

AV-15 PROFESSIONAL RAMP TESTER USERS MANUAL



AV-15 With optional 40db RF pad

Software Version 1.27

POWER

The tester is supplied with (4) AA batteries uninstalled. The AV-15 can be powered by batteries or via the micro USB port. If the AV-15 is always going to be USB powered then the batteries are not required. For battery operation, please install the (4) AA batteries. Remove four rubber feet using small phillips screwdriver. Use care to install batteries in correct orientation (neg battery to springs). When shipping or when storing it is recommended to remove the batteries.

TESTING PROCEDURE

The transmit power of the AV-15 is very low - at approximately 1/4 of one thousandth of a watt (0.25 milliwatt) - so you will need to be close (15-40 ft) to the aircraft for most testing. The power was designed to be very small so that the likelihood of interference is low and so that the sensitivity of the aircraft receivers can be checked. However, when using the AV-15, be sure that you do not interfere with any other aircraft or ATC system. A good method to limit possible interference is to test inside of a metal hangar. Note that when testing the ILS marker beacon, the AV-15 antenna will need to be within a inch or two of the aircraft marker antenna. The aircraft marker receiver was intentionally designed with 100 times lower sensitivity than your other receivers so that it only picks up the marker when the plane is close to the marker transmitter. Make sure the aircraft marker receiver is set to high sensitivity if available. The ADF receiver may also require the AV-15 to be close due to the poor antenna match at its low frequencies. For other test modes allow at least 3 foot spacing between the AV-15 and the aircraft antennas.

When performing transponder testing do a MODE-A test first so that the AV-15 can adjust its receiver to the current RF conditions. It is also a good way to find a useable RF location near the aircraft. Sometimes moving only a foot will change the signal strength quite a bit due to reflections and shadowing of the signal. When doing ADS-B squitter testing, first find a good reception location using the mode-s only all-call command.

******* 20 dbm = 0.1 watt is the MAX allowed input *******

To test a transponder using direct connection, it is required to use an attenuator to reduce the 54dbm, or so, power out to +20dbm or less into the AV-15. An optional attenuator kit is available. Exceeding the 20dbm input level will cause damage to the AV-15.

SCOPE TRIGGER OUTPUT

The AV-15 provides a scope trigger output to support bench testing. The AV-15 is supplied with a MCX to BNC female adapter cable for connection to an oscilloscopes trigger input. The nominal output is 3.3 volt with 270 ohm source impedance. It's best to use a high impedance scope input but a 50 ohm input will not cause harm.

{****} signifies new AV15 command not in AV-10

Note 1; when testing do not overload the AV-15 front end. The AV-15 was designed for input signals to the antenna port of **+20db or less**. When testing with the AV15, stay 3 foot or more away from the DME and transponder antennas, and a couple feet or more from Comm antennas. To perform direct connect transponder testing, 40 db or more, of power appropriate, attenuation **MUST** be used. Sun offers an optional 25 watt 40 db attenuator.

FRONT PANEL OPERATION

To operate the AV-15, turn on unit and wait for its self test to finish. It will display the software version then;

PUSH TO SEL MODE
< VOR >

The AV-15 is controlled using the 3 keys just below the 2 line LCD display. The center key has two functions based on how long the key is pressed. A short normal press is used to select the currently displayed menu item. A long (approx 2 seconds) press causes the unit to stop the current operation and jump back to the < VOR > beginning menu item. The Left and Right keys just move you through the menu's or adjust selection values.

The blue LED just above the 2 line LCD display will turn on to indicate that the AV-15 is transmitting. Connect the antenna to the BNC connector that is above the display. For VOR, ILS, NDB functions you may extend the antenna to full length since they run in the 100-400 MHz range or lower. During DME and TRANSPONDER operation collapse the antenna to its shortest length.

AV-15 OPERATION:

The AV-15 aircraft avionics ramp tester provides test functions for the following aircraft avionic equipment:

1. Generates VOR test signal's at each 45 deg radial

or at 0, 45, 90, 135, 180, 225, 270, 315 deg's from the station.
carrier frequencies 108.0, 110.2, 112.4, 113.6 MHz are selectable.
The station ID tone is a 1020 hZ on/off beep.

