

**RC2K90INT-1 & 2**

**RC2000 Antenna Interface Box**

**Installation Kit**

V. 1.0

Contents Subject to Change

4/25/02

Research Concepts, Inc.

5420 Martindale Road

Shawnee, Kansas 66218-9680 USA

Phone: 913/422-0210 • Fax: 913/422-0211

[www.researchconcepts.com](http://www.researchconcepts.com)

# Manual Revision History

## 4/25/02 Revision 1.0

- ⚡ Added new heater option/information, starting with S/Ns: 6015-6018.
- ⚡ Updated Bill of Materials.
- ⚡ Deleted any brand-specific information for purposes of creating a general manual for all interfaces boxes. All other existing versions of this manual are attainable if requested.

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# 1. Introduction

This document describes a family of products that allow an RC2000 antenna controller to interface with antennas powered by either 90 or 180 volt DC motors (RC2K90INT-1 and RC2K90INT-2) or other motor types (RC2KINT). The RC2000 antenna controller is designed to interface directly with antennas which employ 36-Volt DC motors (8 amps maximum) and single phase pulse type position sensors. When the RC2000 is used with antennas powered by other types of motors an interface box is required.

Three unique interface box configurations are available from Research Concepts. These configurations are designated RC2K90INT-1, RC2K90INT-2, and RC2KINT. All versions of the interface are housed in NEMA 4 type enclosures that are suitable for outdoor mounting.

## RC2K90INT-1 and RC2K90INT-2 Interface Boxes

The RC2K90INT-1 and RC2K90INT-2 interface boxes are designed to interface with either 90 volt or 180 volt DC motors. The RC2K90INT-2 interface box employs a pair of DC motor drive modules and supports simultaneous movement about the antenna's azimuth and elevation axis. The RC2K90INT-1 interface box employs a single DC motor drive module and simultaneous azimuth and elevation movement is not supported.

The DC motor drive modules used in these interface boxes provide dynamic braking of the motors and are available in either 120 or 240 VAC input voltage versions. The following table gives the maximum motor horsepower as a function of AC input voltage and motor voltage.

<u>Input Voltage</u>	<u>Motor Voltage</u>	<u>Maximum Motor Horsepower</u>
120 Volts AC	90 Volts DC	1 1/2 horsepower
240 Volts AC	90 Volts DC	1 1/2 horsepower
220 Volts AC	180 Volts DC	3 horsepower

When ordering an RC2K90INT-1 or an RC2K90INT-2 interface box please specify the AC line voltage, the DC motor voltage and the motor horsepower, and whether two-speed operation, described later in this section, is required.

## RC2KINT Interface Box

The RC2KINT interface box consists of the 2K90INT-2 circuit board mounted in a NEMA 4 type box. The circuit board provides uncommitted relay contact closures to activate motor drive control devices provided by the user.

## Polarization Control

The RC2000 antenna controller is designed to directly interface with three wire servo type polarization control devices. An optional daughter board (designated RC2KPOL) can be installed on most RC2000 models which provides an interface to a 24 volt DC polarization control motor (400 ma) which uses a potentiometer for position sense feedback. The RC2KPOL daughterboard is compatible with many Seavey Engineering rotating feeds. All of the interface boxes described here provide contact closures which can be used to provide polarization control for antennas which use motors other than 24 volts DC. For these applications it is necessary to install the optional RC2KPOL daughter board in the RC2000 antenna controller. Please contact Research Concepts for more information.



## Dual-Speed Antenna Azimuth and Elevation Movement

The RC2000 antenna controllers use a pulse width modulation scheme to obtain slow speed movement when interfaced to 36 volt DC motors. This pulse width modulation scheme is not compatible with the interface box. When the RC2000 A and C model antenna controllers are used with the interface boxes described here, antenna azimuth and elevation movement occurs at fixed speed(s) - the controller's pulse width modulated speed control system must be disabled (from the keypad). These speed(s) are set by the installer via potentiometers located in the RC2K90INT Interface Box. With Dual-Speed interface boxes, two-speed motion is implemented by using the RC2000A's (former) polarotor output to specify the speed. The polarotor output becomes the speed control bit when the *ROTATING FEED PRESENT?* CONFIG Mode item is set to 1. If polarization control is required with a dual speed interface box, the RC2KPOL option must be the polarization control entity. The RC2000 / 2K90INT system does support Polarotor-servo type polarization control schemes but only when operating with a single-speed interface box. A special version of the RC2000C code implements the dual-speed option.

## 2. Theory of Operation

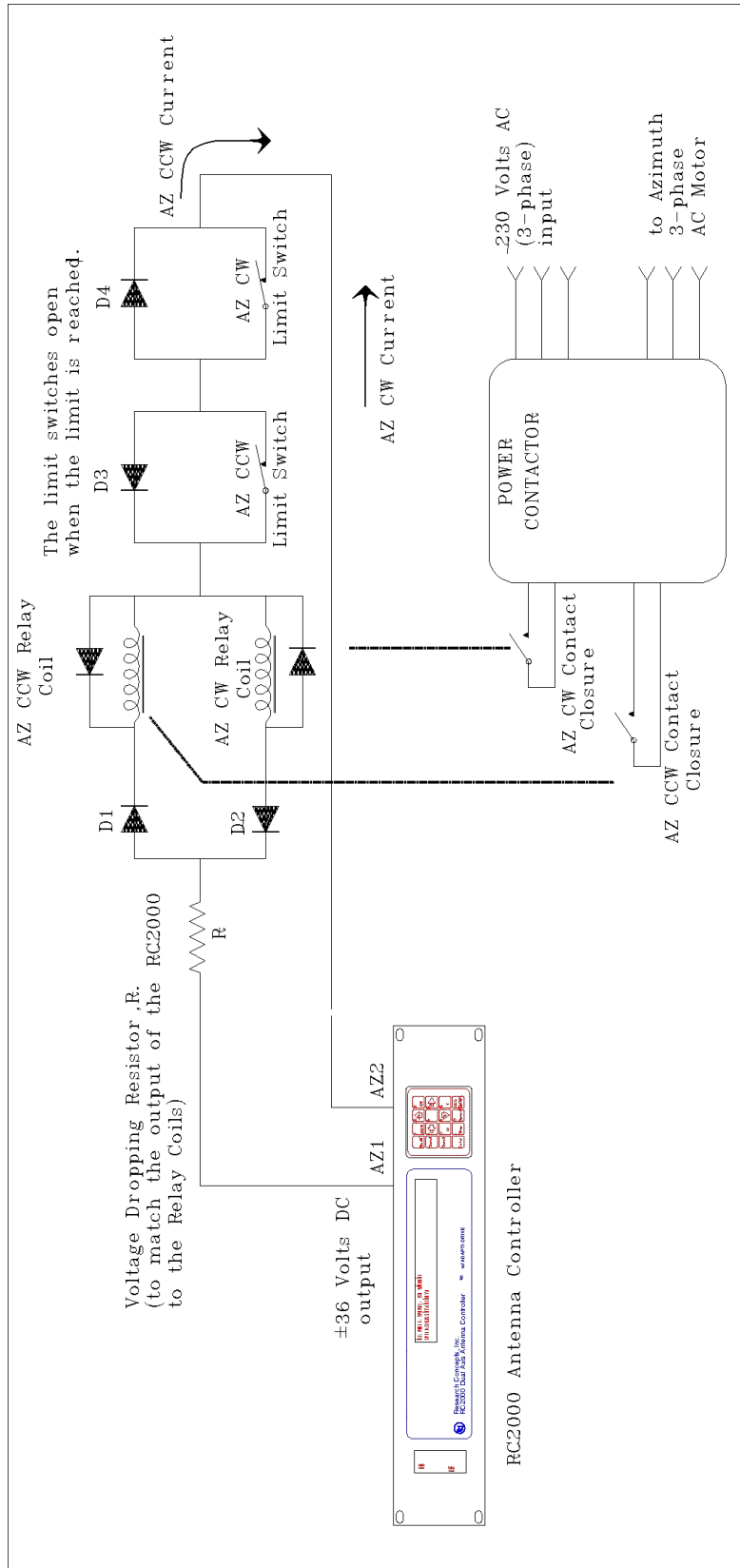
The two issues which must be addressed to interface an RC2000 controller to a large antenna is the application of power to the antenna motors and sensing of the antenna's position. Polarization control may also be an issue. Applying power to the antenna will be addressed first.

### 2.1 Controlling the Motors

Figure 1 shows a schematic representation of a single axis (in this case azimuth) of the antenna control system. The output of the RC2000 on the AZ1 and AZ2 terminals will be +/- 36 volts. When AZIM CCW (east in the northern hemisphere) movement is specified, AZ1 will have the higher voltage, and when AZIM CW (west in the northern hemisphere) movement is specified, AZ2 will have the higher voltage. In a similar fashion, when down movement is specified, EL1 will be at the higher voltage, and when upward movement is specified, EL2 will be at the higher potential. When east movement is specified, current will flow out of the AZ1 terminal of the RC2000, through the dropping RESISTOR, R. The purpose of the dropping resistor is to match the output voltage of the RC2000 (nearly 40 volts) to the voltage rating of the relay coils. The current then continues through STEERING DIODE D1, through the east RELAY COIL, through the EAST LIMIT SWITCH, through the WEST LIMIT SWITCH, and back into the AZ2 terminal of the RC2000. Current flowing through the EAST RELAY COIL will activate the relay and close the EAST CONTACT CLOSURE. This will configure the POWER CONTACTOR to move the antenna in the east direction. When east current flows STEERING DIODE D2 keeps current from flowing through the west RELAY COIL.

When the antenna is within the east limit, the EAST LIMIT SWITCH remains closed. When the east limit is reached, the EAST LIMIT SWITCH will open. When this occurs, STEERING DIODE D3 will keep east current from flowing, but will allow west current to flow. West movement limiting is accomplished in a similar fashion. Note that limit switches are not required. The RC2000 series controllers maintain logical limits based on the position count. Limit switches are pretty cheap insurance, however.

The circuit shown in Figure 1 shows the relay contacts activating power contactors that control the motor drive power. The key part of the circuit outlined in Figure 1 is the use of the AZ1 and AZ2 outputs of the RC2000, the dropping resistor, the relays, steering diodes, and the limit switches to generate contact closures which can be used to control the antenna's azimuth motor.



**Figure 1**

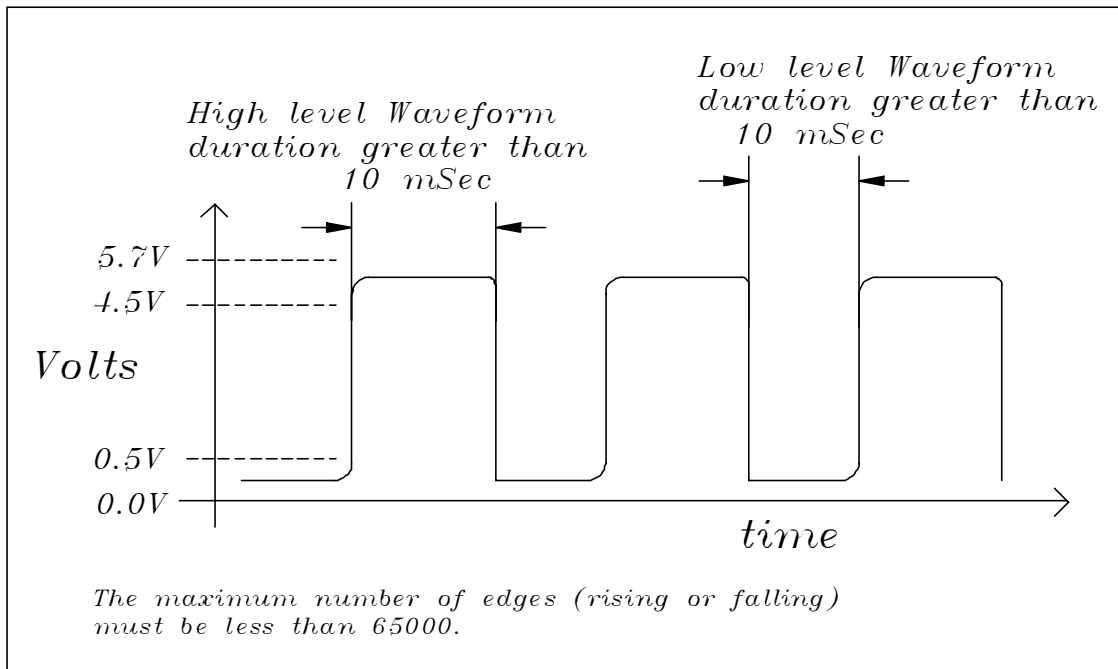
Note that the scheme shown in Figure 1 does not support slow speed movement. RC2000 antenna controllers normally vary motor speed by rapidly switching the 36 volt antenna drive signals off and on - which gives an average voltage of less than 36 volts. If this pulse width modulated signal is applied to the circuit of Figure 1, the relays would chatter and produce erratic operation. When using the interface boxes described here with the RC2000, slow speed operation should be disabled on the controller by setting the azimuth and elevation slow speed codes to 254. The single speed of the interface box is adjusted by varying a pot on the drive module(s).

Slow speed movement via the interface box is supported however. The RC2000 software can use the controller's polarotor output to control a relay which provides a pair of contact closures (NO, COM, and NC) which specify fast or slow speed antenna movement. Note that polarotor control is not supported with the RC2000 controller in this mode but polarization control via the optional RC2KPOL daughterboard is still available.

## 2.2 Position Sensor Interface

The RC2000 series of antenna controllers require the use of single phase pulse type sensors to determine the position of the antenna. A pulse type sensor produces a rectangular shaped waveform as the antenna moves about the axis associated with the sensor. The RC2000 antenna controllers are not compatible with quadrature pulse sensors. 5.7 volts DC is available on the back of the RC2000 (at connector J1-11) to provide power for the pulse sensors.

The RC2000 controllers count the number of rising and falling edges of the waveform. The position count is decremented for east (or down) movement and incremented for west (or up) movement. Referring to Figure 2, the waveform's high level should be 4.5 to 5.7 volts, and the low level should be 0.0 to 0.5 volts. The waveform's minimum high or low pulse duration should be at least 10 milliseconds. This means that pulses less than 10 milliseconds long may not be detected by the antenna controller. The maximum number of counts from the antenna's east limit to its west limit should be less than 65000. Remember, each rising edge and each falling edge of the sensor's output waveform is a separate count.



**Figure 2**

Many large antennas use a sensor attached directly to each of the fundamental axis of the antenna. The sensor used may be a synchro, potentiometer, or a quadrature pulse encoder. A pulse type sensor attached to the fundamental axis of the antenna is not suitable for use with RC2000 antenna controllers. The reason for this requires a bit of explanation.

When a rising or falling edge is detected on the antenna controller's sensor input, the antenna controller must determine whether to increment or decrement the position count. Since single phase pulse sensors are used, the antenna controller must determine which way the antenna was last commanded to move, and decrement or increment the count accordingly. With a pulse sensor connected directly to the antenna's fundamental axis, when the antenna vibrates back and forth due to wind, the pulse sensor produces a steady stream of pulses. The antenna controller will increment or decrement the count depending on which way the antenna was last commanded to move. In reality the antenna is just vibrating in the wind and not really moving. The result of this is an error in the position count maintained by the antenna controller.

