QEX 9 October 1982

The ARRL Experimenters' Exchange

FCC Approves Additional Digital Codes

On September 14, 1982, the Federal Communications Commission (FCC) approved Docket 81-699 (proposed rule making to allow additional digital codes in the Amateur Radio Service). When this item came up, Commissioner Henry Rivera asked whether mention of enforcement in the document before them indicated any unresolved concern on the part of the FCC staff. The answer was that the document simply repeated some of the wording used in the notice of proposed rule making and that everyone realized that the FCC would not be able to monitor all digital transmissions for message content. Chairman Fowler asked if off-the-air sample recordings of unreadable transmissions could be made for later analysis and whether the amateur station could be requested to furnish the information which would allow the FCC to decode the message. Field Operations Bureau Chief, Richard Smith answered "yes." Private Radio Bureau Chief, James McKinney pointed out that the rule change applies to vhf frequencies which propagate more or less line of sight. Also the FCC has the right to close down any offending station. He said that the Amateur Radio Service has an excellent record of self policing. All of this happened in less than ten minutes.

This action is in response to a petition by the ARRL to amend section 97.69 of the FCC rules to permit the use of new and experimental digital processes by radio amateurs. (See "Happenings" in the December 1981 QST.) Currently, the only digital (RTTY) codes authorized for amateur use are ASCII and Baudot.

I do not know exactly what the new rules will say because they are not released until they appear in the Federal Register. But I have a pretty good idea. It will permit the use of any type of digital code above 50 MHz for domestic communications only (also probably to Canada and Mexico if they agree). Stations will still need to identify using voice or cw and will need to maintain a log of the codes used and furnish that information to the FCC upon request.

The original petition by the ARRL requested increase of permissible speed from 1200 to 4800 baud between 50 and 225 MHz. The FCC's notice of proposed rule making proposed that sending speeds up to 19.6 kb/s may be used on ASCII (unspecified speed on additional digital codes) so long as the bandwidth did not exceed 16 kHz. Comments filed by AMRAD suggested that the speed (particularly in the 220-MHz band) be raised to 56 kb/s and that bandwidth be increased to 100 kHz. The League filed comments in support of this and a similar request by Paul Newland, AD7I to raise the limits above 420 MHz. So, at QEX press time, we have to say that we don't know the speed limits in the new rules. But we should know within a few days.

The maximum bandwidth and/or speed is particularly important in the development of a packet radio backbone network (internet) which will connect between cities. If it is too slow, the network trunks will not have enough capacity to handle peak traffic loads.

At this point, if the new rules were effective tomorrow, we would have a difficult time finding high-speed modems. Someone's rule of thumb said that modems above 1200 cost something like a buck a baud. Today's competition seems to be driving the commercial ones down to about half that. Even at that, the price is awful and will drive us to home-brewing. Among those of us who have been discussing high-speed modems, there is no agreement (yet) on the best type of modulation to be used. Leading candidates are: msk (minimum-shift keying where the shift in Hz is half the baud rate) and qpsk (quadinary phase-shift keying).

Packet radio experimenters with Vancouver terminal node controller (TNC) boards have been using non-return-to-zero inverted (NRZI) encoding. NRZI is no longer considered to be state of the art in the computer industry and is being replaced by others such as Manchester and Miller encoding for magnetic storage media. One characteristic of some of the more sophisticated encoding schemes is ensuring of changes of state often enough that the dc component is eliminated. Bob Carpenter, W3OTC, raised the possibility that the right encoding scheme could permit transmission of data without a modem by feeding the data stream directly into the microphone input of a transceiver.

The FCC action clears the air for us to experiment, at least above 50 MHz, with forward error correcting (FEC) codes. There hasn't been a pressing need for them to date in the handful of amateur packet radio networks in North America which are mostly local in coverage. High-speed inter-city paths which are long enough to encounter fading on vhf could be good test beds for certain types of error-correcting codes.