When the AV-15 is powered on it does its self test and shows its software version.
Then the display shows;

PUSH TO SEL MODE

< VOR >

To activate the VOR test mode press & release the center key. The display will show;

PUSH TO SEL FREQ

< 108.0 >

If you wish to use 108 MHz then select it with the center key, else use right and left keys to step to another frequency. When the desired frequency is displayed then select it with the center key. The display shows;

PUSH TO SEL MODE

Start VOR test?

To start push the center key, left and right keys allow selection of 30Hz modulation off And carrier only test modes that may be useful during bench VOR alignment. {*****} Then;

<- VOR RADIAL ->

0 deg FROM

The AV-15 is now transmitting the VOR signal with the 9960 FM subcarrier and the 30 Hz AM signal in phase so that your NAV receiver should display 0 deg from or 180 deg to on its OBS. The AV-15 modulation is generated digitally and is quite accurate. The scope trigger output provides a narrow pulse at the 0 deg phase point of both modulation signals. The blue led above the display is on to show that the AV-15 is in transmit mode. Use the right key to select the 45 deg from radial. The display shows;

<- VOR RADIAL ->

45 deg FROM

The AV-15 now is transmitting the VOR signal with 45 deg phase shift between the 9960 subcarrier reference and the 30 Hz AM modulation. The NAV OBS should show 45 deg FROM or 225 TO the station. The scope trigger output provides a pulse that always goes high at the 0 deg 9960 reference point and low at the 30 Hz 0 deg point. By using the left or right keys other radials can be selected at 45 deg intervals. When finished with VOR testing, press and hold the center key down for about 2 seconds until the blue led blinks, then release the key to return to start of the main menu.

2. ILS test signals.

a) Localizer

108.1 or 110.3 MHz carrier frequency
center, 1/2 and full deflection right and left
no 150Hz or no 90Hz modulation to check NAV flag.
Also generates 1020 Hz beep station ID.

Example;

Use right or left keys to move to;

PUSH TO SEL MODE

< ILS >

Select with center key. To do localizer, select it with center key.

Use left right keys to select carrier frequency, then the display shows;

SEL LOC DDM

DDM=0 or CENTER

Your NAV indicator should show a centered needle for the ILS localizer. DDM stands for difference in depth of modulation between the 90 and 150 Hz AM modulation. Press the right key and the display gives

SEL LOC DDM

1/2 RIGHT .078

Your NAV indicator should show half deflection, DDM=.078. Use the left right keys to select half, full deflection left and right as well as having only 90 or 150 Hz modulation. When you are finished do a long center key push to return to main menu. The glide slope works in a similar fashion.

b) GLIDE SLOPE

108.1 - 334.7, or 110.3 - 335.0 MHz carrier frequency.
Center, 1/2 and Full deflection up and down as well as
no 150HZ or no 90Hz modulation to check flag. No ID.

c) MARKER BEACON

A 75MHz AM modulated RF signal. The beep rate is slowest at outer marker.
The AV-15 provides OUTER, MIDDLE, and INNER marker beacon signals.

As noted above, the marker receiver, in the aircraft, has low sensitivity so you will need to place the AV-15 antenna within a few inches of the marker antenna.

3. DME test signal.

VOR paired 108.00 =17X mode or 108.05=17Y mode selectable.
It Generates a fixed 20NM distance signal to the DME.
After selection the DME should lock to the AV-15 signal within a few seconds.

4. ADF signals.

Provides AM modulated low frequency signals to test that the aircraft ADF-NDB receiver is picking up the radio signal. As explained in the theory section, for direction finding the transmitter needs to be a long way from the aircraft receiver. The signal is small so the AV15 antenna must be close to the NDB's antenna.

5. COMM RADIO TEST. {****}

- a) Generates AM modulated test signal that can be heard on the aircraft communication radio. This provides a simple radio receiver check. The AV-15 sends -17dbm +/-1db to its antenna. With a 3db antenna and 45db path loss the radio should see about -65dbm. Thus a crude check is made of the radio sensitivity. Two channels for the new 8.333 KHz radios are also provided.
- b) Receive the comm radio carrier and display the frequency difference between the AV-15 reference and the comm radios carrier frequency. By keying the comm radio this feature allows for checking the comm radios transmitter frequency accuracy. The AV-15 requires at about -15dbm at its antenna to read the carrier. So the Communication radios output power is also crudely checked. Example; given 10 watt (40db) Output and 45db path loss and 3db AV-15 antenna loss the AV-15 will see about -8dbm. The maximum useful frequency range is about +/- 50,000Hz difference. The minimum Frequency difference is about +/- 50Hz or the display shows zero.

