RC3050 ANTENNA JOG CONTROLLER
USER'S MANUAL

Contents subject to change

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REVISION HISTORY

DATE	MODIFICATION	SOFTWARE VERSION
24 June 1999	Preliminary document	1.04
28 March 2000	Waveguide Switch	1.08
28 August 2001	Schematics Included In Electronic File of Manual; Data Test Sheet Updated	1.08
10 October 2002	AVL Mounting Specific Data updated	1.08
06 December 2007	Added Elevation Scale Factor Calculation and Setup	1.23

WARRANTY INFORMATION

Research Concepts, Inc. (RCI) warrants to the original purchaser, this product shall be free from defects in material and workmanship for one year, unless expressed otherwise, from the date of the original purchase.

During the warranty period, RCI will provide, free of charge, both parts and labor necessary to correct such defects.

To obtain such a warranty service, the original purchaser must:

(1)   Notify RCI as soon as possible after discovery of a possible defect, of:
    (a) the model and serial number
    (b) identify of the seller and date of purchase
    (c) detailed description of the problem, including details on the electrical connection to associated equipment and list of such equipment, and circumstances when problem arose.

(2)   Deliver the product to RCI, or ship the same in its original container or equivalent, fully insured and shipping charges prepaid.

Correct maintenance, repair, and use are important to obtain proper performance from this product. Therefore, read the instruction manual carefully and completely. This warranty does not apply to any defect that RCI determines is due to:
    - Improper maintenance or repair, including the installation of parts or accessories that do not conform to the quality and specifications of the original parts.
    - Misuse, abuse, neglect, or improper installation including disregard for installation of backup or safety override equipment.
    - Accidental or intentional damage.
    - Lightning or acts of God.

There are no implied warranties.

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1.0 INTRODUCTION

The RC3050 3-axis jog controller was designed to provide easy control of mobile satellite antennas. The RC3050 provides manual control of azimuth, elevation and polarization axes. Optionally the RC3050 may automatically stow and deploy the antenna and control a waveguide switch.

The design and function of the RC3050 is derived from the RC3000 Satellite Locator / Inclined Orbit Tracking Controller. The RC3050 may be upgraded to the RC3000 configuration.

PLEASE READ AND UNDERSTAND THE MANUAL. Time invested in understanding its installation and operation will be well spent.

1.1 Manual Organization

This manual contains five chapters and multiple appendices. Each chapter is divided into multiple sections.

This section (1.1) summarizes the contents of the remainder of the manual and the conventions and notations used throughout the manual. Section 1.2 highlights the functionality and features of the RC3050. Section 1.3 reviews the theory of the RC3050's operation and should be understood before installation and initial use of the RC3050.

Chapter 2 describes the installation and configuration procedures for the RC3050. The rest of the manual should be reviewed prior to installation in order to provide context for the installation procedures.

Chapter 3 provides detailed instructions on the operation of the RC3050. This chapter will describe the data presented and user action required for every operational screen.

Chapter 4 provides detailed specifications of the RC3050 along with associated schematics and drawings.

Chapter 5 covers RC3050 error conditions and provides help for system troubleshooting.

The appendices provide additional support for working with the RC3050:

Appendix A provides unique information for a specific mount or family of mounts. **Please refer to appendix A now to note what paragraphs in the base manual are different for your mount.**

Appendix B provides information on the DC motor controller.

MANUAL CONVENTIONS

Throughout the manual, representations of screens the user will see will be shown in the boxed format that follows:

```
        Az     El   Pol
 -123.4 –12.3 -12
 F   CCW   STOW CCW
```

Note that the "Az", "El" and "Pol" labels are permanently marked on the faceplate above the LCD screen.

The following table shows typical abbreviations used both on RC3050 screens and in the manual's text.

ITEM	ABREVIATION(S)
Azimuth	AZ AZIM, Azim
Elevation	EL ELEV, Elev
Polarization	PL POL, Pol
Clockwise	CW
Counter-Clockwise (Anti-Clockwise)	CCW
Down	DN
Latitude	LAT
Longitude	LON
Satellite	SAT
Liquid Crystal Display	LCD

When referring to a particular RC3050 mode of operation that mode's name will be capitalized – ex. AUTO.

1.2 RC3050 Features

The RC3050 antenna controller is designed to provide easy operation of mobile (both vehicle mounted and deployable) mounts. Features provided include:

- 3 axes jog operation
- Simultaneous azimuth, elevation and polarization angle display
- Optional automatic stow and deploy functions
- Optional hand-held remote interface
- Dual speed operation
- Dynamic braking and active IR compensation
- Battery backed-up non-volatile memory for calibration data
- Slim 2U rack mounted unit
- Continuous monitoring of antenna drive status
- 2 row x 16 column Liquid Crystal Display (LCD)
- 8 key keypad
- Upgradeable to the RC3000 Satellite Locator

The RC3050 supports mounts from multiple antenna manufacturers and provides optional software configurations. When the RC3050 is powered on, the following identification screen appears for three seconds.

```
RC3050B      V2S
(c)RCI'99   1.03
```

Hardware Configuration There are two basic versions of the RC3050 hardware. The "A" version is configured with circuitry to support mounts with low voltage (12-36 VDC) DC motors. The "B" version supports higher voltage (40-120 VDC) DC motors.

Software Configuration The software configuration is presented in the upper right corner:

  (Mount Manufacturer)(Model #)-(Jog/Stow)

Descriptions of the options are provided in the following table:

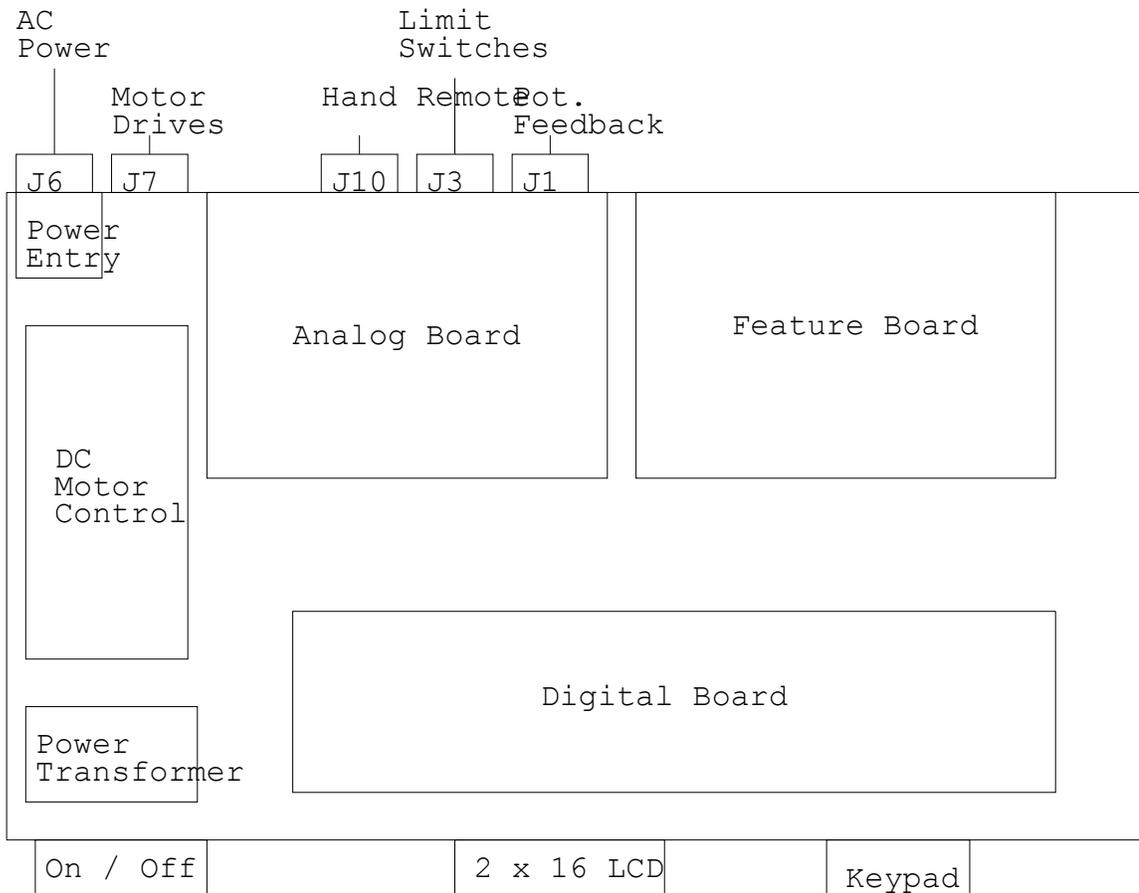| CATEGORY	DESIGNATION	DESCRIPTION
Hardware	A	Low Voltage DC
	B	High Voltage DC
Mount Manufacturer / Model #	A#	AVL Technologies
	V#	Vertex
Jog/Stow	J	Jog (No Stow/Deploy supported)
	S	Stow/Deploy
	W	Waveguide Switch (+Stow/Deploy)

The software version number is presented in the lower right corner.

1.3 Theory of Operation

The RC3050 performs its functions via digital and analog electronic equipment interfaced to the antenna's motor drive and position feedback systems. This equipment is controlled through embedded software algorithms run by the RC3050's microcontroller. This section provides an overview of the equipment, interfaces and major software functions.

1.3.1 Controller Description

The following figure is a block diagram showing the major components of the RC3050 :

```
AC                    Limit
Power                 Switches

        Motor         Hand Remote  Pot.
        Drives                     Feedback

  ┌────┐ ┌────┐       ┌────┐ ┌────┐ ┌────┐
  │ J6 │ │ J7 │       │ J10│ │ J3 │ │ J1 │
  ├────┴─┴────┼───────┴────┴─┴────┴─┴────┴──────────────────────┐
  │ Power     │  ┌─────────────────────┐  ┌────────────────────┐│
  │ Entry     │  │                     │  │                    ││
  └───────────┤  │                     │  │   Feature Board    ││
  ┌───────────┐  │   Analog Board      │  │                    ││
  │           │  │                     │  │                    ││
  │  DC       │  │                     │  │                    ││
  │  Motor    │  └─────────────────────┘  └────────────────────┘│
  │  Control  │                                                 │
  │           │  ┌──────────────────────────────────────┐      │
  └───────────┘  │                                      │      │
  ┌───────────┐  │          Digital Board               │      │
  │  Power     │  │                                      │      │
  │  Transformer │ └──────────────────────────────────────┘     │
  └───────────┘                                                 │
  ┌───────────┐       ┌────────────────┐     ┌────────┐         │
  │ On / Off  │       │  2 x 16 LCD    │     │ Keypad │         │
```

LIQUID CRYSTAL DISPLAY (LCD). The 2 row by 16 column LCD provides the user interface for monitoring the status of the RC3050 and for entering data.

KEYPAD. The 8 key keypad allows the user to enter data and commands to the RC3050.

DIGITAL BOARD.   The digital board is essentially a small computer containing a microcontroller, memory, real-time clock and circuitry to monitor and drive the keypad and LCD. The digital board performs the following major functions:

- monitors user inputs from the keypad
- displays information on the LCD screen according to controller mode, antenna status and user input
- monitors antenna drive status
- battery backs up non-volatile memory (calibration data, etc.)
- performs analog to digital conversion of drive position
- performs automatic antenna movement algorithms (stow, deploy)

FEATURE BOARD. The feature board contains circuitry to provide power transformation for supplying required voltages to other modules.

ANALOG BOARD. The analog board contains circuitry to control the antenna motors and condition antenna feedback signals. The analog board provides the following major functions:

- generation of azimuth and polarization limit indications based on sensed potentiometer feedback
- conditioning of elevation inclinometer input
- conditioning of azimuth stow and elevation up/down/stow limit switch inputs
- activation of relays (based on digital board control) to direct motor drive signals from the DC motor control module.

DC MOTOR CONTROL MODULE. The solid state DC motor speed and reversing control module contains circuitry for antenna motor regulation. This module provides:

- acceleration adjustment for smooth motor acceleration
- deceleration adjustment for ramp down time when motor speed lowered
- anti-plug instant reverse, solid state dynamic braking
- current limiting circuitry to protect the motor against overloads and demagnetization and to
 limit inrush current during startup
- IR compensation to improve load regulation

POWER ENTRY MODULE. The power entry module allows the RC3050 to be configured for 115 or 230 VAC operation.

POWER TRANSFORMER. The power supply module transforms AC input voltage to a regulated DC voltage for use by the digital and drive boards.

1.3.2 System Interface Requirements

The RC3050 is designed to interface with several different mobile antenna mounts. This manual attempts to describe installation and operation in a manner applicable to all mounts.

The typical interfaces required for the RC3050 to perform all its automatic functions are described in section 4.2 (External Interface Specifications). Known differences to these interfaces and how they are accommodated for a particular mount are described in appendix A (Mount Specific Data).

1.3.3 Operational Overview

The RC3050 allows easy antenna operation via its menu based user interface. The screen displayed to the user is based on the current controller mode. Controller modes are divided into two major groups - operational and programming. The operational modes provide for the normal operation of the antenna. The programming group provides for initial configuration of the controller and will typically not be used on a day by day basis. The following example highlights the basic modes of operation provided by the RC3050.

Operational Group Functions

MANUAL. After powering up, the RC3050 enters MANUAL mode. In MANUAL mode the user may jog the antenna in azimuth, elevation and polarization.

```
       Az     El   Pol
   180.0 -12.3 -90
 F   CW   DOWN CCW
```

AUTOMATIC STOW/DEPLOY. From the AUTO mode, the user may ask for the antenna to be automatically moved to the stow or deploy positions.

```
<UP>DEPLOY  AUTO
<DN>STOW
```

Programming Group Functions

The programming group modes provide for initial calibration of the controller and also provides a screen for resetting drive error conditions.

