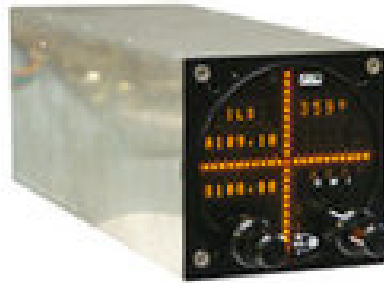




**VAL AVIONICS LTD**

# **INS 429**

**INTEGRATED NAVIGATION SYSTEM**



# **Installation and Operator's Manual**

Revision 3  
April 2015

P/N 1720101-3

**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**

**Document Change List:**

- Revision 0 Initial Printing
- Revision 1 Revised RS-232 command section
- Revision 2 Revised user Controls
- Revision 3 Changed Return Shipping address  
Changed Figure 8 for GNS 400 P4001. Pin 32 is incorrect, changed to pin 31

## Table of Contents

<b>1</b>	<b>SECTION I - GENERAL INFORMATION</b> .....	<b>4</b>
1.1	INTRODUCTION .....	4
1.2	SCOPE.....	4
1.3	EQUIPMENT DESCRIPTION.....	4
1.4	SPECIFICATIONS .....	5
1.5	EQUIPMENT SUPPLIED .....	6
1.6	EQUIPMENT REQUIRED BUT NOT SUPPLIED .....	6
1.7	LICENSE REQUIREMENTS.....	6
<b>2</b>	<b>SECTION II - INSTALLATION</b> .....	<b>7</b>
2.1	GENERAL INFORMATION .....	7
2.2	UNPACKING AND INSPECTION .....	7
2.3	EQUIPMENT INSTALLATION PROCEDURES .....	7
2.3.1	Cooling Requirements .....	7
2.3.2	Mounting Requirements .....	7
2.3.3	Wire Harness Fabrication .....	7
2.3.4	INS 429 Installation.....	8
2.4	POST INSTALLATION CHECK.....	8
2.4.1	Operational Check .....	8
2.4.2	Final Inspection .....	8
2.5	LIMITATIONS.....	8
<b>3</b>	<b>SECTION III - OPERATION</b> .....	<b>9</b>
3.1	GENERAL INFORMATION .....	9
3.1.1	Display Functions .....	9
3.1.2	User Controls .....	9
3.2	System Configuration.....	11
3.2.1	Accessing Setup Functions .....	11
<b>4</b>	<b>SECTION IV - WARRANTY AND SERVICE</b> .....	<b>12</b>
4.1	LIMITED WARRANTY .....	12
4.2	SERVICE.....	12
<b>5</b>	<b>Appendix A – INSTALLATION DRAWINGS AND CONNECTOR LAYOUT</b> .....	<b>13</b>
<b>6</b>	<b>Appendix B – WIRING DIAGRAMS</b> .....	<b>16</b>
<b>7</b>	<b>Appendix C – INSTRUCTIONS FOR CONTINUED AIRWORTHINESS</b> .....	<b>19</b>
7.1	MAINTENANCE INSTRUCTIONS.....	19
<b>8</b>	<b>Appendix D – RS-232 Instruction Listing</b> .....	<b>21</b>
8.1	Input Commands.....	21
8.2	Output Messages .....	21
8.3	Data Format .....	21
8.4	Default Message Output.....	21
8.5	Message Formats.....	22
8.6	Message Definitions.....	23
	Table 1: Specifications.....	5
	Table 2: Equipment Supplied.....	6
	Table 3: Equipment Not Supplied.....	6
	Table 4: Rear Connector Pin Functions .....	15
	Table 5 - Data Output Requests .....	23
	Figure 1: Unit Controls .....	9
	Figure 2: Physical Dimensions .....	13
	Figure 3: P1 Connector Pin Out.....	13
	Figure 4: Panel Cut Out .....	14
	Figure 5: INS 429 Basic Wiring Diagram.....	16
	Figure 6: Interface with AP100.....	16
	Figure 7: Autopilot Connection Diagram.....	17
	Figure 8: External Input Connection Diagram .....	17

# 1 SECTION I - GENERAL INFORMATION

## 1.1 INTRODUCTION

Thank you for purchasing our INS 429 *Integrated Navigation System*. Here at Val Avionics Ltd., our core design philosophy is based on the ease of installation and use. The 429 represents 5 years of refinement in that process, based on the feedback of customers that have used the INS 422. The INS 429 is a totally new concept, designed with new and exciting features.

That design philosophy translates into the ease of installation and simple operation makes the INS 429 *Integrated Navigation System* a navigation solution for a wide variety of aircraft panels, from the Homebuilt through heavy twins. The INS 429 satisfies the need for compact, fully intergraded, quality navigational aid that can be counted on to provide years of reliable service.

Before installing and /or using your new INS 429 please read this manual completely. This will ensure proper installation and familiarize you with all of the features your NAV has to offer.

## 1.2 SCOPE

This manual will provide detailed information about the installation and operation of the INS 429 Integrated Navigation System. It will also provide equipment limitation information and instructions for continued airworthiness.

## 1.3 EQUIPMENT DESCRIPTION

The INS 429 has been designed for simplicity. It is straight forward to install and operate. Using state of the art technology Val Avionics Ltd. has created a navigation instrument that will provide the pilot with simple easy to interpret navigation information for in-route VOR and ILS Approach. The INS 429 can also be coupled to an external GPS system and display the GPS course deviation.

The INS 429 also has an enhanced display that features both active and standby frequency displays. A display that shows the pilot the type of station that is selected as active, be it a VOR or an ILS. Also continually displayed is the selected radial. Other display features include a three light marker and a back course indicator. The course deviation indicators are displayed as a dot matrix array that is easily interpreted by the flight crew. The display incorporates the latest is high intensity LED technology which provides excellent view ability even in direct sunlight.

The unit's controls have been designed for simple user interface. The concentric knobs on the left side of the unit select the standby frequency with a push button flip-flop to load the standby frequency into the active window. The concentric knobs on the right side of the unit select the desired radial. The push button on the right side knob set lets the user flip-flop the selected radial 180°. A long push of the right button will produce the centered radial from the selected station.

The INS 429 has three internal receivers. The VOR/LOC receiver operating from 108.00 MHz to 117.95 MHz, the Glide Slope receiver which operates from 329.15 MHz to 335.0 MHz, and the Marker receiver operating at 75 MHz. The INS 429 also has an external mode. The external mode is selected as a frequency as described above. In external mode the INS 429 can be used as a standard NAV Indicator and coupled to an external NAV or GPS receiver via the rear connector.

