

## AMSAT NETS

The following AMSAT Nets meet regularly to disseminate information to newcomers and to keep regular satellite users in communication with one another.

USA-East Coast Net	Wednesdays	0100 Z	3850kHz LSB	Net Control W3UN or WA3NAN
USA-Mid States Net	Wednesdays	0200 Z	3850kHz LSB	Net Control W7CY
USA-West Coast Net	Wednesdays	0300 Z	3850kHz LSB	Net Control W6DOW
JA-Net	Mondays	1300 Z	3555kHz LSB	Net Control JALANG
Asia-Pacific Net	Sundays	1100 Z	14,280kHz USB	Net Control JALANG
Western Europe Net	Sundays	1000 Local	3780kHz LSB	Net Control G3RWL
International Net	Sundays	1800 Z	14,280kHz USB	Net Control W3ZM or W3UN
	Sundays	1900 Z	21,280kHz USB	Net Control W3ZM or W3UN
Africa-Europe Net	Sundays	1700 Z	14,280kHz USB	Net Control G3IOR
	Saturdays	1000 Z	14,280kHz USB	Net Control G3IOR
Africa Net	Saturdays	1100 Z	14,280kHz USB	Net Control TU2EF
	Saturdays	1130 Z	21,280kHz USB	Net Control TU2EF

The following vhf frequencies are also in Use:

London, England	144.28MHz USB	Net Control G8CSI	Sundays	1930 Local
Atlanta, Georgia	145.80MHz USB/CW	Net Control WA4DDH	Sundays	2000 Local
Washington, D.C.	146.25-85MHz FM	Net Control W3UN	Wednesdays	0200Z
Los Angeles, Calif.	146.25-85MHz FM	Net Control W6CG	Daily	

Bulletins of general interest to those interested in amateur satellites are transmitted regularly on OSCAR-6 reference orbits, at approximately 10 minutes after Ascending Node. These bulletins are transmitted on a downlink frequency of approximately 29,490 kHz and can be received over most of Eastern North America.

Educational bulletins are transmitted regularly by AMSAT Educational Bulletin Stations in North America on even numbered weekdays of the year via the AMSAT-OSCAR 6 two-to-ten meter transponder. These bulletins, addressed to schools, can be heard on 29.50 MHz during morning passes having equatorial crossings between 250 and 305 degrees W. Longitude.

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# AMSAT<sup>TM</sup> NEWSLETTER

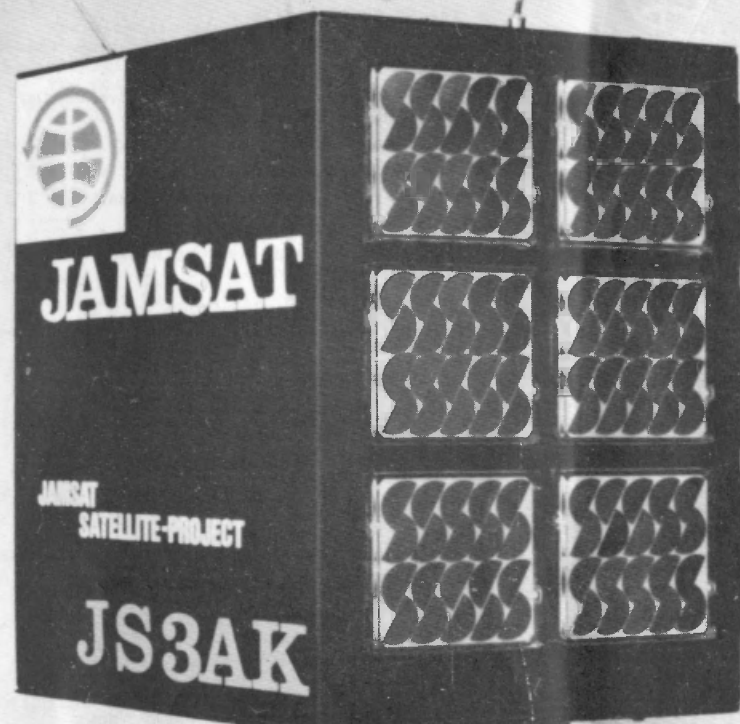
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TABLE OF CONTENTS