The antenna controllers are designed to work with 36 volt actuators. With these actuators the pulse sensor is connected directly to the motor. The motor typically drives either a worm or screw type gear, which will not transmit wind motion from the antenna back to the motor. Therefore, no false counts are recorded by the antenna controller. By placing a Hall-effect sensor on the shaft of the antenna motors drive, a similar decoupling of wind vibration is achieved. On certain models of the RC2000 it is possible to disable the accumulation of position pulses when the antenna is not commanded to move (or is in a coast interval immediately following the release of the motor drive lines).

## **2.3 Polarization Control**

If the polarization is controlled with something other than a polarotor, then an interface for a polarization motor is necessary. Many popular rotating feeds use a 24 VDC motor with a potentiometer as the position feedback device. These feeds can be driven directly by the RC2000 with the RC2KPOL option (ordered separately). The RC2KPOL drive provides greater than 200mA @ 24 Volts for these feeds. In the event that a high voltage DC or AC motor is used to drive the polarization axis, a scheme similar to that described above for controlling the azimuth and elevation motors can be used with the RC2KPOL option

## **3. Circuit Description**

The interface boxes described in the this document use a common printed circuit board to generate the contact closures (described in the previous section) required to control the azimuth, elevation, and (if needed) polarization axis of the antenna. That printed circuit board is designated 2K90INT-2.

The RC2KINT interface box consists of the 2K90INT board in a NEMA 4 enclosure. The user is responsible for using the contact closures generated by the circuit board to control the antenna.

The RC2K90INT-1 interface box uses a single KBPB motor drive module. The motor drive module accepts AC line voltage and contact closures produced by the 2K90INT-2 circuit board and generates the drive voltage used to power the motors. The motor drive voltage produced by the KBPB motor drive module is routed back onto the circuit board where a latching relay directs the current to either the azimuth or the elevation axis. Simultaneous azimuth and elevation movement is not possible with the RC2K90INT-1 interface box.

The RC2K90INT-2 interface box employs a pair of KBPB motor drive modules. Line voltage is connected to both motor drive modules and each motor is directly connected to a motor module - motor drive voltage does not pass through the 2K90INT-2 circuit board. With the RC2K90INT-2, simultaneous azimuth and elevation movement is permitted.

### **KBPB DC Motor Drive Module**

The RC2K90INT-1 and RC2K90INT-2 interface boxes employ KBPB DC motor drive modules manufactured by KB Electronics, Inc. The KBPB motor drive modules use SCRs to rectify the AC line

voltage and control the voltage DC delivered to the armature of the motor being controlled. The KBPB-125 is designed for use with 120 volt AC line voltage. The KBPB-225 is designed for use with 240 VAC line voltage. These motor drive modules also provide speed control, electronic current limiting, IR compensation, and dynamic braking. A resistor which is installed in the KBPB called the Plug-In Horsepower Resistor matches the KBPB's IR compensation and current limit characteristics to the DC motors used on the antenna. When a KBPB is ordered the horsepower of the motors with which the drive module will be used should be specified so that the correct horsepower set resistor can be installed. When the KBPB-225 is used with 90 volt DC motors a modification is performed to the motor drive to limit the voltage applied to the motors to 90 volts DC. This modification is described in section 4.4. The Operating instructions for the motor drive module(s) are included with the operating manual for the RC2K90INT-1 and RC2K90INT-2 interface boxes.

The line voltage is applied to the L1 and L2 terminals. The polarity of the voltage applied to the motor and the operation of the dynamic brake are controlled by the S1, S2, and S3 connections. When the S2 terminal is not connected to either the S1 or S3 terminals the motor drive is in the brake mode. When S2 is connected to S1 voltage is applied to the armature of the motor (via the A1 and A2 terminals). When S2 is connected to the S3 terminal a voltage of the opposite sense is applied to the motor.

The armature voltage (and the motor speed) can be varied by connecting a potentiometer across the P1 and P3 terminals and applying the voltage present at the wiper of the potentiometer to the P2 terminal. Alternatively, the speed can be controlled by connecting the P2 terminal to the S4 terminal and using the potentiometer located on the KBPB module labeled AUX (or R14) to vary the speed. When the interface box is used with the RC2000D dual speed azimuth and elevation control is available by connecting the terminals on the interface board labeled P1\_KBPB1, P2\_KBPB1, P3\_KBPB1 to the P1, P2, and P3 terminals, respectively, of the KBPB. When used with controllers other than the RC2000D the S4 and P2 terminals of the KBPB are connected together and the azimuth and elevation speed is controlled via the AUX (R14) pot (for this configuration only single speed azimuth and elevation movement is available).

## **2K90INT-2 Circuit Board**

Figure 3 is a schematic of the 2K90INT-2 circuit board. The circuit which includes relays K2 and K3 generates the contact closures required to control the azimuth axis as described in figure 1 above. The azimuth +/-36 volt output of the RC2000 is applied to the terminals labeled AZ1\_CTL and AZ2\_CTL. The east and west limit switches and their associated steering diodes are connected to the terminals labeled AZLIM1 and AZLIM2. If limit switches are not used a jumper can be connected between the AZLIM1 and AZLIM2 terminals. When east current flows relay K2 activates which in turn connects the terminal labeled S2\_KBPB1 to the terminal labeled S1\_KBPB1. In a similar fashion, when west current flows relay K3 is activated and the terminal labeled S2\_KBPB1 is connected to the terminal labeled S1\_KBPB1.

The elevation control circuit consisting of relays K5 and K6 operate in a manner identical to the azimuth circuit. The control signals are applied via the EL1\_CTRL and EL2\_CTRL terminals. The contact closures associated with these relays are available at terminals S1\_KBPB2, S2\_KBPB2, and S3\_KBPB2.

The polarization control circuit is implemented with relays K7 and K8. The control inputs for this circuit are generated by the an RC2KPOL board installed in the RC2000 antenna controller and are applied to the circuit board via the P1\_CTL and P2\_CTL inputs. The contact closures associated with polarization control are available at connector J8. The user is responsible for using these contact closures to realize a polarization control scheme for the polarization motors used on his or her antenna.

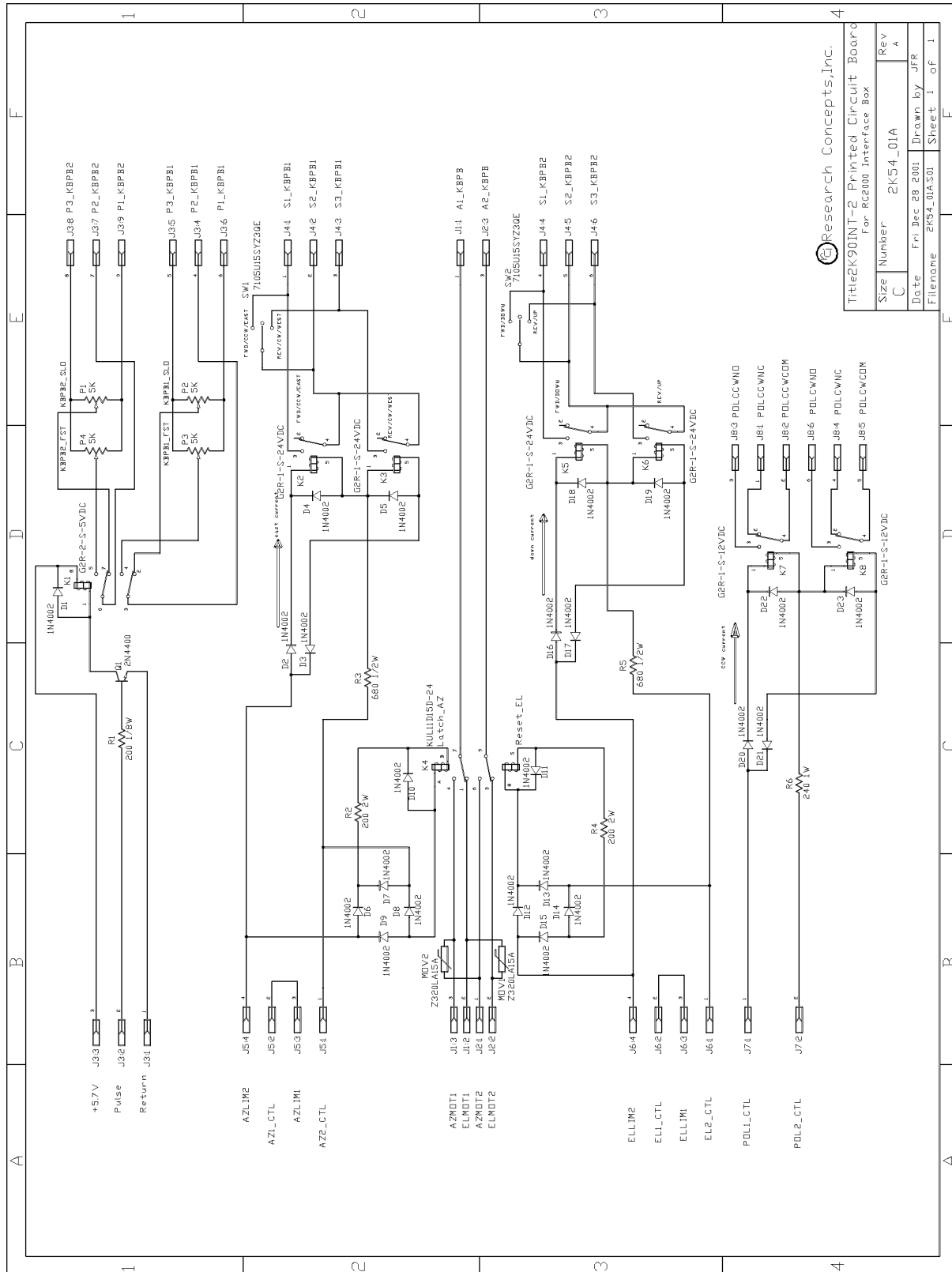


Figure 3

The circuit associated with latching relay K4 is used by the RC2K90INT-1 interface box. With the RC2K90INT-1 interface box a single KBPB DC motor drive module is present and the latching relay is used to route the motor drive current to either the azimuth or elevation axis. The relay will not be included with the RC2K90INT-2 and RC2KINT model interface boxes. When an azimuth control input signal is applied to the AZ1\_CTL and AZ2\_CTL inputs the K4 relay coil labeled 'LATCH\_AZ' on the schematic is energized and the inputs labeled A1\_KBPB and A2\_KBPB (connected to the A1 and A2 outputs of the KBPB) are connected to the azimuth motor via the AZMOT1 and AZMOT2 outputs. The diode bridge formed by diodes D6, D7, D8, and D9 insures that an azimuth control signal of either polarity will result in a unipolar voltage being applied to the 'LATCH\_AZ' coil of the relay. When the azimuth control signal generated by the RC2000 is removed the latching relay stays in the 'azimuth' position.

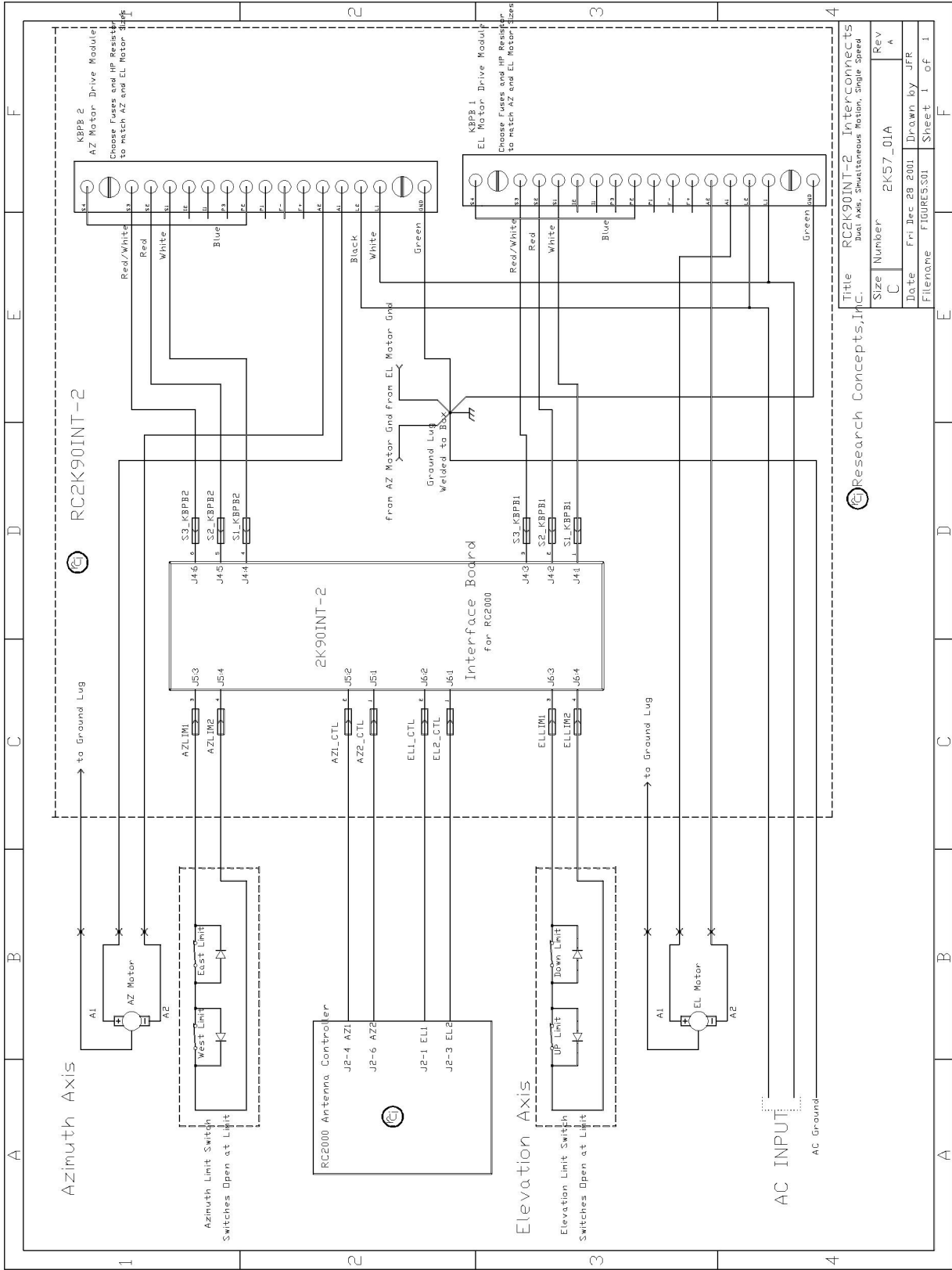
In a similar fashion, when an elevation control input signal is applied to the EL1\_CTL and EL2\_CTL inputs the 'RESET\_EL' coil of the K4 relay is energized and the relay contacts are configured to connect the A1\_KBPB and A2\_KBPB contacts to the elevation motors via the ELMOT1 and ELMOT2 outputs. The diode bridge formed by D12, D13, D14, and D15 allows an elevation drive current of either polarity to activate the 'RESET\_EL' coil of the relay. When the elevation control input is removed the relay will stay in the 'elevation' position until an azimuth input is applied. It is necessary to use a latching relay to select the azimuth or elevation axis to support the dynamic braking capability of the motor drive module. If a non latching relay were used, when the control input is removed (for one of the two axis) the relay would switch while the motor is braking (and current is flowing). This would defeat the braking action and generate noise as the relay contacts open with a load applied.

