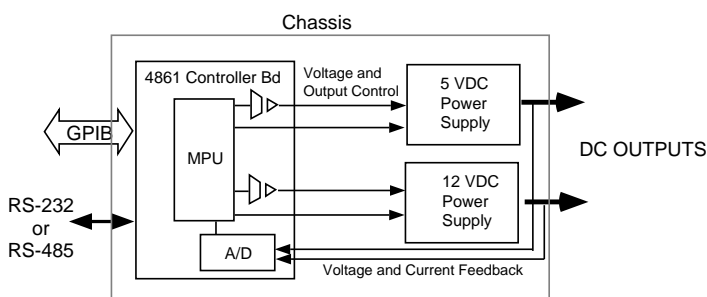

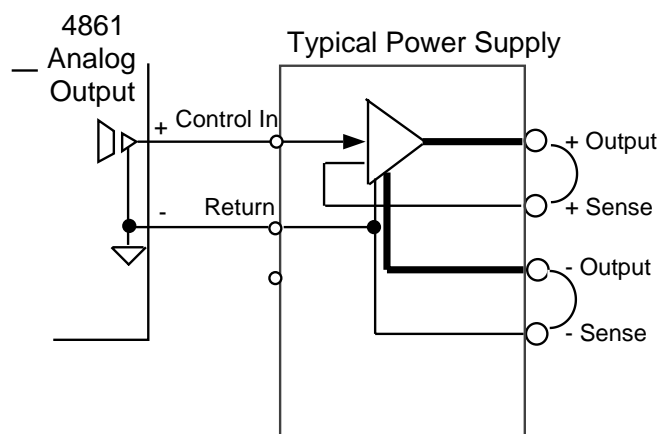**Figure 1   Power Supply Block Diagram**

Figure 2   Voltage Control Connections

Because the 4861 analog outputs are isolated, they can be connected to any potential in the power supply. Twisted pair wires are recommended to minimize noise. If shielded wire is used, connect the shield to chassis ground at the 4861 end of the cable.

The 4861 analog outputs should be scaled to provide the correct control voltage when the end user commands an output voltage value. The slope and offset for the +5 volt control signal are computed as follows :

$$\text{Slope} \quad = \quad \frac{\text{Control Voltage Range}}{\text{Power Supply Output Swing}}$$

$$= \quad \frac{5 - 0}{4.5 - 5.5} \quad = \frac{5}{-1} \quad = -5$$

$$\text{Offset} \quad = \quad \begin{array}{l} -(\text{Slope x Nominal Output Voltage}) \\ + \text{ Nominal Control Value} \end{array}$$

$$= \quad -(-5 \text{ x } 5) + 2.5 = 25 + 2.5 = 27.5$$

The + 12 volt values are computed as:

$$\text{Slope} \quad = \quad \frac{5 - 0}{10.8 - 13.2} \quad = -2.0833$$

$$\text{Offset} \quad = \quad -(-2.0833 \text{ x } 12) + 2.5 \quad = 27.5$$

These values are loaded into the 4861 with the following SCPI configuration commands:

```
INST 1                        'selects analog output #1
VOLTage:LEVel:SLOPe -5   'sets channel #1 gain
VOLTage:LEVel:OFFset 27.5 'sets channel #1 offset

INST 2                        'selects analog output #2
VOLTage:LEVel:SLOPe -5   'sets channel #2 gain
VOLTage:LEVel:OFFset 27.5 'sets channel #2 offset
*SAV 0                        'saves values in 4861's
                                          E²PROM
```

Note that the lower case letters in the SCPI commands can be omitted or the commands can be all in upper case letters. The lower case letters are only shown here for clarity.

e.g.   VOLTage is the same as VOLT or VOLTAGE

Also note that the 4861's analog outputs may not go to exactly 10 volts or to zero. This can be taken into account by proper adjustment of the power supply scale factor. The 4861s are factory calibrated for use on the 0 to + 10 volt range. If they are going to be used on a bipolar range, they should be recalibrated when the range is changed or ordered set to bipolar outputs.