Calibration screens allow the user to calibrate the RC3050 for use with a particular mount.

```
AZIM VOLT:2.500
<UP>SET  (2.489)
```

1.3.4 Drive System

The RC3050 implements several mechanisms for the driving and monitoring of the azimuth, elevation and polarization axis.

Position Sensing and Limits

The RC3050 senses absolute axis position using feedback from potentiometers (inclinometer for elevation). The sensed voltage is scaled appropriately for the particular mount. This sensed position is displayed in angular format.

The bore sight of the antenna is displayed for the azimuth and elevation axis. In elevation, this angle is with respect to the local horizon. In azimuth, this angle is with respect to the centerline of azimuth travel.

The following diagram shows how the range of movement is limited by the RC3050.
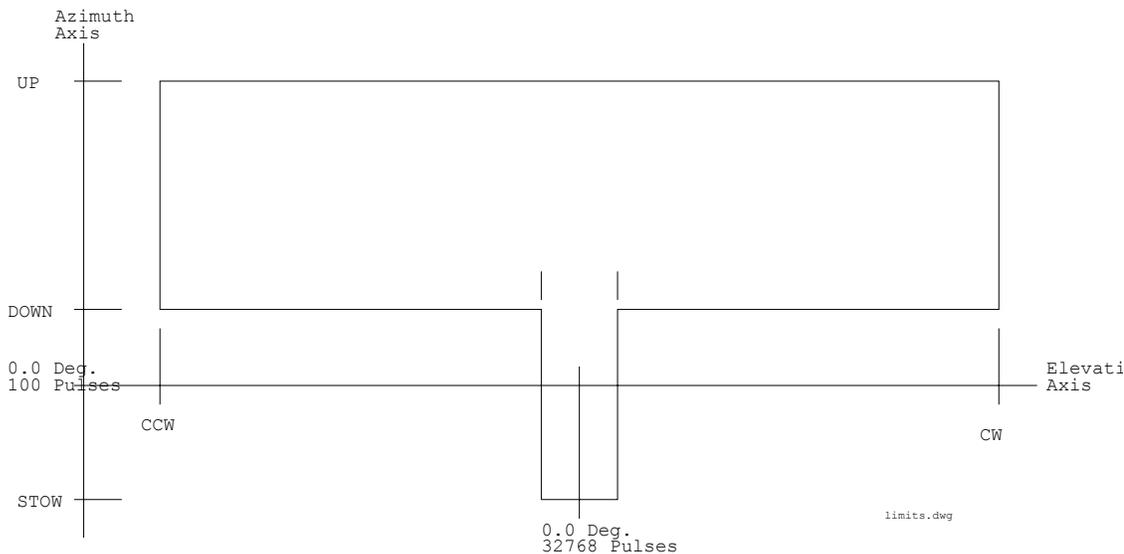
In the azimuth axis, movement in one direction is disabled when clockwise and counterclockwise limit switches are activated. There is also typically a region in the center of azimuth travel indicating that the azimuth axis is in a position that will allow for moving the elevation axis down to the stow position.

 In the elevation axis, there are typically three limit switches. The UP switch prevents further movement up. The "DOWN" switch delimits the elevation the mount may not move further downward unless it has been placed in the azimuth stow region. The STOW switch indicates when the mount has reached its furthest down position which is typically where the dish is stowed for travel.

Jam and Runaway Sensing

The RC3050 continuously monitors the axis positions to detect incorrect movement of the mount. If an axis has been commanded to move and the RC3050 does not detect movement within a prescribed time, the controller will declare a "JAM" condition and not allow further movement in that axis until the condition has been reset.

Anti-Reversal

In order to save wear on the drive motors, the RC3050 limits how fast an axis may reverse its direction. This mechanism prevents a motor from instantly changing direction before coasting to a stop in the original direction.

Automatic Movements

In order to provide smooth automatic movement to target positions, the RC3050 utilizes several parameters to account for different mount characteristics.
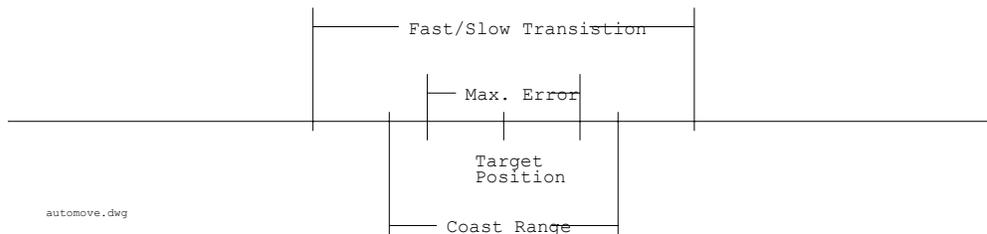
The Fast/Slow Transition parameter defines how far away from a target position the RC3050 will switch from fast to slow motor speed. The Coast Range defines where the RC3050 will deenergize the motor drive to allow the mounts inertia to coast into the target position. The Max Error parameter defines how close to the target position will be considered good enough.

Note that the DC motor control module in the RC3050 provides for smooth acceleration/deceleration, load regulation and dynamic braking of the motors.

1.3.5 System Performance

The performance achieved by the RC3050 is dependent on the mechanical tolerances of the mount, the correctness of the installation and the accuracy of the various sensors.

The RC3050 uses a 10 bit analog to digital converter (1024 cells) for measuring voltages from azimuth, elevation and polarization potentiometers. If ,for example, the azimuth axis has 360 degrees of travel; the resolution achieved is 360 / 1024 (approximately 0.35 degrees).

2.0 INSTALLATION

Proper installation is important if the full capability and accuracy of the RC3050 is to be realized. The procedures that follow will insure the optimum level of performance from all sensors and the system in general. Prior to installation, please review section 1.3.2 (System Interface Requirements) to verify the correct system interfaces are provided.

Installation will be more efficient if each step in the physical installation and calibration be performed in the order in which it appears in the following schedule. Each step is referenced to a particular section of this manual, and should be checked off as it is completed.

The installation procedures are written to cover the most common mount installations. Some steps are slightly different according to the type of mount the RC3050 is interfacing to.   Please review appendix A now for differences applicable to your mount.

SECTION	ACTION	COMPLETE
2.1 Equipment Mounting		
2.1.1	RC3050 Antenna Controller	
2.1.2	Inclinometer	
2.2 Electrical Connections		
2.2.1	Power Entry	
2.2.2	Motor Drive	
2.2.3	Drive Sense	
2.2.4	Limit Switches	
2.2.5	Waveguide Switch	
2.2.6	Hand Held Remote	
2.3 Calibration		
2.3.1	Version Verification	
2.3.2	Drive and Sensor Polarity	
2.3.3	Position Sensor Rigging	
2.3.4	Azimuth and Elevation Limits	
2.3.5	Fast/Slow Motor Speed	
2.3.6	Drive System Checkout	

Installation requires basic operational knowledge of the RC3050. Please review chapter 3 for information on how to navigate the RC3050's screens.

2.1 Equipment Mounting

This section describes the physical mounting requirements for the RC3050 and optional sensor units. Wiring requirements are discussed in section 2.2.

2.1.1 RC3050 Antenna Controller

NOTE: The RC3050 unit should not be installed in the rack until the final step of the Initial Configuration (section 2.3) because access to the interior of the unit may be necessary prior to that procedure. The cables may be run through the chosen location in the rack and connected to their respective components.

The RC3050 enclosure is a standard rack mount chassis that occupies two rack units (2U). The front panel is mounted via four (4) 10-32 screws. Due to the length and weight of the RC3050, much strain can be put on the faceplate particularly in a mobile unit. To help alleviate stress on the front panel mounting, additional mounting points accepting 10-32 screws are provided on each side, back and bottom of the unit. The user may use any of these additional mounting points to provide support for the RC3050 via strapping, shelving, etc. The additional mounting screws on the back of the unit may be also used to provide strain relief for cabling.

CAUTION: support of the back of the RC3050 is a requirement. RCI's warranty does not cover repair to units with ripped faceplates.

The RC3000's LCD is optimized for viewing from a 6 o'clock position. The optimum position to mount the unit would therefore be above the operator's eye level.
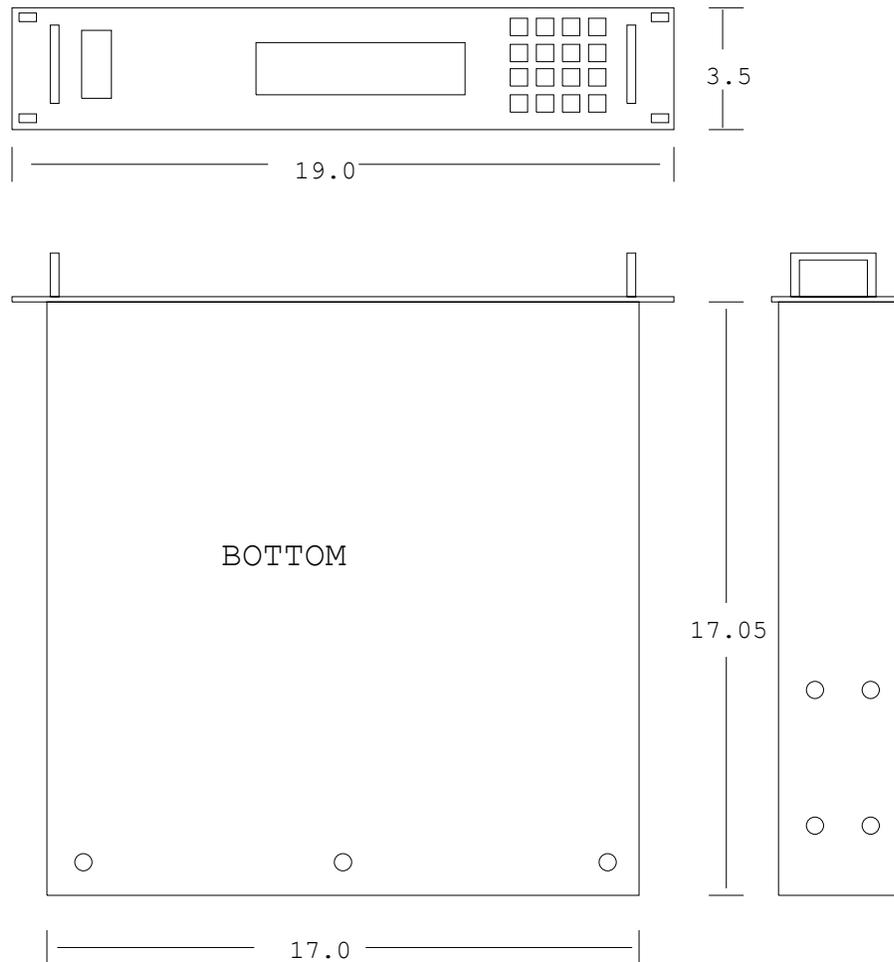
2.1.2 Electronic Clinometer

The electronic clinometers (also referred to as the inclinometer) should be positioned on the mount structure in an orientation that allows the inclinometer's linear range of movement to rotate through the antenna's RF bore sight operational range.

```
              2.274 in.
              (57.759)

                                    DOWN
                        +/- 45  Linear Range
clin1.dwg
```
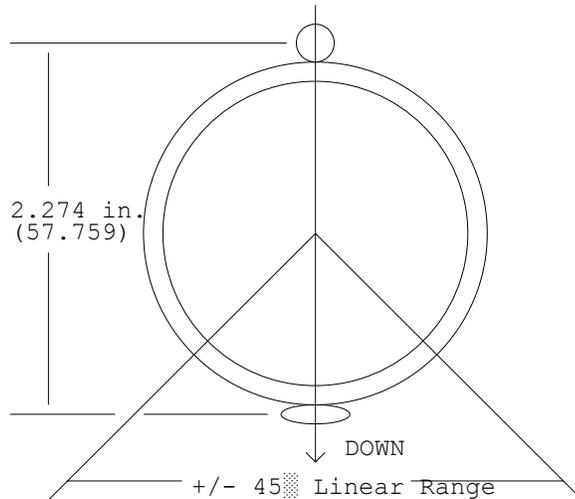
Determining the correct orientation of the inclinometer requires knowledge of the mount's mechanical structure and the antenna's RF offset. Typically the mount manufacturer will place the inclinometer in the correct position on the mount. See appendix A for the correct orientation for a particular mount.

The elevation position sense circuit of the RC3000 is designed to interface to the Lucas/Schaevitz AccuStar model 0211 1002-000 or 0211 1102-000 inclinometers. The inclinometer's position reference is marked on the body of the inclinometer. The inclinometer should be mounted such that the body of the inclinometer is rotated CW (as viewed by an observer looking at the front of the inclinometer) as the antenna's elevation angle increases. The inclinometer must also be oriented properly on the antenna mount.

To describe the orientation of the inclinometer, the term 'elevation offset angle' needs to be defined. Elevation offset angle is defined as the antenna's RF elevation pointing angle (relative to horizontal) when a straight edge oriented vertically across the face of the antenna reflector (reflector top to bottom) is plumb. The inclinometer should be oriented so that when the antenna reflector is plumb the reference mark is deflected CCW (from the vertical position) by an amount equal to the 35 degrees minus the 'elevation offset angle'. If the inclinometer is attached as described the sensor will operate in its most accurate region for elevation look angles up to 80 degrees.

The inclinometer mounting flange allows for some adjustment of the device's rotational orientation. The mounting position selected for the inclinometer should allow for adjustment of the inclinometer's orientation. The inclinometer should be mounted in a location such that it is protected somewhat from blowing rain.