Docket 81-699 applies only to 50 MHz and above. It will not change the situation on hf where we are currently limited to Baudot and ASCII codes. The League has petitioned the FCC to permit "AMTOR" transmissions in the hf bands. That petition has been designated RM-4122. (For details see QST August, 1982.) At the moment, AMTOR is in competition with Docket 82-83 (NOI/NPRM for phone subband expansion, see September, 1982 QST, p.10) for FCC time. Because of the present FCC backlog and finite resources for handling rules changes, other hf data communications experimentation should go the special temporary authority (STA) route for now. A permanent rule change affecting the hf bands is a more complicated procedure than at vhf and above because the signals easily propagate outside the U.S. This makes it necessary for the FCC to be careful that international treaties and ITU regulations are observed.

As you may have heard, the President signed into law certain changes to the Communications Act of 1934 which included those requested by the League. That happened the evening of September 13. If that followed in less than 24 hours with the FCC passing Docket 81-699 doesn't signal a new ball game for Amateur Radio, tell me about it. - W4RI.

Correspondence

Help Finding Parts and with Debugging Circuits

Please enroll me as a subscriber of QEX magazine.

I am currently employed as a research and design engineer with a university research group working in distributed processing and computer networking area. As a side benefit of my work, I have access to data sheets and parts of just-released and soon-to-be-released chips; I am willing to assist any fellow QEX subscribers in obtaining hard-to-find digital semiconductors and data sheets. Additionally, I would also be willing to assist any fellow subscriber in debugging amateur applications of newer digital integrated circuits.

My Amateur-Radio-related interests include: packet radio, SSTV, RTTY, and digital/computer applications to our hobby. I will be bringing up a packet radio repeater in the Stony Brook area of Long Island sometime in the next 2 - 3 months. - Richard J. Spanbauer, WB2CFV, P.O. Box ZZ, East Setauket, NY 11733.

Packet Radio Tests via AMSAT OSCAR-8

In recent weeks, Dr. Tom Clark, W3IWI of AMSAT and myself decided to begin testing the feasibility of transmitting and receiving packet radio data via satellite. We are both using the terminal node controller (TNC) boards produced by the Vancouver Amateur Digital Communications Group (VADCG). Software was supplied by AMRAD, originally written by Doug Lockhart, VE7APU, and modified a great deal by AMRAD.

After several unsuccessful attempts to receive connect sequences from Tom via Mode A we decided to abandon the two-way attempt, and I would try to receive my own data. Since I already had three TNCs and two 1200-baud modems available, I would try sending QST packets and receiving them on another system. A small software modification had to be made such that the QST message and cw i-d were transmitted continuously rather than at 9-minute intervals as allowed by the original software. Better audio matching between modems and radios was also incorporated, and testing resumed.

After several unsuccessful attempts, on September 1, 1982, 0110 UTC, (an experimental day) orbit number 22887 Mode J (or possibly AJ since I was not listening on Mode A), digital packet data was transmitted and received at N5AHD. In some cases, the three-line QST message was partially received and in others it was complete. The mode of transmission was nbfm in the middle of the satellite Mode J passband. At any time the signal was good quieting, and the tuning for zero discriminator reading maintained, the copy was successful. No tests on ssb were made during the orbit.

Later, on September 6, 1982, 1400 UTC, orbit number 22938, with satellite in Mode J, several mode successful receptions were made this time via ssb. The tuning in this mode was much more difficult, which was expected. The number of complete packets received was much lower than when using nbfm, probably due mainly to the better tuning indicator via the discriminator meter.

Needless to say, much more testing is planned, and the results of those tests will be documented. This first iteration was simply to get HDLC packet data through an amateur satellite in low orbit successfully. - Robert J. Diersing, N5AHD, 4129 Montego, Corpus Christi, TX 78411.

Bit-Oriented Packet vs. BISYNC Protocols

For some time I have been intending to write regarding the subject of packet radio. I am not currently involved in this interest but work in the data communications field.

I am curious why a packet protocol should be chosen for Amateur Radio. To me it is like using an expensive off-road 4-wheel drive vehicle for regular travel on an interstate highway.

The packet protocols were developed to attain highest efficiency for a full-duplex connection, allowing nearly unrestricted simultaneous communication in both directions. As a consequence there is a need for an exchange of packet sequence numbers, sent and received, and a complex structure of the packet frame which must be followed on both sides of the connection. There is also the zero-insertion and deletion requirement so that the beginning and ending flag of each frame may be uniquely recognized.

What this all comes down to is an unduly complicated approach not particularly amenable to software solutions for the protocol handler and not needed anyhow when the communication is interactive, i.e., half duplex.