The RC2000D antenna controller supports dual speed azimuth and elevation movement when used with the interface box. With the RC2000D software the controller's polarotor control output may be used to activate relay K1 on the 2K90INT-2 board. This relay provides a pair of speed control channels which can be used with either the KBPB DC motor drive module (in the RC2K90INT-1 or RC2K90INT-2 interface boxes) or a user supplied controller (with the RC2KINT interface box) to obtain dual speed azimuth and elevation movement. When used with other members of the RC2000 controller family only single speed azimuth and elevation movement is available.

The K1 relay is powered with 5.7 volts DC via the terminals labeled +5.7V and Return. 5.7 volts is available at the back panel of the RC2000 antenna controller. To activate the relay (and select high speed movement) 5 volts is applied to the terminal labeled Pulse. Resistor R1 is a dropping resistor on the base of transistor Q1 to limit the voltage at the base to approximately 0.7 volts. When Q1 turns on the relay is activated. The relay provides two speed control channels. Each channel consist of a pair of potentiometers. Only a single channel will be considered. For the KBPB1 speed control channel, the KBPB1\_FST and KBPB1\_SLO pots (designated P2 and P3, respectively) are connected to the P3\_KBPB1 and P1\_KBPB1 terminals. When fast speed is selected the voltage at the wiper of the KBPB1\_FST terminal is presented to the P2\_KBPB1 terminal. When slow speed is selected the voltage on the wiper of the KBPB1\_SLO pot is connected to the P2\_KBPB1 terminal. If contact closures are required rather than switched potentiometer wipers the potentiometers can be replaced with jumpers.

Diodes D1, D4, D5, D10, D11, D18, D19, D22, and D23 are used to suppress the back emf induced in the relay coils when the relays are de-energized. These are sometimes referred to as 'buck diodes'.

The connection of the 2K90INT-2 circuit board to the KBPB DC motor drive module(s) varies with the type of interface box (RC2K90INT-1 or RC2K90INT-2) as well as the type of controller (the RC2000D software supports dual speed azimuth and elevation movement, other models of the RC2000 controller only support single speed azimuth and elevation movement). The wiring schematics for the various configurations are given in figures 4, 5 and 6.

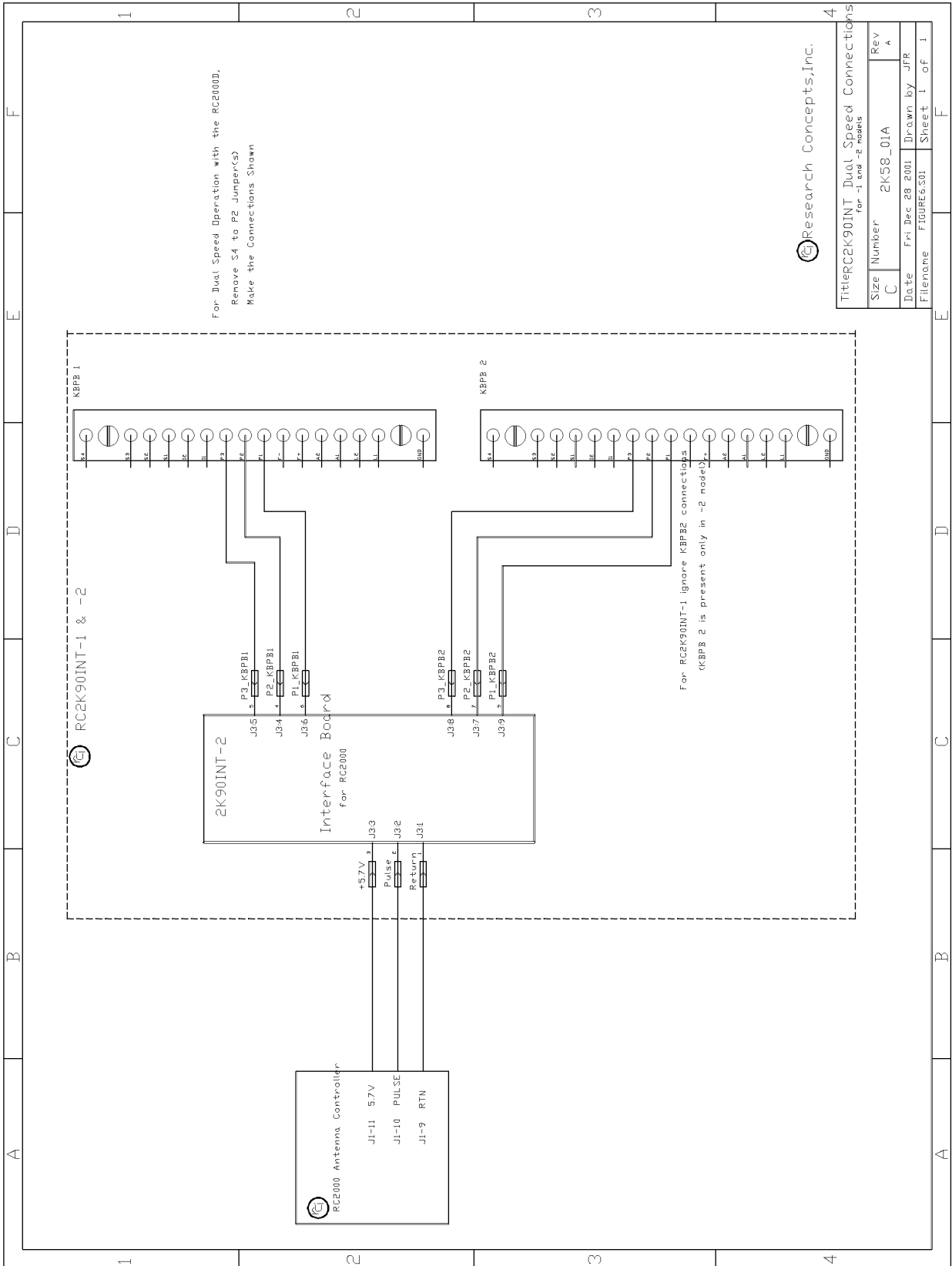


Research Concepts, Inc.

Title		RC2K90INT-2 Interconnects	
Size		Dual Axis, Spun Aluminum Motion, Single Speed	
Rev	Number	Date	Drawn by
A	2K57_01A	Fri Dec 28 2001	JFR
Filename	FIGURE5.301		Sheet 1 of 1

Figure 4





Research Concepts, Inc.

Title: RC2K90INT Dual Speed Connections for -1 and -2 models			
Size	Number	Rev	
C	2K58_01A	A	
Date	Fri Dec 28 2001	Drawn by	JFR
Filename	FIGURE6.301	Sheet 1 of	1

Figure 5

## 4.0 Heater Option

A heater option has been developed for the RC2K90INT series of interface boxes. The KB Electronics KBPB Drive used in RCI 90VDC interface boxes has a low temperature rating of 0 C. This is inadequate for most environments. The heater option, designated RC2K90INT-HTR adds a maximum of 100W of heating to the box allowing a no-wind low temp of -50F for the std. 12 x 12x 6 inch interface box.

The Heater option uses a SPST thermostat that turns on at 32°F. Two 115VAC 54W heating pads are wired in series for 230VAC –rated boxed and parallel for 115VAC –rated boxes. The heating pads are attached to the underside of the baseplate with special high-temperature adhesive. the thermostat and heaters are protected with a single fuse in line with the Hot AC input.

## 5. Installation / Setup

This section describes the installation and setup of the interface box.

### 5.1 Mechanical Installation

The standard interface box is housed in a 12” by 12” by 6” (height x width x depth) NEMA 4 enclosure. NEMA 4 enclosures are suitable for outdoor use. The interface box is designed to be mounted vertically on the antenna kingpost. The mounting holes are suitable for 1/4 inch screws. The hole pattern is 10” (wide) by 12 3/4” high. The hinge is located on the left side of the box. Six 7/8” holes are punched in the bottom of the box. These holes are designed for 1/2 inch electrical conduit fittings.

Higher power (¾ HP to 1 ½ HP at 115VAC, or 1 ½ HP to 3 HP at 230VAC) versions of the interface box are housed in a 20” by 20” by 8” NEMA4 enclosure. The larger box has a bolt pattern 14” wide by 21 ¼” high.

### 5.2 Electrical Installation

This sections covers the electrical connections required to connect the interface box to the AC mains, RC2000 antenna controller, and the antenna motors, limit switches, and sensors. Please refer to the wiring diagrams shown in figures 4 and 5. **The AC power to the interface box should be disconnected whenever the interface box is opened - lethal voltages are present inside the box.**

#### 5.2.1 Connecting to the AC Mains

It is the user’s responsibility to provide AC power at the antenna. An AC disconnect which removes all AC power to the interface box **must** be provided **at the antenna**. Each ungrounded AC line supply conductor must be fused. The interface box is available in two versions, one for use with 120 VAC and another for use with 240 VAC. The AC input voltage required is listed on the inside of the box lid. The connection to the AC mains is made directly to the L1 and L2 inputs on the KBPB motor drive module(s) in the smaller configurations (12x12x6 Housing) and to a 16-terminal block in the larger (20x20x8 Housing) configuration. A ground connection must be made to the ground lug located in the upper left hand corner of the box. The capacity of the AC service should be sufficient to carry the load required by the motors. For the RC2K90INT-2 remember that both motors will be running simultaneously.

#### 5.2.2 Connections to the RC2000

A single cable is often used to connect the RC2000 to the interface box. The only connections required for operation of the interface box are those to the RC2000 azimuth and elevation drive outputs. Each axis

requires a pair of conductors. Since the RC2000 motor drive outputs are not actually carrying motor drive current light gauge conductors (16-20 AWG) can be used, shielded cables are not required.

In most cases the cable used to connect the RC2000 to the interface box will also include the conductors required to interface the RC2000 to the azimuth and elevation position sensors. Each sensor requires 3 conductors in a shielded cable with a drain wire. The conductors in the sensor cable don't carry much current, 22 to 18 gauge conductors work fine. In some cases it will be necessary to splice sensor cables in the interface box. Figure 7 is an example of a sensor cable splice.

When making sensor connections please note the following ...

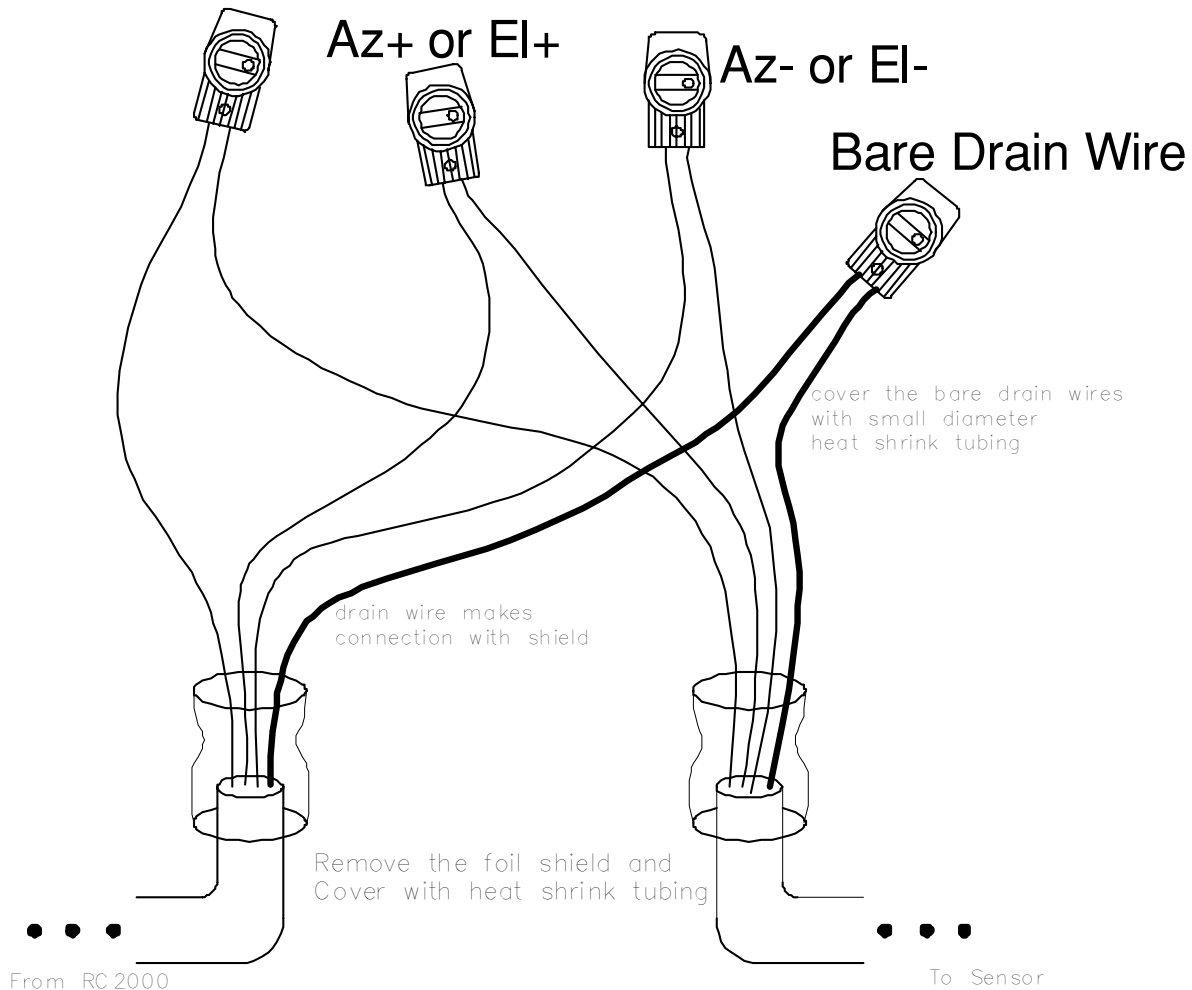
- Always use shielded cables.
- The shield drain wire should only be connected at the RC2000.
- If the cable is spliced, be sure to splice the drain wire.
- Don't allow the shield or drain wire to come in contact with ground anywhere. If the cable insulation is cut at a splice put a piece of heat shrink over the frayed shield to keep it from coming in contact with ground.
- Don't connect the drain wire or shield at the sensor.

*Failure to follow these guidelines can result in unreliable operation of the pulse counters and antenna controller positioning errors*

# Shielded Sensor Cable Splice Inside the Interface Box

3-Conductor (with drain-wire)  
3M Scotchlock Connectors

5.7 Volts



Notes:

1. Make sure that the drain wires are spliced.
2. Do not allow the drain wire or foil to come into contact with ground.
3. Remove the foil shield and drain wire on the sensor end of the cable. Cover the break in the cable so that the shield cannot come into contact with the ground.
4. Use a cable tie for strain relief and to hold the conductors together to minimize the EMI loop area.

**Figure 6**

### 5.2.3 Antenna Motor and Limit Switch Connections

The motor conductors should be sized appropriately for the motor load. Three conductor cable should be used so that the ground terminal of the motor can be connected to the ground lug in interface box. The limit switch conductors carry very little current, a pair of 20 to 18 gauge conductors are sufficient for the limit switch connections.