VERTICAL REFERENCE

INCLINOMETER REFERENCE

X = 35 DEGREES - ANTENNA OFFSET

X

ELECTRICAL
BORESIGHT

INCLINOMETER

ANTENNA OFFSET

HORIZONTAL
REFERENCE

FEED

REFLECTOR

BACKSTRUCTURE

RC3000 INCLINOMETER ORIENTATION
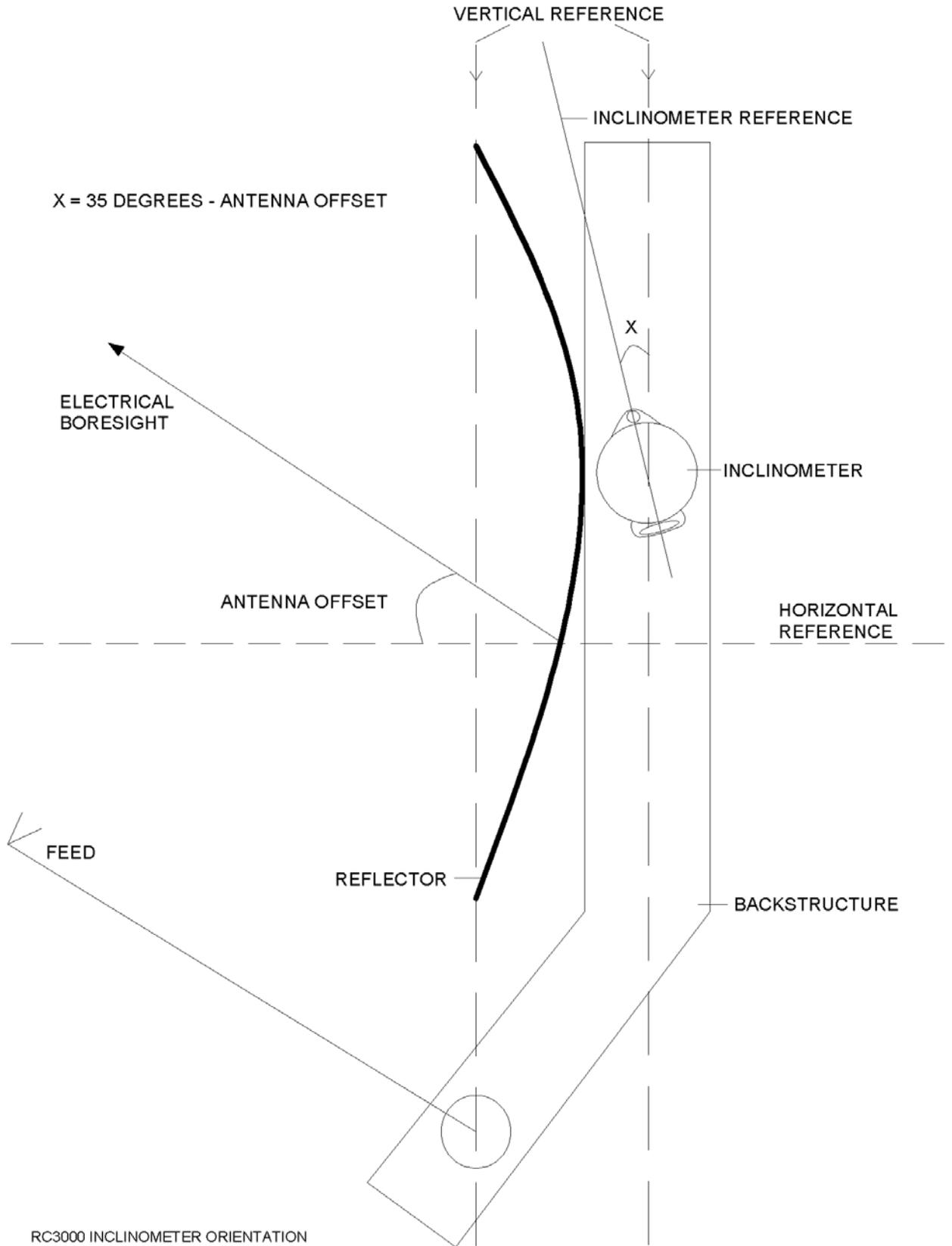
2.2 Electrical Connections

This section provides cabling requirements for interfacing to the RC3050. Note that cables should be made long enough to allow the unit to be open while still connected to the system.

The following sections supply a schedule of connection requirements. Note that the pinout requirements for J1, J3, and J7 are the same as required for RC3000 installations and therefore should not require rework of those cables for retrofitting to the RC3000.   The backpanel diagram shows the location of the connectors.
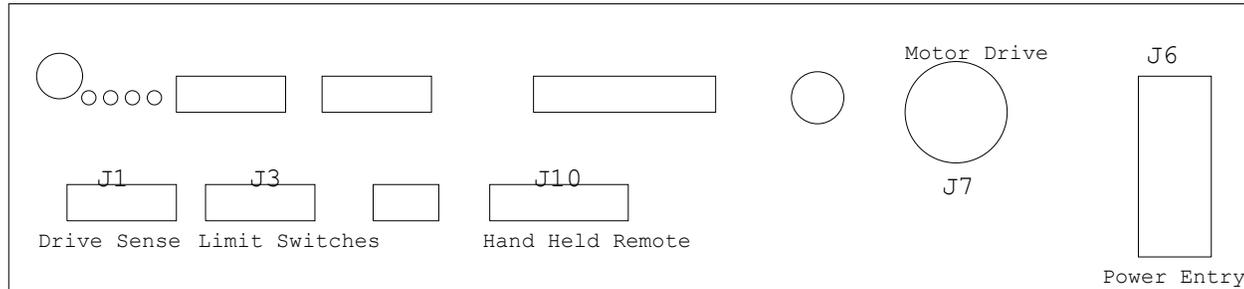
Note that holes in the back panel that are used for additional connectors by the RC3000 are covered by metallic tape for the RC3050.

2.2.1 Power Entry

J6 is an IEC power connector for supplying AC power to the RC3050.

The RC3050 is shipped from the factory with an line cord appropriate for the line voltage selected. If the line cord received with the unit is not appropriate for the power available at the installation site, the installer should check the controller to ensure that the proper line voltage has been selected.

The RC3050A can be configured to operate on either 115 VAC or 230 VAC. The AC input voltage the unit is currently configured for is displayed in a window located in the fuse holder. To change the AC input voltage selection, remove the fuse holder and reverse the jumper assembly (on which the '115' and '230' labels are located).

To convert AC Voltage. Switch the power off at the front panel. Remove the IEC power cord from the back panel power entry module. With a small straight-blade screwdriver, remove the fuse drawer from the power entry module. With the same tool, remove the small plastic circuit card. Rotate the card so that the desired operating voltage will be displayed through the front of the fuse drawer and reinsert the card so that it firmly seats into the power entry module.

NOTE: The RC3050B can only be configured for 115 or 230 VAC since the internal DC motor controller module is different for each voltage. The fuse holder is glued into the correct voltage position and cannot be modified as in the RC3050A case.

The fuse holder is designed to accommodate 1/4" by 1 1/4" fuses. "Slow Blow" type fuses should be used. The following table shows the appropriate fuse for each model and line voltage combination.

MODEL	LINE VOLTAGE	
	115 VAC	230 VAC
RC3050A	8 Amp.	4 Amp.
RC3050B	12 Amp.	6 Amp.

2.2.2 Motor Drive

J7 is an MS3102A22-20S connector, which terminates three motor cables. The minimum wire size for these cables is 16AWG.

```
J7

E  │   AZ Drain                    DC MOTORS
G  │   Az Drive                    ╭─────╮
   │                               │AZIM │
F  │   Az Return                   ╰─────╯

D  │   El Drain
H  │   El Drive                    ╭─────╮
   │                               │ELEV │
J  │   El Return                   ╰─────╯

C  │   Pol Drain
A  │   Pol Drive                   ╭─────╮
   │                               │ POL │
B  │   Pol Return                  ╰─────╯
                                        drive.d
```
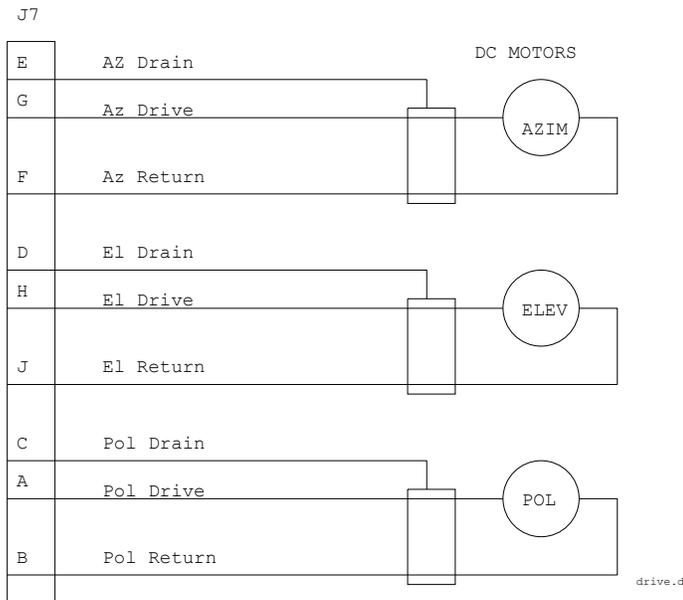
The RC3050A is designed to drive 12 to 36 volt DC azimuth, elevation, and polarization motors. The absolute maximum allowed motor current is 12 Amps. The RC3050A employs a built-in, solid-state motor controller (model 25A8 from Advanced Motion Controls. The motor drive module supports IR compensation, current limiting, dual speed operation, and dynamic braking. The drive train is also protected with resettable fuses.

The RC3050B is designed to drive 90 volt (3/4 horsepower max) or 180 volt (1.5 horsepower max) DC azimuth and elevation motors. Ideally, 90 volt DC motors would be specified with 115 VAC input power and 180 volt DC motors with 230 VAC input power. 180 volt motors cannot be used with 115 VAC input power. The motor drive in the RC3050B is the model KBPB by KB Electronics. This motor drive supports IR compensation, current limiting, dual speed operation, and dynamic braking.

The polarization drive of the RC3000B is designed to power a 12 volt DC motor which draws less than 400 ma.

The following table describes the polarity of the RC3000's motor drive output signals.

Axis	RC3050 Connector J7 Terminals	Polarity
Azimuth	G, F	For azimuth CW movement, terminal G has the higher potential.
Elevation	H, J	For elevation UP movement, terminal H has the higher potential.
Polarization	A, B	For polarization CW movement, terminal A has the higher potential.

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2.2.3 Drive Sense

J1 (DB-15 Female) receives position sense from the azimuth and polarization potentiometers and the elevation inclinometer.

```
J1  ┌────┐
    │ 10 │      AZ Drain
    ├────┤
    │ 9  │      AZ +
    ├────┤
    │ 1  │      AZ Wiper                                        Azimuth Positio
    ├────┤
    │ 2  │      AZ -
    ├────┤
    │ 3  │      POL Drain
    ├────┤
    │ 11 │      POL +
    ├────┤                                                     Polarization Po
    │ 4  │      POL Wiper
    ├────┤
    │ 12 │      POL -
    ├────┤
    │    │
    ├────┤
    │ 7  │      El Drain
    ├────┤
    │ 6  │      El +15
    ├────┤                                                     Elevation Inc
    │ 14 │      El Com
    ├────┤
    │ 8  │      El -15
    ├────┤
    │ 15 │      El Signal
    ├────┤                                                     pos.dwg
    │    │
    └────┘
```
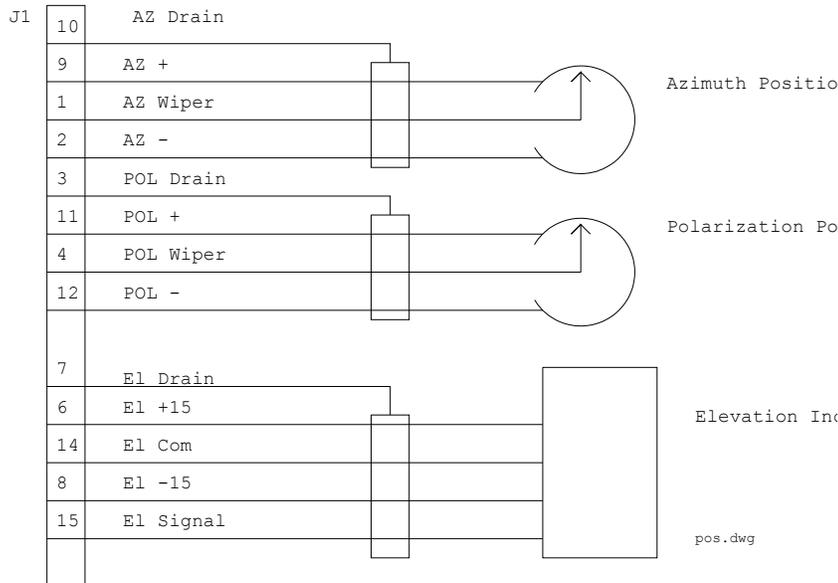
Normally, it is not necessary to modify the sensors on the antenna. The antenna manufacturer will insure that the antenna is compatible with the RC3050. This information is provided for informational purposes only.

The directional sense of azimuth movement is defined as clockwise (CW) or counter-clockwise (CCW) as viewed by an observer located above the antenna. On the controller CW movement results in a greater sensed azimuth position.

The directional sense of polarization movement is defined as CW or CCW as seen by an observer standing behind the antenna reflector looking 'through' the reflector at the satellite. The reference position for the polarization position angle is vertical polarization for a satellite located at the same longitude as the antenna. In the northern hemisphere, for vertically polarized satellites to the west of the antenna, the polarization deflection is defined as CW relative to the reference position. In the northern hemisphere, the polarization angle increases for satellites farther to the west.

