

Research Concepts RC2500 Antenna Interface Unit (AIU) Board Set

A board set has been developed that can be incorporated into an AIU for an RC2500 antenna controller. This board set is the basis of RC2500 AIU's designed by RCI and will be offered to OEM customers that build their own AIU's for use with RC2500's.

The board set consists of two circuit boards. One is designated the Relay Board and the other is referred to as the Local Jog Control Board. The board set is designed to interface with the Vertex7134 compatible, individual limits version of the RC2500.

The board set can form the basis of AIU's with the following capabilities.

- Az/EI Motor Drive Support - Supports either Contactors, AC Inverter, or SCR based variable speed DC motor drives. A single DC drive can be shared by the azimuth and elevation axis.
- Az/EI Speed Control - User adjustable fast and slow speeds for azimuth and elevation drives with 'follow pot' based speed control. Contact closure based speed selection schemes can also be supported.
- Can be configured (via a jumper) to support simultaneous movement of both the azimuth and elevation axis. Invalid commands are locked out (i.e. simultaneous Az CW and Az CCW not allowed).
- Local or remote control of the antenna. Local refers to local jog control from the AIU. Remote refers to control by the RC2500. Local controls include Az CW/CCW, EI Up/Down, Pol CW/CCW, Az/EI Fast/Slow, and Local/Remote. Limits are displayed on the local jog panel.

Relay Board

The Relay Board has a 12" x 12" footprint. The board is powered by 24 volts DC and interfaces to the RC2500 control outputs and limit indication/status inputs, Az/EI/Pol motor drives, and antenna limit switches.

RC2500 Control/Limit Interface

The Relay Board interfaces to the RC2500 control and limit indication circuits via a pair of low current, clamp style terminal strips. For most AIU designs 25 conductor, 22 AWG, shielded cable can be used to interface the RC2500 to the AIU (Belden 9948). The drain wire should be connected at the Relay Board (via the J4 or J6 SHEILD terminals) and open circuited at the controller (place heat shrink tubing over the break in the insulation at the controller end of the cable to prevent the shielding or drain wire from coming in contact with earth ground). Note that 25 conductors may not be sufficient for designs that report Az/EI Drive Alarm status, support an Az/EI Drive Reset capability, AND report the status of the Emergency Switch input.

Az/EI Motor Drives

The Relay Board Az/EI drive control outputs consist of contact closures for Az CCW, Az CW, EI Down, and EI Up. When azimuth or elevation movement is requested either by the controller or the Local Jog Control Board the corresponding contact closure will close. If the jumper labeled J16 shorts the contacts labeled 1 and 3 simultaneous azimuth and elevation movement is allowed. If the jumper shorts the 2 and 3 positions simultaneous az/el movement is not allowed.

The Relay Board contains 4 potentiometers for az/el speed control labeled Az Fast, Az Slow, El Fast, and El Slow. Many motor drives support speed control via an isolated potentiometer (here, isolated means that voltages on the pots are galvanically isolated from all other signals on the Relay Board). The drive produces a reference voltage that is impressed across the potentiometer. The speed of the motor varies as the voltage on the wiper of the pot is varied. NOTE THAT ON MANY DRIVES THE VOLTAGE APPLIED TO AT LEAST ONE SPEED POT TERMINAL IS AT OR NEAR THE LINE VOLTAGE. The drive's speed control signals interface to the Relay Board via the Drive Speed Control connector (J2). The azimuth drive's reference voltage is applied to the Relay Board Az Fast and Az Slow potentiometers. The Az Speed relay connects the wiper's of these pots to the Az Speed Com terminal of connector J2. The El Fast and El Slow pots are utilized in a similar manner.

External azimuth and elevation slow speed potentiometers can be employed if the onboard Az Slow and El Slow potentiometers are removed (interface the external potentiometers to the Relay board via the J1 SPD_CON_POT connector. External potentiometers can be mounted in a place where they are accessible to an operator at the AIU's Local Jog Control panel. The ability to interactively adjust the azimuth and elevation slow speeds is often useful when cutting antenna patterns.