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	PAGE
* The \$2.00 Turnstile . . . . .	3
* 70 cm Linear from Motorola T44 . . . . .	4
* AMSAT-OSCAR 6 in Trouble. . . . .	5
* Cost Performance Criteria for Evaluating Phase III Satellites . . . . .	6
* Board Meeting Minutes, 3 January 1977 . . . . .	8
* Southern Hemisphere Effect. . . . .	10
* AMSAT Area Co-ordinators Overseas . . . . .	11
* Area Co-ordinators Stateside. . . . .	12
* Help Revolutionize Amateur Radio Communications . . . . .	13
* Reference Orbits . . . . .	14
* Letters and Comments . . . . .	19
* Errata . . . . .	23
* OSCAR Award Update . . . . .	23
* Nets . . . . .	24

DAYTON HAM-VENTION

AMSAT - FORUM

9:30 a.m. 30 April 1977

THE FUTURE AMSAT SATELLITES, AOD AND PHASE III

Dr. Tom Clark, WA3LND

LOW ORBIT EARTH SATELLITES AS  
COMMUNICATIONS TOOLS

Dr. Will Webster, WB2TNC

USING A PROGRAMMABLE POCKET CALCULATOR  
FOR OSCAR PREDICTIONS

T. A. Prewitt, W9IJ

THE ULTIMATE QSO - A DISCUSSION OF COMMUNICATIONS  
WITH EXTRA-TERRESTRIAL INTELLIGENCE

Dr. Tom Clark, WA3LND

Moderator: K. O. Learner, K9PVW



THE \$2.00 TURNSTILE

BY JOE KASSER, G3ZCZ

This antenna is cheap and simple, is made out of aluminium angle and plexiglass, requires no special tools, and anyone can assemble it in less than 30 minutes.

The same basic design may be used for both 145 MHz and 432 MHz.

The dimensions of the elements and the matching sections are different for each band of course but the center section is the same.

Aluminum angle may be purchased in six foot lengths. If one such length is cut into four equal pieces, it is the correct size for the two-meter turnstile.

The center piece, shown in Figure 1, comprises a piece of plexiglass 1/4 inch thick and 1 inch square on a side. Four holes are drilled in each corner for mounting the elements and a center hole is drilled for mounting the whole thing to a mast. The holes can be measured and drilled 1/4 inch away from the sides or the elements can be placed into position and spot drilled using a drill press.

The elements are shown mounted to the center piece in Figure 2. A No. 4 bolt passes through the center piece and element. A washer is placed on the bolt below the plexiglass. A solder lug is placed on the bolt between the washer and the nut. The coax cable is soldered to the lug later.

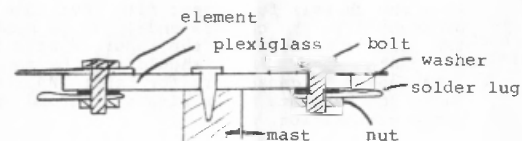
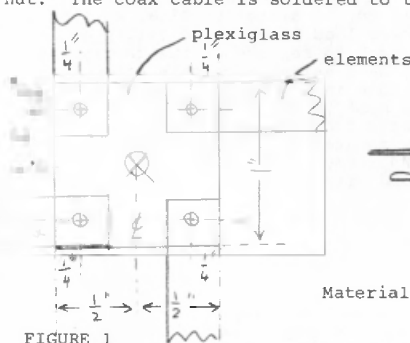


FIGURE 2

Materials: Plexiglass block, 1" square, 1/4" thick  
1/4" aluminum angle lengths  
nuts, bolts, washers and solder lugs

Table 1. Dimensions for the Elements

Frequency	Element Length	0.221λ Spacing	Reflector Length
145.9 MHz	18"	not used	not used
432 MHz	5 1/2"	6 3/4"	6"

The 70 cm antenna is made in the same way but with shorter elements. A reflector element can be placed beneath the driven element. The antenna can be fed in any manner that you wish, for circular or linear polarisation. One technique is to mount the antenna facing North-South and feed each dipole in a linear polarisation mode, switching antennas as necessary. A second technique is to use circular polarisation, but that has to be changed when going from receive to transmit via OSCAR.

RESULTS IN USE

Both the 432 and 145 MHz versions have been used to access the AMSAT OSCAR 6 and 7 spacecraft. The 432 MHz version was fed with 8 W of CW power and 599 signal reports were received. The 145.9 MHz version was fed with 50 W of CW power and signal reports of 569 were received.

For \$2.00 and 30 minutes you can't go wrong.