TURNING THE POWER SUPPLIES OFF AND ON

The power supplies have an enable input that enables or disables the power supply output. The input is coupled through an optical isolator to eliminate ground loops. The 4861's high current digital outputs can be used to drive the enable inputs as shown in Figure 3.
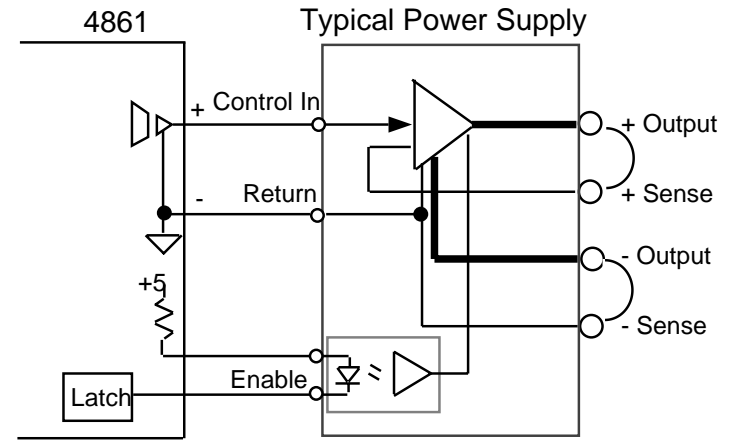

Figure 3   Power Supply Enable Connections

Select the resistor to get the amount of current through the optical isolator as specified by the power supply manufacturer. Do not drive the resistor from a voltage source inside the power supply as that would eliminate the benefits of the isolator.

MEASURING THE POWER SUPPLY'S OUTPUT VOLTAGE

To measure the power supply output voltages, the output voltages are connected to the 4861's analog inputs. The 4861 can read differential voltages on a 10 V, 1 V or 0.1 V range. The + 5 V output is less than 10 volts so it can be connected directly to the 4861. The + 12V output is greater than 10 volts so an external resistor divider must be used to reduce the input to less than 10 volts. In this example, analog input #1 is used for the +5 V supply and analog input #3 is used for the + 12V supply. Analog inputs #2 and #4 are reserved for measuring each supply's output current.

The voltage measurements should be taken at the load. However, that is not practical in a typical power supply application. Instead, connect the 4861 inputs to the sense inputs of the power supply. The sense lines do not carry any current so the readings will reflect the voltage at the load or as close to the load as the user connects them. In Figure 3, the sense leads are shown tied back to the voltage outputs. If 60 Hz noise pickup appears to be a problem, try connecting 100 Kohm pulldown resistors from the analog inputs to analog ground on pin C16.
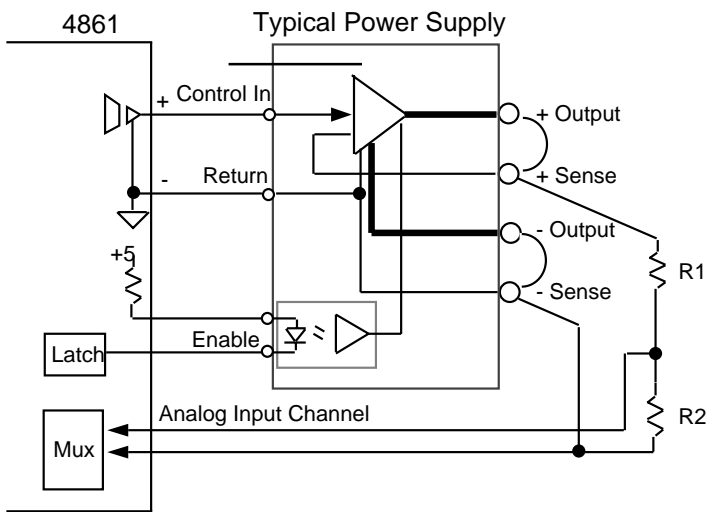
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Figure 4   Measuring Voltage Outputs

Resistors R1 and R2 are used to divide the power supply output so it can be measured on the 4861's 10 V range. Omit them for the + 5 V output. Use twisted shielded wire to minimize noise pickup. Shielded wire is not required for the voltage inputs. Calibrate the analog inputs to adjust the 4861's readings to the output voltage value and to compensate for any errors in the resistor divider. Measure the output with a calibrated DVM to generate a gain value.