The Relay Board's azimuth and elevation slow speed circuits can be modified to produce a form C relay output function. In this configuration, the Az Speed relay is used to selectively connect either the Az Speed 1 or Az Speed 2 terminals to the Az Speed Com terminal. To realize this configuration the Az Slow and Az Fast pots are removed along with resistors R3, R4, R9, and R12. The holes in the board that accept the wipers of the Az Slow, Az Fast, El Slow, and El Fast speed pots (the wiper is the center terminal of the pot) are jumpered to the holes in the board that accept the R3, R4, R9, and R12 resistors, respectively. Place the jumpers in the resistor holes that are electrically connected to terminals of the J2 connector. When configured in this manner, azimuth slow connects the Az Speed 2 terminal (J2) to the Az Speed Com terminal (J2), azimuth fast connects the Az Speed 1 to Az Speed Com, elevation slow connects El Speed 2 to El Speed Com, and elevation fast connects El Speed 1 to El Speed Com.

A Single DC Drive for Azimuth and Elevation

The Relay Board supports using a single, variable speed, DC drive to control both the azimuth and elevation motors. For a single DC drive configuration, the drive and az/el motors are interfaced to the Relay Board via connector J13. The drive outputs are routed to the az/el motors via latching relay K4. A latching relay is required to allow the drive's dynamic braking capability to be utilized by both axis. The KB Electronics model KBPB DC drive has been employed in a single az/el drive AIU.

For single DC az/el drive AIU's with potentiometer based speed control unique azimuth and elevation fast and slow speeds are supported. For this configuration the AZ SPEED COM and EL SPEED COM signals (on connector J2) are routed to the AZ/EL SPEED COM terminal via the EL SLCT 2 relay.

The following table lists which Relay Board components must be installed or removed to support single and dual az/el drive AIU's.

Relay Board Component and Function	Single Az/El Drive AIU Configuration	Dual Az/El Drive AIU Configuration
Jumper J16 – Enables/Disables Simultaneous Az/El	Must be in the 2-3 position to disable simultaneous az/el movement.	Simultaneous Az/El operation can either be enabled or disabled.

Operation		
Latching Relay K4	Must be installed.	Not used but does not have to be removed.
R31 and R32 – jumpers (zero ohm resistors)	May be installed if the DC drive supports potentiometer based speed control. If not present the user will have to parallel the Az Speed 1/EI Speed 1 and Az Speed 2/EI Speed 2 J2 connections.	Must be removed if each drive supports potentiometer based speed control.
EL SLCT 2 Relay	Must be installed to support unique az/el fast and slow speed operation on drives with potentiometer based speed control.	Not used but does not have to be removed.

Limit Switches

The Relay Board is designed to interface with limit switches that include BOTH normally open (NO) and normally closed (NC) contacts. In this discussion, NC refers to a contact that is closed when the antenna is within the antenna's operating region and opens when the limit is reached. NO has the opposite characteristic. The NC contacts are used to limit antenna motion and the NO contacts generate limit indications at the RC2500 and at the AIU's local control panel.

Az/EI Drive Alarm

The RC2500 supports azimuth and elevation drive alarm inputs. The Relay Board includes an optically isolated input circuit that can be configured to work with drives that indicate alarm status via NC or NO contact closures. The Relay Board's default configuration assumes that the drive indicates an alarm condition with a contact closure. Other alarm status output schemes can be accommodated. Contact the factory for more information.

Az/EI Drive Reset

The RC2500 supports a single Az/EI drive reset output. On the Relay Board this output activates a Double Pole, Double Throw, relay. This provides a pair of form C output contact sets.

Pol Drive

Polarization control is provided by two sets of form C relay contacts. One set of form C contacts is associated with Pol CCW movement and the other with Pol CW movement. This contact arrangement can directly drive DC polarization motors.

Local Jog Control Board

The Local Jog Control Board provides jog control of the antenna at the AIU and interfaces to the Relay Board via a 26 conductor ribbon cable. The dimensions of the board are 7" by 3". The board's user interface consists of 5 toggle switches and 8 light emitting diodes (LEDs). The Local Jog Control Board contains a Local/Remote (toggle) switch that determines whether the AIU is controlled via the RC2500 or onboard user interface. Az/EI/Pol jog control is provided by 3 momentary contact toggle

switches. Another toggle switch controls Az/El jog speed. Six of the LED's provide Az/El/Pol Limit indications. The other two LED's indicate Az/El drive alarm status.