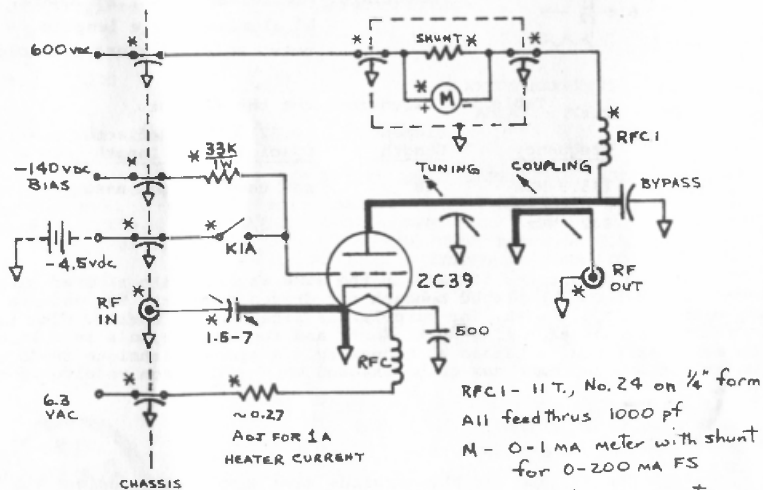
## A 70-CM LINEAR AMPLIFIER FROM A MOTOROLA T44

BY WATSON R. GABRIEL, JR., WB4EXW

Many satellite users would like to have a low-power amplifier for 70 cm that, when used with a moderate-gain antenna, provides suitable ERP for Mode B use. The following description tells how to modify the final 2C39 cavity amplifier from a Motorola T44 450 MHz FM unit for linear service. While I am not the originator of the conversion, I thought it would be of interest to many present and future Mode B users.

To make the 2C39 amp operate in linear service, one has to use grid biasing instead of the usual cathode biasing for triode tubes as one end of the input inductive link which is tied to the 2C39 cathode is at DC ground. Remember that in the 2C39 this cathode connection is also tied to one side of the tube's heater. We will also add switching to cut the 2C39 off during receive periods, plate current metering, and heater current adjustment. One will also have to add a means of blowing air through the cavity for cooling the tube. I used an adapter made from a piece of fiberboard and a PVC pipe fitting so that the hose from my blower can be attached. Some friends have mounted small blowers directly to the end of the cavity enclosure. Air flow should be towards the output end of the cavity.

When removing the cavity from the T44, save the RFC and 500 pf metal-clad bypass capacitor that are attached to the heater terminal as they will be used. Also leave the plate power lead leaving the cavity as long as possible (it is a pain in the neck to replace as the cavity has to be disassembled). Mount the cavity on a suitable chassis after cutting the chassis for proper fit. Suitable input/output connectors can be mounted to the chassis ends. It is best to mount a partition across the chassis to separate the input network from the output connection. The plate current meter should also be mounted in a shielded enclosure with feed-thru capacitors for input and output connections. I used a Radio Shack 0-1 ma meter with a nichrome wire shunt for a 0-200 ma full scale calibration.



(Continued on Page 5)

## AMSAT-OSCAR-6 BATTERY IN TROUBLE

BY RICHARD ZWIRKO, KIHTV

In early January it was noticed that a change for the worse in the condition of the battery of AMSAT-OSCAR-6 took place. Telemetry indicates that we are getting normal or slightly higher than normal counts on channel 3B (1/2 battery voltage) while at the same time the readings for channel 3A (V bus) are about 7 or 8 counts lower than expected. This indicates that one of the Ni-Cd cells in the upper half of the battery has failed. Because of this, it is believed that the battery will not charge at as great a rate as was possible before the failure. If the cell fails completely it will look like a diode during the time when current is being drawn from the battery and will look like an open circuit when the battery is in the charge mode. In its present condition the cell appears to be acting like a diode with a resistor in parallel with it, allowing the battery to be charged to some degree. How long this will last we don't know. Although only one cell appears to have gone bad, it is believed that other cells are close to being in the same condition and may also fail within the year.

Since AMSAT-OSCAR-6 is in total sunlight at this time battery heat is a problem. Telemetry channel 3D indicates that the battery temperature is in excess of 57°C. We do not want to further aggravate the thermal problem so the operation schedule for the satellite will remain the same. If the transponder is left off too much the temperature inside rises and if the bird is left on too much the battery voltage drops. I don't think the average AMSAT-OSCAR-6 satellite communicator realizes how much the AMSAT-OSCAR-6 command stations mean to the life of that particular bird. Without the millions of commands sent to it, AMSAT-OSCAR-6 would probably have died already. Up to the present time the red line cut off point has been a channel 3A reading of 52. With the failure of one cell it has been decided that the point at which AMSAT-OSCAR-6 should be immediately turned OFF will be a 3A count of 44.

