

# Orbit

Journal of the Radio Amateur Space Program

**No. 11**

July/August 1982  
\$2.00 U.S.A./Canada



Published by ANSAT — The Radio Amateur Satellite Corporation



# OSCAR AND IC451A (The Perfect Couple)

ICOM presents a multifunction multimode base station transceiver for use either as part of an OSCAR satellite link on mode B or J, or for use with your favorite 440MHz FM repeater. The IC451A incorporates features customers ask for most.

- 3 Memories with Memory Scan.
- Programmable Band Scan.
- Squelch on SSB! Silent Receive when no signal is present.

- Variable Repeater Split.

Imagine programming 2 of your favorite SSB QSO frequencies as well as the OSCAR B mode J downlink beacon into memory, and silently scanning these frequencies while working other bands in your shack.

The IC451A may be ordered from your authorized ICOM Dealer in either 430-439.9999MHz or 440-449.9999MHz models.



ICOM IS THE LEADER IN AMATEUR AND MARINE COMMUNICATIONS EQUIPMENT



## ICOM

21424400 Hill, Houston, TX 77058  
1011 Towerwood Circle, Dallas, TX 75248





July/August 1982  
Volume 3 Number 3

**ORBIT Staff**

Editor in Chief: V. Riportella, WA2LQQ  
Editor: Tony Dorbuck, K1FM  
Managing Editor: Bob Myers, W1XT  
Illustrations: Keith Foss  
Advertising Director: Roger Soderman,  
WA2NFJ

**Editorial Committee**

Greg Roberts ZS1BI,\* Joe Kasser  
G3ZCZ, Harry Yoneda JA1ANG, Alex  
Schoening DC7AS, Niko Janssen  
PA0DLO, Ross Biggar ZL1WN, Ralf  
Hucke CE6EZ, Domenico Marini I8CVS,  
John Pronko W6XN, Steve Place,  
WB1EYI, Larry Roberts W9MXC, Ron  
Broadbent G3AAJ

**AMSAT Board of Directors**

John Browning W6SP,\* Tom Clark  
W3IWI, Rich Zwirko K1HTV, Jan King  
W3GEY, Pat Gowen G3IOR, Harry  
Yoneda JA1ANG, John Henry VE2VQ

\*Chairman

**AMSAT Officers**

President: Tom Clark, W3IWI  
Executive Vice President:  
Vern Riportella, WA2LQQ  
Vice President Engineering:  
Jan King, W3GEY  
Vice President Operations:  
Rich Zwirko, K1HTV  
Vice President Special Projects:  
Bill Brown K9LF  
Office Manager: Martha Saragovitz  
Treasurer: Roy Rosner, K4YV

**Editorial Office:** P.O. Box 177,  
Warwick, NY 10990

**Advertising Office:** 221 Long Swamp  
Road, Wolcott, CT 06716

**AMSAT:** P.O. Box 27, Washington, DC  
20044.  
Telephone: 301 589-6062  
Telex: 248-566

Second Class postage paid at Water-  
bury, Conn. by ORBIT, 221 Long  
Swamp Road, Wolcott, Connecticut  
06716.

ORBIT (USPS 041-850) is published six  
times per year for \$10. (inseparable  
from membership dues of \$16).

Copyright © 1982 by AMSAT. Contents  
may be reproduced without specific  
permission provided proper credit is  
given, unless otherwise stated and  
copies are sent both to AMSAT and to  
the author. Opinion expressed is not  
necessarily that of AMSAT.

# CONTENTS:

## Technical Features:

### 4 Apple II Computer Antenna and Station Control System

By William D. McCaa, KØRZ

*Personal computers are quickly taking hold in the Ham Shack. Here we find the personal computer controlling many of the station functions.*

### 8 A 435 MHz Helix for Phase III By Bill Allen, W7US

*Another "Twist" on a popular topic: Getting ready for Phase III satellites. Calculations for several versions are given along with a finished model of one.*

### 12. Low-Cost Computer Project By Bob Nickles, KEØT

*A special version of the ZX-81 tailored for tracking tasks.*

### 14 An Introduction to Orbit Calculations By Winston Cope

*A discussion of how the geometry of orbits is handled in a computer program.*

### 16 Phase IIIB Special Service Channel Utilization

By Richard Zwirko,\* K1HTV and Bob Ruedisueli,\*\*W4OWA

*Part II of this informative and intriguing discussion of Phase III Special Service Channels. (Part I appeared in ORBIT No. 10)*

## Informational Topics:

### 22 The NASA Satellite Tracking and Communications Network

By Jim Lacy

*The NASA system for tracking and communications is a worldwide network of hardware, as described here by a twenty-year veteran of public affairs with the space program.*

## Departments:

### 3 Ellipsis . . .By Vern Riportella, WA2LQQ

### 21 AMSAT News

### 28 Satellite Log By Geoffrey Falworth

### 10 Worldwide Satellite Activity By Pat Gowen, G3IOR

### 11 W6 Space Philosopher By John Browning, W6SP

### 27 Around the World By Kaz Deskur, K2ZRO

**Our Cover:** Final preparations were under way for test of the Phase IIIB satellite when this photo was taken. Gordon Hardman, KE3D/ZS1FE performs the task with precision.