## 5.3 RC2000 CONFIGURATION

Via **CONFIG** mode, the user can optimize the operation of the controller for use with the interface box. Certain **CONFIG** mode items must be configured in a certain manner to insure proper operation of the interface box. Other **CONFIG** mode items can optionally be configured so as to optimize the operation of the controller for use with the interface box.

### 5.3.1 Required CONFIG Mode Settings

A number of RC2000 **CONFIG** mode items must be configured properly for reliable operation of the RC2000 with the interface box. Here is a list of those items ...

<b>CONFIG Mode Item</b>	<b>Required Value for Operation with Interface Box</b>	<b>Comments</b>
Azim Slow Speed	254	A slow speed value of 254 disables the RC2000's pulse width modulation based slow speed system. Failure to properly configure this CONFIG mode item can result in damage to the interface box.
Elev Slow Speed	254	A slow speed value of 254 disables the RC2000's pulse width modulation based slow speed system. Failure to properly configure this CONFIG mode item can result in damage to the interface box.
Simultaneous Az/El Enable	0 - DISABLE	With the RC2K90INT-1, simultaneous azimuth and elevation movement is not allowed. With the RC2K90INT-2, the user will generally want to enable simultaneous azimuth and elevation movement
Az/El Slow Deadband	See the comments.	The value of the Az/El Slow Deadband item should be set to approximately the same value as the Az/El Fast Deadband for interface boxes which only support single speed azimuth and elevation movement. Please see the discussion of these CONFIG mode items in the next section.

### 5.3.2 Optional CONFIG Mode Settings

The Az/El Drive Options **CONFIG** mode item controls access to the antenna movement parameters. The antenna movement parameters control the movement of the antenna (i.e. the number of attempts which will be made to hit a target position, the maximum allowable error, the coast distances, etc.). The default movement parameters of the RC2000 are optimized for antenna's powered by 36 volt linear actuators. In almost all cases the default values for these **CONFIG** mode items are not appropriate for antennas powered by other types of motors. Most antennas used with the interface box have drive systems with more inertia and more counts per degree of movement than antennas powered by 36 volt linear actuators.

Please refer to the discussion of these **CONFIG** mode items in the RC2000 manual. Failure to properly configure these **CONFIG** mode items can result in inaccurate antenna positioning and/or excessive wear on the motors and actuators.

Two of the **CONFIG** mode items have special features which are often useful in interface box applications. The last two digits of the Az/EI Fast Deadband parameter can be configured so as to disable antenna runaway errors. The last two digits of the Az/EI Slow Deadband parameter can be configured so as to address the problem of gaps in the program track table which contains a map of an inclined orbit satellite's apparent motion. For a discussion of these features of these two **CONFIG** mode items please refer to the RC2000C manual, Section 7.3 - Operational Troubleshooting Tips.

Many interface box applications are used for inclined orbit satellite uplinks. For transmit applications it is generally advisable to disable the controller's Search Enable **CONFIG** mode item. When the search is enabled, if the antenna is steptracking and the controller's AGC input indicates that the satellite signal has been lost the controller will initiate a search. During a search the controller sweeps the antenna over a parallelogram shaped region where it has calculated that the satellite is likely to be found. This is generally not desirable for transmit applications.

## 5.4 Interface Box Adjustments

Several user adjustments are available on the KBPB motor drive module and the 2K90INT-2 board located in the interface box. The most common adjustment made is to vary the speed of the motors. On interface boxes made for single-speed antenna movement, the speed is adjusted using R14 on the KBPB motor drive. This pot is labeled 'AUX' or R14. Please refer to the KBPB manual for the location of this pot. **The AC power to the interface box should be disconnected whenever the interface box is opened - lethal voltages are present inside the box.**

### 5.4.1 Speed Control

For interface boxes configured for dual speed azimuth and elevation movement, the slow speed adjustment pots are located on the 2K90INT-2 circuit board. For the RC2K90INT-1 interface box adjust the KBPB1\_SLO pot to vary the slow speed for both the azimuth and elevation axis. Adjust the KBPB1\_FST pot to set the fast speed for both axis. For the RC2K90INT-2 interface box the KBPB1\_SLO and KBPB1\_FST pots are used to adjust the speed of the azimuth axis. The KBPB2\_SLO and KBPB2\_FST pots are used to adjust the speed of the elevation axis. The maximum and minimum fast and slow speeds for each KBPB are determined by the MAX and MIN trim pots located on each KBPB. Normally the user should not need to adjust these pots - they are set for maximum speed-range when the interface box is assembled.

### 5.4.2 IR Compensation and Current Limiting

Other trim pot adjustments present on the KBPB are the IR compensation and current limiting. IR compensation is used to increase the voltage to the motor when the motor is loaded so as to maintain a constant speed. Current limiting limits the current applied to the motor. This protects the motor against overloads both while running and at startup. Both of these parameters are controlled via trim pots and with the Plug-In Horsepower Resistor. If the controller was ordered with the proper resistor no adjustment of these trim pots should be necessary. If adjustments are necessary please refer to the KBPB operating instructions included with this manual.

### 5.4.3 Fusing

The KBPB motor drive module has provisions for a built-in AC line fuse and an Armature Fuse. An AC line fuse of 12 amps is appropriate for 90 VDC motors of up to 3/4 HP and 180 VDC motors of up to 1 1/2 horsepower. For larger motors use a 25 amp AC line fuse. To calculate the size of the armature fuse, multiply the full load DC current rating of the motor by 1.7. Both fuses are normal blow, ceramic type

(Buss type ABC, Littlefuse type 314, or equivalent). For more information on fusing please refer to the KBPB operators manual.

#### 5.4.4 KBPB Modification

If a KBPB-225 (designed for use at 220/240 VAC ) is used with 90 volt DC motors the KBPB-225 must be modified to insure that DC voltages greater than 90 volts are not applied to the motor. The model KBPB-225 is used in all interface boxes designed for 220/240 VAC operation. If the customer specifies that the interface box will be used with 90 volt DC motors this modification will be performed when the interface box is assembled. This information is presented here for the case where the KBPB is replaced in the field

Here is the modification: Place a jumper between the A+ and B terminals. These terminals are located on the circuit board near the toroid type transformer. Access to this point is from the same side of the module as where the connector labels are found. The A+ terminal is a .250" quick disconnect type. The B terminal is a .110" quick disconnect type.

## Appendices and Attachments

This section includes the following attachments ...

- KBPB Manual (for model RC2K90INT-1 and RC2K90INT-2 interface boxes)
- A data sheet on the Omron type G2R relay.
- A data sheet on the Potter and Brumfield KUL-11D15D-24 type relay (RC2K90INT-2 only)
- The silk-screen mask of the 2K90INT-2 circuit board
- The bill of materials
- Any appendices related to custom versions of the interface box.

### Bill of Materials

Quan	Model/Description	Manufacturer	Comments (Ref Designators)
1	G2R-2-S-5VDC Relay	Omron	DPDT Relay, 5VDC Coil, (K1)
1	P2R-08P Socket	Omron	Socket for DPDT Omron Relay
4	G2R-1-S-24VDC Relay	Omron	SPDT Relay, 24VDC Coil, (K2, K3, K5, K6)
2	G2R-1-S-12VDC Relay	Omron	SPDT Relay, 12 VDC Coil, (K7, K8)
6	P2R-05P Socket	Omron	Socket for SPDT Omron Relay
1	KUL11D15D24	Potter and Brumfield	DPDT Latching Relay, Dual 24VDC Coil (K4)
1	27E046	Potter and Brumfield	Socket for Latching Relay
1	20C247	Potter and Brumfield	Anchor Clip for Latching Relay
23	1N4002	Motorola	Diode (D1-D23)
4	3329H-1-502 Pot	Bourns	5K Ohm, 1 Turn Potentiometer (P1-P4)
1	2N4400 Transistor	Motorola	NPN Transistor (Q1)
1	200 Ohm , 1/8 Watt		Resistor (R1)
2	200 Ohm, 2 Watt		Resistor (R2,R4)
2	680 Ohm, 1/2 Watt		Resistor (R3, R5)
1	240 Ohm, 1 Watt		Resistor (R6)
5	150626 Connector	Weidmuller	2 Position Screw Terminal Connector

Quan	Model/Description	Manufacturer	Comments (Ref Designators)
9	150646 Connector	Weidmuller	3 Position Screw Terminal Connector
2	Z320LA15A	CKE	320 Volt Metal Oxide Varistor (MOV1, MOV2)
2	7105U15SYZ3QE	C & K	SPDT (MOM-OFF-MOM) Switch (SW1, SW2)
1 or 2	KBPB-125 or KBPB-225	KB Electronics, Inc.	DC Motor Drive Module, the KBPB-125 is used with 120 VAC Versions of the Interface Box, the KBPB-225 is used with 220/240 VAC Versions of the Interface Box [2] [3]
2	6-32 x 3/8" Screw		Phillips Head Screw for Latching Relay Socket
2	#6 Lockwasher		Lockwasher for Latching Relay Screw
2	6-32 Small Outline Nut		Nut for Latching Relay Screw
4	??" Standoff		Circuit Board is Mounted on These Standoffs
4	?? Nut w/ Nylon Insert		For Use with Standoff
4	?? Screw		Connects Standoff to the Mounting Panel
2 or 4	?? Screw		KBPB Mounting Screw [1]
2 or 4	?? Washer		Used with KBPB Mounting Screw [1]
2 or 4	?? Lock Washer		Used with KBPB Mounting Screw [1]
2 or 4	?? Nut		Used with KBPB Mounting Screw [1]
1	1414 PHL6LP	Hammond Mfg.	12" x 12" x 6" NEMA 4 Enclosure with Panel[4]
1	1418 N4D8	Hammond Mfg.	20"x20"x8" NEMA4 Encl. w/Panel [4]
4	Insulated Ring Terminal		Crimp Type, #10 Stud, 10-12 AWG Wire Size - Used for Motor and KBPB Chassis Ground Connection

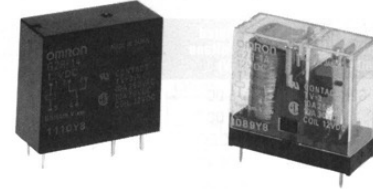
## Notes

- 2 are used for the RC2K90INT-1, 4 are used for the RC2K90INT-2
- Only one motor drive module is used for the RC2K90INT-1, two motor drives are used for the RC2K90INT-2.
- When a KBPB-225 motor drive module is used with a 90 volt DC motor the KBPB should be modified as described in Section 4.4.4. It is not necessary to perform this modification on new Interface Boxes if 220/240 VAC line voltage and 90 volt DC motors are specified when the interface box is ordered (the modification is performed at the factory).
- 12x12x6 box used up to 3/4HP 115VAC or up to 1 1/2 HP 230VAC systems. The 20x20x8 box is used up to 1 1/2HP 115VAC or up to 3 HP 230VAC systems.



## Features

- Slim-styled power relay – available in both latching and non-latching types
- Creepage distance of 7.874 mm (.31 in.) min. between coil and contact
- Single and dual-winding latching types available
- Plug-in and Quick-connect terminals available
- High-sensitivity (360mW), high capacity (16 A) and bifurcated contact types available
- Highly stable magnetic circuit for latching endurance and excellent resistance to vibration and shock
- Safety-oriented design assuring high surge resistance (15,000 V min. between coil and contact with the single-winding type; 10,000 V min. between coil and contact with the dual coil type)



## Contact Data

### Contact ratings

#### One-pole:

*General purpose:* 10 A, 250 VAC, 30 VDC (Resistive); 7.5 A, 250 VAC, 5 A, 30 VDC (Inductive); 3 A, 120 VAC, Tungsten (TV-3); 1/3HP, 120 VAC; 1/2HP, 250 VAC; 1/2HP, 277 VAC

*High-capacity:* 16 A, 250 VAC, 30 VDC (Resistive); 8 A, 250 VAC, 30VDC (Inductive); 3 A, 120 VAC, Tungsten (TV-3); 1/3HP, 120 VAC; 1/2HP, 250 VAC

*High-sensitivity:* 5 A, 250 VAC, 30 VDC (Resistive); 2 A, 250 VAC, 3 A, 30 VDC (Inductive)

*Latching:* 5 A, 250 VAC, 30 VDC (Resistive); 3.5 A, 250 VAC, 2.5 A, 30 VDC (Inductive);

3 A, 120 VAC, Tungsten (TV-3); 1/6HP, 120 VAC; 1/2HP, 250 VAC

#### Two-pole:

*General purpose:* 5 A, 250 VAC, 30 VDC (Resistive); 2 A, 250 VAC, 3 A, 30 VDC (Inductive); 3 A, 120 VAC, Tungsten (TV-3); 1/6HP, 120 VAC; 1/3HP, 240 VAC

*High-sensitivity:* 3 A, 250 VAC, 30 VDC (Resistive); 1 A, 250 VAC, 1.5 A, 30 VDC (Inductive)

*Latching:* 3 A, 250 VAC, 30 VDC (Resistive); 1.5 A, 250 VAC, 2 A, 30 VDC (Inductive);

3 A, 120 VAC, Tungsten (TV-3); 1/6HP, 120 VAC; 1/3HP, 250 VAC

### Contact material AgCdO

**Maximum operating voltage** 380 VAC, 125 VDC

### Maximum operating current

#### One-pole:

*General purpose:* 10 A

*High-capacity:* 16 A

*High-sensitivity:* 5 A

*Latching:* 5 A

#### Two-pole:

*General purpose:* 5A

*High-sensitivity:* 3A

*Latching:* 3A

### Maximum switching capacity

#### One-pole:

*General purpose, Resistive:* Unsealed – 2,500 VA, 300 W; Sealed – 2,000 VA, 240 W

*High-capacity, Resistive:* Unsealed – 4,000 VA, 480 W

*High-sensitivity, Resistive:* Unsealed/Sealed – 1,250 VA, 150 W

*Latching, Resistive:* – 1,250 VA, 150 W

#### Two-pole:

*General purpose, Resistive:* Unsealed – 1,250 VA, 150 W; Sealed – 1,000 VA, 120 W

*High-sensitivity, Resistive:* Unsealed/Sealed – 750 VA, 90 W

*Latching, Resistive:* – 750 VA, 90 W

### Minimum permissible load

#### One-pole:

100 mA at 5 VDC

#### Two-pole:

10 mA at 5 VDC

## Coil Data [% of rated voltage]

**Pickup voltage** 70% max. (DC & High-Sensitivity DC); 80% max. (AC)

**Dropout voltage** 15% min. (DC & High-Sensitivity DC); 30% min. (AC)

**Set voltage** 70% max.

**Reset voltage** 70% max.

**Maximum voltage** 110% at 70°C

## Characteristic Data

### Initial contact resistance

*One-pole:* 30mΩ max.

*Two-pole:* 50mΩ max.

**Operate time** 15ms max.

### Release time

*AC coil:* 10ms max.

*DC coil:* 5ms max.