What is wrong by BISYNC? The great preponderance of today's data communications traffic still uses this protocol. It is relatively uncomplicated, and the protocol easily can be software coded. By use of a modulo 16 sent sequence number, as in HASP, a fully conversational mode could be implemented without all of the complications of the packet protocols. - Forrest Gehrke, K2BT, 75 Crestview, Mountain Lakes, NJ 07046.

Chirpless Oscillator Keying

The chirp in keyed oscillators using bipolar or field-effect devices is caused mainly by voltage-variable interelectrode capacitances. Interelectrode capacitance does not change instantly with applied voltage, hence chirp. Given a well-designed and adjusted oscillator, the circuit shown in Fig. 1 will allow acceptable oscillator keying as high as 30 MHz and probably higher.

Heat can also cause chirp, so low-power input and light loading are indicated. It may well be that I am mistaken about the primary cause of chirp being voltage-variable capacitance, and that thermal effects play the major role. In any case, the cure is the same, and this very simple little idea really works.

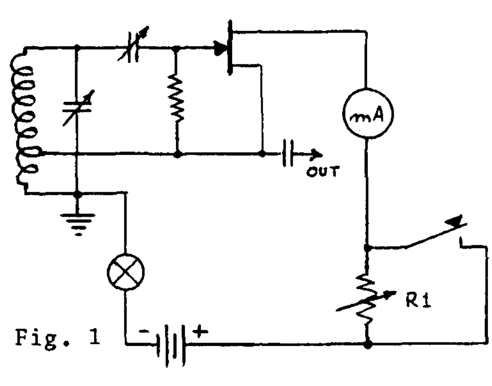


Fig. 1

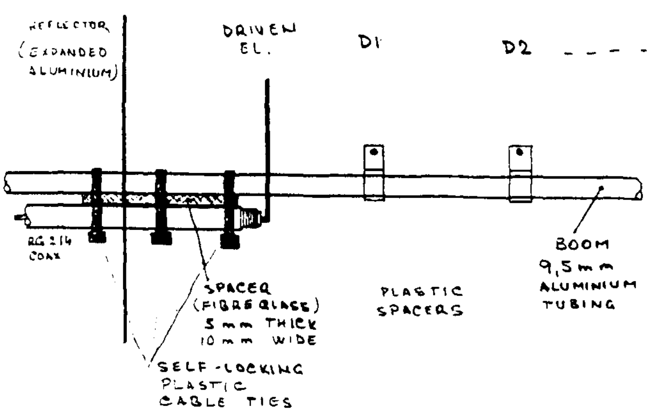
The oscillator in Fig. 1 is shown for clarity -- any good oscillator circuit may be used. Oscillator feedback and R1 are adjusted for minimum change in bias current with keying, consistent of course with the oscillator starting and stopping. Let me borrow a term from the good old days and call it "keep-alive keying." - A. H. Mehner, W7HP, 611 South Tonopah Drive, Las Vegas, NV 89106.

(More correspondence on page 6)

Metal-Boom Quagi

By Ivo Chladek,* ZS6AXT ex-OK2WCG

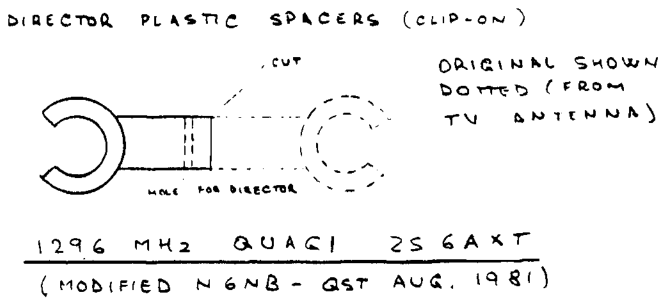
During my experiments with 432-MHz antennas I also tried the DL9KR quagi. The wooden boom of this antenna, however, is very discouraging for permanent installation. There is no reason why this type of antenna should not work with a metal boom if the elements are not influenced by the mounting. To support this idea, I first built the original version of the DL9KR antenna with a wooden boom and matched it to 50 ohms with a quater-wavelength balun. During this process, I found that the square shape of the driven element is difficult to work with and therefore changed the shape to round. By stretching or compressing the driven element, perfect matching was achieved. Encouraged by this result, I built an identical antenna with a metal boom in which all the directors are lifted off the boom by means of small sections of PVC. Comparative measurements indicated that the gain of this antenna is nearly 1 dB higher than that of the original wooden-boom version. This may be the result of lower losses in the PVC spacers than in the wooden boom. To test this idea further, another metal-boom DL9KR-type antenna was built, this time with commercial clip-on spacers made from a different plastic material. The performance of this antenna was identical to that of the previous one. The only other change on the last antenna was the use of a chicken-wire reflector with the same outside dimensions as the original quagi. Details of the director spacers are visible in the sketch, but the dimensions are not critical within reasonable limits.