$$\text{Gain} = \frac{\text{DVM Reading}}{\text{4861 Reading}}$$

$$= \frac{12.000}{6.030} = 1.9900$$

Use the CALibrate command subset to set the 4861's gain

```
INST 3                    'selects analog input #3
CALibrate:MEASure:GAIN 1.9900
                          'sets the gain value
CAL:DATe 12-01-95   'save when all done
```

MEASURING THE POWER SUPPLY'S OUTPUT CURRENT

The power supply output current can be measured by putting a small shunt in series with the load. The shunt is best placed in the return line to keep the common mode voltage on the 4861's inputs under 10 volts. Select the shunt resistance so that its maximum voltage drop does not exceed 100 mv. If the power supply is in a chassis, the resistance of the power cable can be used as the shunt resistor. Select a wire size so the voltage drop comes close to 100 mv at full load. Accuracy of the shunt or cable resistance is not important as long as it is stable and has minimal change due to self heating affects.

Use twisted shielded pair wire and connect the 4861's plus differential input to the load end of the shunt as shown in Figure 5. Connect the minus input to the power supply side of the shunt. Connect the shield to chassis ground at the 4861 end of the cable.
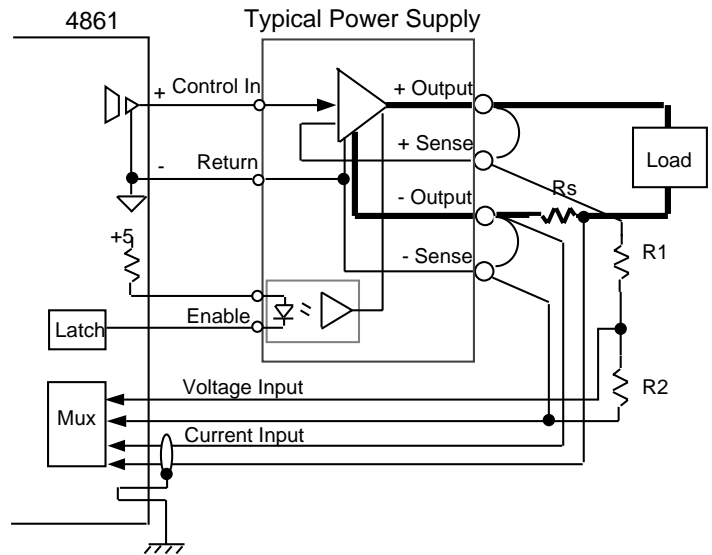

Figure 5   Current Reading Connections

Adjust the 4861's output reading by placing a current meter in series with the load. Use a load as close to maximum as possible. In the case of the example + 12V supply, the 4861 measured 65.7 mv with a 83 amperes load. At a 100 ampere full load, the reading would be 79.157 mv which is within the 4861's 100 mv range. (Note that the 4861 outputs readings of 0 to 100.0 when used on the 0.1 V range.)

Compute the correct gain

$$\text{Gain} = \frac{\text{Load Current}}{\text{4861 Reading}} = \frac{83}{65.7} = 1.2633$$

```
INST 4                      'select channel #4
MEASure:VOLTage:RANGE 0.1
                          'select 0.1 V range
CALibrate:MEASure:GAIN 1.2633
                          'set gain
CAL:DATe 12-01-95       'save when all done
```

