DATEL®
INNOVATION and EXCELLENCE

PC-462
Precision Programmable Power Supply Board

FEATURES

- **4 independently programmable, precision voltage/ current outputs**
- **Remote sensing for all supplies**
- **All channels fully isolated from PC/ATbus**
- **Output current limits**
- **Real time voltage and current monitoring**
- **4 general purpose analog inputs**
- **2 isolated digital inputs**
- **2 isolated relay driver outputs - MOSFET switches**
- **Comprehensive software, free driver library**

Designed for low-cost, medium power source applications, the PC-462 is a high-precision, programmable power supple and sensing board for IBM-PC/AT, PS-30, EISAbus and compatible computers. Four output channels are individually programmable for ranges of 0 to +6.1425V and 0 to -6.1425V at 1A, as well as 0 to +20.475V and 0 to -20.475V at 250 milliamps. It is ideal for applications where highly accurate, very stable DC voltage and current sources are required, with low ripple and low noise characteristics. All input and output channels provide 250Vrms isolation from the PC/ATbus. Combined with comprehensive, graphic-intensive control software, this quad output supply card is easily integrated into most automated test and benchtop power supply applications.

For dynamic test sequences, the host PC can update all four output channels in real time. Voltage and current output levels are continuously monitored by an on-board, 12-bit A/D converter. A rear panel connector provides an additional 4 auxilliary input channels for general purpose use. The input range is ±5.12V but component pads on all of the channels allow for user-selectable ranges as well as current loop inputs and signal filtering. These channels are fully isolated from the PC/ATbus and are ideal for monitoring external voltage/current conditions in adaptive test applications.