**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**

## 1.4 SPECIFICATIONS

**Table 1: Specifications**

SPECIFICATIONS	CHARACTERISTICS
Environmental: (RTCA/DO160D)	
VOR	RTCA/DO-196
Localizer	RTCA/DO-195
Glide slope	RTCA/DO-192
Marker Beacon	RTCA/DO-143 Class B
Physical Dimensions:	
Height	3.40 inches (8.64 cm)
Width	3.45 inches (8.76 cm)
Depth	9.87 inches (25.07 cm)
Weight:	3.25 pounds (1.5 kg)
Mounting:	Panel mounted, no shock mounting required
Temperature Range:	-20 to +55 Celsius with short time operations at +70 Celsius
Power Requirements:	
Voltage	11.0 to 30.0 VDC
Current	0.75 Amp @ 14V, 0.40 Amp @ 28V
Receiver:	
VHF Frequency (VOR/LOC)	108.00 to 117.95 MHz
Sensitivity	2 $\mu$ V to provide 50% Standard Deflection
Channel Spacing (VOR/LOC)	50 KHz
UHF Frequency (Glide slope)	329.15 to 335.0 MHz
Sensitivity	20 $\mu$ V to provide 50% Standard Deflection
Channel Spacing (Glide slope)	150 KHz
Marker Receiver	75 MHz
AGC Characteristics	From 10 $\mu$ V to 200 $\mu$ V the audio level will not vary more than 3db.
External Outputs:	
Audio Output	10mv into a 600 ohm load
CDI Left/Right	150mv into 1K Load
CDI Up/Down	150mv into 1K Load
CDI Glide slope Flag	250mv into 1K Load
CDI VOR/LOC Flag	250mv into 1K Load
External Inputs	
CDI Left/Right	150mv into 1K Load
CDI Up/Down	150mv into 1K Load
CDI Glide slope Flag	250mv into 1K Load
Manufacturer's Model Number	<b>INS 429</b>
Part Number	VPN 0800101-1
FCC ID	EZN5PRINS429

## 1.5 EQUIPMENT SUPPLIED

**Table 2: Equipment Supplied**

QTY	DESCRIPTION	PART NUMBER
1	INS 429 INTEGRATED NAVIGATION SYSTEM	<b>0800101</b>
1	INSTALLATION KIT	<b>0650103</b>

## 1.6 EQUIPMENT REQUIRED BUT NOT SUPPLIED

**Table 3: Equipment Not Supplied**

QTY	DESCRIPTION	PART NUMBER
1	Interconnect Wire Harness	VPN 0751030 or field fabricated
1	Headphone Jacks	Switchcraft P/N 11 (Ref VPN 550017)
1	Circuit Breaker 5 amp	Potter & Brumsfield W58-2 (Ref VPN 0331005)
1	Aircraft Cabin Speaker	Ref aircraft parts manual for specific part number
1	Contact Crimping Tool w/ Positioning Tool	AMP P/N 601966-1 AMP P/N 601699-5

## 1.7 LICENSE REQUIREMENTS

None

## 2 SECTION II - INSTALLATION

### 2.1 GENERAL INFORMATION

This section of the manual will provide the needed information to successfully complete the installation of your new INS 429 *Integrated Navigation System*. Please read this section completely before proceeding with the installation process. Although the INS 429 installation procedures are designed with the do-it-yourselfer in mind, we at Val Avionics Ltd. strongly suggest that you seek the advice of a qualified avionics installation facility before beginning this or any other installation project. Qualified avionics installation technicians can offer good advice as to time-tested installation practices and techniques that can save you many hours of time and frustration.

### 2.2 UNPACKING AND INSPECTION

Use care when unpacking the equipment. Inspect the unit and supplied parts for visual signs of damage during shipment. Examine the unit for loose screws, dents, broken buttons and other signs of damage that may have occurred during shipment. Verify the contents of the container with the list in section 1.5. If any damaged or missing parts are discovered during the inspection save the shipping material and contact the freight carrier to file a claim. If it is suspected that parts were omitted from the container please feel free to contact Val Avionics Ltd., to acquire the missing items.

### 2.3 EQUIPMENT INSTALLATION PROCEDURES

#### 2.3.1 Cooling Requirements

Forced air-cooling is not required for the INS 429 *Integrated Navigation System*. However, when planning the location for mounting, ensure adequate spacing from heat producing sources such as heating or defrosting ducts.

#### 2.3.2 Mounting Requirements

The INS 429 *Integrated Navigation System* should be rigidly mounted in the instrument panel using the hardware provided in the installation kit. Ensure that the mounting location will provide easy access and a clear view of the equipment's front panel from the pilot's position. Ensure that the mounting position will provide adequate clearance between the unit and the associated wire harness and the aircraft controls. Bracing at the rear of the unit should be installed to ensure rigidity in the panel. Consult FAA Advisory Circular AC 43.13-2A for acceptable practices and techniques.

#### 2.3.3 Wire Harness Fabrication

Val Avionics Ltd. recommends that a factory fabricated wire harness (VPN 0751030) be used for the installation of the INS 429 *Integrated Navigation System*. Use of the factory fabricated wire harness will ensure proper operation of the INS 429, reduction in the occurrence of interfering signals and ground loops, greatly reduced installation time, and provide prolonged trouble-free performance of your new equipment. Contact Val Avionics Ltd. or your local avionics distribution center for INS 429 Wire Harness ordering information.

Although strongly recommended, it is not required to use the factory fabricated wire harness when installing the INS 429. A wiring harness can be fabricated in the field. Refer to appendix B of this manual for a complete wiring diagram. The INS 429 is connected to the aircraft's avionics bus via a 5 AMP circuit breaker. All wires must be 22 AWG MIL-SPEC, unless otherwise noted in accordance with current regulations. Two and three conductor shielded MIL-C-27500 or equivalent wire must be used where indicated. Use AMP Contact Crimping Tool (AMP P/N 601966-1) with Positioning Tool (AMP P/N 601699-5) or equivalent to ensure good quality contacts. Refer to FAA Advisory Circular AC 43.13-2A for acceptable practices and techniques.

## **2.3.4 INS 429 Installation**

### **2.3.4.1 Mounting**

The INS 429 is rigidly mounted in a standard 3.125" round cutout on the aircraft panel. Once a location has been selected, a visual inspection should be made of the area directly behind the panel which, will be occupied by the INS 429 and harness assembly for obvious obstructions such as heater ducts, control cables, fuel and oil lines or any other obstruction. Pay particular attention to the control yoke assembly. It should be moved to the full limit of travel and verified that sufficient clearance exists prior to beginning installation. Most aircraft instrument panels will already have existing instrument mounting cutouts. If the location you have selected requires that a mounting hold be cut, refer to Figure 4: Panel Cut Out on Page 14 for the mounting template. Mark and cut the mounting holes as required.

Position the unit in its upright position, and from the rear of the panel, place the unit into the selected 3.125" panel cutout. With the unit held in place, insert four of the supplied 6-32 X 3/8" screws from the front and tighten as appropriate. The installing agency must fabricate and attach rear support brackets to the aircraft structure behind instrument panel as appropriate to support the rear of the INS 429. Then, attach these brackets to the provided attachment points on the rear of the unit with the supplied 6-32 3/8" Screws.

### **2.3.4.2 Antennas**

Two antennas are required for the INS 429 installation. A standard VOR/Glide Slope antenna can be used with the unit such as a COMANT CI-157 or equivalent. The most common location for the antenna is on top of the vertical stabilizer. The VOR/Glide Slope antenna can be coupled to the unit's NAV and G/S antenna ports via an antenna coupler such as a COMANT CI-205 or equivalent coupler. The recommended marker antenna is a COMANT CI-201 or equivalent mounted on the bottom of the aircraft and coupled to the MKR antenna port of the unit.

### **2.3.4.3 Audio**

The INS 429 has two audio outputs, Navigation audio and Marker audio. Although the audio output levels of the receivers are capable of driving a standard headset directly, it is strongly recommended that these audios be coupled to a quality audio selector panel such as a Val Avionics AP 100. For complete details, refer to the interconnect wiring diagrams in Appendix B.

## **2.4 POST INSTALLATION CHECK**

### **2.4.1 Operational Check**

Refer to section three of this manual. Using a calibrated VOR, Localizer, Glide Slope and Marker signals, check all functions of the INS 429 for proper operation. Check the operational functions of other equipment installed in the aircraft in accordance with the individual manufacture's operation manuals to insure that no cross interference exists as a result of this installation.