Randy, VE3SAT, is now able to automatically load AMSAT-OSCAR-7 Codestore via his microprocessor on very short notice. You can now expect to hear C.S. used more than in the past because of this capability. Messages will appear on GMT Sundays on a regular basis. However, important messages might appear at any time during the week if needed so please keep an ear on the beacon frequencies of AMSAT-OSCAR-7 on both modes.

(Continued from Page 4)

The parts with asterisks will have to be added. On my unit, the leads on the 1.5-7 pf input trimmer were long enough to reach from the input connector to the tuned cathode line. A short piece of No. 12 wire connects the RF output terminal to the output connector.

The biasing scheme used is very simple. When in receive mode, the tube is biased into cut-off by the -140 vdc line. During transmit, relay contact K1 closes and -4.5 vdc from a multi-tap battery becomes the grid bias voltage. This yields about 20 ma idling current in my 2C39 with 600 vdc on the plate. The contact closure can come from an external control relay or an internal relay as in my amp.

Tuning is simple. The sliding end of the plate line inside the cavity will have to be extended to bring the range of adjustment of the TUNING control into the 432 MHz area. After voltages have been applied and the heater current resistor set, apply a small amount of drive and tune for max as with any AB1 amplifier. Be sure to use a non-metallic tuning tool for adjusting the COUPLING control as the tuning tool shaft passes by the HV on the plate circuit. Follow recommended limits for the 2C39 as far as plate voltage and current are concerned.

Some fellow hams in this area have made two-stage amps by using both cavities from a T44. The first 2C39 cavity in a T44 is actually a tripler so a new input link must be made for this cavity as is used on the final amp. A two-stage amp works great when driven by a watt or two from a transmitting converter. My 70 cm setup includes a DJ62Z transmit converter followed by a DJ35C 10 watt linear so I only use one 2C39 stage. Try it; works like a champ, even for passes on the horizon! To be honest, the 10 watts from the DJ35C doesn't work bad by itself!

## COST PERFORMANCE CRITERIA FOR EVALUATING PHASE III SATELLITES

BY MARTY DAVIDOFF, K2UBC/3

This paper evaluates the cost effectiveness of Phase III spacecraft by calculating the yearly cost per user. This is accomplished by (1) specifying the channel capacity of a linear transponder used for SSB and CW and (2) estimating the total number of users which a Phase III spacecraft can adequately serve.

### CHANNEL CAPACITY

Channel capacity (the number of simultaneous conversations which a transponder can accommodate) can be estimated in the following manner. Assume that only SSB and CW will be used and that a SSB signal requires a 2.5 kHz bandwidth and that CW requires 0.5kHz. A 100 kHz transponder can accommodate 40 SSB channels or 200 CW channels or some combination of the two. A reasonable balance might be 62.5 kHz for SSB and 37.5 kHz for CW. This results in 100 channels (25 SSB and 75 CW) or an average of one channel per kHz. Using a different averaging method for the SSB and CW channels, such as the arithmetic mean (120) or the geometric mean (about 90), would only result in very minor changes in the following estimates.

### MAXIMUM NUMBER OF USERS PER CHANNEL

Two methods for estimating the maximum number of users which a channel can support will be presented.

FM repeater clubs in the Washington, Baltimore area have demonstrated that single channel "open" repeaters supported by 200 members operate smoothly. Since not all users are members, the actual number of users per channel is in excess of 200. The conclusion is: single channel FM repeaters are capable of supporting in excess of 200 users per channel.

Now consider the HF bands (80-10 meters). In the U.S., 3.3 MHz are assigned to amateurs. In other parts of the world the total amateur bandwidth is somewhat less. However, the policy of this paper is to use conservative estimates, so the 3.3 MHz figure will be applied to all amateurs. Using previous assumptions, this is equivalent to 3,300 1-kHz channels. The world amateur population is approximately 800,000 (QST, Vol. LXI, No. 1, Jan. 1977, p. 55). Assuming that about 75 percent of these amateurs are licensed to operate in the HF bands yields a figure of 600,000 amateurs licensed to use 3,300 channels. This results in approximately 200 users per channel. At times, the HF bands are very crowded; however, they are usable. The conclusion is: an HF channel is capable of supporting approximately 200 users.

The preceding analysis suggests that a Phase III channel will probably be able to support about 200 users.