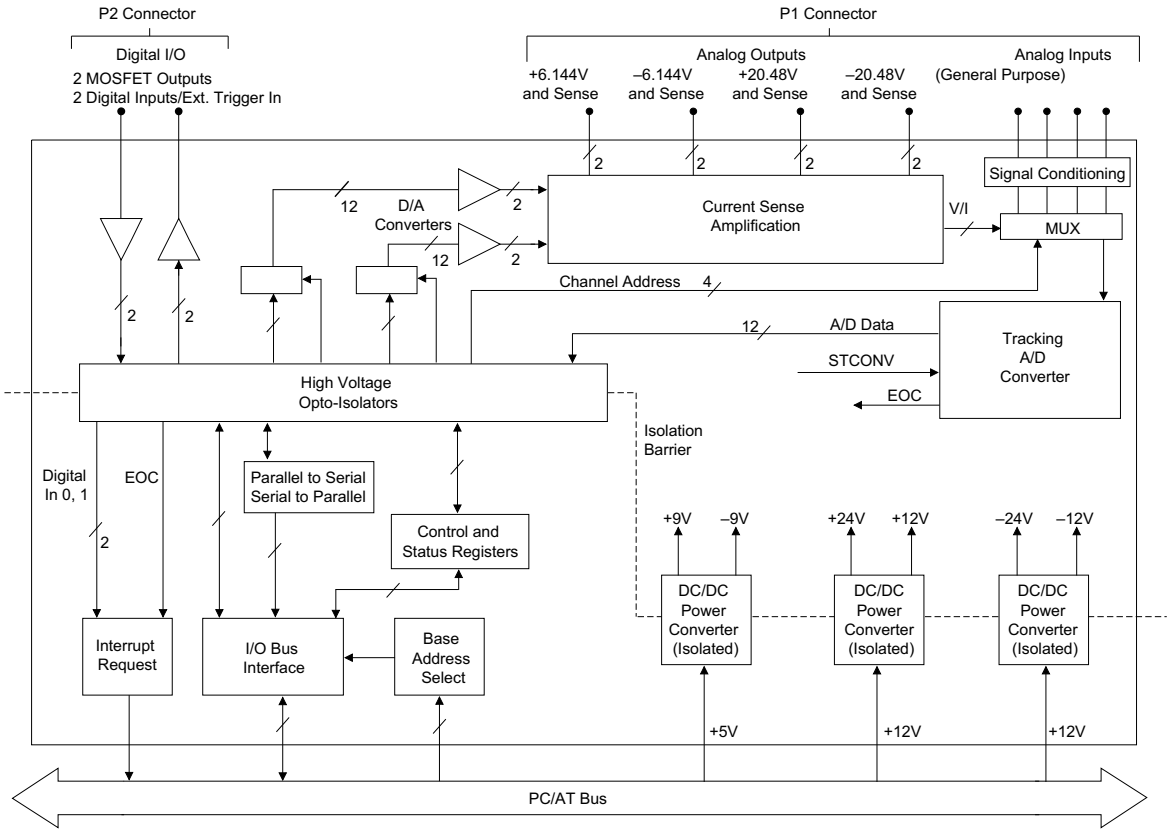


Figure 1. Simplified Block Diagram

Outputs are protected against overload and short circuit damage by fixed current limiting circuits. For any overload condition, the +6.1425V and -6.1425V supplies are limited to 1.2A, while the +20.475V and -20.475V supplies are limited to 300 milliamps. Another protective and very necessary feature is that at power up all output channels reset to 0V. Remote voltage sensing permits regulation with respect to the load eliminating problems associated with lead voltage drops.

Four isolated digital I/O lines are available to monitor and control external devices. The two input lines may be configured to generate interrupt requests to the host computer possibly indicating an external error condition or failure and requesting immediate system attention. One of these lines is software selectable as an A/D digital trigger input The two MOSFET output lines can switch up to 300V at 100 milliamps for an indefinite period of time. These outputs are ideal for switching heavy external loads such as relays, triacs, etc.

The PC-462 is configured on a full size PC/AT card and it is completely contained within the host computer. The direct bus interface increases the output slew rates and decreases the host response time to read back voltage/current data. All isolated input and output channels are available on two D-type connectors on the rear panel. The board is compatible with most popular programming languages and all data is right justified to facilitate integer data typing with high level languages such as C, FORTRAN, Pascal, or Ada. A comprehensive User's Manual details full installation, programming, and application information.

SOFTWARE

Users have tow options for implementing PC-462 software: PC-462SET or user written code. PC-462SET is DATEL's complete solution for setup and real time control of this programmable power supply board. It is a comprehensive, easy-to-use, window-driven utility which configures the hardware, provides a digital multimeter facility on all of the input and output channels, sets user defined current and voltage limits, and configures all interrupt and trigger procedures. Written under Microsoft WINDOWS the highly graphic user interface makes operation and control of the PC-462 a simple task.

Output voltage/current values may be set via the keyboard or by using a mouse and on-screen graphic scroll bars. Error conditions, such as overvoltage or overcurrent, are user configurable to be displayed on the screen, to sound alarm bells, or to shut down the system by resetting all outputs to zero. A system reset key is available for emergencies.

The package consists of a series of pop-up function windows. Both the size and position of each window can be altered and multiple windows may be displayed simultaneously. After configuring the board, real time control and monitoring of the PC-462 continues while running other foreground processes on the host computer. This is ideal for running long, dynamic test sequences where the host PC is required to carry out other concurrent tasks.

For custom applications, the User's Manual contains detailed register and timing information as well as example software routines necessary to help users to develop their own code - in any programming language. The PC-462 is supplied with a low-level device driver library written in C and supplied on MS-DOS diskettes. The library may be incorporated into user programs and used for configuring and controlling the PC-462. Also, the complete source code listing (PC-462SRC) for PC-462SET is available from DATEL on 3.5" MS-DOS diskettes tofurther facilitate software development.

SPECIFICATIONS

(Typical at 25°C, dynamic conditions, unless noted)

ANALOG OUTPUTS	
Number of Channels	4
Output Configuration	Single-ended, common isolated analog ground
Full Scale Output Ranges (See Notes 1 & 4)	OUT 1 0 to +6.1425V @ 1A OUT 2 0 to -6.1425V @ 1A OUT 3 0 to +20.475V @250mA OUT 4 0 to -20.475V @ 250mA
Isolation	250Vrms isolation to PC/AT bus
Isolation Resistance	10 Megohms
Output Resolution	12 binary bits
Input Data Coding	Straight binary, right justified
Channel Addressing Mode	Random access via host software
Isolation Capacitive Coupling	850 picofarads
OUTPUT PERFORMANCE	
Output Voltage Accuracy	OUT 1&2: ±0.05% of full scale OUT 3 &4: ±0.025% of full scale
Output Setting Time	OUT 1&2: 400µs max. OUT 3&4: 600µs max.
Output Voltage Slew Rate	1V per µs into 1µF load
Output Noise, dc to 10kHz	OUT 1&2: 2mV max (half load) OUT 3&4: 1mV max (half load) OUT 1&2: 5mV max (full load) OUT 3&4: 2mV max (full load)
Output Current Limit	OUT 1&2: 1.2 Amps max. OUT 3&4: 300mA max.