In fact, this type of mounting of the elements is very suitable for optimizing the spacings of individual elements. However, I would not recommend trying any adjustments unless you really know what you are doing and have some measuring equipment and reasonable space for experiments.

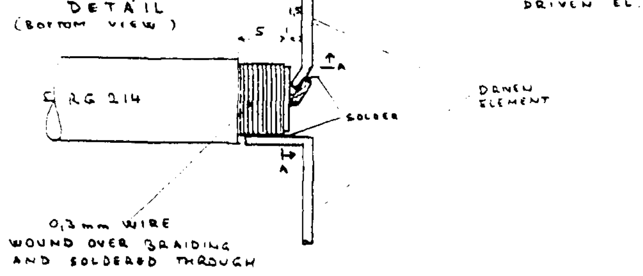
*P.O. Box 3093, Kenmare, 1745, Republic of South Africa

I did not try to optimize the DL9KR 432-MHz antenna as the back yard of my house is not large enough. However, when I built the N6NB quagi for 1296 MHz with a metal boom, I could not resist trying it. The main reason for this was that the spacings of the directors in the original antenna were uneven. With the antenna elevation at about 30 degrees and the measuring dipole some 8 meters high and 20 meters away, nothing was interfering with my adjustments.

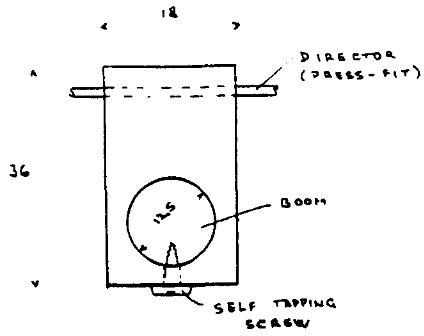


The results were far beyond expectations: the improvement measured was close to 4 dB for the 15-element quagi as compared with the original version with a metal boom. In this case, I did not build an exact copy of the original N6NB antenna for comparison but hope that somebody will enter one of the antenna contests with my version of the quagi. This array should have a gain of around 20 dB which should be enough for a Phase III satellite.

The most important dimensions and constructional details are shown in the sketches and table. The reflector is fixed to the boom by means of two aluminum strips on the sides of the boom. The director spacers are made by cutting commercial TV antenna spacers in half. The coaxial cable is connected directly to the driven element as in the N6NB original. However, I did not use any connectors, and in fact, the use of BNC plugs and sockets for outside installation is not recommended. The only suitable type of connector for this purpose is a (well-put-together) type N. The antenna is fixed to the rotator behind the reflector; both mass and wind resistance are minimal.