# LET'S TALK

# OSCAR

DATA IS DERIVED FROM OBSERVATIONS BY PROJECT OSCAR REPRODUCTION AUTHORITY. SELF ADDRESSED, STAMPED ENVELOPE OF OSCAR P.O. BOX 1136 LOS ALTOS, CA 94024 OF THE LATEST AVAILABLE DATA.

SUPPORT THE AMATEUR SATELLITE PROGRAM AMSAT P.O. BOX 27 WASHINGTON, DC 20044

COMPILED AND COORDINATED BY JOHN PRONKO W6XN RANDY COLE KN6W AND JACK SOMERS WA6VGS

PRINTED BY **Henry Radio**

**AT HENRY RADIO  
WE'RE DEDICATED TO EVERY  
ASPECT OF AMATEUR RADIO  
...FROM THE EXCITING AND SOPHISTICATED  
TECHNOLOGY OF TODAY TO HELPING THE  
YOUNG NOVICE GET HIS FIRST SIGNAL ON THE AIR.**

**AND OUR OSCAR 8 & 9 ORBITAL DATA  
SHEETS AREN'T ALL WE HAVE TO OFFER**



MON	11	1982	ORBIT	UTC	LONG	ORBIT	UTC	LONG	ORBIT	UTC	LONG	ORBIT	UTC	LONG	ORBIT
101	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951
1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063
2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079
2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095
2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111
2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127
2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143
2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159
2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175
2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191
2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207
2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223
2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239
2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255
2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271
2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287
2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303
2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319
2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335
2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351
2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367
2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383
2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399
2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415
2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431
2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447
2448	2449	2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460	2461	2462	2463
2464	2465	2466	2467	2468	2469	2470	2471	2472	2473	2474	2475	2476	2477	2478	2479
2480	2481	2482	2483	2484	2485	2486	2487	2488	2489	2490	2491	2492	2493	2494	2495
2496	2497	2498	2499	2500	2501	2502	2503	2504	2505	2506	2507	2508	2509	2510	2511
2512	2513	2514	2515	2516	2517	2518	2519	2520	2521	2522	2523	2524	2525	2526	2527
2528	2529	2530	2531	2532	2533	2534	2535	2536	2537	2538	2539	2540	2541	2542	2543
2544	2545	2546	2547	2548	2549	2550	2551	2552	2553	2554	2555	2556	2557	2558	2559
2560	2561	2562	2563	2564	2565	2566	2567	2568	2569	2570	2571	2572	2573	2574	2575
2576	2577	2578	2579	2580	2581	2582	2583	2584	2585	2586	2587	2588	2589	2590	2591
2592	2593	2594	2595	2596	2597	2598	2599	2600	2601	2602	2603	2604	2605	2606	2607
2608	2609	2610	2611	2612	2613	2614	2615	2616	2617	2618	2619	2620	2621	2622	2623
2624	2625	2626	2627	2628	2629	2630	2631	2632	2633	2634	2635	2636	2637	2638	2639
2640	2641	2642	2643	2644	2645	2646	2647	2648	2649	2650	2651	2652	2653	2654	2655
2656	2657	2658	2659	2660	2661	2662	2663	2664	2665	2666	2667	2668	2669	2670	2671
2672	2673	2674	2675	2676	2677	2678	2679	2680	2681	2682	2683	2684	2685	2686	2687
2688	2689	2690	2691	2692	2693	2694	2695	2696	2697	2698	2699	2700	2701	2702	2703
2704	2705	2706	2707	2708	2709	2710	2711	2712	2713	2714	2715	2716	2717	2718	2719
2720	2721	2722	2723	2724	2725	2726	2727	2728	2729	2730	2731	2732	2733	2734	2735
2736	2737	2738	2739	2740	2741	2742	2743	2744	2745	2746	2747	2748	2749	2750	2751
2752	2753	2754	2755	2756	2757	2758	2759	2760	2761	2762	2763	2764	2765	2766	2767
2768	2769	2770	2771	2772	2773	2774	2775	2776	2777	2778	2779	2780	2781	2782	2783
2784	2785	2786	2787	2788	2789	2790	2791	2792	2793	2794	2795	2796	2797	2798	2799
2800	2801	2802	2803	2804	2805	2806	2807	2808	2809	2810	2811	2812	2813	2814	2815
2816	2817	2818	2819	2820	2821	2822	2823	2824	2825	2826	2827	2828	2829	2830	2831
2832	2833	2834	2835	2836	2837	2838	2839	2840	2841	2842	2843	2844	2845	2846	2847
2848	2849	2850	2851	2852	2853	2854	2855	2856	2857	2858	2859	2860	2861	2862	2863
2864	2865	2866	2867	2868	2869	2870	2871	2872	2873	2874	2875	2876	2877	2878	2879
2880	2881	2882	2883	2884	2885	2886	2887	2888	2889	2890	2891	2892	2893	2894	2895
2896	2897	2898	2899	2900	2901	2902	2903	2904	2905	2906	2907	2908	2909	2910	2911
2912	2913	2914	2915	2916	2917	2918	2919	2920	2921	2922	2923	2924	2925	2926	2927
2928	2929	2930	2931	2932	2933	2934	2935	2936	2937	2938	2939	2940	2941	2942	2943
2944	2945	2946	2947	2948	2949	2950	2951	2952	2953	2954	2955	2956	2957	2958	2959
2960	2961	2962	2963	2964	2965	2966	2967	2968	2969	2970	2971	2972	2973	2974	2975
2976	2977	2978	2979	2980	2981	2982	2983	2984	2985	2986	2987	2988	2989	2990	2991
2992	2993	2994	2995	2996	2997	2998	2999	3000	3001	3002	3003	3004	3005	3006	3007
3008	3009	3010	3011	3012	3013	3014	3015	3016	3017	3018	3019	3020	3021	3022	3023
3024	3025	3026	3027	3028	3029	3030	3031	3032	3033	3034	3035	3036	3037	3038	3039
3040	3041	3042	3043	3044	3045	3046	3047	3048	3049	3050	3051	3052	3053	3054	3055
3056	3057	3058	3059	3060	3061	3062	3063	3064	3065	3066	3067	3068	3069	3070	3071
3072	3073	3074	3075	3076	3077	3078	3079	3080	3081	3082	3083	3084	3085	3086	3087
3088	3089	3090	3091	3092	3093	3094	3095	3096	3097	3098	3099	3100	3101	3102	3103
3104	3105	3106	3107	3108	3109	3110	3111	3112	3113	3114	3115	3116	3117	3118	3119
3120	3121	3122	3123	3124	3125	3126	3127	3128	3129	3130	3131	3132	3133	3134	3135
3136	3137	3138	3139	3140	3141	3142	3143	3144	3145	3146	3147	3148	3149	3150	3151
3152	3153	3154	3155	3156	3157	3158	3159	3160	3161	3162	3163	3164	3165	3166	3167
3168															