OUTPUT PERFORMANCE (Continued)	
Output Stability	Unconditionally stable into any load
Transient Response (Half Load Change)	200 microseconds maximum
Temp. Coefficient of Gain	±20ppm of FSR per °C
Temp. Coefficient of Offset	±20ppm of FSR per °C

ANALOG INPUTS	
Number of Channels	12 dedicated to internal measurements, 4 general purpose
Dedicated Channels	CH 0 OUT 1 Voltage monitor CH 1 OUT 1 Current monitor CH 2 OUT 2 Voltage monitor CH 3 OUT 2 Current monitor CH 4 OUT 3 Voltage monitor CH 5 OUT 3 Current monitor CH 6 OUT 4 Voltage monitor CH 7 OUT 4 Current monitor CH 8 +5.12V Ref. monitor CH 9 -5.12V Ref. monitor CH 10 GND CH 11 GND
General Purpose External Channels	Channels 12, 13, 14, and 15
Analog Input Range	±5.12V (see Tech Note 2)
Input Configuration	Isolated, 250Vrms channel to PC/AT bus
DC Accuracy	±0.025% of full scale (plus ±1LSB at 12 bits)
Input Impedance (See Tech. Note 3)	10 megohms minimum
Input Bias Current	±500 nanoamps
Input Capacitance	1000 pF in series with 2 kΩ resistor
Input Overvoltage	±6V sustained max., no damage
Addressing Modes	Random via host software

A/D CONVERTER	
Resolution	12 binary bits
Conversion Time	50 microseconds
Output Coding	Straight binary; 11 data bits, 1 sign bit (MSB)
A/D Trigger Source	Initiated via host software or by external TTL input
External Trigger Pulse Width	20µs min., active low. TTL levels on digital input line 0.

DIGITAL INPUTS	
Number or Channels	2
Isolation	250 Vrms to PC/AT bus
Input Current	0 mA OFF, 10 mA ON, TTL levels
Input Bandwidth	50 kHz

DIGITAL OUTPUTS	
Output Type	MOSFET power switches, passive.
Number of Channels	2 channels, high voltage and current capability for switching heavy loads
Output Ratings	300V, 100 mA continuous. External excitation required.
Isolation	250 Vrms to PC/AT bus, MOSFET switches
Switch ON Resistance	25 Ohms
Switch Time	ON 1 millisecond OFF 1 millisecond

PC-AT BUS INTERFACE	
Architecture	I/O mapped, pluggable to IBM-PC/AT, PS-30, EISA bus and compatible computers. Decodes four 16-bit I/O registers.
I/O Mapping	Decodes I/O address lines A9 through A3. A2..A0 are decoded on-board for individual register access. Highest base address is 3F8 hex.
Data Bus	16-bit I/O transfers, all data is right justified

PC/AT bus INTERFACE (Continued)	
PC/AT bus Interrupt	1 line, software selectable on IRQ 10, 11, 12, or 15
Bus Interrupt Sources	Software selectable as: 1. A/D End of Conversion (EOC) 2. Digital input channel 0 low 3. Digital input channel 1 low
CONNECTORS	
Analog Connector, P1	25-pin female, DB-25S connector on rear mounting bracket for easy access to precision voltage and sense outputs and general purpose analog inputs.
Digital I/O Connector, P2	9-pin female, DB-9s connector on rear mounting bracket. Includes +5V system power connection.
MISCELLANEOUS	
Power Requirements (See Tech. Note 4)	4A max. from PC/AT bus +5V 1.5A max. from PC/AT bus +12V
Operating Temp.	0 to 50°C
Storage Temp. Range	-25 to 80°C
Relative Humidity	10% to 90%, non-condensing
Altitude	0 to 10,000 ft (0 to 3047 meters). Forced cooling is recommended.
Outline Dimensions	4.5" H x 13.31" L x 0.5" W (11.43 x 33.81 x 1.59 cm), full size PC/AT board. Uses a single PC/AT slot.
Weight	0.466kg (1 pound)

TECHNICAL NOTES

1. All outputs reset to 0V at power up. The output voltage steps on each supply are:

   OUT 1 and OUT 2 1.5 millivolts per LSB
   OUT 3 and OUT 4 5.0 millivolts per LSB

2. Users can select different voltage ranges for this general purpose analog input channel by inserting attenuation resistors into component pads provided. Capacitors mounted in these pads can provide signal filtering. Discrete components needed for current loop inputs would mount in these pads as well.
3. The input impedance of 10 megohms minimum avoids attenuation errors due to external source resistances.
4. Power requirements are specified with all outputs driving FULL loads. At full load on all channels, the maximum total power required is 40 Watts. At half load it is 20 Watts, and at quarter load 10 Watts, etc. 1.5 Amp maximum current can be drawn from OUT 1 and OUT 2.
5. Recalibration is recommended at 90 day intervals, depending on operating conditions.