432 MHz QUAGI SPACERS FOR DIRECTORS



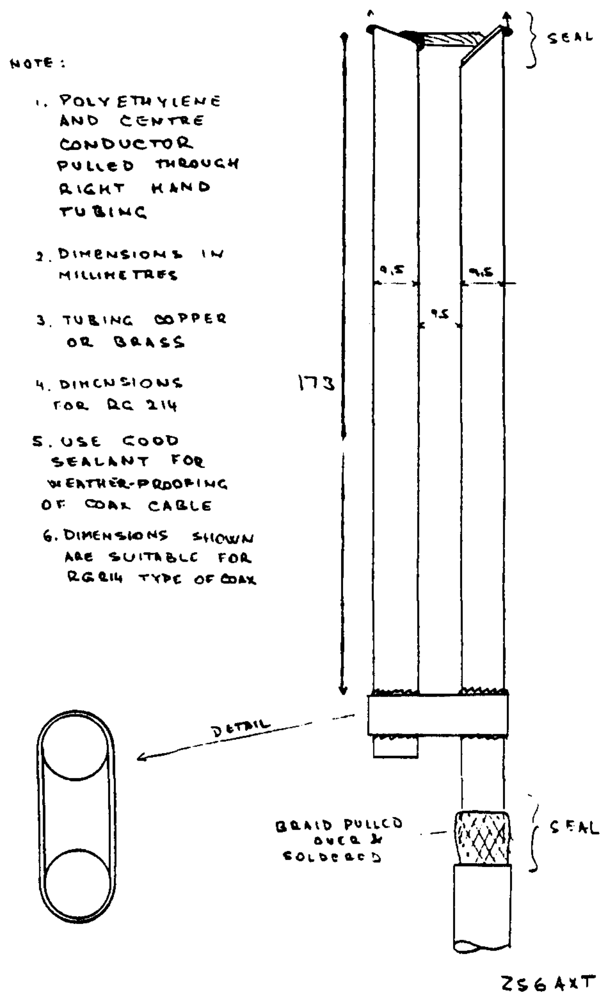
By the way, the 70-cm DL9KR quagi is mounted on a 35-mm diameter mast, between the second and third directors. No degradation of either SWR or field strength was noted. For this antenna, I made a quater-wavelength balun for a simple reason: it holds the driven element in place. This involves more mechanical work, but I prefer it even though it is probably not really necessary.

After completing any of the above antennas, it is necessary to check the SWR; the reflected power should be less than 5% of the forward power. If this is not the case, check your construction carefully or, even better, let someone else check it.

Finally, good luck with your DX hunting on 70 and 23 cm.

P.S. For the past six months I have been running a beacon, permanently beamed to Europe, on 432.896 MHz with about 700 W erp. I am preparing EME equipment for 432, 1296 and 2320 MHz. However, any special components are not obtainable here, and we are really battling the problem. If you know somebody who is willing to help, it would be greatly appreciated.

1:1 BALUN 432 MHz



ELEMENT	LENGTH (MM)	SPACING FROM REFLECTOR (MM)
REFLECTOR	150 X 150	-
DRIVEN ELEMENT	235	60
D1	99.5	100
D2	98.5	172
D3	98	244
D4	97.5	319
D5	96.5	391
D6	96	465
D7	95.5	548
D8	94.5	636
D9	94	734
D10	93.5	832
D11	92.5	933
D12	92	1048
D13	91	1166

NOTE: ALL ELEMENTS ARE CU ENAMEL WIRE 1.5 MM DIAMETER. REFLECTOR IS EXPANDED ALUMINUM 150 X 150 MM MINIMUM SIZE.

ZS6AXT QUAGI FOR 1296 MHZ (MODIFIED N6NB, QST AUGUST 1981)

Great·Circle Bearing and Distance to Each State

David G. Meier,* N4MW

Accurate antenna bearings are important for many Amateur Radio applications such as tropo and meteor scatter. Determining the proper bearing is often just guesswork. This computer program will calculate bearing and distance from any point in the USA to each state.

The program is written in Microsoft BASIC under Ohio Scientific's OS-65D operating system but easily can be converted to other versions of BASIC. Nautical distance and bearing are calculated to the center of a rectangle enclosing each state. Minimum and maximum bearings are determined from bearings to each corner of the rectangle. If statute miles are desired, change the heading in line 1050 from "NM" to "SM" and the 60 in line 1170 to 69.

Once the program is running, enter the station latitude and longitude to the nearest tenth degree. I usually use coordinates obtained for the nearest airport listed in the Aircraft Owners and Pilots Association Airport Directory. The program will print minimum, average and maximum bearing plus distance to each state in alphabetical sequence as shown in the sample printout for the McLean, VA vicinity. If you do not have access to a computer, I will provide a custom printout if you will provide an s.a.s.e.