---

# Ellipsis...

AN EDITORIAL BY VERN RIPORELLA, WA2LQQ\*

---

Poised as we are on the brink of substantially new ways of communicating with the rest of the world's amateurs, it might be a particularly good time to briefly examine how we got here in the first place. More important even than the lessons of the past, we suspect, are the methods we use to plan for the future. How will they be different as we bridge from Phase II to Phase III and later satellites?

For the last 20 years or so satellites have been "born" mostly of opportunity. Launch opportunity. Given a specific "ride," our people have consistently come up with the resources to build a piece of hardware which made the most of what they had available. Under these circumstances, however, it is difficult to plan for the long term. After all, why should one build an attached garage when it is unsure that the house will be standing when the garage is done?!

Seen another way, the time between available launches has tended to be similar to the life of the satellites we've built. AMSAT-OSCAR 7 was a notable exception in that it maintained a substantial fraction of its overall mission capability until nearly twice its design life had elapsed. Thus we had at that time the rare pleasure of having TWO OSCARs to enjoy concurrently. Now of course we are immersed in wealth of sorts having (would you believe it?) 7 (or 7½) satellites to enjoy. But still with expected usable lifetime comparable to intervals between launches, it remains difficult to think in terms of multi-satellite systems, system capability and so forth.

In fact, until now we have been building these marvelous little machines one at a time. Given the limited resources, volunteer environment and costs involved we wonder how it could possibly have been done differently. That is, given the terribly risky nature of getting "here" from "there," it is difficult to reckon more than even a few alternate paths to where we now find ourselves. Frankly, we've gotten here by a rare combination of good fortune and the sweat, guts, heart-break and determination of less than a score of key "doers."

The complexion of our very special hobby will be markedly changed by this time next year. Thousands, perhaps tens of thousands of potential new satellite users will appear all at once on the scene responding to the enormously attractive vistas Phase IIIB will paint. AMSAT leadership has wrestled with the problems perceived in responding to a ponderous growth impulse

such as is forecast by some. On the positive side of the forecast growth is the anticipation that with growth will come the resources to change the way we do "business." The planning business, that is.