6. TRANSPONDER A/C/S ADS-B

- a) Generates MODE-A test signal and display's squawk code and reply percentage. Also allows side lobe suppression check. If the transponder IDENT is activated then the AV-15 will display IDENT. The AV-15 sends about 235 MODE-A interrogations per second. The AV-15 sends 1030MHz P1 and P3 pulses spaced 8.0uS apart. The P2 side lobe suppression pulse can be selected as the same amplitude as P1-P3 or -9db {*****}. The suppression pulse is sent 2.0uS after the P1 pulse if enabled. No P4 pulse is sent. The top LCD line display's the squawk code then F1=nn. The hex number nn is the approx transponders F1 pulse width. The hex number times 50nS equates to the measured F1. If the transponder is sending ident then the word IDENT replaces the F1 display. Reply percent is on the bottom LCD line.

Example; After turning on the AV15 and waiting for the self test to run, the display will read

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PUSH TO SEL MODE
<  VOR  >
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push left push button so that display line 2 reads;

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< TRANSPONDER >
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now push center button to select transponder testing.
The display will now show

SEL TXPDR MODE
MODE A SQUAWK

If we wanted to do a different transponder test we would use the right or left buttons to step through the tests available. Since we wish to do the Mode-A test we press the center button to select it. The display will show

SIDELOBE SUPPRES
NO SLS P2 OFF ?

If we wish to do Mode-A with the SLS off then press center select button. If you wish to send a P2 pulse that is equal in amplitude or -9db to the P1 pulse then use the right or left buttons. Once the center button is pressed the AV-15 will begin sending Mode-A interrogations and looking for replies. The AV-15 will display something like;

SQ=1200 F1=08
Reply%=100

Line 1 displays the Squawk code and the F1 shows the pulse width of the reply F1 pulse where a Hex number between 7 to A is normal. Line 2 displays the reply percentage. If all interrogations result in a good reply to the AV-15 then 100% is shown. To stop Mode-A testing and select a different test, press and hold the center button down until the blue LED goes off or blinks. The power switch will also work but any saved mode-S address info will be lost.

- b)** Generates MODE-C test signal and displays the altitude and reply percentage. Also allows sidelobe suppression check.

The AV-15 sends about 235 MODE-C interrogations per second. The AV-15 sends 1030MHz P1 and P3 pulses spaced 21.0uS apart. The P2 sidelobe suppression pulse is the same amplitude or -9db {*****} from P1-P3 and sent 2.0uS after the P1 pulse if enabled. No P4 pulse is sent. The top LCD line displays the raw received code in hex and the calculated altitude. The bottom line gives reply percentage.

- c)** checks the Aircraft Transponders Transmit carrier frequency.

The AV-15 sends MODE-A requests and displays a number that is representative of the magnitude of the received reply. By moving a filter about the nominal 1090MHz receive frequency the approximate transponder transmit frequency is determined. The filter can be moved +/- 15MHz from 1090MHz in 1MHz steps. Use the left button to move down and the right key to move the offset up in frequency. The bottom LCD line shows the offset and the filter output magnitude. The MAG=(number) will be largest at the transmit frequency. For example, if you get -2 MHz MAG=(77), -1 MHz MAG=(122), 0 MHz MAG=(85). Then the acft transponder Tx freq is a bit less than 1 MHz lower than the 1090 MHz nominal transmit frequency.

- d)** Aircraft transponder receive frequency check. {*****}

To determine where the transponder is most sensitive to ATC requests, this feature allows you to step the AV15 transmitted frequency +/- 15 MHz from the nominal 1030 MHz. For example if you find that by moving the frequency, your getting 100% reply from -3 MHz up to +5 MHz that would indicate that your transponders IF filter is a bit high. For best reception the transponder may need alignment, especially if the MTL value needs improvement.