PROGRAMMING NOTES

(Refer to PC-462 user's Manual for detailed programming information)

1. Since all registers are I/O mapped, I/O read and write commands must be used. For example, in C, 'outport' will write a 16-bit word from that register.
2. When setting a value on an output channel, command and address information must be written before writing DAC data.
3. The PC-462 may be programmed in almost any high- or low-level language. The following example program illustrates how to set an output channel's value:

```
#define BASE 0x300 /* User-defined base address*/
#include <stdio.h>
#include <math.h>
main ( )
 {
unsigned short channel_addrs_reg, dac_data_reg;
int channel, dac_data;
float volts, full_scale
    channel_addrs_reg = BASE + 2;
    dac_data_reg = BASE + 4;
    printf ("Which channel (0...3) => ");
    scanf ("%d, &channel);
    printf ("Output voltage => ");
    scanf ("%f", &volts);
    outport (channel_addrs_reg, channel);
    switch (channel)   /* Set channel full scale */
    {                  /* output voltage levels */
    case 0:
    case1: full_scale = 6.1425;
           break;
    case 2:
    case 3:        full_scale = 20.475;
                   break;
    }
    dac_data = (int) (fabs(volts) * 4096.0/full_scale);
    outport (dac_data_reg, dac_data) /*Update channel */
    return (0);
```

PROGRAMMING NOTES (Continued)

4. Note that DAC data may be entered from a keyboard, it may be generated in software, or it may be played back from a user-created disk file.
5. Load overvoltage/overcurrent conditions may be monitored in real time by selecting the A/D converter input channel and then polling the A/D data register. The ideal situation is to continuously scan each of the output channels using software.
6. Monitor external system error conditions by configuring one of the two digital input lines as an interrupt request to the host PC. On error, shut the system down by resetting all the outputs to 0V. Status poling may not detect the exact instant that an error occurs.
7. A/D scanning of the dedicated channels or general purpose auxilliary channels may be stepped along in software or by an external digital trigger input. Synchronize software initiation by having the time of day clock interrupt the CPU periodically.

I/O REGISTER MAP

The base address may be selected anywhere up to 3F8 hex, on 8-byte boundaries. At power-up, all control registers contain zeroes and all output channels reset to 0V. The DAC data register may be written after programming the channel address and command modes. 16-bit I/O word instructions must be used. Unlisted registers are not used. DAC register (BASE + 4) data must be integer format and must be scaled relative to a channel's full scale output voltage range - see Programming Note 4.

I/O Address (hex)	Direction	Description
BASE + 0	Write	Command Register
BASE + 0	Read	Status Register
BASE + 2	Write	Channel Address Register
BASE + 4	Write	DAC Data Register
BASE + 6	Write	Conversion Register Start A/D
BASE + 6	Read	A/D Data Register

COMMAND REGISTER (Write I/O Base + 0)

15 - 8	7 6 5	4 3	2	1 0
Not Used	Intrpt Level 2 1 0	Intrpt Source 1 0	Trig Select	Digital Outport 1 0

Digital Outport (Bits 1, 0) — Isolated digital MOSFET output bits. Can be used for normal switch applications or for driving power relays when switching heavier loads.

Trigger Select (Bit 2) — This bit selects the A/D converter trigger source as follows:

- 0 Internal trigger - write to A/D start conversion register (Write BASE + 6)
- 1 External trigger - active low signal on digital input line DIG IN 0 initiates one A/D conversion on the selected channel. A/D channel selection is made by writing bits 7 through 4 in the channel address register. 20 micro seconds minimum trigger pulse width.