Thus, as we stand on the brink of Phase III, we bridge two great ages in amateur satellites. Until now we've been treating amateur satellites as if they were experimental. All the OSCARs and RSs which have flown have required special equipment and, more important we suspect, special knowledge and training. Let's face it. OSCAR 8 doesn't come with an automatic transmission. Some folks can't drive stick shift, you know! Our growth has been limited by the nature of folks who want to turn on their radios and have the darn thing there to use...almost like the ionosphere. But Phase III will mark the beginning of amateur satellites as a *utility*. With easier use will come the utilitarians. Their presence in our numbers will allow us to approach the task of planning in new and exciting ways. Moreover, the advent of long-life satellites will prove conducive to thinking in terms of multi-satellite systems; in terms of system capabilities.

Given a steadily growing user base from which to draw resources we can for the first time *afford* to design systems the way they should be designed. In the past the "driver" in system design has been mainly what we could accomplish within certain limited envelopes. First came the basics; the ride itself; where the ride was going and how much weight it could carry determined just about everything in all previous amateur satellite missions. Indeed this overall constraint persists since it largely dictates what will become of Phase IIIB. It will likely affect Phase IIIC also when a ride is confirmed for it. In the future we may be able to specify a long-term goal and then build in the short-term to meet that goal. Perhaps a concrete, familiar example will help to illustrate the idea.

Early in his Presidency, John Kennedy crystallized national resolve by setting a long-term, ambitious, imaginative goal: To place a man on the moon in the decade of the Sixties. As we recall it was done in 1969. But to attain that goal required the efforts of millions of individuals, billions of dollars and most of a decade. But in the end it worked. It worked to put a man on the moon. It worked because to reach that lofty goal required the attainment of millions of smaller, intermediate goals.

*(Continued on page 7)*

# Apple II Computer Antenna and Station Control System

By William D. McCaa, Ph.D., \* KØRZ

*Personal Computers are quickly taking hold in the Ham Shack. Here we find the PC controlling major station functions.*

The microprocessor control of satellite ground station antenna systems is certainly not a new subject to the amateur satellite user. Over the years, the amateur journals have published numerous technical articles on this subject. However, most of these require that the prospective builder have a good understanding of computer programming, electronic digital circuits, and circuit board construction practices. It is the intent of this article to provide the satellite user who already has an Apple-II Computer a how-to-do-it simply and effectively, without undertaking an extensive construction project and programming effort.

The system as described can be used to perform in *real time* a number of station functions. It can be used to point the antennas, control the station ac power, select the appropriate station transmitter, rf power, and receiver, correct for doppler shift, and do most if not all of the station functions that a satellite user must do while operating a pass. In addition, the software can be prepared so as to provide the operator a *real time* display of the satellite status of several satellites simultaneously, their Reference Crossing, time remaining in the present pass, time to next pass, and antenna pointing data for other ground station locations.

Fig. 1 is a photograph of the CRT display for Boulder, Colorado driven by the Apple-II. The display does not scroll but instead updates a stationary line at a time. It requires about 35 seconds for the entire screen to update. The top line displays the date and time in UTC. The second line indicates that the antenna system is tracking RS-4. Inverted video is displayed whenever the system is locked and tracking a selected satellite. Looking across the fourth through the eleventh line we

see the following data displayed for each satellite: the name, the present orbit number, the ground track or sub-satellite point latitude and longitude, the time in minutes to the next acquisition of AO-8, UO-9, RS-6, and RS-3, or if the satellite is in range the time remaining in the pass until loss of signal as is the case for RS-8, RS-4, RS-5, RS-7 and finally the azimuth and elevation to each satellite in range. The bottom set of lines thirteen through twenty display the reference data for each satellite as well as the UTC time of acquisition and loss of each satellite.

## General System Configuration

The Apple II computer controls the pointing of satellite antenna systems as well as other station functions automatically thru the use of a Mountain Computer 16 Channel A/D + D/A board and Apple Clock board. The Apple II must be equipped with Applesoft in ROM or a Language System, 48K of RAM, and at least one Disk II drive, as well as the above mentioned Mountain Computer boards. The rotators must be capable of providing a DC voltage proportional to their position and have their brake released during tracking times. The A/D + D/A operates between -5 and +5 VDC and rotators that provide a higher position voltage can be used by dividing the voltage down to the 5 volt level. In addition to the hardware already mentioned the user will have to construct a few simple circuits to enable telling the Apple II what satellite to track, and to allow the Apple II to control the rotators and any other function desired such as powering the station on acquisition of a selected satellite.