- e)** MTL and Output Power check {*****}

This routine allows you to determine the transponders minimum trigger level (MTL) [its input sensitivity] as well as the power of the

transmit signal from the transponder. This test can be done via the antenna over air, or using the optional 40db attenuator, a direct connection measurement can be performed. **NOTE !!! +20 dbm [0.1 Watt] is the max input** to the AV-15. A 250 watt transponders output is 54 dbm. Using the optional 40 db attenuator, between the AV-15 and the txpdr, the signal will be reduced to +14 dbm which is within limits for the AV-15. The tester measures MTL by attenuating its transmit signal until 90% or less reply percentage is found. Transponder output power is measured at a specific point. So that power output droop, as a function of message content, can be measured, [Australia], the F2 pulse [last pulse] power is measured for A/C modes. While doing a Mode A MTL/power test, the squawk code can be changed as the AV-15 is displaying the F2 pulse power. Since F2 pulse is after the squawk data, the power reading will change if the transponder has power droop. The AV-15 also provides a P1/P2 trigger output for an oscilloscope to facilitate bench testing.

The following is an example;

select TRANSPONDER test mode.

Then select MTL-POWER CHECK?

The AV-15 then asks for Path Loss. It starts with -50db and, by using the left / right keys, that value can be modified between -40 to -60 db.

If you are doing a direct connect via a 40+ db attenuator, then you know exactly what the path loss between the AV-15 and the txpdr is. If you are doing an over air measurement, a well established procedure is 40db path loss and about 4 foot spacing from the transponder antenna. Another good choice is -50db if you are about 15 foot from the txpdr antenna. If your location is poor due to reflections, you can find a better local or average as follows; You don't know the path loss exactly but, since the transponder Tx and Rx frequencies are less than 6% different, most of the time the path loss for will be about same. Not always the same, due to reflections, but on average they will be about equal.

Use center key to select your Path Loss value.

Next you will select the type of transponder mode to use for the measurement.

You can choose between Mode A [best for power droop test]

Mode C or Mode S only all-call. Therefore Power/MTL for A/C/S can easily be measured.

When the test is started, the AV-15 will slowly move MTL power down until a drop in reply percentage is found. The AV-15 will continue to vary Tx output to hold around 90% reply. The Po=nnn will slowly show the measured Power from the transponder. If reflections are a problem, Move around to find an average MTL and Power reading. As we said before, the path loss will on average be the same for Tx and Rx directions. If your Loss guess was to high, then both MTL and Power will be less than spec. If your Loss guess was low, then both MTL and Power will be better than spec. A little common sense here and you will determine MTL and Power with adequate accuracy.

RF POWER TABLE;

45 dbm	=	15 db watt	=	32 watts
46 dbm	=	16 db watt	=	40 watts
47 dbm	=	17 db watt	=	50 watts
48 dbm	=	18 db watt	=	63 watts
49 dbm	=	19 db watt	=	80 watts
50 dbm	=	20 db watt	=	100 watts
51 dbm	=	21 db watt	=	126 watts
52 dbm	=	22 db watt	=	158 watts
53 dbm	=	23 db watt	=	200 watts
54 dbm	=	24 db watt	=	251 watts
55 dbm	=	25 db watt	=	316 watts
56 dbm	=	26 db watt	=	398 watts
57 dbm	=	27 db watt	=	501 watts

- f) All ATCRBS transponders are required to go inactive or suppress for 35 +/- 10 microseconds (uS) after receiving the P1-P2 side lobe suppression signal. This ATCRBS suppression feature is now also used by the mode-s system. The ground stations mode-s interrogation

begins with two pulses spaced 2.0 uS apart just like the SLS pulses. The mode-s message then continues while the ATCRBS transponders are in suppression. Therefore it is nice to know if your transponder is being suppressed as it should. The AV-15 provides this "SLS TIME CHECK ?" function to measure the actual suppression time. The AV-15 sends out a SLS pulse pair then sends a mode A inquiry after the variable delay time. The time between the SLS pulse pair and the inquiry is adjustable by you. So by decreasing the delay time until the reply percentage begins to fall, the transponder suppression time is determined. The top LCD line display's the squawk code and reply percentage. The bottom line display's the delay time in microseconds. Use the left and right keys to change the delay time.

g) A/C/S ALL-CALL and READs mode-S reply message.