Interrupt Source Select

Bit 4	3	
1	1	Interrupt on End of A/D Conversion (EOC)
0	1	Interrupt when Digital Input 0 low
1	0	Interrupt when Digital Input 1 low
0	0	Not Used

Interrupt Level Select

Bit 7	6	5	
0	0	0	Disable Interrupts
0	0	1	Interrupt on IRQ 10
0	1	0	Interrupt on IRQ 11
0	1	1	Interrupt on IRQ 12
1	0	0	Interrupt on IRQ 15
1	0	1	Not Used
1	1	0	Not Used
1	1	1	Not Used

STATUS REGISTER (Read I/O BASE + 0)

15 - 8	7 6 5	4 3	2	1 0
Not Used	Interrupt Level 2 1 0	Interrupt Source 1 0	EOC Status	Digital Inport 1 0

Digital Inport (Bits 1, 0) — Isolated digital input bits. These may be used as general purpose TTL input lines or to generate interrupt requests to the host PC from an external event, e.g. overcurrent or overvoltage.

EOC Status (Bit 2) — 0 = A/D conversion in progress, data invalid
1 = A/D conversion done, data valid EOC is a 7 microsecond wide, active high pulse and occurs at the end of each A/D conversion.

Status Bits (Bits 7...3) — Follow the corresponding bits in the commandregister

Status Bits (Bits 15...8) — Not used

CHANNEL ADDRESS REGISTER (Write I/O BASE + 2)

15 - 8	7 6 5 4	3 2	1 0
Not Used	A/D Channel Select 3 2 1 0	Not Used	D/A Channel Select

D/A Channel Select (Bits 1, 0)

Bit 1	0	
0	0	Select OUT 1 for update (0 to +6.1425V)
0	1	Select OUT 2 for update (0 to -6,1425V)
1	0	Select OUT 3 for update (0 to +20.475V)
1	1	Select OUT 4 for update (0 to -20.475V)

Bits 3, 2 — Not used

A/D Channel Select (Bits 7 - 4)

Bit 7	6	5	4	
0	0	0	0	OUT 1 Voltage monitor
0	0	0	1	OUT 1 Current monitor
0	0	1	0	OUT 2 Voltage monitor
0	0	1	1	OUT 2 Current monitor
0	1	0	0	OUT 3 Voltage monitor
0	1	0	1	OUT 3 Current monitor
0	1	1	0	OUT 4 Voltage monitor
0	1	1	1	OUT 4 Current monitor
1	0	0	0	+5.12V Reference monitor
1	0	0	1	-5.12V Reference monitor
1	0	1	0	Ground
1	0	1	1	Ground
1	1	0	0	Isolated analog input channel 2
1	1	0	1	Isolated analog input channel 2
1	1	1	0	Isolated analog input channel 2
1	1	1	1	Isolate d analog input channel 3

Bits (15 - 8) — Not used

DAC DATA REGISTER (Write I/O BASE + 4)

15 - 12	11	10 — 1	0
Not Used	DAC 1 (MSB)	DAC Data Bits 2 through 11	DAC 12 (LSB)

12-bit DAC data is right justified with the Most Significant Bit (MSB) at bit 11. The MSB is referred to as DAC bit 1. The Least Significant Bit (LSB) is DAC 12. Writing to this register always updates the selected channel.

START CONVERSION REGISTER (Write I/O BASE + 6)

15 14 . . . . . 1 0
X X . . . . . X X

'X' indicates don't care bit

Writing any data value to this register starts and A/D conversion on the channel specified by bits 7 through 4 in the channel address register.

A/D DATA REGISTER (Read I/O BASE + 6)

15 - 12	11	10 — 1	0
0 - 0	AD 1 (MSB)	A/D Data Bits 2 through 11	AD 12 (LSB)

The host reads 12-bit A/D data from this register. All data is right justified. The upper 4 bits are zeroed. A/D data is read from one of the internal voltage/current monitor signals or from one of the 4 general purpose external analog channels. The analog source is secified in the channel address register.

REAR PANEL INPUT/OUTPUT CONNECTIONS

All input and output connections are made using two female connectors on the rear mounting panel. P1 is a 25-pin, DB-25S connector for all load conections to the PC-426 output channels. P1 also includes the four auxilliary, general purpose analog input connections.