RC2500 Interface to the AIU

This section describes the interface of the RC2500 (running the Vertex 7134 ACU compatible software with support for individual limits) to the Relay Board. The assumption here is that the AIU contains a 24 volt DC power supply that powers the RC2500 – AIU control loop and the Relay Board.

This section begins with a description of the controller's antenna I/O sub-systems and concludes with a discussion of the interactions between the controller and the AIU.

RC2500 Antenna Controller I/O

All controller output signals are optically isolated pull down (open collector) type current drivers. There are a number of terminals dedicated to the return signals associated with these pull down drivers. The controller's unregulated 24 volts DC power supply and return are available on the Auxiliary I/O connector (J6). In general, a separate 24 volt DC power supply should be employed to power the Relay Board.

The controller inputs are optically isolated. A current of approximately 1 milliamp (ma) will 'turn the input on'. The input circuits consist of 4.4 K ohms in series with the light emitting diode of an opto-isolator. Note that each input has a return associated with it. A given return may be connected to a number of 'inputs'. To interrupt the current for a given input circuit, the input or the return signal paths may be opened.

Note that some versions of the RC2500 documentation state that J6 is the Antenna I/O connector and J7 is the Auxiliary I/O connector. The labeling on the back of the controller lists J7 as the Antenna I/O connector and J6 as the Auxiliary I/O connector. The back panel is correct.

Here is a description of the signals present on the J7 Antenna I/O connector (D25 male on the controller) ...

Terminal	Signal Name	Description
1, 3, 4, 6, 7, 9	AZ CW, AZ CCW, EL UP, EL DOWN, POL CW, POL CCW respectively.	Pull down type current drivers. The controller turns the driver ON to command the antenna to move in the direction associated with the driver.
2, 5, 8	DRIVE COMMON	The return paths associated with the az, el, pol, az/el fast, and drive enable drivers. Note that this signal is also available on the controller's Auxiliary I/O connector (J6-9).
10	SUMMARY LIMIT INPUT	Summary/Azimuth CCW Limit. Versions of the RC2500 that are plug compatible with the Vertex 7134 interpret this signal as a Summary limit. When the current in this circuit is interrupted the controller assumes that one of the antenna's limit switches are active. When this input is asserted the controller displays the 'Summary Limit' alarm

Terminal	Signal Name	Description
		message. 'Individual limit input' versions of the software interpret this signal as the Azimuth CCW Limit input. Note that this signal is also present on the Auxiliary I/O connector (J6-16).
11, 12, 13	NO CONNECTS	Not Connected. These can be tied together with bus wire and used for wiring on the back of the J7 mating connector to simplify system interconnect.
14, 15	AZ DRIVE FAULT INPUT EL DRIVE FAULT INPUT	These inputs indicate the fault status of the azimuth and elevation drives. When current flows in these circuits the controller assumes that the drives are OK. The return current associated with these inputs returns via the SUMMARY LIMIT RETURN.
16	EMERGENCY STOP RETURN	This is the return associated with the Emergency Stop input.
17, 18	SUMMARY LIMIT RETURN	The return associated with the SUMMARY LIMIT and AZIM CCW LIMIT inputs. See the discussion of the SUMMARY LIMIT signal. Note that this signal is also present on the Auxiliary I/O connector (J6-4).
19	EMERGENCY STOP	Emergency Stop input. When current flows in this circuit the controller assumes that the AIU Emergency Stop is not active. If the controller senses that the Emergency Stop is active the controller disables antenna control and displays the 'Emergency Stop' message.
20	NO CONNECTS	Not Connected. Can be tied to the adjacent ESTOP terminal with bus wire and used for wiring on the back of the connector to simplify system interconnect.
21, 22	AZ FAST, EL FAST	Azimuth and elevation fast/slow current drivers. When fast speed is specified these drivers conduct. Return current flows out the Drive Common terminals.
23	DRIVE ENABLE	This output is used to reset the azimuth and elevation drives. The driver conducts when the antenna drives are enabled, the driver shuts off (does not conduct) to reset the azimuth and elevation motor drives. The return associated with this current driver is DRIVE COMMON.