### PHASE III USER CAPACITY

The data previously developed suggest that a 100 channel (100 kHz) transponder will be capable of serving up to 20,000 users before severe overcrowding becomes a problem. This assumes, of course, that users cooperate during peak load periods.

Since the Phase III user capacity is an extremely important parameter in this paper, the figure arrived at should be checked. Consider the situation where the number of users reaches the maximum capacity figure of 20,000. The satellite will be available about 170 hours per week. Assuming only two-way QSO's, 50 percent of time listening - 50 percent of time transmitting, this results in just under two hours of satellite time per user per week. Taking into account roundtables (nets) and the fact that even casual ragchewers spend more time listening than transmitting probably brings the average figure closer to three hours of satellite time per user per week. DX'ers, prefix hunters and state hunters normally spend a great percentage of their operating time listening. It's therefore conceivable that, even with the maximum of 200 users per channel, the average ragchewer will have 5 operating hours per week available. Since this is an average value, many users will no doubt be able to spend 8-10 hours per week operating through the satellite. While this number may seem small, remember that satellite operating time is only one aspect of amateur radio. Most amateurs will divide their time devoted to the hobby between HF operation, 2 meter FM, reading radio magazines, attending club meetings, constructing equipment, etc., as well as operating through satellites. Consequently the maximum capacity figure of 200 per channel appears reasonable.

It is interesting to speculate on the scenarios that may occur should crowding become a problem. One school of thought hypothesizes that users will switch from SSB to CW to increase the number of available channels. Another school of thought points out that a given amount of data can be transmitted much faster by SSB than by CW and that, when this time factor is taken into account, SSB is actually more efficient. However, this latter argument depends on users limiting themselves to essential information, a goal of questionable desirability. The purpose here is not to pursue these scenarios, or to discuss others which could produce similar results, but only to show that a number of options do exist should overcrowding become a problem.

### COST (\$) TO THE USER

Assuming a Phase III spacecraft cost of \$200,000, a six-year lifetime, and 10,000 users (half capacity) results in a yearly cost per user of about \$3.50. Even if only half of the actual users provide financial support to AMSAT, a yearly fee of \$7.00 would adequately cover expenses. Using these conservative estimates, it would appear that the current AMSAT membership fee can provide the income needed to support a growing satellite program.

### ADDITIONAL CONSIDERATIONS

It should also be noted that a number of factors should contribute to lowering the yearly cost per user for future Phase III spacecraft. The factors include (1) transponder improvements resulting in increased bandwidth, (2) solar cell research which should result in a big decrease in this significant expense, (3) launch opportunities which will not require that AMSAT provide an apogee kick motor on the spacecraft, eliminating this expense.

The cost effective analyses discussed in this paper can not be directly applied to Phase II (low-altitude) spacecraft, since the limited access time tends to concentrate users, requiring revision of the nominal channel capacity figure of 200 users per channel.

It's also of interest to compare the yearly cost per channel of the transponder to be included in the first Phase III spacecraft with "typical" ground-based two-meter FM repeaters. The previous assumptions (spacecraft = \$200,000, transponder = 100 channels, lifetime = 6 years) yield a yearly cost per channel for the spacecraft of about \$350.

The electric and telephone charges alone for the local Baltimore repeater (WR3AFM) equipped with telephone autopatch exceed \$350 per year. It's very difficult to calculate "typical" capital costs of two-meter FM repeaters, but advertisements in amateur journals suggest that there is a market for commercial repeaters costing about \$1,000. Repeater users using "surplus commercial strips" can also be expensive when the total costs, including 450 MHz links and commercial antennas, are taken into account. A very crude guess is that capital cost for the "average" two-meter FM repeater designed to accommodate a large number of users is about \$2,000 prorated over 8 years. This results in a yearly cost of \$250 for capital equipment. Electric bills easily raise the yearly cost to \$350 and inclusion of autopatch facilities puts the repeater in the \$500 per year category.

### CONCLUSIONS

A 100 kHz Phase III satellite transponder can accommodate 20,000 users equipped for the uplink frequency. As a result, a Phase III program using current technology can be financially self-supporting through AMSAT membership fees once the first Phase III satellite is in orbit. The calculations may be regarded as conservative in that (1) the value assumed for satellite user capacity can easily be raised by increasing the percentage of CW or roundtable operation, (2) the number of actual users assumed for calculations (10,000) is only half the estimated capacity (20,000) and, (3) the number of users assumed to be supporting the program financially (5,000) is only half the actual users. The yearly cost per user per channel is expected to decrease for future Phase III spacecraft permitting a rapidly increasing Phase III program.