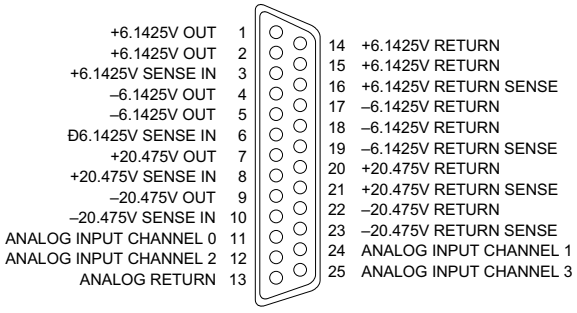


Figure 2. Voltage/Current Outputs, Analog Inputs - P1

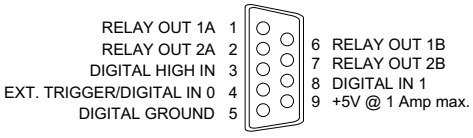
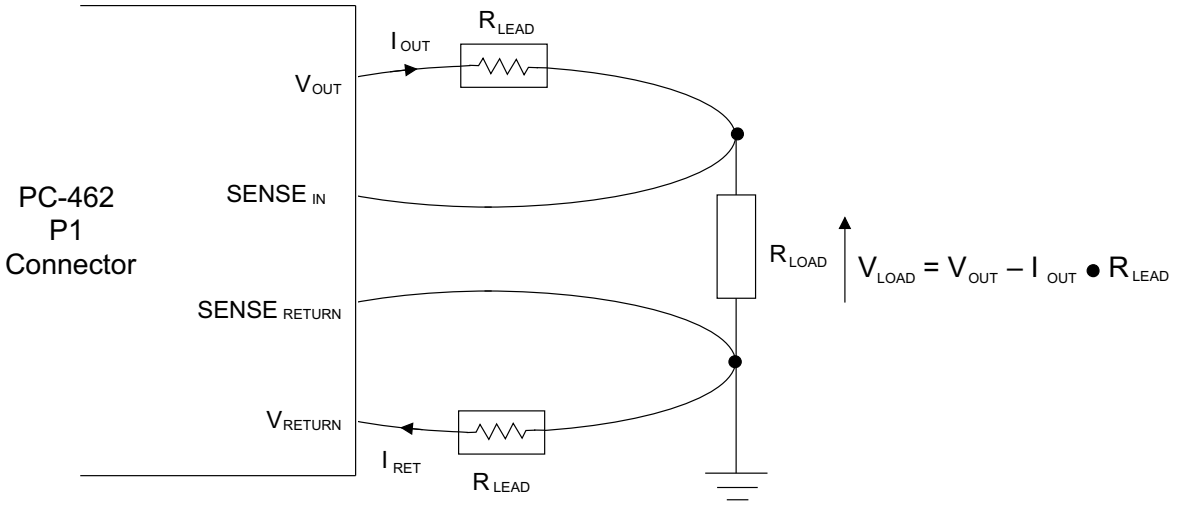


Figure 3. Isolated Digital Port - P2

P2 is a 9-pin, DB 9S connector and it provides connections to the digital I/O port.

LOAD CONNECTIONS

Figure 2 illustrates a typical load connection to one of the output channels. Make sure that the SENSE OUT and SENSE RETURN connections are completed so that the voltage across the load is exactly the required value. This remote voltage/current sensing facility eliminates attenuation errors due to lead resistance voltage drops. The feedback loop adapts the PC-462 output level so that the load voltage is regulated to the desired value, i.e. lead attenuation is cancelled. Note that there are no voltage drops on the SENSE IN or the V_{RET} lines since no current flows through them.



Important: Connect the sense outputs at the load.

Note: The voltage across the load is the true value. The voltage at the P1 connector (V_{OUT}) will be somewhat higher (±1V max.) to compensate for lead attenuation

Figure 4. Typical Load Connections

MOSFET OUTPUT CONNECTIONS

The two isolated MOSFET output lines may be used to switch heavy loads or drive standard TTL level devices. Figure 5a illustrates a typical connection to a solid state relay. The relay in turn may switch higher rated loads - in excess of 300V, 100 milliamps.