**Set time – Latching** 20ms max.

**Reset time – Latching** 20ms max.

**Insulation resistance** 1,000MΩ min. (at 500 VDC)

### Dielectric strength

#### One-pole:

*Between coil and contacts:* 5,000 VAC, 50/60 Hz for 1 minute

*Across open contacts of same pole:* 1,000 VAC, 50/60 Hz for 1 minute

#### Two-pole:

*Between coil and contacts:* 5,000 VAC, 50/60 Hz for 1 minute

*Between contact sets:* 3,000 VAC, 50/60 Hz for 1 minute

*Across open contacts of same pole:* 1,000 VAC, 50/60 Hz for 1 minute

#### Latching:

*Between set and reset coils:* 1,000 VAC, 50/60 Hz for 1 minute

**Ambient temperature** -40° to 70°C

### Service life

#### Mechanical:

*AC coil:* 10,000,000 operations min.

*DC coil:* 20,000,000 operations min.

**Electrical:** 100,000 operations min. for all resistive and inductive ratings with the following exceptions: *One-pole, General purpose, Sealed:* 8 A, 250 VAC, 30 VDC

*Two-pole, General purpose, Sealed:* 4 A, 250 VAC, 30 VDC

## Construction Data

**Termination** Plug-in, Quick Connect, and PCB terminals

**Construction** Semi-sealed and Fully-sealed

**Weight** .6 oz (17 g), Latching, Quick Connect Type: .71 oz (20 g)

**Packaging method** Trays



**Ordering Information**

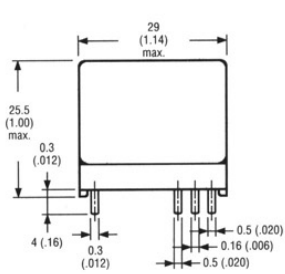
Part number	Rated voltage (V)	Coil res. (Ohms)	Power	Contact rating	Type
G2R-1	-DC5	5 DC	47	530mW	10 A SPDT
	-DC6	6 DC	68		10 A PCB
	-DC12	12 DC	275		10 A General
	-DC24	24 DC	1,100		10 A Purpose
	-DC48	48 DC	4,170		10 A Semi-Sealed
	-AC24	24 AC	260	0.9 VA	10 A
	-AC120	120 AC	6,500		10 A
	-AC240	240 AC	30,000		10 A
G2R-14	-DC5	5 DC	47	530mW	10 A SPDT
	-DC6	6 DC	68		10 A PCB
	-DC9	9 DC	153		10 A General
	-DC12	12 DC	275		10 A Purpose
	-DC24	24 DC	1,100		10 A Sealed
	-DC48	48 DC	4,170		10 A
	-AC12	12 AC	65	0.9 VA	10 A
	-AC24	24 AC	260		10 A
G2R-1-E	-DC5	5 DC	47	530mW	16 A SPDT
	-DC12	12 DC	275		16 A PCB
	-DC24	24 DC	1,100		16 A High-Capacity
	-DC48	48 DC	4,170		16 A Semi-Sealed
	-AC24	24 AC	260	0.9 VA	16 A
G2R-14-H	-DC5	5 DC	70	360mW	5 A SPDT
	-DC6	6 DC	100		5 A PCB
	-DC12	12 DC	400		5 A High-Sensitivity
	-DC24	24 DC	1,600		5 A Sealed
G2R-1A	-DC5	5 DC	47	530mW	10 A SPST-NO
	-DC6	6 DC	68		10 A PCB
	-DC12	12 DC	275		10 A General
	-DC24	24 DC	1,100		10 A Purpose Semi-Sealed
G2R-1A4	-DC5	5 DC	47	530mW	10 A SPST-NO
	-DC12	12 DC	275		10 A PCB
	-DC24	24 DC	1,100		10 A General
	-AC24	24 AC	260	0.9 VA	10 A Purpose Sealed
G2R-1A-E	-DC5	5 DC	47	530mW	16 A SPST-NO
	-DC12	12 DC	275		16 A PCB
	-DC24	24 DC	1,100		16 A High-Capacity Semi-Sealed
G2R-1-S	-DC5	5 DC	47	530mW	10 A SPDT
	-DC6	6 DC	68		10 A Plug-in
	-DC12	12 DC	275		10 A General
	-DC24	24 DC	1,100		10 A Purpose
	-AC12	12 AC	65		10 A Unsealed
	-AC24	24 AC	260	0.9 VA	10 A
	-AC120	120 AC	6,500		10 A

Note: 1. Other coil voltages available. Consult Omron.

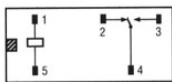
Part number	Rated voltage (V)	Coil res. (Ohms)	Power	Contact rating	Type
G2R-1-T	-DC5	5 DC	47	530mW	10 A SPDT
	-DC12	12 DC	275		10 A Quick
	-DC24	24 DC	1,100		10 A Connect
	-AC24	24 AC	260	0.9 VA	10 A Upper
	-AC120	120 AC	6,500		10 A Mounting Bracket Unsealed
G2R-2	-DC5	5 DC	47	530mW	5 A DPDT
	-DC12	12 DC	275		5 A PCB
	-DC24	24 DC	1,100		5 A General
	-AC24	24 AC	260	0.9 VA	5 A Purpose
	-AC120	120 AC	6,500		5 A Semi-Sealed
G2R-24	-DC5	5 DC	47	530mW	5 A DPDT
	-DC6	6 DC	68		5 A PCB
	-DC12	12 DC	275		5 A General
	-DC24	24 DC	1,100		5 A Purpose
	-DC48	48 DC	4,170		5 A Sealed
	-AC24	24 AC	260	0.9 VA	5 A
G2R-24-H	-DC5	5 DC	70	360mW	3 A DPDT
	-DC6	6 DC	100		3 A PCB
	-DC12	12 DC	400		3 A High-Sensitivity
	-DC24	24 DC	1,600		3 A Sealed
G2R-2A4	-DC5	5 DC	47	530mW	5 A DPST-NO
	-DC12	12 DC	275		5 A PCB
	-DC24	24 DC	1,100		5 A General
	-AC24	24 AC	260	0.9 VA	5 A Purpose Sealed
	-AC120	120 AC	6,500		5 A
G2R-2-S	-DC5	5 DC	47	530mW	5 A DPDT
	-DC12	12 DC	275		5 A Plug-in
	-DC24	24 DC	1,100		5 A General
	-AC24	24 AC	260	0.9 VA	5 A Purpose
	-AC120	120 AC	6,500		5 A Unsealed
G2RK-1	-DC5	5 DC	47	850mW (Set)	5 A SPDT
	-DC12	12 DC	275		5 A PCB
	-DC24	24 DC	1,100	600mW (Reset)	5 A Dual Coil Latching Semi-Sealed
G2RK-2	-DC5	5 DC	47	850mW (Set)	3 A DPDT
	-DC12	12 DC	275		3 A PCB
	-DC24	24 DC	1,100	600mW (Reset)	3 A Dual Coil Latching Semi-Sealed

**Dimensions** [Unit: mm (inch)]

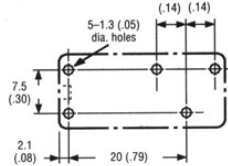
**PCB Terminal: SPDT**  
(General Purpose, High Sensitivity)



**Terminal arrangement/ Internal connections**  
(bottom view)

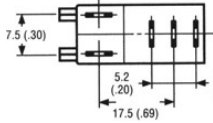
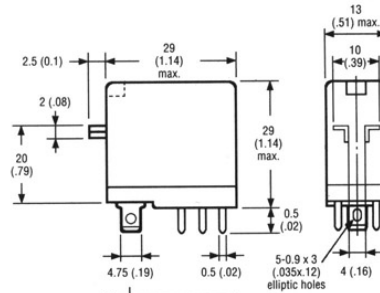


**Mounting holes**  
(bottom view)

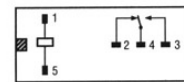


Note: 1. For SPST-NO, standard version, remove terminal no. 2.  
2. ■ and □ indicate mounting orientation marks.

**Plug-in: SPDT**

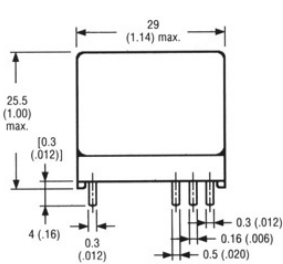


**Terminal arrangement/ Internal connections**  
(bottom view)  
**G2R-1-S**

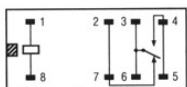


Note: 1. ■ and □ indicate mounting orientation marks.

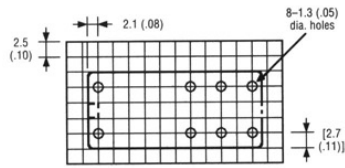
**PCB: SPDT High Capacity**



**Terminal arrangement/ Internal connections**  
(bottom view)

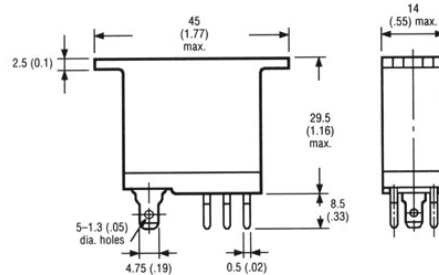


**Mounting holes**  
(bottom view)

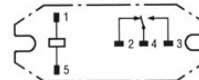


Note: 1. For SPST-NO, high-capacity version, remove terminal nos. 2 and 7.  
2. ■ and □ indicate mounting orientation marks.

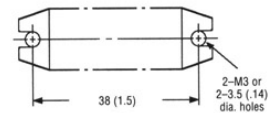
**Quick Connect: SPDT**



**Terminal arrangement/ Internal connections**  
(bottom view)



**Mounting holes**  
(bottom view)

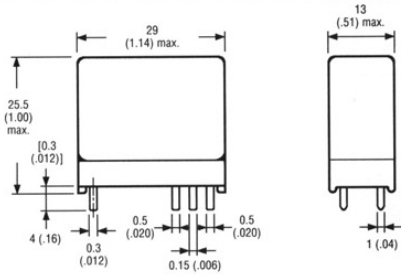


Note: 1. For SPST-NO, quick connect version, remove terminal no. 2.

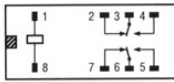
CAN'T FIND THE PRODUCT SOLUTION YOU NEED? MANY OTHER STYLES AND VARIATIONS ARE AVAILABLE. CALL YOUR OMRON REPRESENTATIVE FOR MORE INFORMATION.

**Dimensions** [Unit: mm (inch)]

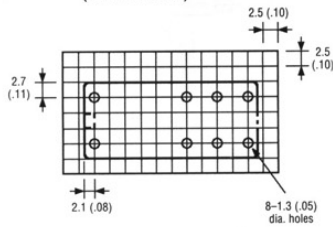
**PCB Terminal: DPDT**  
(General Purpose, High Sensitivity)



**Terminal arrangement/ Internal connections**  
(bottom view)

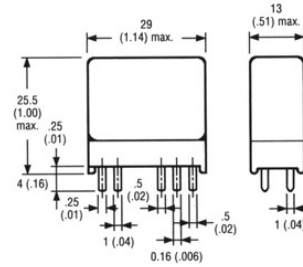


**Mounting holes**  
(bottom view)

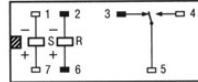


Note: 1. For DPST-NO, general purpose and high-sensitivity versions, remove terminal nos. 2 and 7.  
2. and indicate mounting orientation marks.

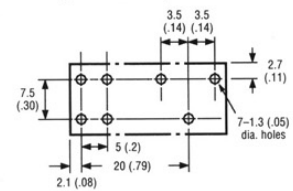
**SPDT Dual Coil Latching**



**Terminal arrangement/ Internal connections**  
(bottom view)

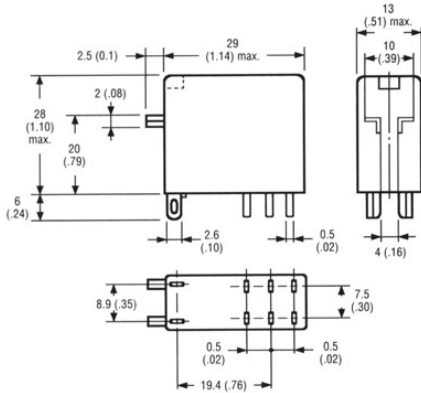


**Mounting holes**  
(bottom view)

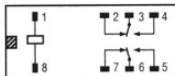


Note: 1. For SPST-NO, latching version, remove terminal no. 3.  
2. and indicate mounting orientation marks.

**Plug-In: DPDT**

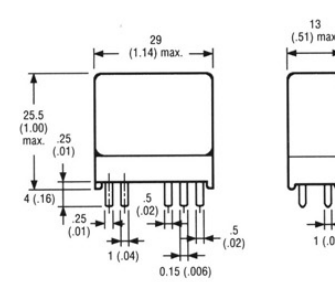


**Terminal arrangement/ Internal connections**  
**G2R-2-S**  
(bottom view)

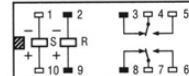


Note: 1. and indicate mounting orientation marks.

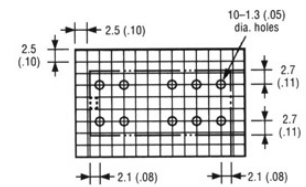
**DPDT Dual Coil Latching**



**Terminal arrangement/ Internal connections**  
**G2R-2-S**  
(bottom view)



**Mounting holes**  
(bottom view)



Note: 1. For DPST-NO, latching version, remove terminal nos. 3 and 8.  
2. and indicate mounting orientation marks.

ACCESSORY ITEMS FOR KBPB AVAILABLE FROM YOUR DISTRIBUTOR



**LIMITED WARRANTY**  
 For a period of 18 months from date of original purchase KB will repair or replace without charge devices which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. The foregoing is in lieu of any other warranty or guarantee expressed or implied, and we are not responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person, caused by items of our manufacture or sale. Some states do not allow certain exclusions or limitations found in this warranty so that they may not apply to you. In any event, KB's total liability, under all circumstances, shall not exceed the full purchase price of this unit. (Rev. 10/84)

The information contained in this brochure is intended to be accurate. However, the manufacturer retains the right to make changes in design which may not be included herein.

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 12095 NW 39th Street, Coral Springs, FL 33065 • (954) 346-4900 • Fax (954) 346-3377  
 Outside Florida Call TOLL FREE (800) 221-6570 • Email-info@kbelectronics.com  
 www.kbelectronics.com A40210A PC 2.5M C3/01

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TABLE 2. ELECTRICAL RATINGS

MODEL NUMBER	AC LINE VOLTAGE (VAC)**	MOTOR VOLTAGE (VDC)	RATING WITHOUT AUXILIARY HEATSINK			RATING WITH AUXILIARY HEATSINK		
			AC LOAD CURRENT (RMS AMPS)	DC LOAD CURRENT (AVG. AMPS)	MAX. HP	AC LOAD CURRENT (RMS AMPS)	DC LOAD CURRENT (AVG. AMPS)	MAX. HP
KBPB-125	120	90-130	12.0	8.0	¾	24.0	16.0	1½
KBPB-225	240	180	12.0	8.0	1½	24.0	16.0	3

TABLE 3. GENERAL PERFORMANCE SPECIFICATIONS

Speed range (ratio)	50:1	CL torque range (% full load)	0-200
Load regulation—armature feedback (0-full load, 50:1 speed range) (% base speed)	1*	Accel time range (0-full speed) (secs.)	2-10
Load regulation—tachometer feedback (0-full load, 50:1 speed range) (% set speed)	1*	Decel time range (full-0 speed) (secs.)	2-10
Line voltage regulation—armature feedback (at full load, ±10% line variation (% base speed))	½*	Min. speed trimpot range (% full speed)	0-30*
Line voltage regulation—tachometer feedback (at full load, ±10% line variation (% set speed))	½*	Max. speed trimpot range (% full speed)	50-110*
Control linearity (% speed vs. dial rotation)	2	IR compensation trimpot range (at specified full load) (volts)	0-24
		Maximum allowable ambient temperature at full rating ("C/F)	45/113
		Tachometer feedback input volts (per 1000 RPM) (VDC)	7/50
		Maximum number of startstops or reversals (operations/min.)	10**

\* Performance is for SCR rated PM motors only. Lower performance can be expected with other motor types. Factory setting is for 3% load regulation. To obtain superior regulation, see Sec. III F. Other factory trimpot settings are as follows: CL-150% FL, Accel-1 sec., Decel-1 sec., MIN-0 speed, MAX-full speed & IR-6 volts.