### **2.4.2 Final Inspection**

Verify that the wiring is bundled away from all controls and that no part of the installation interferes with the movement of the aircraft controls. Move all of the aircraft controls through their full range of movement while visually verifying that the installation does not mechanically interfere with the control movement. Verify that the wiring harnesses are properly secured to the aircraft structure in accordance with accepted practices as described in AC 43.13 and that adequate strain relief and service loops have been provided. Ensure that there are no kinks or sharp bends in the wire harnesses. Verify that the wire bundles are not exposed to any sharp or abrasive surfaces. Complete log book entries, FAA form 337, weight and balance computations and other documentations as required.

## **2.5 LIMITATIONS**

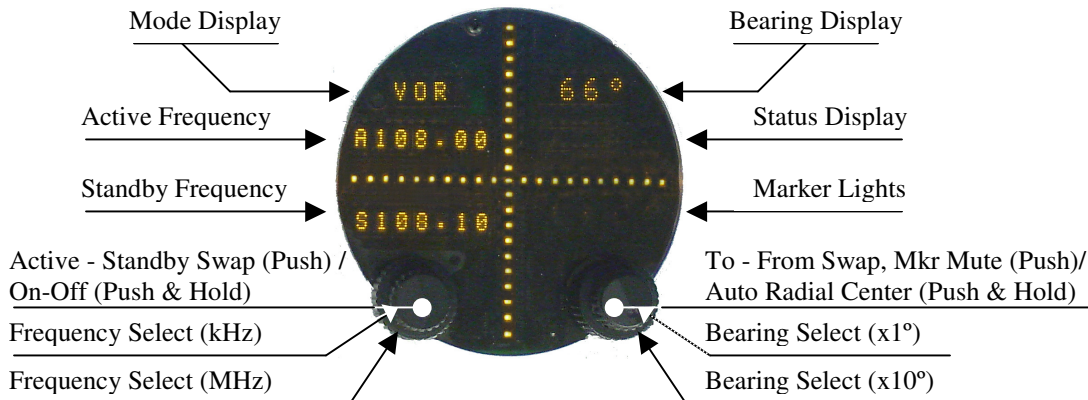
There are no known limitations to the operation of the INS 429. Instructions for Continued Airworthiness and Return to Service Instructions can be found in Appendix C.



## 3 SECTION III - OPERATION

### 3.1 GENERAL INFORMATION

This section will provide detailed operating instructions for your new INS 429 Integrated Navigation System. Please read this section completely to become familiar with all of the features of the unit.



**Figure 1: Unit Controls**

#### 3.1.1 Display Functions

The **Mode** display will change automatically in conjunction with the frequency that is loaded into the active frequency position. “**VOR**” will appear if a VOR frequency is loaded and “**ILS**” will appear if an ILS frequency is loaded. When “**EXT**” is loaded in the active position, the mode display will display “**XVOR**”, “**XILS**” or “**XGPS**” depending on the type of device that is connected to the external inputs at the rear connector of the INS 429.

The **Bearing** and **Status** displays are contained in the upper right quadrant of the INS 429. The bearing (or radial) will be displayed at all times in the top (**Bearing**) display and either “**TO**”, “**FROM**”, or “**BKCS**” in the lower (**Status**) display. If the unit is not receiving a valid VOR signal the lower display will be blank and the CDI display will be flagged.

The unit displays a flagged condition by showing full deflection of dots in both directions. In the case of a horizontal flag (VOR / Localizer), the CDI will show a horizontal bar indicating a flag. In the case of a vertical flag (Glide Slope), the VDI will show a vertical bar indicating a flag.

The marker receiver is always operational and the marker lights are located horizontally in the lower right quadrant of the unit's display.

#### 3.1.2 User Controls

Refer to Figure 1: Unit Controls. The user controls consist of two sets of concentric rotary knobs. The set on the left control functions on the left side of the display and the set on the right control the functions on the right side of the display. Both sets of knobs contain three parts, the inner knob (the small one) the outer knob (the large one) and a momentary push button (the end of the small knob).

### 3.1.2.1 Turning the unit on/off

To turn the unit on, momentarily press the left hand inner knob. The unit will go through a short initialization routine at start up and then begin operation at the same settings that were loaded at the last power down. To turn the unit off, press and hold the left inner knob for three seconds.

### 3.1.2.2 Setting Active and Standby Frequency

The knob functions of the left hand set are as follow; the inner knob will change the frequency by KHz or the numbers to the right of the decimal point (108.15) in 50kHz increments. The outer knob will change the frequency by MHz or the numbers to the left of the decimal point (108.15) in 1 MHz increments. Only the frequency in the standby position will change. The standby frequency is displayed at the bottom on the left side of the display and is identified by the letter "S" to the left of the frequency (S108.15). To load the standby frequency in to the active position, momentarily press on the inner knob. This will swap the standby frequency with the active frequency. The active frequency is identified by the letter "A" at the left of the frequency display (A108.15). If the external inputs are active (configured in the setup pages see section 3.2.1.3 on pg. 11) "EXT" will appear in the standby frequency position while rotating the outer knob. "EXT" is located between "117.XX" and "108.XX".

"EXT" stands for *external* as in external function. "EXT" can be loaded into the active display position by momentarily pressing on the inner knob. When "EXT" is loaded into the action position the INS 429 will display CDI and VDI information from an external receiver source such as an external GPS or an external NAV.

### 3.1.2.3 Setting a Bearing

The knob functions on the right side of the unit are as follow; the inner knob changes the bearing display by 1° increments. The outer knob changes the bearing display by 10° increments.

### 3.1.2.4 To/From Swap and Auto Radial Centering

When "VOR" is displayed in the mode display, momentarily pressing the inner right knob will change the displayed bearing to the 180° reciprocal. Pressing and holding the inner knob for three seconds will change the bearing to the centered "FROM" radial of the received VOR station.

### 3.1.2.5 Selecting the Backcourse

When ILS is displayed in the mode display pressing and holding the right inner knob for three seconds will enable the ILS in the back course mode and "BKCS" will be displayed in the Status display. While in the back course mode the glide slope VDI display will be flagged. Pressing and holding the right inner knob again for three seconds will return the ILS to the standard display mode.

### 3.1.2.6 Changing the Volume

The receiver's audio volume is controlled by momentarily pressing both of the inner knobs at the same time. "VOL" will be displayed in the standby frequency display and the volume level is indicated by the numeric value after "VOL" (i.e. "VOL 15"). The volume level can be adjusted from 0 to 20 by rotating the left hand large knob. Normal display operation resumes after 5 seconds or by pushing both knobs at the same time.

### 3.1.2.7 Marker Mute

When the unit is selected to an ILS frequency and is displaying "ILS", the marker receiver's audio can be muted for 1 minute by momentarily pressing the right button. This does not function on VOR frequencies.

## 3.2 System Configuration

### 3.2.1 Accessing Setup Functions

During startup, the unit's setup can be accessed by pressing both buttons simultaneously until the unit's Mode display shows "CONF". In this mode, the marker volume, marker mix, and external interface enable can be configured. To select each individual setting, rotate the right outer knob until the Active Frequency display and Standby Frequency display show the desired setting. To exit this mode and resume normal operation, press both buttons simultaneously.

#### 3.2.1.1 Marker Volume

When the Active Frequency display shows "Marker", and the Standby shows "Vol", the marker volume can be adjusted by rotating the right inner knob. The settings range between 5 and 20 in accordance with FAA regulation.