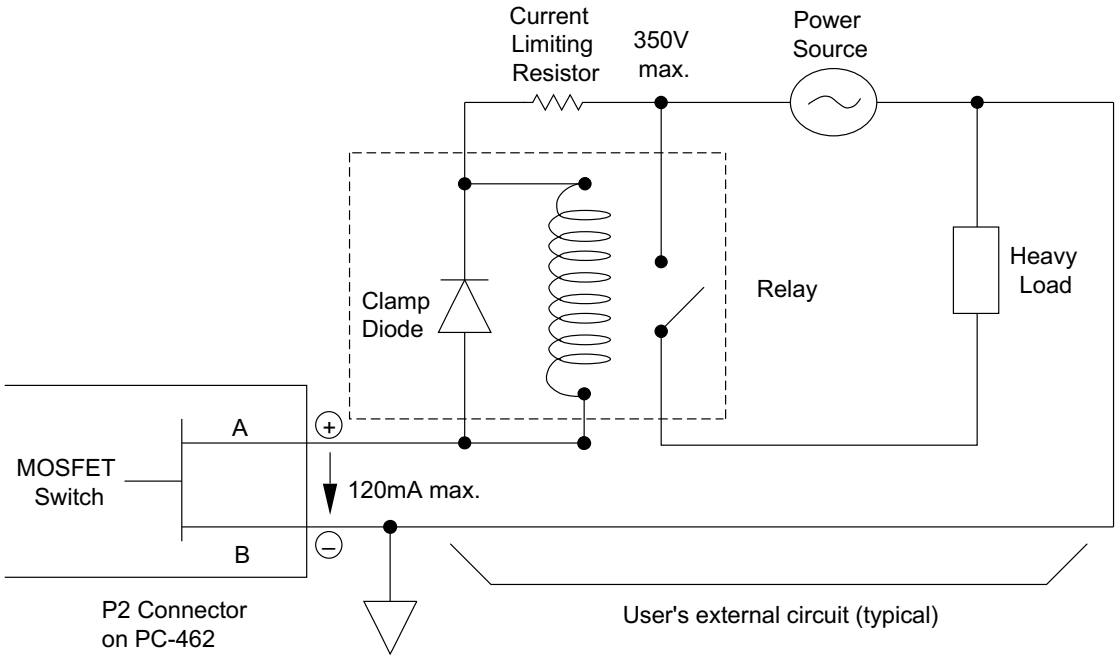
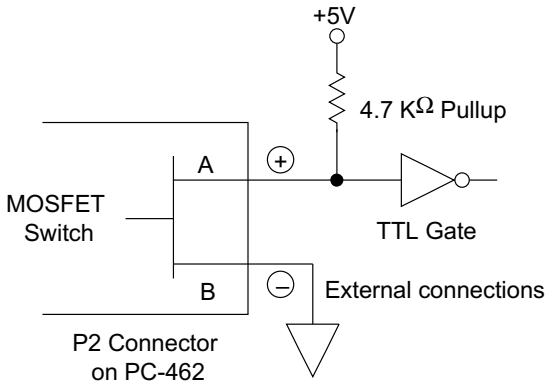


Figure 5a. Typical MOSFET Output Switching a Relay



Standard TTL gates and logic devices may be driven by pulling up the digital output lines to the +5 rail through a resistor

Figure 5b. MOSFET Output Driving TTL Load

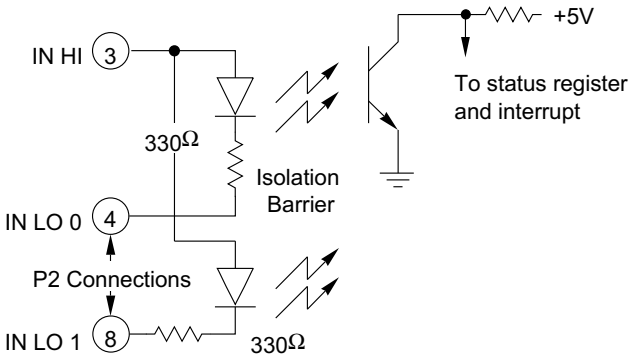


Figure 6. Digital Inputs

Figure 7. PC-462SET Channel Setup and Monitoring

Figure 8. PC-462SET Configuration and Input Scaling Windows

ORDERING GUIDE

Model	Description
PC-462	Programmable power supply board. Includes a comprehensive user's Manual and low level driver library.
PC-462SET	Window-driven setup/configuration software utility. All software runs under Microsoft WINDOWS. This package includes the executable files on 3.5" diskettes.
PC-462SRC	Complete source code to setup/configuration utility on 3.5" diskettes. All code written in C and Visual BASIC under Microsoft WINDOWS 3.0.
PC-462LV/LVS	Interface software to National Instruments' LabVIEW. See PC-462LV data sheet.
PC-490A/-490B	Screw termination adapter to facilitate input/output wiring (490A DB-9, 9-pin, 490B DB-25, 25-pin)