SENSING THE POWER SUPPLY'S STATUS

The power supplies provide a status output that indicates if the output voltage is enabled or disabled. These status signals can be sensed by connecting them to the 4861's digital inputs. The status signal is often the open collector output of an optical isolator. Use a pullup or pulldown resistor to supply current to the isolator. Connect the status output to the 4861's digital inputs as shown in Figure 6.
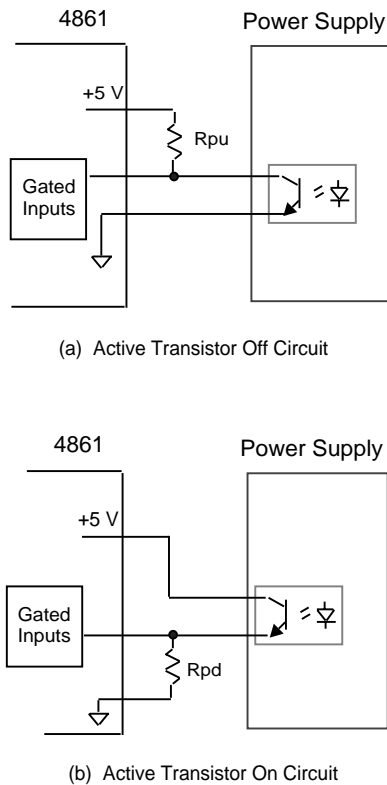
(a) Active Transistor Off Circuit

(b) Active Transistor On Circuit

Figure 6   Status Signal Input Circuits

Use circuit (a) when the transistor is open for a logical true level and you want a high true signal. Rpu is 10 K to 33 Kohms. Use circuit (b) when the transistor is on for a low true condition and you want a high true input. Select Rpd so the input voltage is <0.5 volts for an open circuit.

The 4861 reads the digital inputs in the Questionable Condition Register with the STATUS:QUES:COND? query. The response is a decimal value that is the binary sum of the on binary bit values. The 4861 can also be set to monitor the input bits and to generate an SRQ on the GPIB bus when the signals change level.

FINAL CONSIDERATIONS

Power Supply Isolation - Throughout this application note, all of the signal connections have been kept isolated to prevent ground loops between the power supplies. Each 4861 analog output is isolated and the 4861 analog inputs are isolated from each other and ground by a minimum of 750 Kohms. The 4861's digital signals are not isolated and the user should obtain power supply modules that provide the required isolation or isolate the signals himself. Disconnect the completed wiring harness from the 4861 and test it to be sure that the supplies are not accidentally shorted together.

AC Noise - Use twisted pair wires for the 4861's analog inputs and output signals to minimize noise pickup. Use shielded twisted pairs for the low level current voltage inputs. Connect the shield to chassis ground at the 4861 end of the shield. Be sure that the 4861 always has a good connection to chassis ground. If 60 Hz AC noise is riding on any of the inputs, try connecting a pair of 100 Kohm resistors from the analog inputs to the 4861's analog ground on pin C16 to reduce the AC noise level.

IDN Message - Use the CAL:IDN <string> command to change the IDN message and complete the customization of your unit. <string> is up to 72 characters long and includes your company name, model number, serial number and product revision level fields separated with commas. Unused fields must contain a 0. Refer to Table 3.1 in the 4861's Instruction Manual for an example of the IDN message. Follow the CAL:IDN command with the CAL:DATe command to save the new IDN message.

e.g.   CAL:IDN Acme Power Company, 100A, 123,0
             CAL:DAT 12-31-95

Limit Checking - The 4861 includes a SCPI limit command that can be set to limit the output from accidentally exceeding a fixed amount. For instance, the end user may not want the + 5V output to go above 5.3 volts. If the power supply (4861) was given a command that resulted in an output > than the limit, the command will be ignored and the ERR LED will illuminate. The limit command settings are normally left for the end user and are defaulted to the maximum value. Limits must be reset after changing the output scale factors. Digital output #4 can be enabled to follow the ERR LED and drive a remote indicator with the CAL:FAULT command. Use the *SAV 0 command to save the FAULT setting.

Setup Protection - Use the CAL:LOCK command to prevent the end user from changing any of the setup parameters noted in Table 1-4 of the 4861 manual. When locked, the associated SCPI commands are 'removed' from the SCPI command tree.

Documentation - System documentation is easily created by copying portions of the 4861 manual and editing it to fit the application. Omit those sections that are not appropriate to the application and move the commands that would change any factory settings to the calibration section.

SUMMARY

This application bulletin has shown how to connect to and control analog power supplies using an ICS 4861 board as the power supply controller. The adaptation process is simplified by the versatility of the 4861's firmware and its ability to save user inputted constants. Additional functions such as custom commands or over-current checking can be implemented with custom firmware.