#### 3.2.1.2 Marker Mix

When the Active Frequency display shows "Marker", and the Standby shows "Mix", the marker mix function can be turned on and off. This function allows for the VOR/Localizer audio output (Pin 33) to also contain the Marker audio signal. "On" mixes the audio onto that one line, "Off" separates the audio to their separate lines as indicated on the wiring diagram.

#### 3.2.1.3 External Mode

When the Active Frequency display shows "Extern", and the Standby shows "Mode", the external mode function can be turned selected. When this function is "Off", the frequency selection will rollover from 117 MHz to 108 MHz with no "Ext" shown in the frequency display. This setting is typical for an installation that does not utilize the External Navigation inputs. "Anl" selects the analog inputs and enables the "Ext" selection in the frequency display.

## 4 SECTION IV - WARRANTY AND SERVICE

### 4.1 LIMITED WARRANTY

The equipment delivered with this Standard Factory Warranty is manufactured by Val Avionics, Ltd. and is guaranteed against defective materials and workmanship for one year from date of original retail purchase. Any unit found to be defective due to material and workmanship during the warranty period will be repaired or replaced at the sole discretion of Val Avionics Ltd.

Val Avionics, LTD liability under this warranty is limited to servicing, repairing or adjusting any equipment returned prepaid to the Val Avionics' factory by express written or verbal authorization for that purpose and to repair or replace defective parts thereof.

If, upon examination, it is determined that a malfunction has been caused by misuse of the equipment, installation or operation not in accordance with factory instructions, accident or negligent damage, alterations of any manner, and repair by other than the factory, the repairs will not be covered under the warranty. In such cases, an estimate will be submitted for approval before repair is initiated. In most cases, Val avionics, Ltd. will provide 72-hour turn around on its warranty and repair service. We recommend that contact be made with the FACTORY CUSTOMER SERVICE DEPARTMENT prior to any unit return and obtain RETURN AUTHORIZATION AND INSTRUCTIONS. This will provide proper control and expedite service.

Val Avionics, Ltd. reserves the right of continuous product development without obligation to install changes in previously manufactured products.

Installation of Val Avionics, Ltd. products must conform to methods acceptable by the Federal Aviation Administration as described in the appropriate Federal Aviation Regulations (FAR's) and Advisory Circulars (AC's).

To ensure proper warranty registration, type or print clearly the application information on the enclosed PRODUCTS WARRANTY REGISTRATION FORM and return to Val Avionics, Ltd.

### 4.2 SERVICE

Repair service for the INS 429 *Integrated Navigation System* is available at our manufacturing facility. Units in need of servicing should be returned prepaid to Val Avionics Ltd at the following addresses.

**If you are shipping by the US Postal Service address To:**

Val Avionics  
P.O. Box 13025  
Salem, OR 97309

**If you are shipping by FedEx, UPS or other shipping company, address to:**

Val Avionics  
2950 Pringle Rd. SE  
Salem, OR 97302

## 5 Appendix A – INSTALLATION DRAWINGS AND CONNECTOR LAYOUT

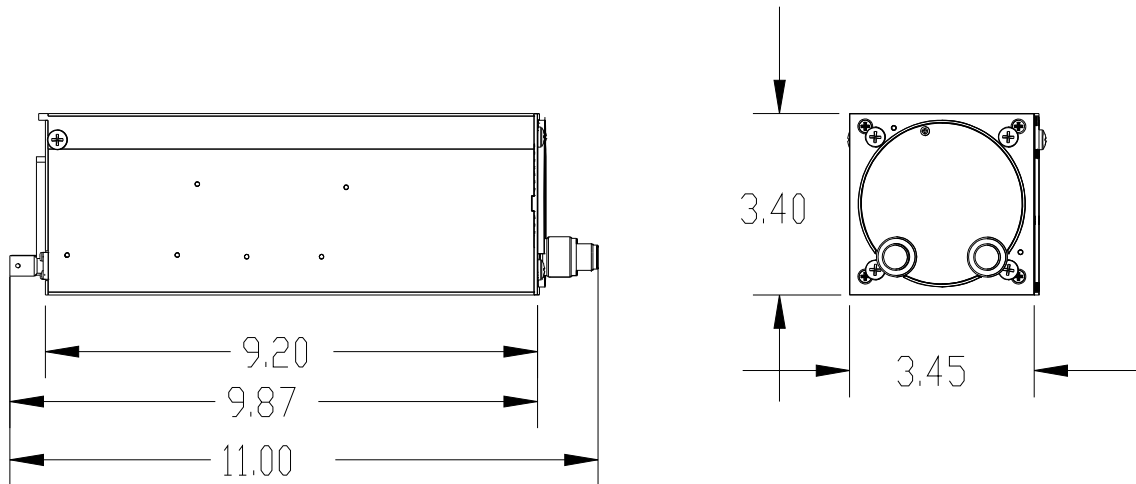


Figure 2: Physical Dimensions

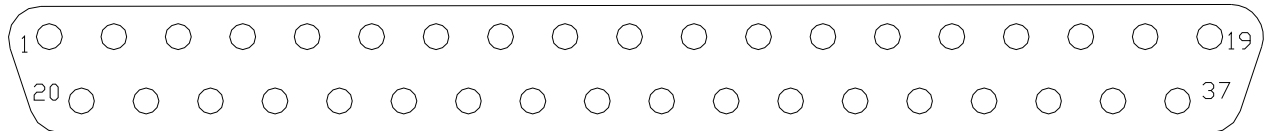
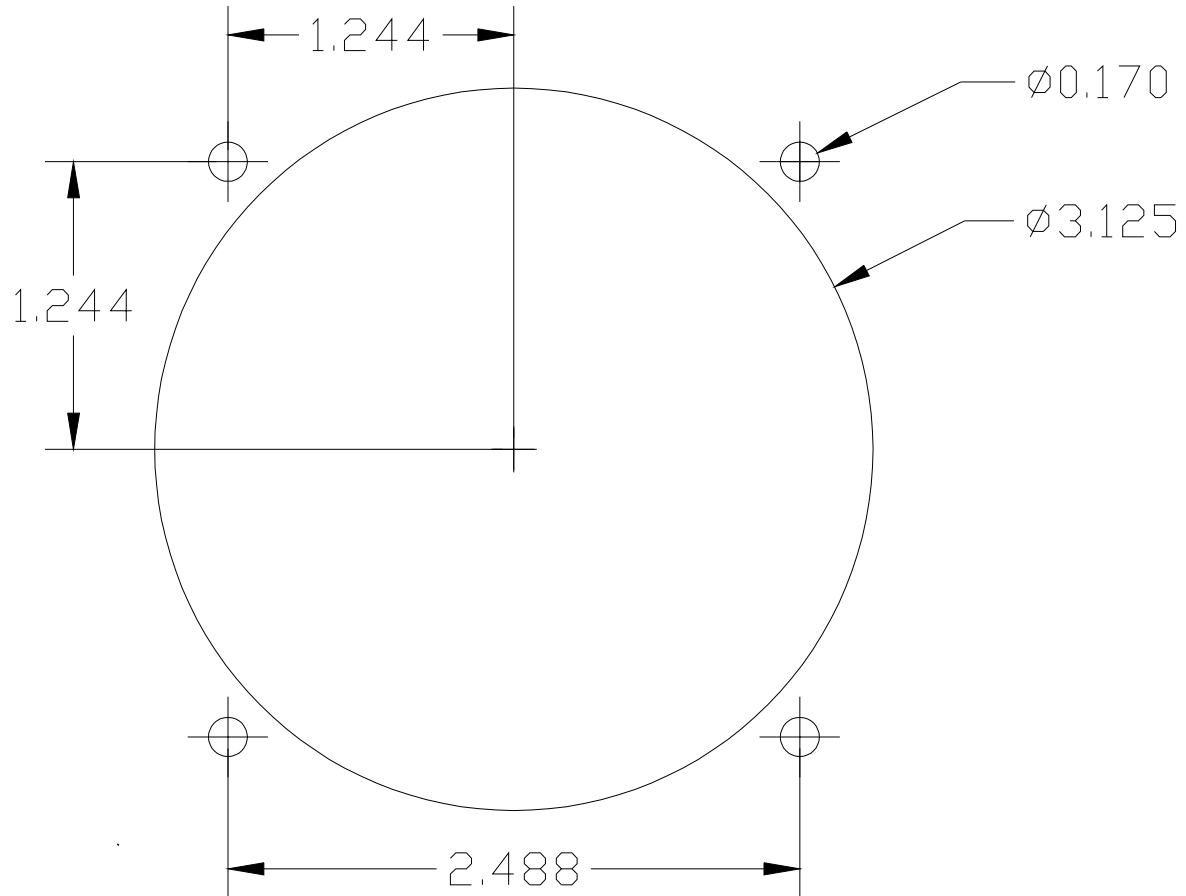