\*\* Rating is based on a brake time of (1) second. For increased operations per minute or longer brake time, consult factory.

INTRODUCTION

The KBPB® Full Wave Solid State DC Motor Speed and Reversing Control represents the latest state-of-the-art design achievable through modern technology.

Features Include:

- **Integrated Circuitry**  
Used to control and amplify command and reference levels with both closed and open loop feedback to provide superior motor regulation. (Speed changes due to load, line voltage, or temperature variations are held to minimum levels.)
- **High Quality Components**  
Selected and tested for proven dependability.
- **Transient Protection**  
Used to prevent failure of the power bridge circuit caused by voltage spikes on the AC line.
- **High Reliability**  
When used in accordance with the instructions included in this manual, the KBPB® will provide years of trouble-free operation.

SECTION I. APPLICATION INFORMATION

**A. Motor Type.** The KBPB® is designed for Permanent Magnet (PM) and Shunt Wound D.C. motors. Controls operated on 120 volt AC inputs are designed for 90 volt SCR rated motors. Controls operated on 240 volt AC inputs are designed for 180 volt SCR rated motors. Use of higher voltage motors will result in degradation of full speed performance. Also, if motor is not an SCR rated type, the actual AC line amperage at full load should not exceed the motor's DC nameplate rating.

**B. Torque Requirements.** When replacing an AC induction motor with a DC motor and speed control, consideration must be given to the maximum torque requirements. The full load torque rating of the DC motor must be equal to, or greater than, that of the AC motor.

**C. Acceleration Start.** The KBPB® contains an adjustable acceleration start feature which allows the motor to smoothly accelerate from 0-full speed over a time period of 2-10 seconds. The "ACCEL" is factory set at 1 second.

**D. Limitations in Use.** The KBPB® controls are designed for use on machine applications.

KBPB® "Cycler"  
 Solid State DC Motor Speed Controls

Improved—Contains CE  
 KBMM® Speed Control and APRM®-2C for Faster Switching

Installation and Operating Instructions

© 1989 KB ELECTRONICS, INC.



A COMPLETE LINE OF SCR DRIVES



- Ratings up to 1½ HP-120V & 3HP-240V
- Multiple Horsepower Capability with Plug-In Horsepower Resistor® (supplied separately)
- Voltage Following
- Contains the KB APRM (PATENTED) which provides Instant Anti-Plug Reversing and Solid State Dynamic Braking.
- Adjustable ACCEL and DECEL
- Provision for AC Line and Armature fusing (fuses supplied separately) \*Patented

See SAFETY WARNING on page 18.

IMPORTANT

- Read these simplified instructions before operating control. (SEE WARNING ON PAGE 18)
1. Be sure input AC line voltage corresponds to control voltage. (See electrical rating chart page 4)
  2. Install the correct Plug-in Horsepower Resistor® (supplied separately) according to input voltage and motor horsepower (see chart, page 5).
  3. Recheck connections: AC line to L1 and L2; armature to A1 and A2 and Field (Shunt motors only) to F+ and F-. Connect ground via ground screw. (Note: If motor runs in improper direction, interchange armature leads)
  4. Connect S1 to S2 or S2 to S3 to activate control. LED brake light will be "on" if no connection is made.
  5. AC Line Fuse and Armature Fuse must be installed in this product. (supplied separately)—(see page 10, Table 6)
  6. Nominal trimpot settings are as follows (expressed in % of full CW rotation):

TABLE 1: NOMINAL TRIMPOT SETTINGS—SPEED CONTROL MODULE

MIN (minimum speed):	15%	CL (current limit/torque):	65%	For detailed instructions see Sec. III
MAX (maximum speed):	65%	ACCEL (acceleration start):	20%	
IR (IR compensation):	25%	DECEL (deceleration):	20%	

FOR TECHNICAL ASSISTANCE CALL TOLL FREE (OUTSIDE NY STATE ONLY) 1-800-221-6570

PLUG-IN HORSEPOWER RESISTOR®

A Plug-in Horsepower Resistor® must be installed to match the control to the motor horsepower and voltage. See Table 4 for the correct value. Plug-in Horsepower Resistor® are stocked by your distributor (supplied separately).



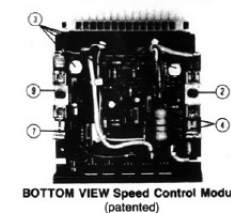
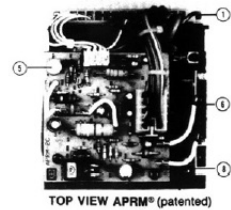
TABLE 4. PLUG-IN HORSEPOWER RESISTOR® CHART

MOTOR HORSEPOWER RANGE**	Armature Voltage, 90-120V DC	Armature Voltage, 180V DC	Plug-in Horsepower Resistor® Resistance Value (Ohms)	KB P/N
1100-1500	1/50-1/25		1.0	9833
1/50-1/30	1/25-1/15		.51	9834
1/30-1/20	1/15-1/10		.35	9835
1/20-1/12	1/10-1/6		.25	9836
1/12-1/8	1/6-1/4		.18	9837
1/8-1/5	1/4-1/3		.1	9838
1/4	1/2		.05	9839
1/3	3/4		.035	9840
1/2	1		.025	9841
3/4	1-1/2		.015	9842
1***	2***		.01	9843
1-1/2***	3***		.006	9850

\* Motor horsepower and armature voltage must be specified when ordering so that proper resistor will be supplied.  
 \*\* For oversizing motor horsepower range use lower value Plug-in Horsepower Resistor.  
 \*\*\* Auxiliary heatsink must be used to achieve HP rating.

FIG. 1 FEATURES AND FUNCTIONS

- (1) Barrier Terminal Block
- (2) AC Line Fuse (supplied separately)
- (3) Trimpots: Min, Max, CL, IR
- (4) Trimpots: Accel, Decel
- (5) Trimpot: Aux Speed
- (6) Dynamic Brake Resistor
- (7) Plug-in Horsepower Resistor® (supplied separately)
- (8) "Brake" LED
- (9) Armature Fuse (supplied separately)



**E. Switching Applications:** KBPB® contains the KB APRM® which is designed to provide anti-plug instant reverse, solid state dynamic brake and rapid cycling. The maximum recommended number of run-brake cycles is 10 per minute. If higher rates are required, contact our sales dept.

**CAUTION:** Consult factory before using on constant horsepower applications such as saws or drill presses. Do not use in explosive atmosphere.

**CAUTION:** Be sure the KBPB® is used within its max. ratings. Follow all installation instructions carefully. (Refer to Section II.)

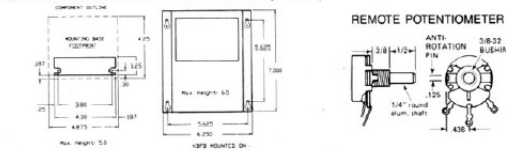
SECTION II. INSTALLATION INSTRUCTIONS

**A. Location and Mounting.** The KBPB control should be mounted on a flat surface and located in an area where it will not be exposed to contaminants such as water, metal chips, solvents or excessive vibration.

When mounting in an enclosure the air space should be large enough to provide adequate heat dissipation. The maximum allowable ambient temperature at full rating is 45°C/113°F. Consult factory if more information is required.

\* Warning: Do not mount control with terminal block legend facing down. (Relay Plunger down.)

FIG. 2 MECHANICAL SPECIFICATIONS (inches)



**B. Initial Setup and Wiring**

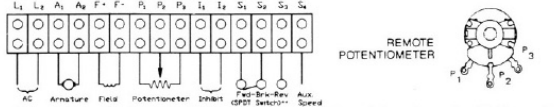
1. Install proper size Plug-in Horsepower Resistor<sup>®</sup>. (See chart page 5—table 4)
2. The KBPB<sup>®</sup> can be connected to a standard 120V or 240V 50/60 Hz AC line [Be sure the AC input voltage corresponds to the control voltage rating and the motor rating (e.g. 90–130VDC motor on 120VAC and 180VDC motor on 240VAC)].
3. Follow the recommended supply wire sizes as per Table 5.
4. Follow the NEC and other electrical codes that apply. CAUTION: Separate branch protection must be provided on 240V circuits. (Do not fuse neutral or grounded conductor.)
5. Connect control according to connection diagram—See Fig. 3.

**TABLE 5. MINIMUM SUPPLY WIRE SIZE REQUIREMENTS**

MAX. MOTOR AMPS (DC AMPS)	MAX. MOTOR HP 90V	MAX. MOTOR HP 180V	MINIMUM WIRE SIZE (AWG) Cu Only	
			MAX. 50 FOOT RUN	MAX. 100 FOOT RUN
6.0	1/2	1	16	14
12.0	1	2	14	12*
18.0	1 1/2	3	12	12

\* Maximum recommended wire size.

**FIG. 3 CONNECTION DIAGRAM**



\* For detailed connection diagrams see KBPB connection diagrams. \*\* Since only 10 ma of current is switched, any switch or relay can be used except a solid state type or relays with capacitors or R-C networks (snubbers) across their contacts

**CAUTION:** If control is wired to a transformer, it is advisable to switch the secondary to disconnected power. If the primary is switched, additional snubber capacitors may have to be added across the transformer output to prevent damage to the power bridge.

**CAUTION:** Do not bundle control wires P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, I<sub>1</sub>, I<sub>2</sub>, S<sub>1</sub>–S<sub>4</sub> with line or motor leads. If wires are over 18", use shielded cables.

**C. Voltage Following.** All models can be controlled with an isolated analog reference voltage (0–5VDC) in lieu of the main speed potentiometer. The voltage is connected to P<sub>2</sub>(+) and F<sub>–</sub>. The control output voltage will linearly follow the input voltage. The source impedance of the input should be 10K ohms or less. The Min trimpot can be used to provide an offset speed. If an offset is not required adjust the Min to 0+ or 0– speed as desired. The Max trimpot is rendered inoperative in the voltage following mode. Use auxiliary trimpot to limit the control range. If the input signal is not isolated, or is a current signal (4–20ma), the KBSI-240D Signal Isolator must be used. It will allow direct connection to process controllers and microprocessors.

**CAUTION:** 1. The voltage leading P<sub>2</sub> and F<sub>–</sub> must be isolated from the AC line. Do not ground P<sub>2</sub> or F<sub>–</sub> to set up a zero or ground reference.  
2. Do not bundle signal wires to P<sub>2</sub> and F<sub>–</sub> with AC line or motor connections. If signal wires are over 18", use shielded cables.

**D. Fusing.** The KBPB<sup>®</sup> has provision for a built-in AC line fuse and armature fuse. The AC line fuse protects the control against catastrophic failure. If the fuse blows, the control is miswired, the motor is shorted or grounded, or the KBPB<sup>®</sup> control is defective. The armature fuse provides overload protection for the motor and control. Choose the proper size armature fuse by multiplying the maximum dc motor amps by 1.7. **NOTE:** Be sure to fuse each ungrounded AC line supply conductor. Do not fuse neutral or grounded conductors. All fuses should be normal blow ceramic 3AG, ABC or equivalent. (See Table 6 on page 10)

**TABLE 6. ARMATURE FUSE CHART**

90VDC MOTOR HORSEPOWER	180VDC MOTOR HORSEPOWER	APPROX. DC MOTOR CURRENT (AMPS)	FUSE RATING (AC AMPS)
1/30	1/15	.33	1/2
1/20	1/10	.5	3/4
1/15	1/8	.85	1
1/12	1/6	.85	1-1/4
1/8	1/4	1.3	2
1/6	1/3	1.7	2-1/2
1/4	1/2	2.5	4
1/3	3/4	3.3	5
1/2	1	5.0	8
3/4	1-1/2	7.5	12*
1	2	10.0	15
1-1/2	3	15.0	25*

\* Also used as AC Line Fuse.

**NOTES:**  
1. AC Line Fuse is chosen according to the maximum rating of the control:  
12 Amp fuse for all motors up to 3/4 HP-90V and 1 1/2 HP-180VDC.  
25 Amp fuse for all motors 1 and 1 1/2 HP-90V and 2 and 3 HP-180VDC.  
(Use Buss ABC, Litt. 326 ceramic fuse or equivalent.)

2. Armature Fuse can be chosen in accordance with the fuse chart. Note: The armature fuse is calculated based on the approximate full load DC current rating of the motor times a form factor of 1.5. If motor has characteristics not consistent with these approximations, a different fuse value may have to be used. Fuses are available from your distributor. Also available is a Fuse Kit (KB Part #9570) containing 700 assorted fuses.

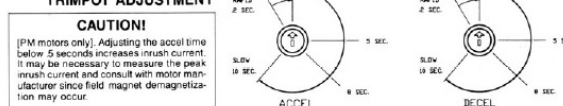
**SECTION III—ADJUSTMENTS AND CONTROL FUNCTIONS**—See Safety Warning Page 18

The KBPB has been factory adjusted to provide 0-full speed using the speed control knob. Minimum and Maximum speed trim pots are provided to change the speed from other than 0-full speed. The Acceleration (ACCEL) trimpot is provided to allow for a smooth start over an adjustable time period each time the AC power is applied or the speed pot is rotated. The DECEL trimpot controls the amount of ramp-down time when the speed pot is adjusted to a lower speed. **Note:** If P<sub>2</sub> is connected to P<sub>1</sub>, or the enable lead, P<sub>3</sub>, is opened, the control will ramp down to the MIN speed trimpot setting. If I<sub>1</sub> is shorted to I<sub>2</sub>, the control will coast down to zero speed. The Current Limit (CL or torque output) adjustment is factory set to approximately 1 1/2 times the motor rating. The IR Compensation (IR) is factory adjusted to provide excellent motor regulation under normal operation. The KBPB contains the KB APRM<sup>®</sup> which provides anti-plug "instant" reverse and solid state dynamic braking. The APRM<sup>®</sup> contains a trimpot which is used to preset a fixed speed for either the forward or reverse direction (see KBPB connection diagrams for additional information).

**NOTE:** In order for the IR comp and CL trimpot settings to be correct, the proper Plug-in Horsepower Resistor<sup>®</sup> must be installed for the particular motor and input voltage being used. Do not attempt to change the settings of the trim pots unless absolutely necessary since they are factory adjusted to near optimum settings.