*3205 Covington Pike, Memphis, TN 38128, 901-377-0834.

```
 1000 REM GREAT CIRCLE BEARING AND DISTANCE
 TO EACH STATE
 1010 REM DAVID MEIER N4MW  8 DECEMBER 1981
 1020 INPUT"LATITUDE, LONGITUDE (DEGREES)";
LA,LN
 1030 C=57.29578:LA=LA/C:LN=LN/C:S1=SIN(LA)
:C1=COS(LA)
 1040 S1$="           ----BEARING----     AVERA
GE"
 1050 S2$="STATE   MIN   AVG   MAX    DIST
(NM)"
 1100 PRINT#4,"  GREAT CIRCLE BEARINGS AND
DISTANCES FROM";
 1110 PRINT#4,LA*C"LAT"LN*C"LNG TO EACH STA
TE":PRINT#4
 1120 PRINT#4,S1$TAB(40)S1$:PRINT#4,S2$TAB(
40)S2$:PRINT#4
 1130 FORST=1TO50:HL=360:HH=0
 1132 READS$,N,E,S,W:LA(1)=N/C:LN(1)=E/C:LA
(3)=S/C:LN(2)=W/C
 1140 LA(2)=LA(1):LA(4)=LA(3):LN(3)=LN(1):L
N(4)=LN(2)
 1150 LA(5)=(N+S)/2/C:LN(5)=(E+W)/2/C
 1160 FORN=1TO5:X=S1*SIN(LA(N))+C1*COS(LA(N
))*COS(LN(N)-LN)
 1170 X=ATN(SQR(1-X*X)/X):D=INT(X*60*C+.5)
 1180 X=(SIN(LA(N))-S1*COS(X))/(SIN(X)*C1)
 1190 X=INT(ATN(SQR(1-X*X)/X)*C+.5)
 1200 IFSIN(LN-LN(N))<0THENX=360-X
 1210 IFX<0THENX=X+180
 1220 IFX>360THENX=X-180
 1230 IFN=5GOTO1260
 1240 IFX<HLTHENHL=X
 1250 IFX>HHTHENHH=X
 1260 NEXTN
 1270 IFST/2=INT(ST/2)GOTO1290
 1280 PRINT#4,TAB(2)S$TAB(7)HLTAB(13)XTAB(1
9)HHTAB(26)D;:GOTO1300
 1290 PRINT#4,TAB(42)S$TAB(47)HLTAB(53)XTAB
(59)HHTAB(66)D
 1300 IFST/10=INT(ST/10)THENPRINT#4
 1310 NEXTST
 2010 DATAAL,35,85,30,88.5,MT,49,104,44.5,1
16
 2020 DATAAK,70,140,58,164,NE,43,95.5,40,10
4
 2030 DATAAZ,37,109,31,115,NV,42,114,35,120
 2040 DATAAR,36.5,90,33,94.5,NH,45,71,42.7,
72
 2050 DATACA,42,114,32.5,124.5,NJ,41.2,74,3
9,75
 2060 DATACO,41,102,37,109,NM,37,103,31,109
 2070 DATACT,42,71.8,41,73.7,NY,45,72,41,80
 2080 DATADE,40,75,38.5,75.8,NC,36.5,76,33.
8,84
 2090 DATAFL,31,80,25,87.5,ND,49,96.5,46,10
4
 2100 DATAGA,35,81,30.5,85.5,OH,42,80.5,38.
5,84.8
 2110 DATAHI,22,157.7,19,160,OK,37,94.5,33.
5,103
 2120 DATAID,49,111,42,117,OR,46,117,42,124
.3
 2130 DATAIL,42.2,87.8,37,91.4,PA,42.2,75,3
9.8,80.5
 2140 DATAIN,41.7,84.8,38,88,RI,42,71,41.5,
71.8
 2150 DATAIA,43.3,90,40.5,97,SC,35.2,78.6,3
2,83
 2160 DATAKS,40,94.5,37,102,SD,46,96.5,42.5
,104
 2170 DATAKY,39,82,36.5,89.5,TN,36.6,82,35,
90
 2180 DATALA,33,90,29,94,TX,36.5,94,26,106.
5
 2190 DATAME,47,67,43,71,UT,42,109,37,114
 2200 DATAMD,40,75,38,79.3,VT,45,72,42.7,73
.5
 2210 DATAMA,42.6,70,41.5,73.5,VA,39.2,76,3
6.5,83.5
 2220 DATAMI,47,82.5,41.7,90.5,WA,49,117,45
.5,124.7
 2230 DATAMN,49,90,43.3,97.3,WV,40.3,77.8,3
7.3,82.5
 2240 DATAMS,35,88,30.5,91.5,WI,47,87,42.5,
93
 2250 DATAMO,40.5,89,35.5,95.8,WY,45,104,41
,111
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GREAT CIRCLE BEARINGS AND DISTANCES FROM 38.9 LAT 77.2 LNG TO EACH STATE

	----BEARING----			AVERAGE		----BEARING----			AVERAGE
STATE	MIN	AVG	MAX	DIST (NM)	STATE	MIN	AVG	MAX	DIST (NM)
AL	218	233	250	603	MT	294	299	307	1506
AK	317	326	335	2950	NE	280	286	292	1042
AZ	263	271	278	1695	NV	274	282	289	1849
AR	244	256	265	763	NH	31	39	49	392
CA	269	281	291	1971	NJ	36	59	87	144
CO	272	279	285	1315	NM	257	267	276	1414