Figure 3: P1 Connector Pin Out



(Drawing Not to Scale)

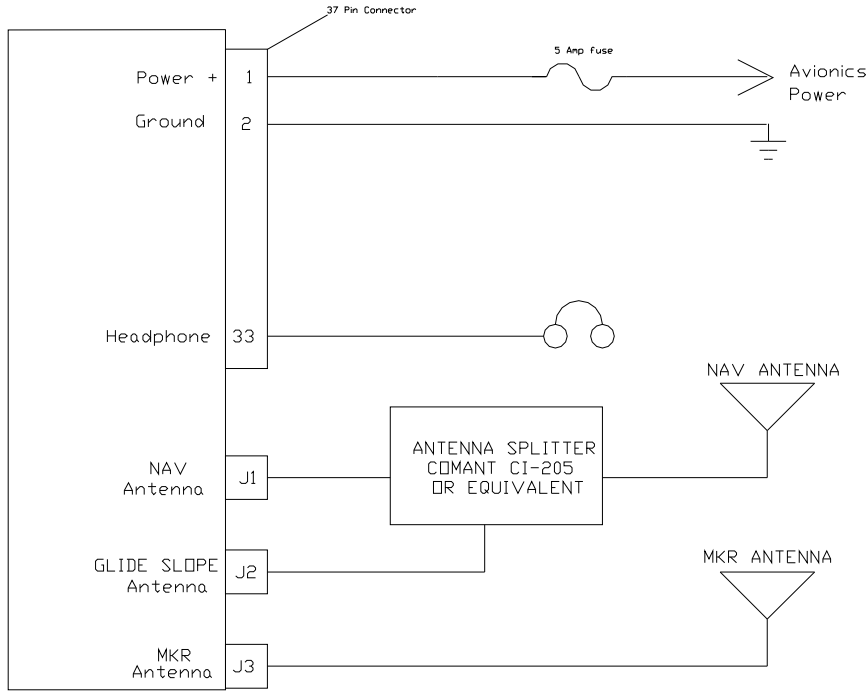
**Figure 4: Panel Cut Out**

**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**

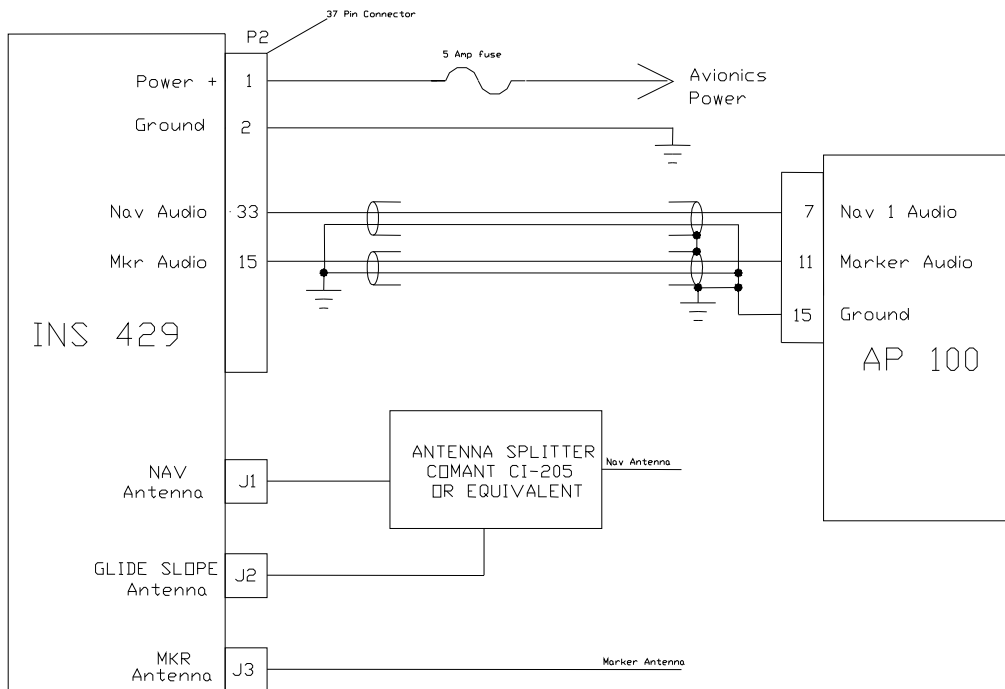
**Table 4: Rear Connector Pin Functions**

<b>Pin</b>	<b>Function</b>	<b>I/O</b>
1	Main Power	Input
2	Airframe Ground	
3	External CDI +Left	Input
4	External CDI +Flag	Input
5	External VDI +Up	Input
6	External VDI +Flag	Input
7	External ILS Energize	Input
8	External From Flag	Input
9	External GPS Annunceator	Input
10	Resolver Sin Output	Output
11	Autopilot +Down	Output
12	Autopilot +Left	Output
13	Autopilot CDI +Flag	Output
14	ILS Energize	Output
15	Audio Output Marker	Output
16	RS-232	Input
17	Not Used	
18	Not Used	
19	Not Used	
20	Main Power	Input
21	Airframe Ground	Input
22	External CDI +Right	Input
23	External CDI -Flag	Input
24	External VDI +Down	Input
25	External VDI -Flag	Input
26	External To Flag	Input
27	External VLOC Annunceator	Input
28	Resolver Referance	Input
29	Resolver Cos Output	Output
30	Autopilot +Up	Output
31	Autopilot +Right	Output
32	Autopilot VDI +Flag	Output
33	Audio Output (NAV / (NAV/MKR Mix))	Output
34	RS-232	Output
35	Ground	
36	Not Used	
37	Not Used	