2.2.4 Limit Switches

J3 (DB-15 Female) connects to the azimuth stow, elevation stow, elevation up and elevation down limit switches.

```
J3   9   AZ Stow +                              NC      LIMIT SWITCHES

     7   AZ Stow -                                      Azimuth Stow


    10   EL Up +                                NO

    14   EL Up -                                        Elevation Up


     5   EL Down +                              NO

     6   EL Down -                                      Elevation Down


    11   EL Stow +                              NO

    13   EL Stow -                                      Elevation Stow

     2   Pol Stow +                             NO

     1   Pol Stow -                                     Polarization Stow

     4   Drain          Switch Annotations are for the Limit Condition^limit_sw.dwg
```
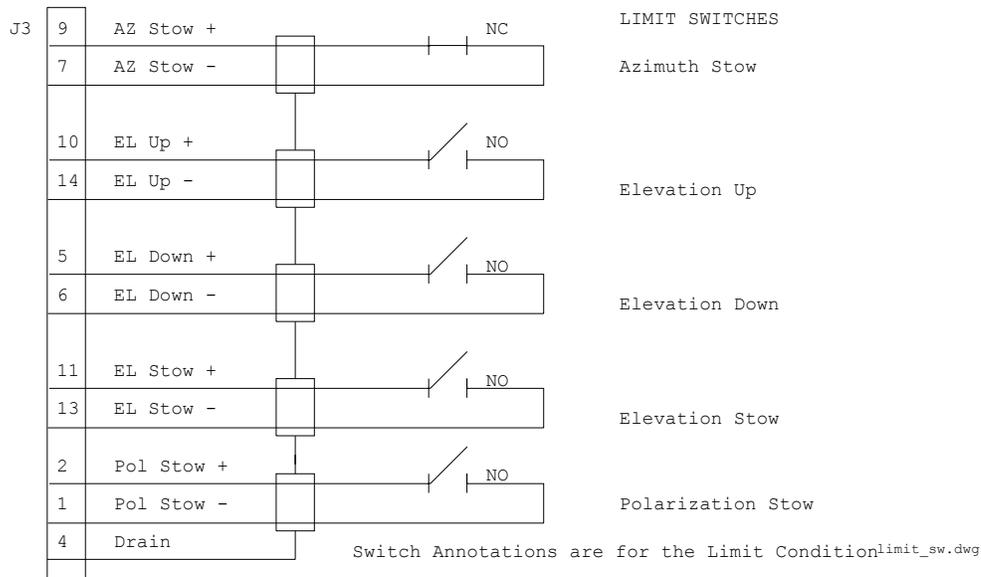
The + side of each limit switch circuit supplies 12 VDC. This 12 VDC supply is protected by a resettable fuse rated at 250 mA.

The azimuth stow switch must be closed when at the azimuth stow position. If the azimuth stow limit switch cable is severed, the RC3050 will think that the azimuth is not at the stowed position. Logic within the RC3050 will not allow elevation to move below the elevation down limit switch if an azimuth stowed condition is not recognized.

The elevation up switch must be open when the elevation axis has reached the up limit. If the elevation up limit switch cable is severed, the RC3050 will think that the elevation axis is at the up limit. Logic within the RC3050 will not allow the elevation axis to move up if an up limit condition is recognized.

The elevation down switch must open when the elevation axis has reached the down limit. If the elevation down limit switch cable is severed, the RC3050 will think that the elevation axis is below the down limit. Logic within the RC3050 will not allow the azimuth axis to move when the elevation down condition is recognized.

The elevation stow switch must open when the elevation axis has reached the stow position. If the elevation stow limit switch cable is severed, the RC3050 will think that the elevation axis is at the stow position. When the elevation stow limit is sensed, the RC3050's hardware also internally generates an elevation down indication. Logic within the RC3050 will not allow the elevation axis to move down when the elevation stow condition is recognized.

2.2.5 Waveguide Switch

J12 (DB-15 Female) connects the optional waveguide switch (RC3KF-WG-DRV1) module to a waveguide switch of the type shown in the following diagram.
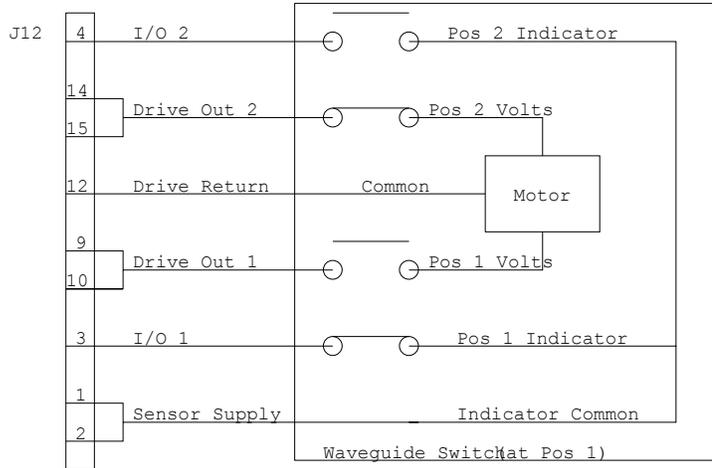
Drive Out 1,2 provide 28 VDC to energize the waveguide switch.

NOTE: The RC3050 assumes the waveguide switch's position 1 is the horizontal (H) position. If the H and V positions need to be reversed, both the position volts (9/10 and 14/15) and the position indicator (3 and 4) lines need to be swapped.

2.2.6 Hand Held Remote

J10 (DB-25 Female) connects to the optional Hand-held remote control (RC8097RC) which allows antenna jog operations independent of the front panel. The remote control is housed in a 3" x 6" x 1.75" aluminum case. The remote control should be connected to the RC3050 with a 25' multi-conductor cable.

The RC8097RC places all, of the back panel antenna move functions and antenna position status indicators into the operator's hand. The LEDs on the remote switch-pad indicate the antenna status:

Azimuth Axis: STOW, CCW Limit, CW Limit.
Elevation Axis: STOW, Up Limit, Down Limit.
Polarization Axis: CCW Limit, CW Limit

P10 - Hand Held Remote Control

DB25 male

1	Black w/ White Stripe
2	Red w/ Black Stripe
3	Orange w/ Black Stripe
14	Black w/ Red Stripe
4	Orange w/ Red Stripe
17	Blue w/ Red Stripe
5	Red w/ White Stripe
15	Blue w/ White Stripe
6	Green w/ White Stripe
19	Green
7	Orange
20	Red
8	Blue w/ Black Stripe
21	White
9	Green w/ Black Stripe
22	Blue
16	White w/ Red Stripe
23	Black w/ Red & White Stripe
11	Green w/ Black & White Stripe
24	Red w/ Green Stripe
12	White w/ Red & Black Stripe
25	Orange w/ Green Stripe
13	Red w/ White & Black Stripe

(Optional)

Remote

.
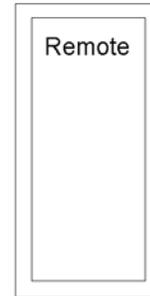
2.3 Calibration

Calibration may be done in any area (possibly a shop environment) where the antenna may be moved throughout its entire range of travel.

At this point, the installer will have to start operating the RC3050 from the front panel. Section 3 will need to be reviewed to perform the steps described below.

2.3.1 Version Verification

Input Power

Before powering the unit on for the first time, please confirm that the input voltage the unit is configured for matches the intended input supply voltage. See 2.2.1.

Software Version Verification

When the RC3050 is turned on, a power up banner appears for 3 seconds. This banner indicates the software options enabled in the RC3050's EPROM and PLD. The software option data shown should be checked to confirm that all desired options are available. See 1.2 (Controller Features) for a description of the various software options.

2.3.2 Drive and Sensor Polarity Confirmation

In this step the polarity of the motor drive signals and the polarity of position feedback sensors are confirmed. The RC3050 interfaces with position sensors mounted on the antenna. The RC3050 is designed for use with antennas which use potentiometers for azimuth and polarization position sensing and a Lucas AccuStar Clinometers (with analog output) for elevation sensing.

Place the RC3050 in MANUAL mode. Values for the azimuth, elevation and polarization axes should be displayed though they may not be reasonable since calibration has not yet been performed.

NOTE: be careful when initially moving a mount since limit switches may not yet be configured correctly. In MANUAL mode movement will stop whenever a particular jog key is released. The RC3050 may also always be turned off to stop movement.

The first action is to raise the antenna in elevation. Push the UP key from MANUAL mode. The antenna should raise. If not check the polarity of the motor drive lines (section 2.2.2).

The elevation sensor should be mounted on the antenna so that the sense voltage produced at the sensor increases as the antenna is jogged upward. In MANUAL mode, when the EL UP key of the RC3050 is depressed (and if the antenna moves up) the elevation position should increase (see section 2.2.3).

Movement in the azimuth axis will not be allowed until the elevation axis clears the "down" region. Clockwise and counterclockwise are defined as seen by an observer located above the antenna looking down on the antenna. In MANUAL mode, when the AZ CW key of the RC3050 is depressed the antenna motors must be configured so that the antenna moves clockwise. Clockwise is defined from the viewpoint of looking at the antenna from above.

The azimuth potentiometer should be wired so that clockwise movement results in a higher azimuth position sense voltage. When moving clockwise the displayed azimuth position should increase.

The polarization potentiometer must be wired so that the sensed polarization position increases as the Pol CW key is depressed.

The following diagram shows the suggested polarization axis sign convention. This sign convention is used by the RC3000 for automatic polarization calculation/movement. The diagram depicts looking at the arc of satellites from behind the antenna.

```
                                      Horizontal
     Horizontal                                                  Horizontal
                         Vertical
                                                    Clockwise
         Counter-Clockwise              Clockwise
              Vertical                                    Vertical

East Horizon                                                     West Horizon
(Northern Hemisphere)                                            (Northern Hemisph

       pol.dwg
```
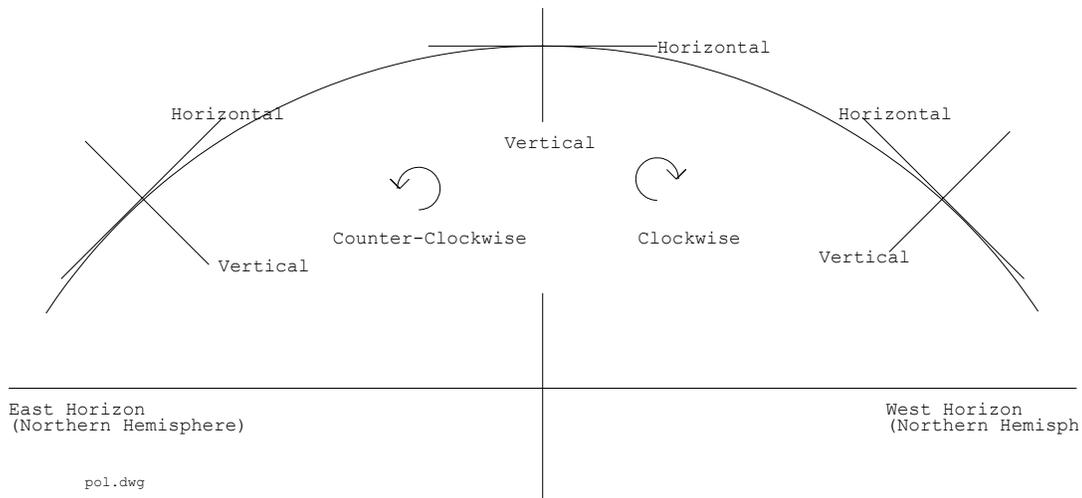
2.3.3 Position Sensor Rigging and Calibration

This installation step verifies that the azimuth and polarization potentiometers and the elevation inclinometer are mounted in the correct positions to provide position feedback.

AZIMUTH CENTERLINE

The first step is to check that the antenna is positioned on the centerline of azimuth movement. Also the azimuth stow limit switch should be in the center of the azimuth detent notch. It is very important that this position be confirmed in this manner or problems could be encountered during the automatic stow function.

Place the RC3050 in the AZIM VOLT mode (see 3.3.2). The azimuth voltage shown on the screen should be 2.5 +/- 0.1 volts. Since 5 volts is sent to the sensor, if the pot is adjusted at the center tap position correctly, the the reading should be half. If not, loosen the pot restraining collar and rotate the shaft such that the displayed value is as near 2.50 volts as possible and secure the collar.

After positioning the pot correctly, store the value as described in 3.3.2. This will define to the RC3050's software the voltage that should be seen when the azimuth axis is in its centerline position.

POLARIZATION CENTER

Next, move the polarization motor to midrange of its travel. The displayed voltage for polarization should be close to 2.5 V. If not, adjust the polarization potentiometer to achieve this value and secure the pot.

Store the polarization reference voltage as described in 3.3.4.

ELEVATION REFERENCE POSITION

To perform this step raise the antenna until the reflector is in the reference position appropriate for this mount (see Appendix A). This angle can be confirmed by use of a level or digital inclinometer placed on a correct portion of the antenna structure.

The elevation voltage shown on the screen should be near the target value for your mount as noted in appendix A. This voltage allows for the greatest range of linear feedback from the elevation inclinometer throughout the mount's operational range. If not, loosen the elevation sense restraining plate and rotate the inclinometer until the elevation voltage is as near to the target voltage as possible. Secure the restraining plate and store the voltage as described in 3.3.3.