The following procedure, presented in order of adjustment sequence, should be used when readjusting all trimpot functions:

**Fig. 4 ACCEL/DECEL TRIMPOT ADJUSTMENT**



**CAUTION!**  
[PM motors only] Adjusting the accel time below 5 seconds increases inrush current. It may be necessary to measure the peak inrush current and consult with motor manufacturer since field magnet demagnetization may occur.

3. Lock shaft of motor (be sure CL pot is in full CCW position). Apply power and rotate CL pot CW slowly until DC ammeter reads 1.5 times motor rating (do not exceed 2 times motor rating).

**NOTE:** If only an AC ammeter is available, it can be installed in series with AC input line. Follow above instructions; however, set AC amperage at .75 times motor rating.

**F. IR Compensation Adjustment.** IR compensation is provided to substantially improve load regulation. If the load presented to the motor does not vary substantially, the IR adjustment may be set at a minimum level (approximately 1/4 of full setting). The control is factory adjusted to approximately 3% regulation. If superior performance is desired (less than 1% speed change of base speed from 0 to full load), then the IR comp. should be adjusted as follows:

**NOTE:** Excessive IR comp. will cause control to become unstable, which causes motor cogging.

1. Set IR comp. trimpot at approximately 25% of CW rotation. Run motor unloaded at approximately 1/2 speed and record RPM.
2. Run motor with maximum load and adjust IR comp. trimpot so that the motor speed under load equals the unloaded speed per step 1.
3. Remove load and recheck unloaded RPM. If unloaded RPM has shifted, repeat procedure for more exact regulation.

The KBPB is now compensated to provide minimal speed change under large variations of applied load.

**SECTION IV. KBPB APPLICATION INFORMATION**

The KBPB is designed to offer a variety of switching functions. The APRM<sup>®</sup> module is the interface between command signals and the KBMM speed control module. By using terminals S<sub>1</sub>, S<sub>2</sub> and S<sub>3</sub> the KBPB can be made to perform the following functions: Run-Brake, Forward-Brake-Reverse and Forward-Reverse (instant anti-plug reverse). Terminal S<sub>4</sub> is used to supply a control voltage which is adjustable with the APRM<sup>®</sup> trimpot R11. This voltage is used to preset a

**A. Acceleration Start.** The ACCEL is factory set at approx. 1 second. To readjust to different times, set the knob to the desired position as indicated in Fig. 4.

**B. Deceleration.** The DECEL is factory set to provide minimum ramp-down time. To increase the ramp-down time adjust the DECEL trimpot as indicated in Fig. 4.

**C. Maximum Speed Adjustment.** Turn Speed Control Knob to full speed (maximum CW position). Adjust max. speed trimpot to new desired setting.

**NOTE:** Do not attempt to adjust the max. speed above the rated motor RPM since unstable motor operation may occur. For moderate changes in the max. speed, there will be a slight effect on the min. speed setting when the min. speed is set at zero. There may be a significant variation in the min. speed setting if the min. speed is at a higher than zero setting.

**D. Minimum Speed Adjustment.** If a higher than zero minimum speed is desired, readjust the minimum speed by turning the speed control knob to zero setting (full CCW position). Then adjust the min. speed trimpot to the desired setting.

**NOTE:** The min. speed adjustment will affect the max. speed setting. Therefore, it is necessary to readjust the max. speed after the min. speed, and it may be necessary to repeat the sequence until both the min. and max. speeds are set to desired levels.

**E. Current Limit (CL/Torque Adjustment).** CL circuitry is provided to protect the motor and control against overloads and demagnetization of PM motors. The CL also limits the inrush current to a safe level during startup. The CL is factory set to approximately 1.5 times the full load rating of the motor. (CL trimpot is nominally set to approx. 65% of full CW rotation.)

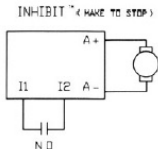
**NOTE:** The correct value Plug-in Horsepower Resistor<sup>®</sup> must be installed in order for the CL and IR comp. to operate properly.

**To set the CL to factory specifications adjust as follows:**

1. Set speed control knob at approximately 30–50% CW rotation. Set CL trimpot to full CCW position.
2. Connect a DC ammeter in series with the armature lead.

Jog or Run speed, either in Forward or Reverse direction. (DECEL Trimpot does not affect the brake time.)

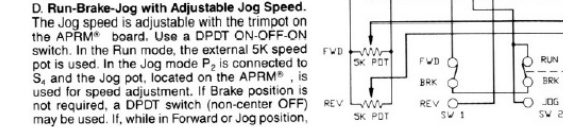
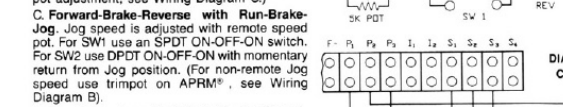
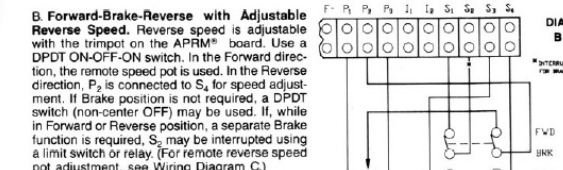
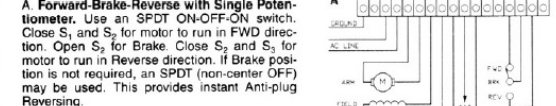
In order for the KBPB control to drive a motor, S<sub>1</sub> and S<sub>2</sub> must be connected together for Forward and S<sub>3</sub> and S<sub>4</sub> must be connected together for Reverse. If no connection is made to S<sub>3</sub>, the control will be in a "Brake" mode. The brake circuit consists of an SCR and dynamic brake resistor (RB). An LED indicator on the APRM<sup>®</sup> shows that power is applied to the SCR gate. If braking is not required, the wire to RB must be disconnected. (Note that the LED will still light with RB disconnected.)



**INHIBIT<sup>®</sup>** Terminals I<sub>1</sub> and I<sub>2</sub> provide an inhibit<sup>®</sup> function which electronically extinguishes the output of the control. This circuit is activated by connecting the I<sub>1</sub> and I<sub>2</sub> terminals together. When installing the KBPB be sure to follow the mounting and wiring instructions found in Sec. II.

**NOTE:** When switching terminals S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>, S<sub>4</sub> approximately 10ma of current with full motor voltage may be present. Other terminals (I<sub>1</sub>, I<sub>2</sub>, P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, and S<sub>4</sub>) are low voltage to each other, but line voltage to ground. Any switch or relay can be used for switching except solid state relays or contacts with R-C networks (snubbers). S<sub>1</sub> and S<sub>2</sub> must be opened before S<sub>3</sub> and S<sub>4</sub> are closed and vice versa.

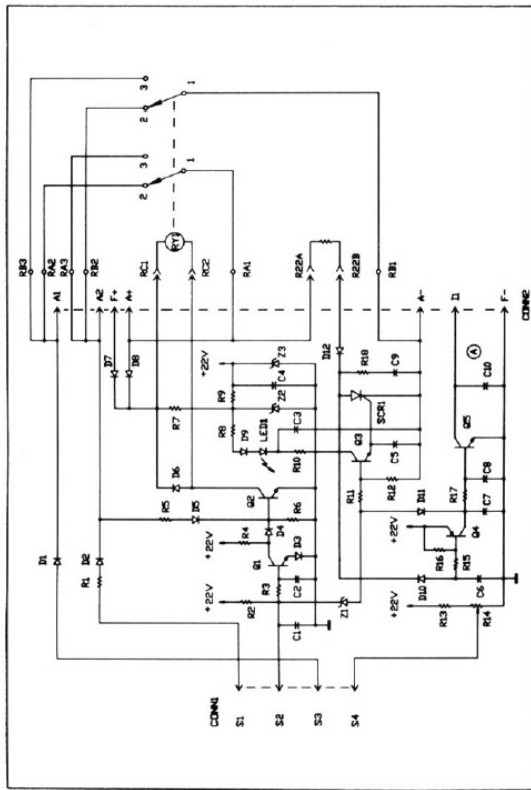
The following wiring diagrams are presented to demonstrate the capabilities of the KBPB.







SECTION IV. (C) APRM® SCHEMATIC—(patented)



SEC. VI. (D) 120V SPEED CONTROL MODULE PARTS LIST

CKT. REF.	VALUE/RATING	MFG. TYPE	FUNCTION
C1	0.01 ufd-25V	Ceramic Tubular	Capacitor
C14-16,18	0.01 ufd-25V	Ceramic Tubular	Capacitor
C2	1.5 ufd-50V	Electrolytic	Capacitor
C3	0.47 ufd-50V	Film/Mylar	Capacitor
C4	0.33 ufd-50V	Metal Film	Capacitor
C5	0.033 ufd-50V	Metal Film	Capacitor
C6,8,10,12,24	0.022 ufd-25V	Ceramic Tubular	Capacitor
C7	0.1 ufd-50V	Metal Film	Capacitor
C11,13	4.7 ufd-50V	Electrolytic	Capacitor
C17	100-0 ufd-55V	Electrolytic	Capacitor
C19	100-0 ufd-50V	Electrolytic	Capacitor
C20	0.047 ufd-50V	Metal Film	Capacitor
C21,23	1 ufd-250VDC	Metal Film	Capacitor
C22	0.022 ufd-50V	Metal Film	Capacitor
D1-D10	1A-600V	Diode	Diode
D11,12	1.5A-600V	Power Diode	Power Diode
D13, D14	25A-600V	Diode	Diode
D15	15A-600V	Power Diode	Power Diode
IC1		Integ. Op-Amp	Integ. Op-Amp
IC2		Integ. Op-Amp	Integ. Op-Amp
J1		Jump	Jump
J2		Jump	Jump
J3		Jump	Jump
J4		Jump	Jump
J5		Jump	Jump
J6		Jump	Jump
J7		Jump	Jump
J8		Jump	Jump
J9		Jump	Jump
J10		Jump	Jump
J11		Jump	Jump
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J387		Jump	



# DIGITAL TACHOMETER SENSOR KITS

## POWER/MATION

W238 N 1690 Rockwood Drive  
Waukesha, WI 53188  
Phone: (414)523-0600  
800-242-2060  
Fax: (414) 523-0611

### SPECIFICATIONS

**INPUT:** 5-16VDC

**OUTPUT:** NPN, 20ma

**TEMPERATURE:** Minus 40°F to plus 225°F

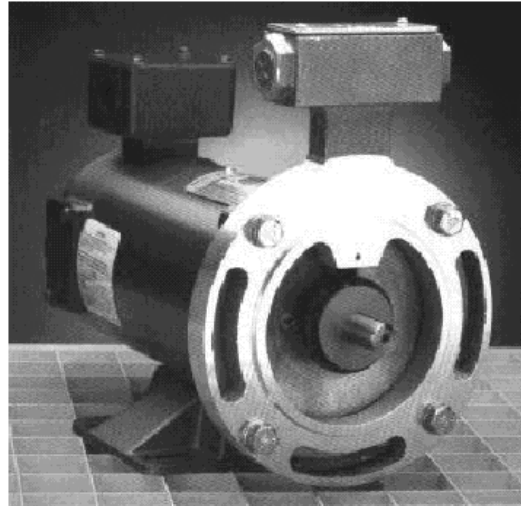
**OUTPUT CONNECTION:** Three Wire

**PULSES PER REVOLUTION (ppr):** 1 \*

**WAVE FROM:** Square Wave

**ENVIRONMENT:** Impervious to dust, oil & water

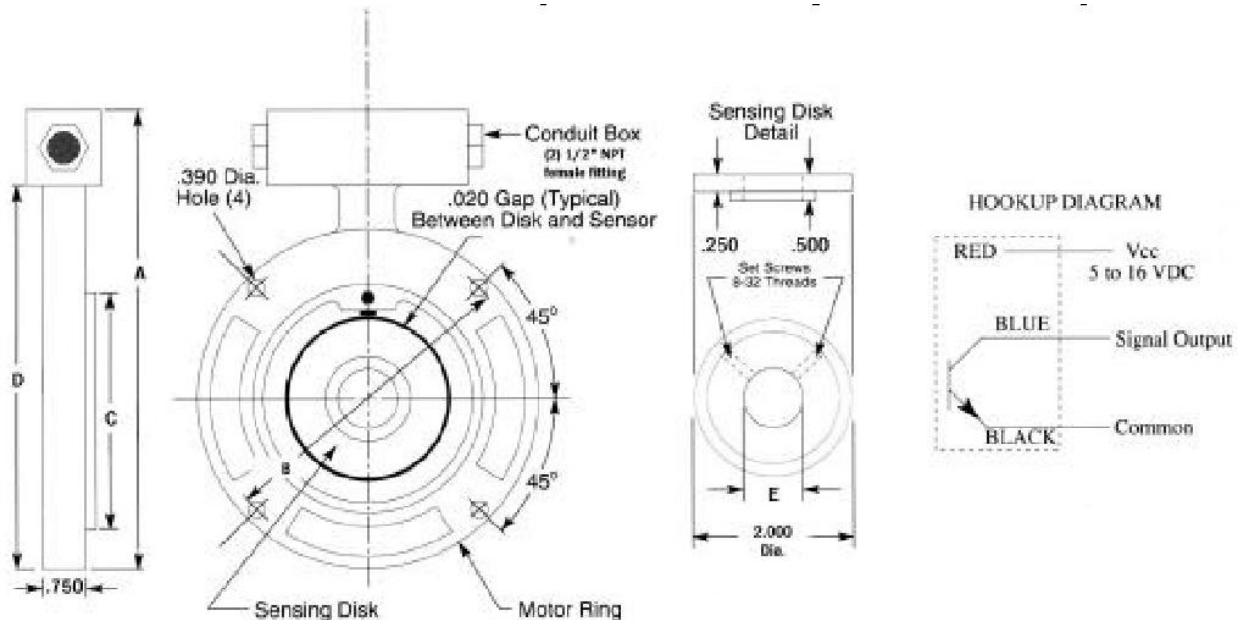
\* 2, 15 & 60 ppr models are available



## ORDERING CHART

MOTOR FRAME SIZE	KIT MODEL NUMBER	DIMENSIONS				
		A	B	C	D	E
56C	DTK-056 M1	9.375	5.875	4.500	7.875	5/8"
143TC, 145TC, 182C & 184C	DTK-184 M1	9.375	5.875	4.500	7.875	5/8"
182TC, 184TC, 213C, 215C & 254C	DTK-215 M1	12.312	7.250	8.500	10	1-1/8"
213TC, 215TC, 254UC & 256UC	DTK-254 M1	12.312	7.250	8.500	10	1-3/8"
254TC & 256TC	DTK-256 M1	12.312	7.250	8.500	10	1-5/8"

NOTE: Kits consist of motor face ring, sensor, mounting bolts and sensing wheel.



NOTE: To interface sensor to controller, use a shielded triple (18-22 AWG) with bare drain wire, such as Belden 8772.