## 6 Appendix B – WIRING DIAGRAMS



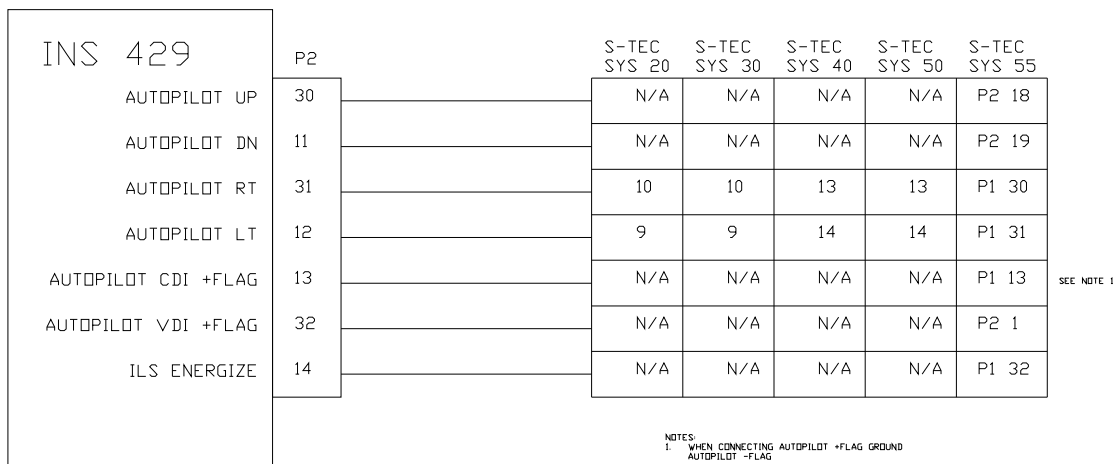
**Figure 5: INS 429 Basic Wiring Diagram**



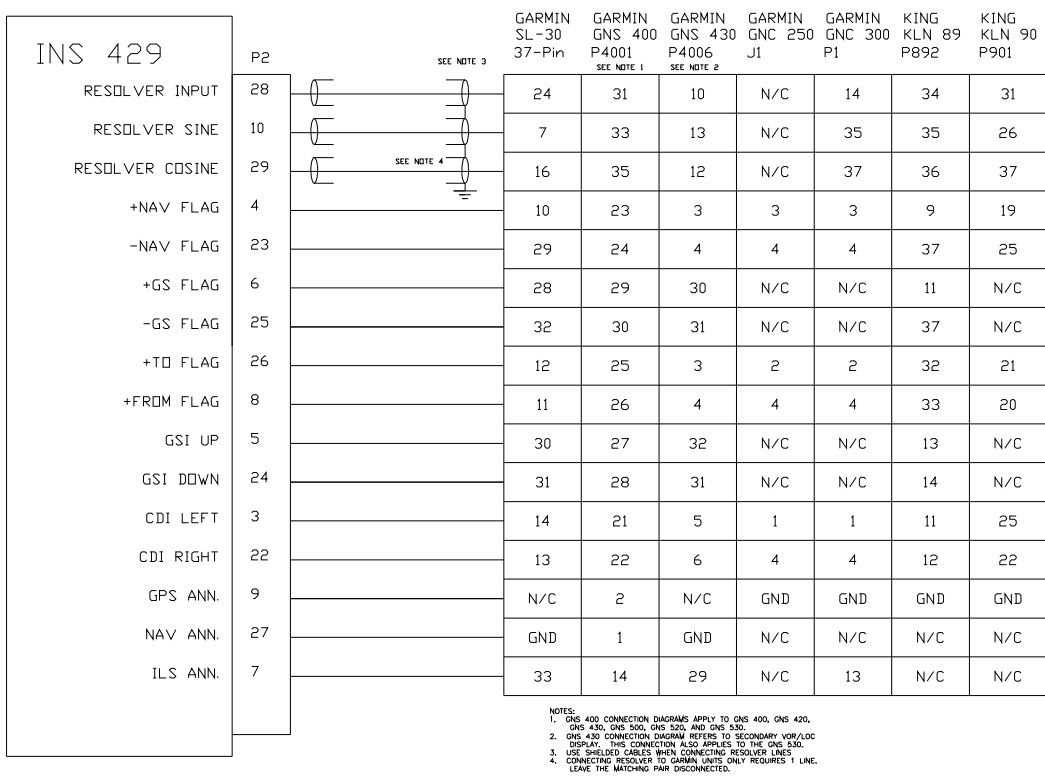
**Figure 6: Interface with AP100**



**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**



**Figure 7: Autopilot Connection Diagram**



**Figure 8: External Input Connection Diagram**

**VAL AVIONICS LTD  
INS 429 INTEGRATED NAVIGATION SYSTEM  
INSTALLATION AND OPERATOR'S MANUAL**

**This Page Intentionally  
Left Blank**

## 7 **Appendix C** – INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

### 7.1 MAINTENANCE INSTRUCTIONS

Maintenance of the INS 429 Integrated Navigation System is on condition only. **No periodic maintenance is required.** VOR calibration, in accordance with 14 CFR 91.171, is required to be checked every 30 days. If unit is found to be out of calibration, send unit in for service. If unit is removed for service, upon re-installation perform Post Installation check as described in section 2.4 of this manual.

**VAL AVIONICS LTD  
INS 429 INTEGRATED NAVIGATION SYSTEM  
INSTALLATION AND OPERATOR'S MANUAL**

**This Page Intentionally  
Left Blank**

## 8 Appendix D – RS-232 Instruction Listing

This appendix includes the interface specifications for the RS-232 serial port. The RS-232 port can be used to input active and standby frequencies as well as using an external serial resolver such as an EFIS system. The interface format conforms to NMEA 0183 message format specifications.

### 8.1 Input Commands

The following input command messages are supported:

- Input VOR frequency data from a remote source
- Input Localizer frequency data from a remote source
- Request data output
- Set active VOR/LOC frequency data from a remote source
- Set standby VOR/LOC frequency data from a remote source
- Set Omni-Bering Select (OBS) value from remote source

### 8.2 Output Messages

The INS 429 output messages include:

- Reset status
- CDI, GSI, and flags
- Decoded OBS setting
- Radial from active VOR
- Communications Error
- NAV Receiver status
- NAV audio mode
- NAV microcontroller software version

### 8.3 Data Format

The data format for serial communication is:

- Baud rate           9600
- Data bits           8
- Stop bits           1
- Parity              none

### 8.4 Default Message Output

At system start when the INS 429 is configured to operate in normal mode, the following messages will be configured for output and the specified rates:

- CDI, VDI, and Flags at 10 Hz (high rate)
- Decoded OBS Setting at 10 Hz (high rate)
- Radial from Active VOR at 10 Hz (high rate)
- NAV Receiver status at 1 Hz (low rate)

These default rates can be changed by using the Request Data Output message.

## 8.5 Message Formats

All messages will conform to the NMEA 0183 proprietary message format as follows. All characters will be standard ASCII characters. No binary data characters will be used.

“\$”	.....	Start of message character, ASCII “\$” (024h)
“P”	.....	Proprietary message identifier
“MRR”	.....	II Morrow company identifier
c	.....	Message class identifier. Used to identify a message as either a COMM or VHF NAV message. Those message types, which are also supported by the VAL COM 2000 VHF Transceiver, will use the “C” identifier to allow the INS 429 to accept COMM radio commands from existing products. All other messages will use the “V” identifier to indicate that they relate to a VHF NAV receiver.
nn	.....	Message identifier, two-digit number in ASCII characters.
d...d	.....	Message data characters defined for each message.
checksum	.....	Message checksum, including message identifier through data characters. The two-digit checksum is generated by adding all values of valid characters together, ignoring carry (if any). This value is converted into two encoded hex <sup>1</sup> characters (30h-3Fh).
<CR>	.....	ASCII carriage return (0Dh)
<LF>	.....	ASCII line feed (0Ah)

The maximum message length, including the start of message character (“\$”) and the end of message <CR><LF> sequence, is 25 bytes.