ELEVATION SCALE FACTOR CALIBRATION

This step is performed to characterize the output signal from the elevation inclinometer.
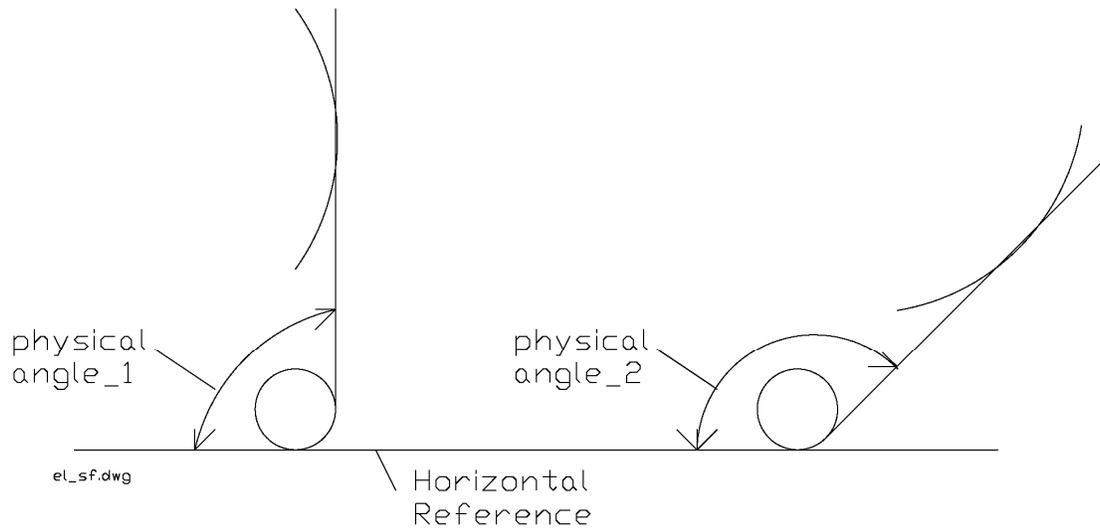
1) With the elevation axis in the reference position, note the angle **(using an accurate inclinometer placed on the mount itself not the angle displayed on the RC3000)** and the A/D voltage at that point.

    Physical_Angle_1 (Reference) _____Degrees

    Voltage_1 (Reference) _____Volts

2) Raise the antenna approximately 30 to 50 degrees and note the angle and voltage.

    Physical_Angle_2_____ Degrees

    Voltage_2 _____ Volts

3) Calculate the output signal from the elevation inclinometer.

$$\text{Milivolts/degree} = \left(\frac{\left(Voltage\_2 - referenceVoltage\right)}{\left(Physical\_Angle\_2 - reference\_angle\right)} \right) * 1000$$

4) Enter the mV/deg in the EL SF field of the configuration screen.

REFERENCE POSITION VERIFICATION

To verify that data has been entered correctly, return to the MANUAL mode screen. Make sure the azimuth, elevation and polarization axis are the reference positions used in the previous steps. The displayed azimuth angle should be 0.0 +/- 0.3 degrees. The displayed elevation angle should be near the elevation offset value for your mount (see appendix A). The displayed polarization angle should be 0.0 +/- 0.3 degrees.

2.3.4 Azimuth and Polarization Electrical Limits

In this step, the antenna's azimuth and polarization electrical limits are set. These limits are set using four potentiometers on the controller's analog board thus it will be necessary to remove the controller's top cover. These four pots are labeled A-CW (azimuth clockwise), A-CCW (azimuth counter-clockwise), P-CW (polarization clockwise), P-CCW (polarization counter-clockwise). These 4 pots on the analog board are accessed via holes in the feature board.

To set the azimuth clockwise limit, go to MANUAL mode and jog the antenna in azimuth to the desired azimuth clockwise limit. If the controller indicates that the azimuth clockwise limit is reached before the antenna reaches the desired position for that limit, the A-CW pot may have to be adjusted to allow the antenna to move. Adjust the A-CW pot until the azimuth limit indication flickers between CW and blank.

To verify that the A-CW has been adjusted properly, verify that the antenna cannot move clockwise in azimuth but can move counter-clockwise.

A similar procedure is used to set the azimuth counter-clockwise limit, polarization clockwise limit, and polarization counter-clockwise limit. Once the limits have been set, replace the cover of the controller and install the controller in the instrument rack.

2.3.5 Fast/Slow Motor Speed

The fast and slow output voltages for your particular mount will be set at the factory and typically will not need to be adjusted. On RC3050B models, there is only one fast/slow adjustment potentiometer on the analog board. On RC3050A models, there are fast/slow adjustment potentiometers for each axis on the relay board next to the digital board.

The slow speed for an axis should be set low enough that automatic movements perform smoothly. Care should be taken that slow speed is not set so low that the axis is prone to jamming.

2.3.6 Drive System Checkout

This step confirms the configuration of the drive system for all three axis. Manually move the mount to each axis limit and confirm drive current to the motor is shut off when the limit is reached. Also check the displayed position value and confirm that it is reasonable.

Perform the STOW (3.2.2.2) and DEPLOY (3.2.2.3) functions and confirm the mount correctly stows and deploys.

2.4 Miscellaneous Adjustments

LCD Contrast

An LCD contrast potentiometer is located on the RC3050 digital board. This potentiometer will be set at the factory but the user may want to adjust its setting for a particular installation's lighting conditions.

3.0 DETAILED OPERATION

3.1 Operation Overview

The functionality of the RC3050 is achieved by placing the controller in the desired mode of operation. The figure shows the hierarchy of the RC3050's modes. Each mode has a unique display screen that presents the information applicable to that mode's operation.

As the figure shows, there are two main groups of modes – operating and programming. Transitions between modes within a group are initiated via a momentary press of the Mode key while a transition between the two groups requires the Mode key to be held down for three seconds.

After installation the programming group of modes will typically not be used for day to day operations. Sections 3.2 (operating modes) and 3.3 (programming modes) detail each mode.


```
MANUAL          AUTO
3.2.1           3.2.2

        Waveguide       DEPLOY
        3.2.3           3.2.2.1

                        STOW
                        3.2.2.2

modes35_2.dwg
```

OPERATING GROUP

```
DRIVE RESET
3.3.1

AZIM VOLT
3.3.2

ELEV VOLT
3.3.3

POL VOLT
3.3.4

AZ/EL LIMITS
3.3.5

POL LIMITS
3.3.6

ELEV SCALE
FACTOR 3.3.7
```

PROGRAMMING GROUP
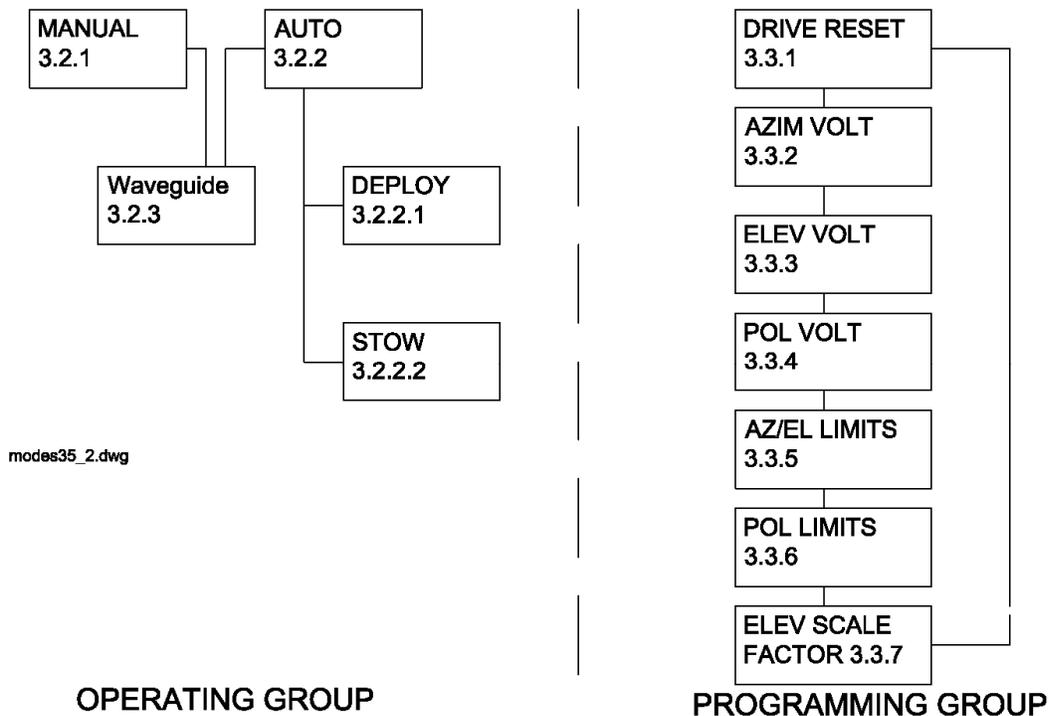
3.2 Operating Group

Within the operating group of modes exist two high level modes – MANUAL and AUTO. The MANUAL mode allows the user to manually jog the antenna while the optional AUTO mode allows the user to select the modes that implement the RC3050's automatic movement features. While in either one of these modes, a momentary push of the Mode key will transition the RC3050 to the other mode.

Upon powering up the RC3050, an identification screen is displayed for five seconds. The software version data is discussed in 1.2 (Controller Features).

```
RC3050B        V2S
(c)RCI'99   1.03
```

Following this screen the MANUAL mode is entered.

3.2.1 Manual Mode

```
    Az     El  Pol
 180.0 –12.3 -90
FV   CW  DOWN CCW
```

In MANUAL mode, the user may jog the antenna in all three axis. A momentary push of the Mode key will move the controller from the MANUAL mode to the AUTO mode.

Az
El

The Az column shows the current angular value of the azimuth axis. It also shows the status of azimuth limits (STW, CCW, CW). The azimuth axis may be moved by pressing the Az CCW or Az CW keys.

The El column shows the current angular value of the elevation axis. It also shows the status of elevation limits (STW, DOWN, UP). The elevation axis may be moved by pressing the El Up or El DN keys.

Pol

This field shows the current angular value of the polarization axis along with its limits (CCW, CW). Some mounts may also have a polarization stow switch indicated by "STW". The polarization axis may be moved manually be pressing the Pol CCW or Pol CW keys.

Speed

The lower left corner of the display shows the selected drive speed. The speed may be toggled between F(ast) and S(low) by pressing the Fast/Slow key.

Waveguide Position

If the optional waveguide switch module is installed, the current position (H or V) will be displayed next to the speed indication. The position of the waveguide can be changed via the WAVEGUIDE mode (3.2.3).

3.2.2 Auto Mode

The optional AUTO mode allows the user to initiate automatic stowing or deployment of the antenna.

```
<UP>DEPLOY  AUTO
<DN>STOW
```

3.2.2.1 Deploy

```
     Az    El  Pol
 180.0 -12.3 -90
<ANY KEY>STOP
```

The DEPLOY mode automatically moves to the mount's predefined "deploy" position. The deploy sequence will initially move in the elevation axis followed by the azimuth axis and finally in the polarization (if enabled for a particular mount) axis. During the deploy sequence, the position of azimuth, elevation and polarization will be displayed. See appendix A for the deploy position for a particular mount.

The automatic movement may be terminated anytime by pressing any key. Following completion of movement to the deploy position, the RC3050 will return to MANUAL mode.

3.2.2.2 Stow

```
     Az    El  Pol
 180.0 -12.3 -90
<ANY KEY>STOP
```

The STOW mode automatically moves to the mount's predefined "stow" position. The stow sequence will initially move in the azimuth axis followed by the polarization (if enabled for a particular mount) axis and finally in the elevation axis. During the stow sequence, the position of azimuth, elevation and polarization will be displayed. See appendix A for the stow position for a particular mount.

The automatic movement may be terminated anytime by pressing any key. Following completion of movement to the stow position, the RC3050 will return to MANUAL mode.

3.2.3 Waveguide Mode

The optional WAVEGUIDE mode allows the user to change the position of a waveguide switch.

```
POS:H   WAVEGUIDE
<F/S>TOGGLE POS
```

POS:

This field shows the currently sensed position of the waveguide switch. "H" denotes the horizontal position, "V" the vertical, "?" indicates that neither position is sensed and "*" indicates that both H and V are sensed (probably an error condition).

Pressing the Fast/Slow button will toggle the switch position. During the switch transition, a "+" will be displayed when going to the H position and a "-" will be shown while going to the V position. Note that after 5 seconds the switching operation will timeout and drive voltage will be stopped if the desired position has not been sensed.

3.3 Programming Group

The programming group has four different screens. Momentarily pressing the Mode key will switch between these screens in a similar fashion as the MANUAL and AUTO modes switched in the operating group.

3.3.1 Drive Error Resets

The RESET DRIVE screen provides the way to reset drive system errors (JAMMED or RUNAWAY). See the drive system theory section (1.3.7) for description of these conditions.

The screen shows the error condition for each axis.

```
     Az    El  Pol
   JAM  RUN   OK
 F/S-RESET DRIVE
```

Pressing the Fast/Slow key resets all three axes to the OK condition.

```
     Az    El  Pol
   OK   OK   OK
 F/S-RESET DRIVE
```

3.3.2 Azimuth Reference Voltage

The AZIM VOLT screen allows the user to set the reference voltage that defines the centerline of azimuth travel. When this voltage is seen the RC3050 will generate an azimuth position of 0.0 degrees. See the Drive System theory section 1.3.7.

```
 AZIM VOLT:2.500
 <UP>SET  (2.482)
```

AZIM VOLT: stored voltage

The first line shows the stored value for azimuth reference voltage. The default value is 2.500 volts for case where the azimuth potentiometer is perfectly centered.

<UP>SET (current voltage)

The second line shows the azimuth voltage currently read by the RC3050's microcontroller. If this represents the desired reference voltage (see installation step 2.3.3), press the UP key to store the value.