ATCRBS MODE-A/C transponders will send a normal MODE-A reply. MODE-S transponders will send an S reply. The AV-15 will display the HEX Aircraft ID and a all 0's CRC error code for good received S reply's. The AV-15 sends 1030MHz P1 and P3 pulses spaced 8.0uS apart. A 1.6uS wide P4 pulse is sent 2.0uS after P3. The reply from an old ATCRBS transponder is ignored by the AV-15.

h) ATCRBS only ALL-CALL message,

The AV-15 sends MODE-A 1030MHz P1 and P3 pulses spaced 8.0uS. The 0.8 uS P4 pulse is sent 2.0uS after P3. The mode-S transponder should not reply due to the short P4 pulse. The AV-15 looks for erroneous mode-s reply's. When working with an old ATCRBS transponder the top LCD line will display the squawk code and F1 pulse width while line 2 shows "OK; no S reply". When testing a MODE-S unit the top LCD line should display "SQ=0000 F1=(small)". The second line should be the same "OK; no S reply". If the AV-15 finds a MODE-S all-call reply then it will display "MODE-S ERROR" on LCD line 1 and "ALL-CALL REPLY" on line 2.

i) send MODE-S only ALL-CALL.

The AV-15 will send a differential phase-shift keyed (DPSK) MODE=S ALL-CALL interrogation. ATCRBS MODE-A/C will not respond since the interrogation starts with two 1030MHz pulses spaced 2.0uS apart that is seen as a side lobe suppression. Since an all 1's ALL-Call address is sent, any MODE-S transponder will send a MODE-S reply. The AV-15 will display the HEX aircraft address and all 0's CRC for a good reply. The Hex address is also saved to RAM for use by following discrete addressed commands. The top LCD line display's the calculated CRC and L= the capability number 1 to 7. 0=level 1 unit. 4-7=level 2 transponder unit. This command runs aprox 50 times per second.

Info; when the transponder is set to on ground status it may not provide all-call reply's. The aircraft hex address must be entered into the AV-15 manually or from a ADS-B ID squitter if available.

j) Mode-S DF=4 discrete addressed altitude request.

The saved address from (i) or (n) is used as a starting point of the adjustable address. The AV-15 sends a UF=4 Altitude request command with the 24 bit Address as defined by you. So to see if the Transponder responds with its Altitude, that should match its mode C altitude reply, just use the saved address. To insure that it does not reply to other addresses, change the saved address before sending the command. After the address is selected the AV-15 will display the hex ID on top LCD line and the calculated altitude on the bottom line. This command runs at aprox 50 times per second.

Info: The Aircraft hex address must be manually entered if the all-call or ADS-B ID are not functioning. To set the hex address, select yes to modify address. Then use the right and left buttons to change a digit's hex value and the center button to enter each hex character. The AV-15 starts with a \$000000 hex address after power on and it must equal the aircraft hex address, as set in the transponder, for commands h, i, j, or k to function.

k) Mode-S DF=5 discrete addressed Squawk code request.

The saved address from i or n is used as a starting point of the adjustable address. The AV-15 sends a UF=5 ID request command with the 24 bit Address as defined by you. So to see if the Transponder responds with its SQUAWK, that should match its mode C SQUAWK reply, just use the saved address. To insure that it does not reply to other addresses, change the hex address before sending the command. The AV-15 will display the hex ID on the top line and the squawk code on the bottom line. This command runs at approx 50 Hz.

l) Mode-s DF=20 discrete addressed Tail number (ID) request. The transponder should reply with its flight number or tail number. The AV15 will display the tail number on line 1. The hex aircraft code is displayed on line 2.

m) Mode-s DF=21 discrete addressed capability report request. The AV15 will display the raw transponder reply in hex as well as the received aircraft hex address. All of line 1 gives 16 hex char's or the first 8 bytes and line 2 provides 6 hex char's or 3 bytes giving the first 11 message bytes in hex. Line 2, second half, provides the decoded aircraft hex address given by 6 hex char's. If the address is correct then the parity was good and the first 11 bytes are OK. The meaning of each bit can be found in the standard documents. The first two hex characters of the top line should be A8 through AF to signify that a DF=21 command was received.