This message format is the same as is used in the VAL COM 2000 VHF Transceiver. The INS 429 will be able to accept all messages intended for a COM 2000 without generating a serial communications error. It will ignore all of those messages.

---

<sup>1</sup> Encoded Hex: each character consists of 4 bits of data placed in the low order nibble +30h. For example, the 8-bit value of 5Fh would be encoded as two characters with values of 35h and 3Fh, which map to the ASCII characters “5” and “?” respectively.

## 8.6 Message Definitions

### Input Messages

#### REQUEST DATA OUTPUT

This input is used to request an output message to be sent by the INS 429.

#### Message format:

- “V” .....Message class. This is a VHF NAV message.
- “24” .....Message identifier.
- ii .....Output identifier of requested message, two ASCII characters.
- dd.....Message data, two encoded hex<sup>2</sup> characters (30h-3Fh), used for specific output request. Set to “00” if not needed. These characters are used for such items as selecting a specific EEPROM address to output.
- A.....Request type: (ASCII) “0”= output repeatedly at low speed (1 Hz); “H” = output repeatedly at high speed (10 Hz).

ii	Output	Dd	Data Description	a
“20”	Reset Status	“00”		“0”
“21”	CDI, GSI, and Flags	“00”		“0”, “L”, “H”
“22”	Decoded OBS Setting	“00”		“0”, “L”, “H”
“23”	Radial from Active VOR	“00”		“0”, “L”
“28”	Receiver Status	“00”		“0”
“30”	NAV Microcontroller Software Version	“00”		“0”
“32”	ADC Data Output	cc	ADC channel: “00” to “08”	“0”
“35”	Comm Transceiver Status	“00”		“0”
“36”	Comm Software Version	“00”		“0”

**Table 5** - Data Output Requests

#### Example messages:

```
$PMRRV242100L<chksm><CR><LF>
```

Request periodic output of CDI, GSI, and related flags at low (1Hz) rate.

```
$PMRRV2432050<chksm><CR><LF>
```

Request a single output of ADC data from channel 5.

#### SET ACTIVE VOR/LOC FREQUENCY AND RECEIVER FUNCTION

This message is used to set the standby VOR or Localizer frequency as well as the receiver operating function. The INS 429 can detect if the supplied frequency corresponds to a VOR or a Localizer channel, so this command will work for both types of NAV aids.

---

<sup>2</sup> Encoded Hex: each character consists of 4 bits of data placed in the low order nibble +30h. For example, the 8-bit value of 5Fh would be encoded as two characters with values of 35h and 3Fh, which map to the ASCII characters “5” and “?” respectively.

**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**

**Message format:**

\$PMRV27E4N<chk sm><CR><CR><LF>

This example command would set the active VOR frequency to 117.100 MHz. This can be interpreted by noting that the ASCII 'E' corresponds with 45h, + 30h = 75h, converted to decimal equals 117 for the MHz portion of the command. The kHz portion converts ASCII '4' to 34h, - 30h = 4h, x 25 kHz steps = 100 kHz. This command would also set the receiver function to normal, leaving the standby channel inactive.

Note: The INS 429 will check input frequencies for validity. An RS-232 serial error message output will be generated if the frequency is invalid.

### SET STANDBY VOR/LOC FREQUENCY AND RECEIVER FUNCTION

This message is used to set the standby VOR or Localizer frequency as well as the receiver operating function. The INS 429 can detect if the supplied frequency corresponds to a VOR or a Localizer channel, so this command will work for both types of NAV aids.

**Message format:**

"V".....Message class. This is a VHF NAV message.

"28".....Message identifier.

mk.....Standby VOR/LOC frequency:

m = desired frequency in MHz in hexadecimal, where m = desired frequency - 30h, with desired frequency in range of 108 to 117 MHz.

k = desired frequency in kHz, where k = (desired frequency / 25 kHz) + 30h, desired frequency in range of 000 to 975 kHz in 50 kHz steps, or the even numbers from 30h to 56h.

a.....Receiver function: N = normal, 0 = unchanged.

**Example message:**

\$PMRRV28?PN<chk sm><CR><LF>

This example command would set the standby VOR frequency to 111.800 MHz. This is interpreted by noting that the ASCII '?' corresponds with 3Fh, + 30h = 7Bh, converted to decimal equals 111 for the MHz portion. The kHz portion converts ASCII 'P' to 50h, -30h, -30h yields 20h, x 25 kHz steps = 800 kHz portion. This command would also set the receiver function to normal, so the receiver would receive only the active VOR channel.

Note: The INS 429 will check input frequencies for validity. An RS-232 serial message output will be generated if the frequency is invalid.

### SET STANDBY COMM FREQUENCY AND TRANSRECEIVER FUNCTION

This message is issued to set the standby COM frequency.

**Message format:**

"V"..... Message class. This is a VHF NAV message.

"29"..... Message identifier.

Mk..... Standby COM frequency:

m = desired frequency in MHz in hexadecimal, where m = desired frequency - 30h, with desired frequency in range of 118 to 136 MHz, or 162 MHz.

k = desired frequency in kHz, where k = (desired frequency / 25 kHz) + 30h, with desired frequency in range of 000 to 975 kHz in 25 kHz steps.



**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**

a.....Transceiver function: N = normal, 0 = unchanged.

**Example message:**

\$PMRRV29G4M<chksm><CR><LF>

This example command would set the standby VOR frequency to 119.100 MHz. This is interpreted by noting that the ASCII 'G' corresponds with 47h, + 30h = 77h, converted to decimal equals 119 for the MHz portions. The kHz portion converts ASCII '4' to 34h, - 30h yields 4h x 25 kHz steps = 100 kHz.

**Note:** The COM 2000 will check input frequencies for validity. An RS-232 serial error message output will be generated if the frequency is invalid.

**SET ACTIVE COMM FREQUENCY AND TRANSCEIVER FUNCTION**

This message is used to set the Active COMM frequency as well as the COMM transceiver function.

This message is only available in normal mode.

**Message format:**

"V" .....Message class. This is a VHF NAV message.  
"42" .....Message identifier.  
mk .....Active COMM frequency:  
    m = desired frequency in MHz in hexadecimal, where m = desired frequency - 30h, with desired frequency in range of 118 to 136MHz, or 162MHz.  
    k = desired frequency in kHz, where k = (desired frequency / 25kHz steps.)  
    a = Transceiver function: N = normal, 0 = unchanged.

**Example message:**

\$PMRRV42G4N<chksm><CR><LF>

This example command would set the active VOR frequency to 119.100MHz and place the COMM radio in Normal receive mode. This is interpreted by noting that the ASCII 'G' corresponds with 47h, + 30h = 77h, converted to decimal equals 119 for the MHz portion. The KHz portion converts ASCII '4' to 34h, - 30h yields 4h, x 25KHz steps = 100 kHz.

**Note:** The COM 2000 will check input frequencies for validity. An RS-232 serial error message output will be generated if the frequency is invalid.

**SET OMNI-BEARING SELECT (OBS) VALUE**

This message is used to set the OBS value used by the INS 429 as the elected radial for computing the course deviation from a VOR. This message will have no effect unless the INS 429 is configured to use the internal OBS source, or a serial OBS source.

**Message format:**

"V" ..... Message class. This is a VHF NAV message.  
"34" ..... Message identifier.  
vvv ..... OBS Value in degrees, ranging from "000" to "359".

**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**

**Example message:**

\$PMRRV34310<chk sm><CR><LF>

Set the OBS value to 310 degrees.