If the MODE key is pressed while in this mode, the screen will change to the elevation voltage screen. The stored azimuth reference voltage will remain.

If the UP key is pressed to store the value, the following screen will appear asking for confirmation that the stored reference voltage is to change.

```
 <MODE>EXIT  AZIM
 <DN>CONFIRM  SET
```

Pressing the DN key will confirm that the azimuth reference voltage is to be changed. Pressing the Mode key will keep the reference voltage from being changed and will advance the screen to the elevation voltage screen.

3.3.3 Elevation Reference Voltage

```
ELEV VOLT:1.690
<UP>SET  (1.582)
```

The ELEV VOLT screen performs in the same manner as described for the AZIM VOLT screen.

3.3.4 Polarization Reference Voltage

```
 POL VOLT:2.500
<UP>SET  (2.482)
```

The POL VOLT screen performs in the same manner as described for the AZIM VOLT screen.

3.3.5 Azimuth and Elevation Limits

This screen shows the current state of the azimuth and elevation limits as an aid in troubleshooting.

```
AZ CW:0 CC:0 S:1
EL UP:0 DN:1 S:0
```

The first line shows the state of the azimuth clockwise (CW:), counter-clockwise (CC:) and stow (S:) limits. The second line shows the state of the elevation UP:, down (DN:) and stow (S:) limits. If a limit is active a "1" will be displayed. If a limit is not active, a "0" will be displayed.

3.3.6 Polarization Limits

This screen shows the current state of the polarization limits as an aid in troubleshooting.

```
PL CW:0 CC:1 S:*
```

The first line shows the state of the polarization clockwise (CW:), counter-clockwise (CC:) and stow (S:) limits. If a limit is active, a "1" will be displayed. If a limit is not active, a "0" will be displayed. For some mounts, there is no polarization stow switch in which case a "*" will be displayed.

3.3.7 Elevation Scale Factor

The EL SF screen shows the current state and allows the user to set the scale factor for the elevation axis.

```
EL SF:      49.1
<UP/DN> <F/S>SET
```

EL SF: stored scale factor

The first line shows the state of elevation scale factor. This displayed value will change as the user sets a new scale factor.

<UP/DN> <F/S>SET

The second line allows two operations. The UP and DN keys allow the user to increment or decrement the scale factor to the desired value.

If the MODE key is pressed while in this mode, the screen will change to the reset drive screen. The stored elevation scale factor will remain.

If the FAST/SLOW key is pressed to store the value, the following screen will appear asking for confirmation that the stored scale factor is to change.

```
<MODE>EXIT  UP
<DN>CONFIRM  SET
```

Pressing the DN key will confirm that the elevation scale factor is to be changed. Pressing the Mode key will keep the scale factor from being changed and will advance the screen to the reset drive screen.

3.4 Alarm Displays

The alarm system monitors important system parameters and flashes a message on the bottom line of the LCD display if an error is found. The parameters monitored include the condition of the lithium battery, status of the azimuth and elevation antenna drive systems, and the values of certain variables. Some error codes have priority over others. Alarm conditions are sampled sequentially, with the highest priority sampled first. As corrective action is taken for each error, the code is eliminated, and if there is a lesser error, it will then appear.

LOW BATTERY

The RC3050 constantly monitors the level of the lithium battery. When the power level is low, this error code will appear. Replace the battery with a Duracell DL2450.   Make sure that the unit is unplugged from the AC power before removing the cover to change the battery. Take care to hold the battery tab away from the battery housing while replacing the battery, and it will not be necessary to reprogram the memory. Since there is a chance that the non-volatile memory will be corrupted when the battery is changed, please refer to chapter 5 concerning restoring the Non-Volatile Memory before changing the battery.

ANT AZIM, ANT ELEV, ANT POL

These alarm messages indicate that an error has been detected for the axis referenced in the alarm message. When one of these alarms are detected, the axis is disabled. Go to DRIVE RESET mode (section 3.3.1) to view the actual fault condition which was detected and to clear the fault.

4.0 SPECIFICATIONS

4.1 RC3050 Specifications

PHYSICAL

Size: 19.0" x 3.5"H x 18.0"D (Rack)

Weight: 22.5 lbs.

Temperature: 0-50°C

Input Power: 115/230 VAC, 50/60 Hz., 48 W

DRIVE

Output: 12-36VDC, 8.0 Amps 280VA ("A" model)

                             90 VDC (3/4 horsepower max) / 180 VDC (1.5 max) ("B" model)

Sensor Input: potentiometer (0-5V)

                                   50W (Typical - INDICATOR Mode)

                                   850W (Full - CONTROLLER Mode)

Non-Volatile Memory Battery   Duracell DL2450

SYSTEM ACCURACY

Elevation: +/-.2 degrees (typical)

Azimuth: +/- 0.3 degrees (typical)

4.2 External Interface Specifications

Overview

The RC3000 Satellite Locator and RC3050 3-Axis Jog Controller are designed for use with mobile satellite uplink vehicles (also referred to as satellite news vehicles - SNV's). These products represent design evolution of the popular RC8097 Satellite Locator.

The **RC3050** is a microprocessor-based instrument that controls antenna motion from a front panel keypad. A liquid-crystal-display shows antenna position and position-limit status simultaneously. Self-contained drive electronics eliminates the need for external drive enclosures. The 3050 can be supplied with an optional hand-held remote control, (option **RC3050HRC**), and the ability to auto-deploy and auto-stow (option **RC3050ASD**).

In addition to the features of the RC3050, the **RC3000** is an antenna controller which can incorporate sensors that allow it to calculate the antenna pointing solution (azimuth, elevation and polarization angles) required to intercept a given satellite. It incorporates an electronic compass option, **RC3000FG**, that allows the controller to determine the vehicle's magnetic heading and a GPS receiver option ,

RC3000GPS, which provides the controller with the vehicle's latitude and longitude. The controller employs an algorithm that calculates the local magnetic variation at the vehicle's location. (The magnetic variation is the difference between magnetic north and true north). The magnetic variation is used to determine the vehicle's true heading given the vehicle's magnetic heading. Various other options to the RC3000 include, PC Remote Control via RS-232 or RS-422, option **RC3000CRC**, and Inclined-Orbit Satellite Tracking, option **RC3000TRK**. Further details of the RC3000 product may be found in the RC3000 or RC3050 cutsheets, the RC3000 product selector guide, or by contacting RCI.

Antenna Interface

The RC3000 locator is designed to control an elevation over azimuth type antenna. The antenna may be mounted facing either forward or rearward. The controllers may be grouped into two broad categories according to the motor-type used on the mount; Low-Voltage DC Motors (12 to 36 VDC) are driven by the "A" version (RC3000A and RC3050A) and High-voltage DC Motors are driven by the "B" version.

Azimuth Axis Interface

The RC3000A is designed to drive a low-voltage DC motor in azimuth. The absolute maximum allowed motor current is 12 Amps. The motor-gearbox can be protected from excessive torque by OEM-specified resettable fuses in the drive system (specify desired maximum motor current). The RC3000A uses a solid-sate motor controller (model 25A8 from Advanced Motion Controls – (805)389-1935) The RC3000A supports both fast and slow speed speed az/el motor movement. The motor controller employs dynamic braking.

The RC3000B is designed to drive a 90 volt DC azimuth motor. The motor should be rated at 1 horsepower or less. The 8097 uses a built-in solid state motor controller (model KBPB from Penta Power - (800)221-6570) for the azimuth and elevation motors. The RC3000B supports both fast and slow speed speed az/el motor movement. The motor controller employs dynamic braking.

A 1K or 5K ohm potentiometer can used for azimuth position sensing. The 3000 employs a 10 bit A/D (analog to digital) converter to sense azimuth. Position resolution can be calculated by dividing the total designed azimuth travel by 983. (eg. $\pm$90° mount has 180° total travel B 983 = 0.18° azimuth resolution) The RC3000 is setup for symmetrical azimuth travel. For asymmetrical travel contact RCI. The potentiometer can be connected directly to the azimuth axis (1:1 gear ratio) or driven by a gear. When ordering a 3000 for a new mount, the user should specify:

The total possible travel for the antenna in azimuth. (eg. $\pm$140 °)

Where the limits should be set. (eg. $\pm$135°)

The number of turns possible for the azimuth pot. (alternatively the pot manufacturer and part number) (eg. 5-turns)

The gear ratio between the pot and the azimuth axis. (eg. 10:1)

The RC3000 supports an azimuth stow limit. When this switch is closed the controller will allow the antenna to move below the elevation down limit until the elevation stow limit is active. The 3000 does not support cw and ccw limit switches. These limits are derived from the potentiometer voltage. If required, the user may add in limit switches incorporating steering diodes on the antenna mount.

Elevation Axis Interface

The RC3000 elevation motor interfaces (A and B versions) are similar to the azimuth axis. The

elevation sensor is an inclinometer (AccuStar 02111002-000 by Schaevitz (609)662-8000) which produces an analog voltage proportional to the true elevation angle. The inclinometer must be mounted on a surface of the antenna mount that allows it to rotate with elevation. See the accompanying diagram for the physical dimensions of the inclinometer.

The RC3000 supports elevation stow, down, and up limit switches. If the azimuth stow limit is not active, the antenna can only be moved in elevation between the down limit and up limit. If the azimuth stow limit is active, the antenna may be moved in elevation between the elevation stow limit and the elevation up limit. When the antenna is below the elevation down limit the antenna may not be moved in azimuth or polarization.

The limit conditions for each of the limit switches is:

Name	Switch Position when the Limit is Active
Azimuth Stow	Closed
Elevation Stow	Open
Elevation Down	Open
Elevation Up	Open

For example, when the elevation down limit is active the elevation down limit switch should be open.

Polarization Axis Interface

The RC3000A is designed to drive a low-voltage DC motor in polarization. The absolute maximum allowed motor current is 12 Amps. The motor-gearbox can be protected from excessive torque by OEM-specified resettable fuses in the drive system (specify desired maximum motor current). The RC3000A supports both fast and slow speed polarization motor movement. The motor controller employs dynamic braking.

The polarization motor interface for the RC3000B is based on a 12 volt DC motor which draws less than 400 ma. Position sense is provided by a potentiometer in a manner similar to the azimuth axis. When ordering an RC3000 for a new mount, the user should specify:

The total possible travel for the antenna in azimuth. (eg. $\pm$100 °)

Where the limits should be set. (eg. $\pm$90°)

The number of turns possible for the azimuth pot. (alternatively the pot manufacturer and part number) (eg. 3-turns)

The gear ratio between the pot and the azimuth axis. (eg. 5:1)

The A version of the RC3000 supports a polarization Stow limit switch. The 3000 does not support polarization limit switches. The user may provide these externally using micro switches and steering diodes if needed. Some A versions support a fairing deploy switch rather than the pol stow limit.

230 Volt Operation

The RC3000A can operate from 115VAC or 230VAC 50 – 60 HZ. A voltage switch is located in the power entry switch. The RC3000B may be <u>ordered</u> in 115 or 230 VAC line voltage configurations. If 230 VAC operation is desired, 90 or 180 volt DC motors may be used for the azimuth and elevation axis (specify motor voltage). A 12 volt motor should still be used for the polarization axis.

Physical Characteristics

The RC3000 is designed for rack mounting. The dimensions are 19" x 3.5" x 17.5" (width x height x depth). The weight of the RC3000A is 19 lbs. The RC3000B weights 13lbs. The liquid crystal display (LCD) used with the unit is designed for viewing from a 6 o'clock position. This means that the controller should be mounted above eye level of the operator. An LCD module designed for a 12 o'clock viewing angle is also available.

Cabling and Connectors

The only cables supplied with the unit are the AC line cord and the cables for the electronic compass and the GPS receiver. All other cables must be supplied by the customer.

The following table describes the connectors on the back of the RC3000.