Terminal	Signal Name	Description
24	MAINTENANCE	<p>Maintenance input. When current flows in the MAINTENANCE – MAINTENANCE RETURN circuit the controller assumes that the AIU is able to accept drive commands from the controller. If current is not flowing in the MAINTENANCE – MAINTENANCE RETURN circuit the controller disables antenna control and displays the 'Maintenance' alarm message.</p> <p>This terminal also powers all of the RC2500's isolated output drive circuits (AZ CCW/CW, EL DOWN/UP, POL CCW/CW, AZ/EL FAST, and DRIVE ENABLE). 17 to 27 volts DC is required to power the controller's output circuits. The current that powers the output drive circuits flows out of the DRIVE COMMON terminals.</p>
25	MAINTENANCE RETURN	The return associated with the MAINTENANCE input.

The following table discusses the signals on the RC2500's J6 Auxiliary I/O connector (D25 female on the controller) ...

Terminal	Signal Name	Description
4	AZ CCW LIMIT RETURN	This terminal is internally connected to the SUMMARY LIMIT RETURN signal of the Antenna I/O connector (J7-17,18).
3, 5, 6, 7, 8	AZ CW RETURN EL DOWN LIMIT RETURN EL UP LIMIT RETURN POL CW LIMIT RETURN POL CCW LIMIT RETURN (respectively)	These pins are the return signals associated with various limit inputs found on the J6 connector.
16	AZ CCW LIMIT	<p>Az CCW Limit input circuit. The interruption of current flow in this circuit is interpreted by the controller as a limit condition.</p> <p>This terminal is internally connected to the SUMMARY LIMIT input terminal found on the Antenna I/O connector (J7-10).</p>
15, 17, 18, 19,	AZ CW LIMIT INPUT EL DOWN LIMIT	Limit input circuits. The interruption of current flow in these circuits is interpreted by the controller as a

Terminal	Signal Name	Description
20	INPUT EL UP LIMIT INPUT POL CW LIMIT INPUT POL CCW LIMIT INPUT	limit condition.
9	DRIVE COMMON	This terminal is internally connected to the DRIVE COMMON terminals found on the Antenna I/O connector (J7-2, 5, 8).
13	GROUND	This terminal is tied (internally) to the ground return of the controller's 24 VDC unregulated power supply.
25	24 VDC	This terminal is (internally) tied to the controller's unregulated 24 volt DC power supply.

Controller - AIU Interaction

This section describes how the controller interfaces with the AIU. Three topics are covered here ...

1. Antenna Status/Limit Inputs and Control Outputs
2. Powering the controller's isolated output circuits and the monitoring the AIU's Local/Remote control switch.
3. Powering the Relay Board and Emergency Stop switch considerations.

Antenna Status/Limit Inputs and Control Outputs

The controller has optically isolated status/limit inputs and control outputs.

The controller's status input circuits detect current flow. Current flows into an input terminal, through a 2.2 K ohm protection resistor, through the light emitting diode associated with the opto-isolator, through another 2.2 K ohm protection resistor, and out the return terminal associated with the input. A current flow of 1 ma is sufficient to activate the current input. One ma corresponds to about 6 volts across the input circuit. The sense of the input is such that current flow is associated with a state where it is safe to move the antenna. The most common fault is an open circuit. An open circuit will interrupt current flow to provide fail safe operation.

The controller's output circuit's are open collector type with built in overcurrent and thermal protection. All collector current returns to the AIU via the three Drive Common lines. The maximum voltage on the driver is 27 volts (DC) and the maximum current is 700 ma. The isolated portion of the output driver IC's (integrated circuits) used in the RC2500 must be powered by the AIU. See the next section for details on this requirement.