## OUTPUT MESSAGES

### RESET STATUS

This message is sent to indicate to the host that the INS 429 is running and ready to accept data on the serial port. It will be sent once upon startup and when requested by the host.

**Message format:**

“V”.....Message class. This is a VHF NAV message.\

“20”.....Message identifier.

**Example message:**

\$PMRRV20<chk sm><CR><LF>

INS 429 is running and ready to accept serial input.

### CDI, GSI, AND RELATED FLAGS

This message outputs the current values of the CDI, GSI, and their related flags. After power up this message will be output at a 10 Hz rate.

**Message format:**

“V”..... Message class. This is a VHF NAV message.

“21”..... Message identifier.

cc..... CDI deflection. An eight-bit value indicating the amount of deflection of the CDI needle, represented as two encoded hex<sup>3</sup> digits. The CDI deflection is a twos complements signed integer in the range of –100 to 100. –100 indicates full left deflection, 0 indicates no deflection, and 100 indicates full right deflection.

gg ..... GSI deflection. An eight-bit value indicating the amount of deflection of the GSI needle, represented as two encoded hex<sup>xx</sup> digits. The CDI deflection is a twos complement signed integer in the range of –100 to 100. –100 indicates full deflection upwards, 0 indicates no reflection, and 100 indicates full deflection downwards.

ff..... Flags. Eight bits for HNAV and VNAV related flags, represented as two encoded hex digits.

- |             |  |
|-------------|--|
| Bit 1 (1sb) | Back Course enable (1 = enabled)       |
| Bit 2       | Localizer detect (1 = using localizer) |
| Bit 3       | FROM flag (1 = From) <sup>4</sup>      |
| Bit 4       | TO flag (1 = To)                       |
| Bit 5       | GSI superflag (1 = valid)              |
| Bit 6       | GSI valid (1 = valid)\                 |
| Bit 7       | NAV superflag (1 = valid)              |

---

<sup>3</sup> Encoded Hex: each character consists of 4 bits of data placed in the low order nibble +30h. For example, the 8-bit value of 5Fh would be encoded as two characters with values of 35h and 3Fh, which map to the ASCII characters “5” and “?” respectively.

<sup>4</sup> The TO and From flag can not both be 1, indicating that they are both valid. They can both be zero, indicating that neither is valid. This situation will occur whenever the receiver determines that it is within the “cone of confusion” directly over the VOR, or when no signal is being received.

**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**

Bit 8 (msb) NAV valid (1 = valid)

**Example message:**

\$PMRRV21817???:<chksm><CR><LF>

This message indicates a full left CDI deflection (-127), a full up GSI deflection (127), both the GSI and NAV flags/superflags are valid, TO flag set, FROM flag not set, using a localizer, with no back course enable.

**DECODED OBS SETTING**

This message outputs the current OBS setting, which may be read from an external resolver or from user input to the front panel. After power up this message will be sent at a 10 Hz rate.

**Message format:**

“V” ..... Message class. This is a VHF NAV message.  
“22” ..... Message identifier.  
v ..... Valid flag. “0” = OBS invalid/not present, “V” = OBS setting is valid.  
ddd ..... Three digit OBS setting, in degrees. Values are in the range of “000” to “359”.

**Example message:**

\$PMRRV22V170<chksm><CR><LF>

A valid OBS setting of 170 degrees.

**RADIAL FROM ACTIVE VOR**

This message outputs the current bearing from the active VOR station. This message will be output even when a localizer is being tracked by the NAV receiver. In this case, the bearing will be marked as invalid. After power up this message will be sent at a 10 Hz rate.

**Message format:**

“V” ..... Message class. This is a VHF NAV message.  
“23” ..... Message identifier.  
v ..... Valid flag. “0” = bearing not valid, “V” = bearing is valid.  
dddf ..... Bearing to a resolution of 1/10<sup>th</sup> of a degree. ddd = three digit bearing in degrees, ranging from “000” to “359”. f = 1/10<sup>th</sup> of a degree.

**Example message:**

\$PMRRV23V1654<chksm><CR><LF>

A valid bearing of 165.4 degrees FROM the active VOR station.

**COMMUNICATIONS ERROR**

This message is used to indicate a communication error.

**Message format:**

“V” ..... Message class. This is a VHF NAV message.  
“27” ..... Message identifier.  
e ..... Error code: (ASCII)  
    “0” = input message checksum error.  
    “1” = unknown message.  
    “2” = error or mismatch in message data.

**Example message:**

\$PMRRV271<chksm><CR><LF>

Received an unknown message.

**VAL AVIONICS LTD**  
**INS 429 INTEGRATED NAVIGATION SYSTEM**  
**INSTALLATION AND OPERATOR'S MANUAL**

### NAV RECEIVER STATUS

This message is used to output the current status of the NAV receiver. It will be output upon request or whenever the status changes.

#### Message format:

“V” ..... Message class. This is a VHF NAV message  
“28” ..... Message identifier  
mk ..... Standby NAV frequency: m = MHz, where m + 30h = desired MHz frequency in the range of 108 to 117 MHz. k = (desired frequency / 25 kHz) + 30h, with desired frequency in range of 000 to 975 kHz in 50 kHz steps.  
s ..... Status: “N” = Normal mode, “M” = Monitor mode

#### Example message:

```
$PMRRV28E4?PM<chksm><CR><LF>
```

Active NAV frequency is 117.100 MHz, Standby NAV frequency is 111.800 MHz, receiver is in monitor mode.

### NAV MICROCONTROLLER SOFTWARE VERSION

This message is used to output the version string for the NAV microcontroller software.

#### Message format:

“V” ..... Message class. This is a VHF NAV message.  
“30” ..... Message identifier.  
vvvv ..... Software version in ASCII  
e ..... Engineering version flag:  
    “R” = Released version.  
    “E” = Engineering version.

#### Example message:

```
$PMRRV300103E<chksm><CR><LF>
```

NAV Microcontroller software is version 1.03. It is an engineering version.

### COM TRANSCEIVER STATUS

This message outputs the result of a specific system test.

#### Message format:

“V” ..... Message class. This is a VHF NAV message.  
“35” ..... Message identifier.  
mk ..... Active frequency: m = MHz, where m = desired MHz frequency – 30h, ranging from 118 to 136 MHz, 162 (i.e., 76h to 88h, A2h); k = (kHz offset / 25 kHz) + 30h, ranging from 000 to 975 kHz steps.  
mk ..... Standby frequency: m = MHz, where m = desired MHz frequency – 30h, ranging from 118 to 136 MHz, 162 (i.e., 76h to 88h, A2h); k = (kHz offset / 25 kHz) + 30h, ranging from 000 to 975 kHz steps.  
a ..... Transceiver status:  
    R = Normal receive  
    T = Transmit enabled  
    S = Stuck mic  
    F = Comm failure  
s ..... Squelch test setting: (ASCII) 0 = automatic; 1 = test

**VAL AVIONICS LTD  
INS 429 INTEGRATED NAVIGATION SYSTEM  
INSTALLATION AND OPERATOR'S MANUAL**

**Example message:**

\$PMRRV35G4LFR0<chksm><LF>

Active frequency is 119.100 MHz, the standby frequency is 124.550 MHz, receiver function, squelch is automatic.

**COM SOFTWARE VERSION**

This message is used to output the version string for the VHF COM receiver software.

**Message format:**

“V” ..... Message class. This is a VHF NAV message.

“36” ..... Message identifier.

vvvv ..... Software version in ASCII

**Example message:**

\$PMRRV300103<chksm><CR><LF>

COM software is version 1.03.