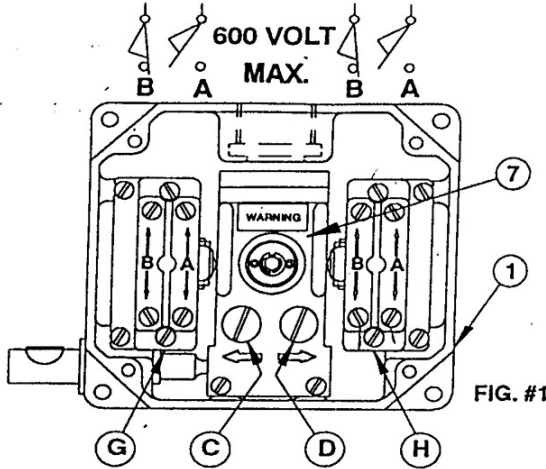


**Rotary Limit Switch**

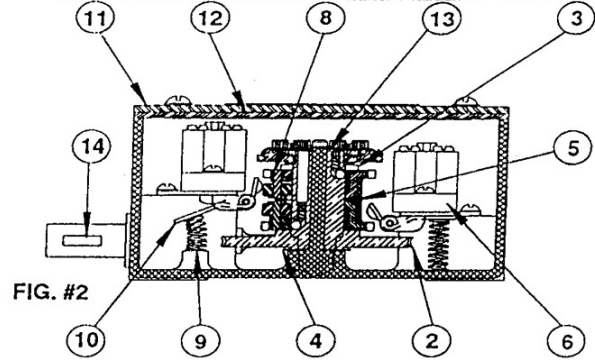
**INSTRUCTION SHEET 2006 2 CIRCUIT UNIT**

1080 N. Crooks Road Clawson, MI 48017  
 TEL. (810) 438-0700 FAX (810) 435-8120

Contact positions shown are when cams ARE NOT actuating levers.



Nominal Input Shaft to Cam Ratio	Turns of Input Shaft			
	Maximum	Minimum	Over Travel	To Reset
5:1	4	1/8	1/8	1/16
10:1	8-1/2	1/4	1/4	1/8
20:1	17	1/2	1/2	1/4
30:1	26	1	3/4	3/8
40:1	35	1	1	1/2
60:1	53	2	2	3/4
80:1	72	2-1/2	2-1/2	1
120:1	100	3	3	1-1/2



**DESCRIPTION**

This rotary limit switch is designed to control the limits of travel of rotating reversing equipment. The limit switch input shaft is connected to a worm gear. Adjustable self lubricating nylon roller cams are concentrically mounted to the worm gear. These adjustable cams actuate the precision limit switches by utilizing a lever assembly.

**INSTALLATION**

This limit switch may be mounted in any convenient position. When installed this limit switch will provide long life with a minimum amount of service maintenance.

The following recommendations will prove helpful.

- 1 - Install the limit switch so that the shaft load will not exceed (5) five pounds.
- 2 - A flexible coupling is recommended for all installation other than gear drive application.
- 3 - Coupling should be employed in a manner that results in a minimum of thrust loading on the shaft. If switches are mounted with the shaft up or down, some additional thrust loading resulting from the weight of the shaft plus a very light coupling is permissible.
- 4 - Whenever possible, a separate support bearing for the drive sprocket should be used.
- 5 - Permissible speed of the input shaft 2000 R.P.M.

**LUBRICATION**

This limit switch was lubricated at the factory and should not require lubrication for the life of the switch.

**ADJUSTMENT**

Refer to figure 1. The electrical switch units "G" and "H" are shown with the contact positions assumed when the cams are not actuating the switch units.

When the cam rotates and actuates the switch, the "B" (closed) contact opens and the "A" (open) contact closes. Each precision switch has (1) one independent adjustable cam.

**TO ADJUST SWITCH "G"**

1. Loosen Red Set Screw
2. Turn "C" to Trip "G"
3. Tighten Red Set Screw

**TO ADJUST SWITCH "H"**

1. Loosen Blue Set Screw
2. Turn "D" to Trip "H"
3. Tighten Blue Set Screw

**WARNING:**  
 LOOSEN CAM SET SCREW BEFORE ADJUSTING OR DAMAGE OF CAMS WILL OCCUR

**RENEWAL PARTS**

When ordering Renewal Parts give this form No. PF-046, Item No., Description, Part No., Quantity, and the Complete Unit Number stamped on the label. Reference FIG. #1 and FIG. #2 above.

ITEM	DESCRIPTION	PART NUMBER	QTY.
1	Case and Shaft assembly .....		1
	5:1 Ratio .....	PSD-0091300-DN	.....
	10:1 Ratio .....	PSD-0091400-DN	.....
	20:1 Ratio .....	PSD-0091500-DN	.....
	30:1 Ratio .....	PSD-0091600-DN	.....
	40:1 Ratio .....	PSD-0091700-DN	.....
	60:1 Ratio .....	PSD-0091800-DN	.....
	80:1 Ratio .....	PSD-0091900-DN	.....
2	Cam block & Worm Gear assy.		1
	5:1 Ratio .....	PSD-0090500-DN	.....
	10:1 Ratio .....	PSD-0090600-DN	.....
	20:1 Ratio .....	PSD-0090700-DN	.....
	30:1 Ratio .....	PSD-0090800-DN	.....
	40:1 Ratio .....	PSD-0090900-DN	.....
	60:1 Ratio .....	PSD-0091000-DN	.....
	80:1 Ratio .....	PSD-0091100-DN	.....
3	Shim Cam Block (.080 THK.)..	PS-0003300-A	1
	Shim Cam Block (.020 THK.)..	PS-0000800-A	1
5	Shim Cam Block (.016 THK.)..	PS-0003200-A	2
	Limit Switch Standard S.P.D.T.	1950-1-A-B-DO	2
6	Optional D.P.D.T.	1950-4-A-B-DO	.....
	Optional S.M.S.B.	1950-1408	.....
	Adjusting Bracket Assembly ..	PSD-0024600-B	1
8	Gear and Roller Assembly .....	PSD-00904-00-A	2
9	Spring, Compression .....	PM-0018000-A	2
10	Lever Assembly .....	PSD-0024400-A	2
11	Cover .....	PC-0069100-A	1
12	Cover Gasket .....	PS-0000900-A	1
13	Spacer Center Post .....	M-0073000-A	1
14	Woodruff Key (#404) .....	04-564019-DN	1

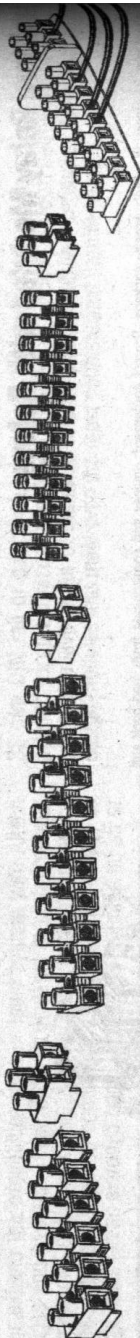
FORM PF-046  
 REV. "A" 10/94  
 OCT. 1990

# Altech Corp.

## Eurostrips®

### CN-TS6\_4WP

# Eurostrips®, Panel Mount Terminal Blocks and Ceramic Euroblock



Compact, easy to use double row tubular screw terminal strips are a safe, cost effective alternative to barrier strips. Ideal for HVAC, appliance, power distribution and more. Dead front design. Supplied with wire protector. White polyamide 6.6 housing. Strips are easily cut to the desired number of poles.

**TS6 Flat Base (Continued)**  
 300 V, 40 A, 18-10 AWG. Pole Spacing: 12 mm (0.47"). Mounting Hole Diameter: 4.2 mm (0.17"). Width: 23 mm (0.91")

Stock No.	Mfr.'s Type	Part No.	No. of Poles	Length mm (in.)	EACH	
					1-99	100-499
502-1402	TS6/5WP	40.405	5	56.0 (2.21)	1.47	1.24
502-1403	TS6/6WP	40.406	6	68.0 (2.68)	1.76	1.48
502-1404	TS6/7WP	40.407	7	80.0 (3.15)	2.02	1.74
502-1405	TS6/8WP	40.408	8	92.0 (3.62)	2.31	1.98
502-1406	TS6/9WP	40.409	9	104.0 (4.10)	2.59	2.22
502-1407	TS6/10WP	40.410	10	116.0 (4.57)	2.88	2.47
502-1408	TS6/11WP	40.411	11	128.0 (5.04)	3.17	2.73
502-1409	TS6/12WP	40.412	12	140.0 (5.51)	3.17	2.73

**TSF6 Standoff Feet**  
 600 V, 30 A, 18-10 AWG. Pole Spacing: 12 mm (0.47"). Mounting Hole Diameter: 4.2 mm (0.16"). Width: 23.0 mm (0.91")

Stock No.	Mfr.'s Type	Part No.	No. of Poles	Length mm (in.)	EACH	
					1-99	100-499
502-1482	TSF6/2WP	40.502	2	20.0 (0.79)	.60	.50
502-1483	TSF6/3WP	40.503	3	32.0 (1.26)	.91	.77
502-1484	TSF6/4WP	40.504	4	44.0 (1.73)	1.21	1.02
502-1485	TSF6/5WP	40.505	5	56.0 (2.20)	1.52	1.27
502-1486	TSF6/6WP	40.506	6	68.0 (2.68)	1.82	1.54
502-1487	TSF6/7WP	40.507	7	80.0 (3.15)	2.12	1.79
502-1488	TSF6/8WP	40.508	8	92.0 (3.62)	2.38	2.04
502-1489	TSF6/9WP	40.509	9	104.0 (4.10)	2.67	2.29
502-1490	TSF6/10WP	40.510	10	116.0 (4.57)	2.97	2.56
502-1491	TSF6/11WP	40.511	11	128.0 (5.04)	3.28	2.81
502-1492	TSF6/12WP	40.512	12	140.0 (5.51)	3.28	2.81

**TSF16 Standoff Feet**  
 600 V, 63 A, 14-6 AWG. Pole Spacing: 15 mm (0.59"). Mounting Hole Diameter: 4 mm (0.16"). Width: 26.5 mm (1.04")

Stock No.	Mfr.'s Type	Part No.	No. of Poles	Length mm (in.)	EACH	
					1-99	100-499
502-1533	TSF16/2WP	40.702	2	25.0 (0.98)	1.44	1.21
502-1535	TSF16/3WP	40.703	3	40.0 (1.58)	2.16	1.82
502-1537	TSF16/4WP	40.704	4	55.0 (2.17)	2.83	2.42
502-1541	TSF16/5WP	40.705	5	70.5 (2.78)	3.54	3.04
502-1539	TSF16/9WP	40.709	9	131.0 (5.16)	6.24	5.48
502-1542	TSF16/12WP	40.712	12	176.0 (6.93)	7.63	6.88

**TS1.5 Flat Base**  
 300 V, 15 A, 20-14 AWG. Pole Spacing: 8 mm (0.32"). Mounting Hole Diameter: 2.8 mm (0.11"). Width: 18.2 mm (0.72")

Stock No.	Mfr.'s Type	Part No.	No. of Poles	Length mm (in.)	EACH	
					1-99	100-499
502-1402	TS1.5/2WP	40.002	2	13.6 (0.53)	.43	.36
502-1403	TS1.5/3WP	40.003	3	21.5 (0.85)	.65	.56
502-1404	TS1.5/4WP	40.004	4	29.5 (1.16)	.87	.73
502-1405	TS1.5/5WP	40.005	5	37.4 (1.47)	1.08	.91
502-1406	TS1.5/6WP	40.006	6	45.4 (1.79)	1.30	1.10
502-1407	TS1.5/7WP	40.007	7	53.3 (2.10)	1.52	1.27
502-1408	TS1.5/8WP	40.008	8	61.3 (2.41)	1.74	1.48
502-1409	TS1.5/9WP	40.009	9	69.2 (2.72)	1.95	1.65
502-1410	TS1.5/10WP	40.010	10	77.2 (3.04)	2.13	1.83
502-1411	TS1.5/11WP	40.011	11	85.1 (3.35)	2.29	1.97
502-1412	TS1.5/12WP	40.012	12	93.0 (3.66)	2.34	2.01

**TS2.5 Flat Base**  
 300 V, 30 A, 18-12 AWG. Pole Spacing: 10 mm (0.39"). Mounting Hole Diameter: 3.5 mm (1.4"). Width: 22.3 mm (0.88")

Stock No.	Mfr.'s Type	Part No.	No. of Poles	Length mm (in.)	EACH	
					1-99	100-499
502-1422	TS2.5/2WP	40.202	2	17.0 (0.67)	.45	.37
502-1423	TS2.5/3WP	40.203	3	27.0 (1.06)	.67	.57
502-1424	TS2.5/4WP	40.204	4	37.0 (1.46)	.89	.75
502-1425	TS2.5/5WP	40.205	5	47.0 (1.85)	1.11	.94
502-1426	TS2.5/6WP	40.206	6	57.0 (2.24)	1.34	1.13
502-1427	TS2.5/7WP	40.207	7	67.0 (2.64)	1.56	1.31
502-1428	TS2.5/8WP	40.208	8	77.0 (3.03)	1.78	1.50
502-1429	TS2.5/9WP	40.209	9	87.0 (3.43)	2.00	1.69
502-1430	TS2.5/10WP	40.210	10	97.0 (3.82)	2.18	1.88
502-1431	TS2.5/11WP	40.211	11	107.0 (4.21)	2.40	2.06
502-1432	TS2.5/12WP	40.212	12	117.0 (4.61)	2.40	2.06

**TS6 Flat Base**  
 300 V, 40 A, 18-10 AWG. Pole Spacing: 12 mm (0.47"). Mounting Hole Diameter: 4.2 mm (0.17"). Width: 23 mm (0.91")

Stock No.	Mfr.'s Type	Part No.	No. of Poles	Length mm (in.)	EACH	
					1-99	100-499
502-1442	TS6/2WP	40.402	2	20.0 (0.79)	.58	.49
502-1443	TS6/3WP	40.403	3	32.0 (1.26)	.88	.74
502-1444	TS6/4WP	40.404	4	44.0 (1.73)	1.18	.99



English

WIRING (Reference Page 11)

- 1. All wiring must comply with applicable local codes and ordinances.
- 2. Connect the heater leadwires to the proper A.C. power source.
- 3. The heater must be properly grounded.


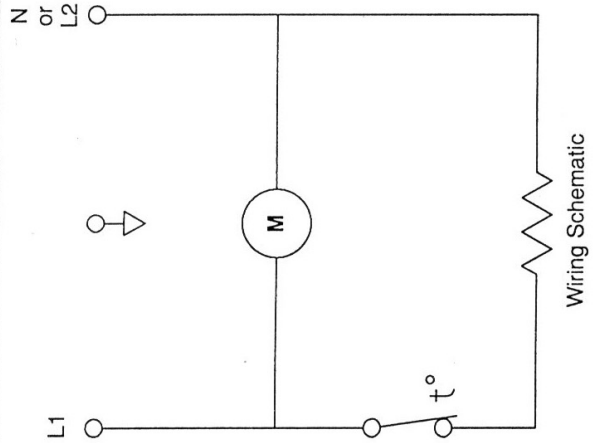
NOTE: Exposed wires should not come in contact with the heater housing.

MAINTENANCE

- 1. Always disconnect power supply before inspecting or working on the heater.
- 2. Generally the unit requires no maintenance since the bearings are permanently lubricated and sealed. The fan cannot be field serviced; it should be replaced if defective. Contact Hoffman Enclosures Inc. for replacement parts.

**⚠ WARNING**

To avoid electric shock, do not energize any circuits before all internal and external electrical and mechanical clearances are checked to assure that all assembled equipment functions safely and properly.

Wiring Schematic

Electric Heater  
 Elektrisches Heizgerät  
 Réchauffeur électrique