Powering the Controller's Isolated Output Section and the AIU's Local/Remote Control Function

The controller has optically isolated outputs and inputs. As mentioned in the table above that documents the controller's J7 connector, the Maintenance input has two functions. Voltage applied to

the Maintenance input powers the controller's output circuits. A minimum of 17 volts DC and a maximum voltage of 27 volts DC is required to power the output circuits. The return path for the current that powers the drive circuitry is via the J7 Drive Common connections. The output circuitry's open collector outputs will only pull down if the output circuits are powered.

The other function of the Maintenance input is to show the Local/Remote status of the AIU. Local at the AIU corresponds to Maintenance for the controller. When the controller detects the Maintenance condition the 'MAINTENANCE ALARM' message is displayed by the controller. The maintenance status input circuit is optically isolated. The input current for the Maintenance status circuit is returned via the MAINT RETURN terminal of connector J7. A current flow of at least one milliamp in the input circuit is interpreted by the controller as the Maintenance condition not active.

The AIU's Local Jog Control Board contains a Local/Remote switch. When the switch is in the Remote position the controller's Drive Common lines are tied system ground (the low side of the 24 VDC power supply). This ties the emitter of the open collector drivers to AIU system ground and allows current to flow into the Maintenance input to power up the controller's output driver circuits.

When the AIU's Local/Remote switch is in the Local position the user can jog the antenna manually from the AIU. The Drive Common lines of the controller are allowed to float. This disables control of the AIU from the RC2500 by disconnecting the Drive Common lines from the AIU's. If the Maintenance Return terminal of the RC2500 is tied to one of the Drive Common lines current in Maintenance input circuit will be interrupted and the controller will display the 'MAINTENANCE ALARM' message.

Powering the Relay Board and Emergency Stop Switch Implementation

All AIU's should be equipped with an emergency stop switch. Typically it is a push type switch with a large, mushroom, shaped actuator. This type of switch is available in multi-pole configurations. Part of any emergency stop switch function should include removing power from the Relay Board and the controller's output drive circuits.

A qualified electrician or engineer familiar with local safety requirements and the az/el/pol motor drives employed by the AIU should be consulted as whether additional safety devices activated by the Emergency Stop switch are required.

The Relay Board is powered via the J14 Pwr_Conn terminal strip. A 24 volt DC power supply should be connected to the 24 VDC and 24 VDC RETURN terminals of that connector. To disable antenna movement initiated by both the local jog control panel and the RC2500 the emergency stop switch should remove the 24 volt DC power supply from the Relay Board. The maximum current draw of a Relay Board interfaced to an RC2500 and Local Jog Control Board is around 500 ma.

The controller's Emergency Stop input should be connected to one the Relay Board's J6 24VDC terminals. The controller's Emergency Stop Return line should be connected to the AIU's 24 volt DC power supply ground. AIU system ground is available at the Relay Board's ACU_LIM_INP (J6) connector on the three ACU LIM COM terminals. The AIU's ACU LIM COM lines are connected to the RC2500's AZ CW LIMIT RETURN, AZ CCW LIMIT RETURN, EL UP LIMIT RETURN, EL DOWN LIMIT RETURN, POL CW LIMIT RETURN, and POL CCW LIMIT RETURN terminals on the RC2500's J6 connector (the 'LIMIT RETURN signals are on adjacent pins of the J6 connector and can be connected together with bus wire). Note that the RC2500's J7 SUMMARY LIMIT RETURN terminal is connected internally to the RC2500's J6 AZ CCW LIMIT RETURN terminal. To connect the RC2500's EMERGENCY STOP RETURN signal to AIU system ground a jumper can be placed between the RC2500 J7 EMERGENCY STOP RETURN and SUMMARY LIMIT RETURN signals on the J7 mating connector.

The Relay Board J4, J6, and J13 connectors have SHIELD connections. All of the SHIELD terminals are routed to the J14 CHASSIS terminal. Also, if the J15 jumper is in place the SHIELD terminals are connected to the 24 VDC RETURN power supply return terminals. Note that one side of each of the MOV devices present on the board is also connected to the 24 VDC RETURN terminals.

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Document Revision History

7.13.00 – Original document, smm