<u>Designation</u>	<u>Type</u>	<u>Function</u>
J1	DB15 female	az/el/pol position sense
J2	DB15 female	AGC port (RC3000TRK)
J3	DB15 female	limit switches
J4	DB15 male	Pulse sensor input (RC3000TRK)
J5	DB9 female	Serial Comm. Port (RC3000CRC
J6	IEC fused Power Entry	
J7	Amphenol 22-20S	az/el/pol motors
J8	Amphenol 126-221	HPA disable and acc.
J9-GPS	DB9 female on dongle	GPS & cable, (RC3000GPS)
J9-FG	DB9 female on dongle	FG Compass & cable (RC3000FG)
J10	DB25 female	Handheld Remote Control (RC3000HRC)
J11	F female	Block LNB signal for auto peak

4.3 Schematics
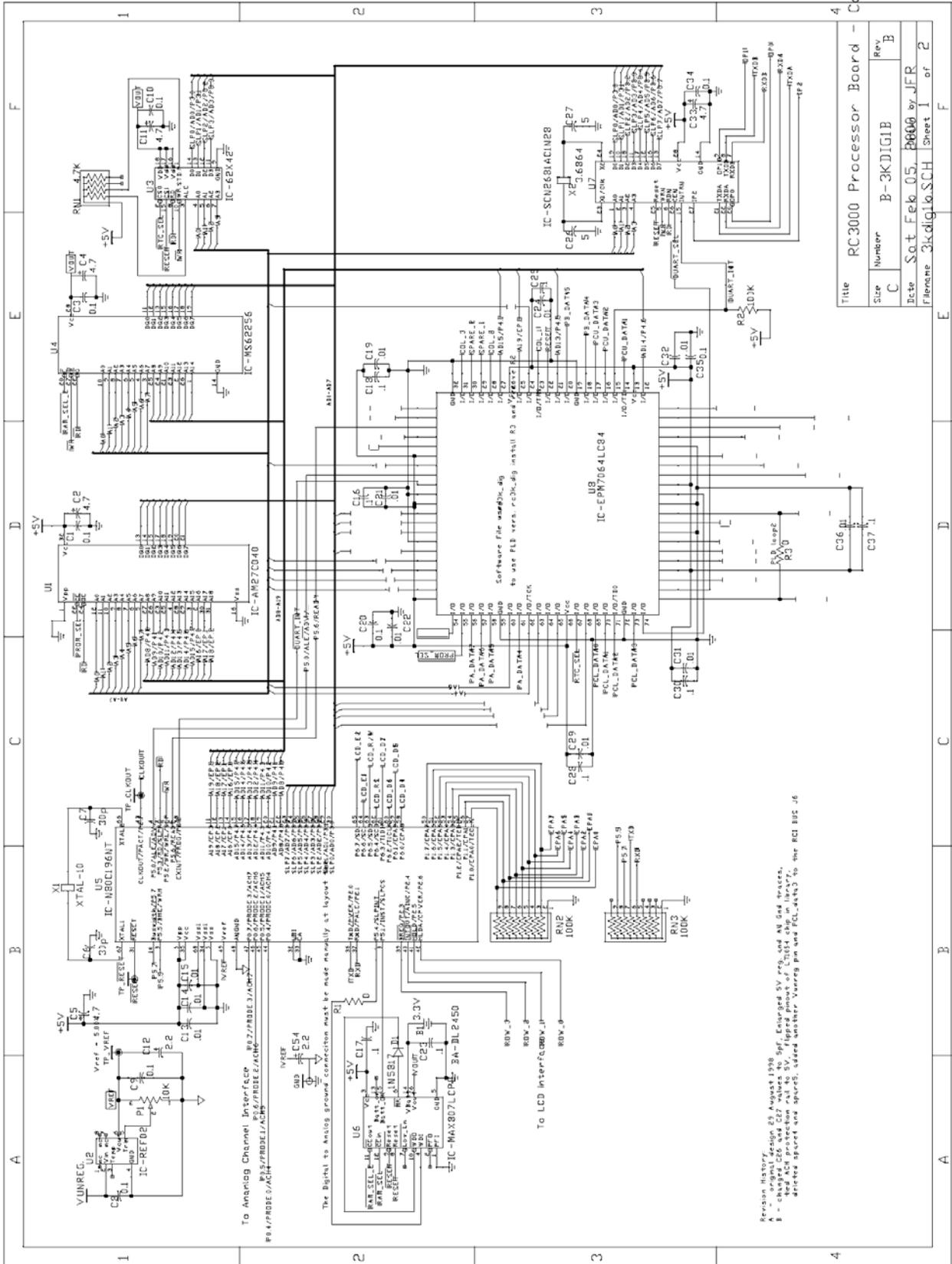
Research Concepts, Inc.; 5420 Martindale Road; Shawnee, Kansas 66218-9680 USA   www.researchconcepts.com
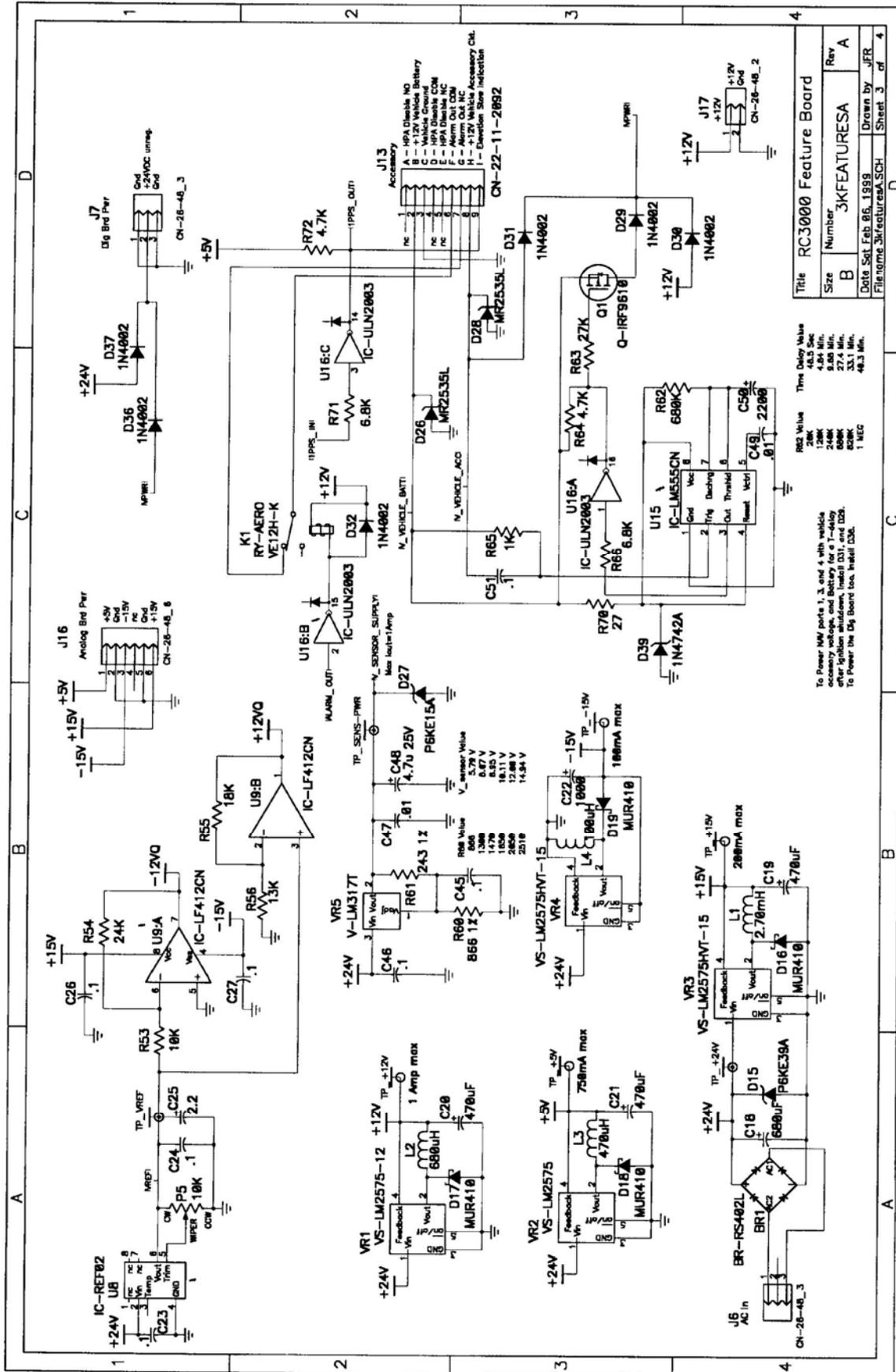
5.0 TROUBLESHOOTING

Limit Switches

The various limit switches serve as safety interlocks to prevent mount damage. The RC3050 checks for limit conditions via both software and a Programmable Logic Device on the analog board. The following table summarizes the interlock logic employed:

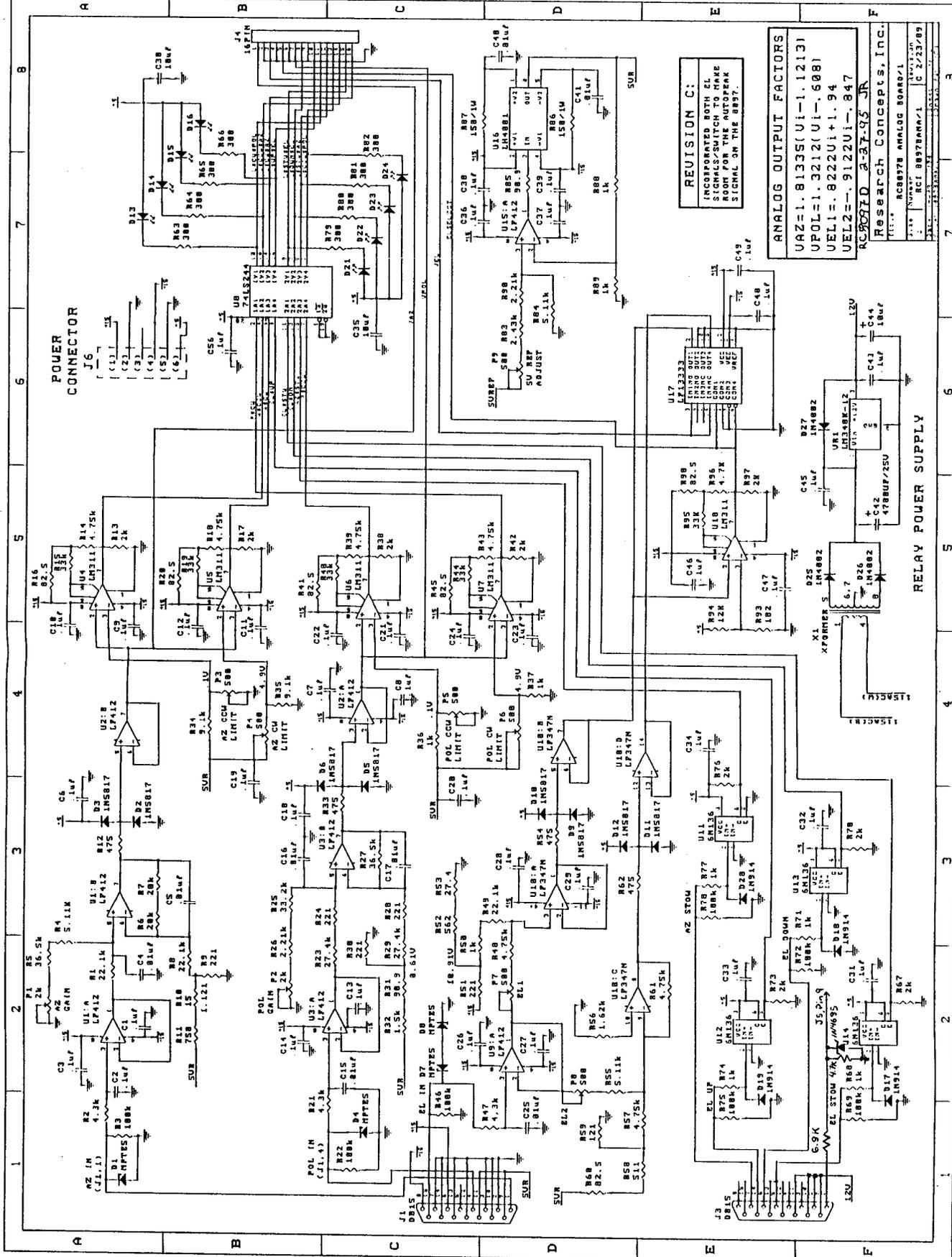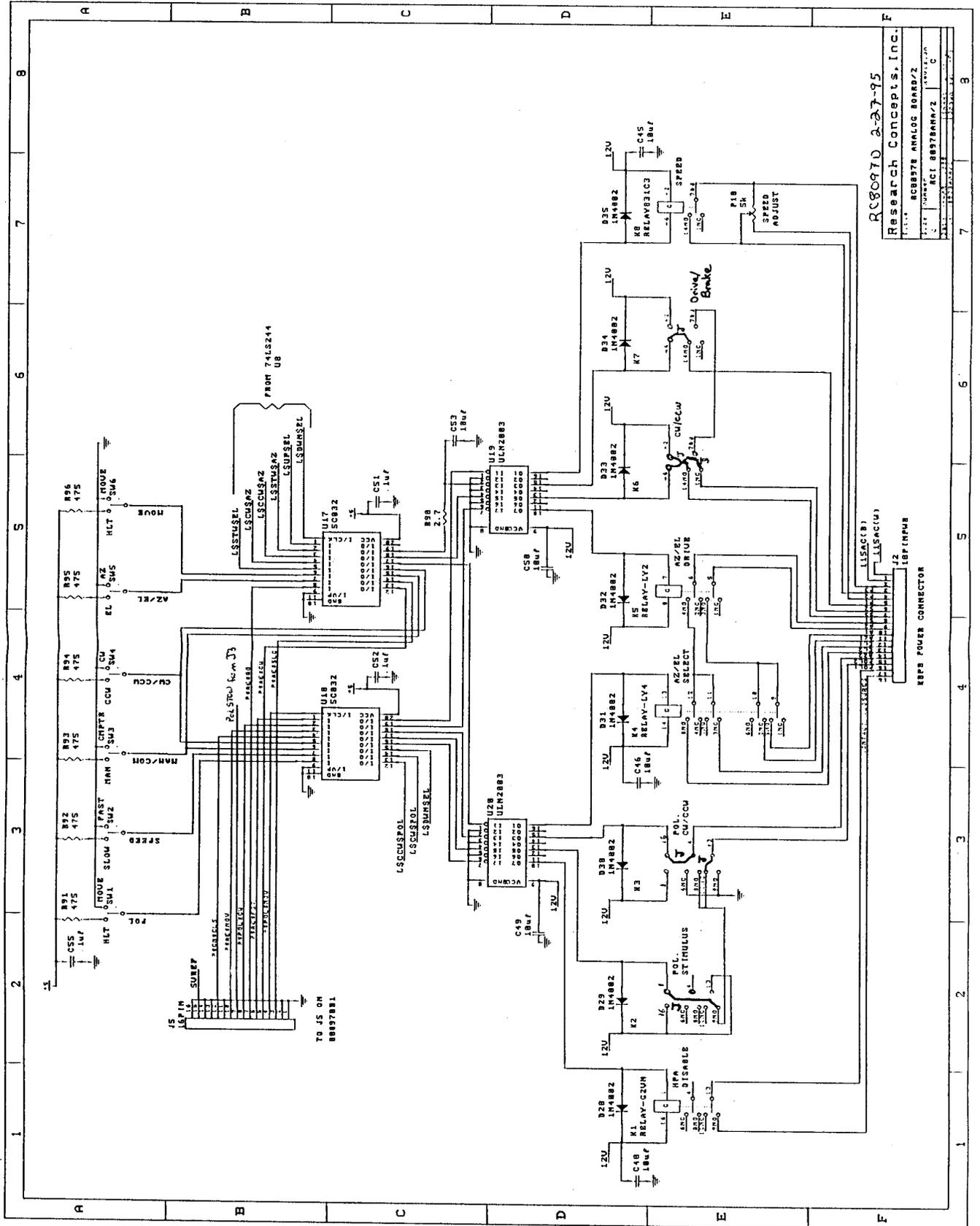| LIMIT	INTERLOCK LOGIC
Azimuth STOW	Elevation movement below the Elevation DOWN position is not allowed unless the Azimuth STOW condition is active.
Azimuth CCW	CCW movement in azimuth is not allowed when the azimuth CCW condition is active.
Azimuth CW	CW movement in azimuth is not allowed when the azimuth CCW condition is active.
Elevation DOWN	No azimuth movement is allowed when the Elevation DOWN condition is active.
Elevation STOW	No further elevation down movement is allowed when the Elevation STOW condition is active. NOTE: when the Elevation STOW condition is active, the RC3000 internally also generates an Elevation DOWN condition.
Elevation UP	No further elevation up movement is allowed when the Elevation UP condition is active.
Polarization CCW	CCW movement in polarization is not allowed when the polarization CCW condition is active.
Polarization CW	CW movement in polarization is not allowed when the polarization CW condition is active.
Polarization STOW	Elevation movement below the Elevation DOWN position is not allowed unless the Polarization STOW condition is active. NOTE: only certain mounts mechanize the Polarization STOW limit switch – check appendix B for your mount.