Note 2; For the following Squitter functions, the squitter messages are sent by the transponder without being requested by the AV15 and are sent infrequently. The best way to check squitter is to first run the mode-s only all-call command and find a good location. After finding a location where AV15 reception is good, then run the squitter functions. Sometimes when testing in a hangar with lots of reflections off walls other equipment and even people, a few inches of AV15 movement can change the reception dramatically. The AV15 antenna can also be mounted on our tripod-25 foot cable accessory which can help in keeping the antenna stationary or while allowing you to operate the equipment while in the cockpit.



n) ADS-B MODE-S ID SQUITTER

The AV-15 will listen for the ID-SQUITTER AND display the HEX Address and 0's CRC for good reply. The HEX aircraft

address is also saved in RAM for use by commands h to k above.

o) AIRCRAFT TAIL NUMBER SQUITTER

The AV-15 will listen for the flight number - tail number squitter and display the Tail number and the HEX ID. Note that this squitter is only sent a couple times per minute. It is necessary to be sure you have a good reception location before running this command see note above.

p) LOCATION SQUITTER

The AV-15 will listen for the GPS derived location squitter and display the calculated LATitude and LONGitude in decimal degrees. Due to the way position data is sent, It takes at least 2 received squitters to calculate the position. This position command includes 2 additional characters during location squitter display:
An S or A (Surface or Airborne), followed by a hex value from 0 to B that represents the NIC (Navigational Integrity Category) Value. The NIC value represents a radius of containment value defined as follows:

- 0 = unknown
- 1 = < 20 NM
- 2 = < 8 NM
- 3 = < 4 NM
- 4 = < 2 NM
- 5 = < 1 NM
- 6 = < .6 NM
- 7 = < .2 NM
- 8 = < .1 NM
- 9 = < 75 meter
- A = < 25 meter
- B = < 7.5 meter

q) TEST SQUITTER function.

The AV-15 will display the first squitter transmission it finds each time you short press the center key. This can be used to manually decode squitter messages or to check that squitters are being sent.

ABOUT CALIBRATION

The AV-15 has been designed using today's most advanced electronics. Sun Avionic's custom designed digital circuitry resides in a large gate array. The chip contains Sun's proprietary micro-computer and what would have been a couple of PC boards full of parts only a few years ago. The AV-15 design is digital where all timing and RF frequencies used in the unit are derived from one high precision crystal oscillator that is compensated to +/- 1.0 parts per million over 0 to 50 deg C. The AV-15 is calibrated using NIST traceable equipment and supplied with a statement of calibration document and a calibration sticker that attests that factory calibration was done and it will meet its published specifications. There are no user adjustable parts in the unit as all calibration variables reside in firmware. Of course, anything can and will break. If you suspect a problem, check another aircraft to see if the problem persists. Make sure batteries are good (unit may act up as batteries fail). Check that a line of sight RF path exists between the AV-15 and the aircraft antenna. Try turning the unit off for a few seconds. Read the operating manual for the aircraft equipment to be sure it's set up correctly. Contact Sun if needed and we will attempt to help.

The AV15 factory calibration is valid for 1 year and we offer a 1 day turn Re-cal service at the factory for \$150 US plus shipping and any repairs if required. We also have a calibration procedure on this web site for guidance if you wish to do recalibration.

BATTERY REPLACEMENT and USB POWER

The AV-15 is powered by (4) AA batteries. Heavy duty alkaline or equivalent should provide over 2 hours of continuous operation. To replace the batteries, remove the four rubber feet using a #1 phillips Screw driver to access the battery holder. Make sure battery negative goes to spring end of holder positions. Before long term storage it's best to remove the batteries to prevent battery leakage damage. Also promptly replace expended batteries. The AV-15 can also be powered by a micro USB power adapter. A standard 1/2 amp or greater adapter will work fine. Turn the unit to off and plug in the adapter to turn on the unit under USB power.

REGULATIONS

Sun Avionics has done its best to provide a useful piece of test equipment; Please understand your requirements when using the AV-15. Your country's aviation authority has rules that determine who may work on or repair avionic equipment. Please understand and follow those requirements. Your aviation authority also has determined what needs to be tested to return equipment to airworthiness status. Based on our understanding of (part 43 appendix F ATC Transponder Tests and Inspections), the AV-15 can perform all the tests required. Proper use also requires that the operator understand the operation of the avionics device he is testing. A great deal of information can be found on our website (see our Navigation and Transponder Principles <../NavTransPrinciples.html> link) , the internet or from manufacturers manuals. It is the operators responsibility to insure safe use of the AV-15. We hope you find the AV-15 to be a useful tool for avionic system testing and trouble shooting, hopefully making flying safer and a bit more cost effective.

For updated information, questions, or to send your comments please see our web site:

www.sunavionics.com <<http://www.sunavionics.com>>

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