Many problems are caused by limit switches either activating incorrectly or the RC3000 not sensing the limit switch's state correctly. Some examples of problems caused by limit switch sensing follow:

Mount will move down in elevation but not up. Check that the Elevation UP limit switch is not stuck in the active state.

Mount will not move below the DOWN elevation limit. Check that the Azimuth STOW limit switch has activated correctly. Also check the polarization STOW limit switch if the mount is so equipped.

Mount will only move up in elevation. Check that the Elevation STOW limit switch is not stuck in the STOW condition.

Mount is above the Elevation DOWN position but will not move in azimuth. Check that the Elevation DOWN limit switch is not active.

Failure of a limit switch to activate properly may be due to the limit switch mechanism itself, cabling to the limit switch or failure of the RC3050 to sense the limit switch correctly. Isolating the problem to the RC3050 or switch/wiring may be accomplished by jumpering the appropriate pins on the J3 connector. NOTE: only the Elevation STOW/DOWN/UP, Azimuth STOW and Polarization STOW (if applicable) are mechanized via discreet limit switches – Azimuth CW/CCW and Polarization CW/CCW limits are mechanized differently and will be discussed later.

After removing the wiring harness from J3, the first thing to check is that 12 VDC is present at the "+" pin of each limit switch. Pins 2,5,9,10 and 11 should have +12 VDC present (see 2.2.4 – J3 wiring diagram). If +12 VDC is not present, there is a power supply failure within the RC3050. Contact your vehicle integrator, mount manufacturer or RCI for further instructions on how to proceed.

If +12 VDC is present, the limit switch sensing logic may be checked by jumpering between the appropriate pins and noting if the limit switch condition is sensed correctly by the RC3050. The state of the limit switches should be monitored via the Limit (3.3.5,.6) screens. The following table shows which pins to jumper and state that should be seen via the Limits Maintenance screen.

LIMIT	J3 PINS	JUMPERED	OPEN
Azimuth STOW	9,7	1	0
Elevation DOWN	5,6	0	1
Elevation STOW	11,13	0	1
Elevation UP	10,14	0	1
Polarization STOW	1,2	0	1

The azimuth CW/CCW and polarization CW/CCW limit conditions are mechanized by potentiometers inside the RC3000 that should be set to correspond to the axis voltage at the limit conditions. If any of these limits appear to be activating at the wrong time, check the setting of the potentiometers as described in the azimuth and polarization calibration procedures.

STOW OPERATION WILL NOT PROCEED BELOW THE DOWN ELEVATION LIMIT

The Stow operation first tries to achieve an azimuth position of 0.0 degrees. It then confirms that the azimuth stow switch is activated. If the azimuth stow switch is not activated, the stow operation will begin moving down in elevation but the normal safety logic will not allow the elevation axis to go below the DOWN limit switch position.

If this condition occurs, verify the action of the azimuth stow switch.

Some mounts also have a polarization stow switch. If this switch is not activated, movement below the DOWN switch position is also inhibited.

A JAMMED CONDITION OCCURS FREQUENTLY

A "JAM" condition occurs when the RC3050 thinks the mount should be moving but there is no indication of changing movement from the particular axis.

Several situations may cause a JAM condition:

- the mount truly has a mechanical condition preventing it from moving when commanded

- the motor drive lines have been disconnected or the motor failed. Check that voltage is appearing at the motor when the axis is being commanded to move.

- a problem has forced the axis feedback potentiometer from moving. Conditions such as a failed potentiometer or stripped gears to the pot may cause this case. Check that a changing voltage is output from the potentiometer while the axis moves.

APPENDIX A – MOUNT SPECIFIC DATA

For

VERTEX SMK / DMK

Mount Variations

The following table lists the different mounts supported by the RC3050 and the required software model number required to support that mount.

MODEL #	MOUNT	MODEL #	MOUNT
V1	2.4 m. DMK	V5	1.5 m. SMK-LT
V2	1.5 m. SMK	V6	N/A
V3	2.6 m. DMK	V7	1.2 m. SMK-LT
V4	1.2 m. SMK	V8	1.8 m. SMK-LT

All Vertex mobile mounts supported by the RC3050 use 90 VDC motors thus requiring the RC3050B hardware configuration.

System Interfaces

All Vertex mounts provide the basic RC3050 interface requirements. Azimuth stow and elevation UP, DOWN and STOW limit switches are provided.

Sensor Rigging and Calibration

To calibrate all Vertex models, the front of the dish should be placed in the vertical position.

MODEL #	RF Boresite Angle	Target Inclinometer Voltage
V1	22.3	1.69
V2	15.8	1.69
V3	22.3	1.69
V4	12.8	1.69
V5	15.8	1.69
V6	N/A	N/A
V7	12.8	1.69
V8	18.5	1.69

Stow and Deploy Positions

MODEL #	STOW			DEPLOY		
	AZ	EL	POL	AZ	EL	POL
V1	0.0	Stow(1)	N/A	0.0	22.3	N/A
V2	0.0	Stow(1)	N/A	0.0	15.8	N/A
V3	0.0	Stow(1)	N/A	0.0	22.3	N/A
V4	0.0	Stow(1)	N/A	0.0	15.8	N/A
V5	0.0	Stow(1)	N/A	0.0	15.8	N/A
V6	N/A	N/A	N/A	N/A	N/A	N/A
V7	0.0	Stow(1)	N/A	0.0	12.8	N/A
V8	0.0	Stow(1)	N/A	0.0	18.5	N/A

(1) The elevation stow position does not correspond to an indicated angle since the stow position is outside the effective range of the electronic clinometer. The RC3050 will drive down until it reaches the elevation stow switch.

MOUNT SPECIFIC DATA
For
AVL TECHNOLOGIES

Mount Variations

The following table lists the different mounts supported by the RC3050 and the required software model number required to support that mount.

MODEL #	MOUNT DESCRIPTION
A1	1.2 m. ERA
A2	1.5 m. ERA
A3	1.2 m. USA
A4	1.8 m. USA
A6	1.8 m. USA with pol stow switch
A7	1.2 m. USA with 400 degree azimuth travel
A8	1.5 m. ERA without polarization axis
A9	1.5 m. ERA with special polarization axis
AA	2.4 m. with 400 degree azimuth travel
AB	1.2 m. ERA with 400 degree azimuth travel
AC	1.2 m. ERA with unique polarization
AD	1.2 m. USA with 400 degree azimuth and unique polarization
AM	1.2 m. MVSAT with delayed stow
AN	1.2 m. MVSAT with regular stow
AS	1.2 m. Smart MVSAT - * this mount has its own appendix A

All AVL mobile mounts supported by the RC3050 use 36 VDC motors thus requiring the RC3050A hardware configuration.

System Interfaces

All AVL mounts provide the basic RC3050 interface requirements. Azimuth stow and elevation UP, DOWN and STOW limit switches are provided.

Sensor Rigging and Calibration

To calibrate all Vertex models, the front of the dish should be placed in the vertical position.

MODEL #	RF Boresite Angle	Target Inclinometer Voltage
A1	20.0	1.69
A2	20.0	1.69
A3	17.3	1.69
A4	22.3	1.69
A6	20.0	1.69
A7	17.3	1.69
A8	20.0	1.69
A9	20.0	1.69
AA	22.3	1.69
AB	20.0	1.69
AC	20.0	1.69
AD	17.3	1.69
AM	17.3	1.69
AN	17.3	1.69

Stow and Deploy Positions

MODEL #	STOW			DEPLOY		
	AZ	EL	POL	AZ	EL	POL
A1	0.0	Stow(1)(2)	0.0	0.0	20.0	0.0
A2	0.0	Stow(1)(2)	0.0	0.0	20.0	0.0
A3	0.0	Stow(1)	0.0	0.0	17.3	0.0
A4	0.0	Stow(1)	0.0	0.0	22.3	0.0
A6	0.0	Stow(1)(2)	0.0	0.0	20.0	0.0
A7	0.0	Stow(1)	0.0	0.0	17.3	0.0
A8	0.0	Stow(1)	0.0	0.0	20.0	0.0
A9	0.0	Stow(1)	0.0	0.0	20.0	0.0
AA	0.0	Stow(1)	0.0	0.0	22.3	0.0
AB	0.0	Stow(1)(2)	0.0	0.0	20.0	0.0
AC	0.0	Stow(1)(2)	0.0	0.0	20.0	0.0
AD	0.0	Stow(1)	0.0	0.0	17.3	0.0
AM	0.0	Stow(1)(3)	0.0	0.0	17.3	0.0
AN	0.0	Stow(1)	0.0	0.0	17.3	0.0

(1) The elevation stow position does not correspond to an indicated angle since the stow position is outside the effective range of the electronic clinometer. The RC3050 will drive down until it reaches the elevation stow switch.

(2) The Polarization stow switch must be activated on these mounts in order to proceed below the DOWN limit.

(3) When the elevation axis encounters the STOW limit, there will be a 4 second delay as the elevation axis seats itself.

APPENDIX B – DC MOTOR CONTROLLER

The following pages are reprints of the manuals for the two different motor speed controllers used in the RC3050. The AMC drive is used for the RC3050A (low voltage DC) and the KBPB drive is used for the RC3050B (high voltage DC).

These manuals show how to set characteristics (acceleration, deceleration, current limiting, IR compensation, etc) of the drive module. These characteristics are set at the factory to values appropriate to the particular mount. Modification of these settings should only be done with direction from Research Concepts Inc

Please see additional page inserts for Appendix C, following this page.

Research Concepts, Inc.; 5420 Martindale Road; Shawnee, Kansas 66218-9680 USA   www.researchconcepts.com

APPENDIX C– RC3050 Test Data Sheet

Research Concepts, Inc. • 5420 Martindale Road • Shawnee, Kansas 66218-9680 USA

Date Assembled_____   Initials _____
Date Tested _____   Initials _____
Date Shipped _____   Initials _____
Model# _____   Mount _____   Line Voltage _____
Power Entry Fuse_____   Bus Power Fuse _____   3KA Transf._____
Customer _____   PO # _____   End-User _____
FEATPLD#_____   BAN3-AZPLD _____   BAN3-POLPLD_____
Firmware Version _____   DIGPLD# _____
Inclinometer Serial Number_____

FC-3KDIG1A Voltages
+24Vunreg(+22 to +32) _____
+5V($\pm$0.25V) _____
+9V($\pm$0.25V) _____
-9V($\pm$0.25V) _____
Vref(5.00$\pm$0.00) _____

FC-3KFEAT1B Voltages
+24 Vunreg(+22 to +32) _____
+5V($\pm$0.25V) _____
+12V($\pm$0.25V) _____
+15V($\pm$0.25V) _____
-15V($\pm$0.25V) _____
Vref(5.00$\pm$0.00) _____

FC-8097BAN3 Voltages
Vref(5.00$\pm$0.00) _____

Drive System Voltages
Vunreg _____
V(Fast) _____
V(Slow) _____
V(AzFast) _____V(AzSlow) _____
V(ELFast) _____V(ELSlow) _____
V(PolFast)_____V(PolSlow)_____

AZ Sense Voltages ($\pm$0.01V from tables)
V(0.1) _____   V(4.9)_____
V(CCW) _____   V(CW) _____

EL Sense Voltages ($\pm$0.01V from tables)
V(0.1 /EL1)_____   V(4.9/EL1) _____
V(0.1/EL2) _____

POL Sense Voltages ($\pm$0.01V from tables)
V(0.1) _____   V(4.9) _____
V(CCW) _____   V(CW) _____

Handheld Remote Control   _____

Site Voltage
Set Site voltage   115VAC / 230VAC

Notes:
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Model_____   Mount type_____   Voltage_____   Serial Number_____

Product Test/Repair History

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Problems Encountered During Testing

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