CT	40	51	61	257	NY	31	12	342	252
DE	44	75	110	86	NC	158	212	248	262
FL	190	209	230	731	ND	299	305	312	1127
GA	202	220	242	472	OH	262	290	322	265
HI	279	281	283	4259	OK	254	265	273	1052
ID	288	296	304	1667	OR	289	293	297	1955
IL	260	278	296	577	PA	26	349	324	129
IN	264	281	298	430	RI	51	55	59	316
IA	282	289	299	765	SC	190	210	233	363
KS	267	275	281	984	SD	289	295	303	1079
KY	239	263	274	408	TN	226	249	261	459
LA	231	241	252	867	TX	233	255	273	1217
ME	27	42	59	517	UT	276	282	288	1586
MD	56	21	305	6	VT	23	33	44	358
MA	36	51	62	312	VA	72	243	275	135
MI	290	311	336	529	WA	296	299	303	1950
MN	293	306	322	845	WV	197	268	342	138
MS	230	243	256	712	WI	292	306	322	670
MO	254	270	284	715	WY	284	290	296	1387

Correspondence... (continued from page 2)

Advice Needed on Dish Construction

We are in the process of reading the last issue of QEX. Keep up the good work. We think it is great.

I have a couple of questions for your TAs. We are in the process of building the 12-foot stressed parabolic dish described in the last edition of "The ARRL Antenna Book." We plan on building a permanent one, as opposed to portable, using the table in figure 43, page 12-16.

First question: We would like to use 1/2-in. aluminum tubing around the circumference using tees at each spoke. The only readily available material would be to use copper plumbing tees, and fasten them with sheet-metal screws. Would there be a reaction between the copper and aluminum that could reduce the efficiency of the antenna?

Question two: We also plan on housing the feed horn, LNA and LNA power supply in a 5 in. x 12 in. PVC pipe and suspending it out from the dish on an adjustable tripod. This adjustable focus will allow us to change the focus out to about 6 ft from the vertex. Is this a good idea? - Ray Arnold, N7CQP, Rte 2, Box 181, Manhattan, MT 59741, 406-285-6714 after 5 P.M. MST.

From the ARRL TA Newsletter...

Power-FET Technology

There will be an excellent two-part QST article on the state of the power-FET art, tentatively planned for the December 1982 and January 1983 issues under the byline of ARRL Helge Granberg, K7ES. He describes a 2-30 MHz broadband linear amplifier that outputs 1600 W. He uses MRF150s (16 transistors in 8 amplifier blocks) with a 50-V dc supply.

An ARRL-organized technical session on power FETs and their applications will be presented at IEEE MIDCON in Dallas, TX in November. Papers will be given by Roy Hejhall, K7QWR, Ed Oxner, KB6QJ, Dr. Phillip Soo-Hoo of GE and Doug DeMaw, W1FB. An ARRL session has been accepted for IEEE SOUTHCON in Atlanta, GA next January. The session will deal with antennas. Papers will be given by Jerry Sevick, W2FMI, Arch Doty, K8CFU and a co-authored paper by Jack Belrose, VE2CV and Doug DeMaw, W1FB.

A 60-watt-output power FET Class C amplifier was developed recently by W1FB for use in the MIDCON papers. Samples of the MRF138 were provided by Helge Granberg. Tests were conducted at 7 MHz in a broadband, push-pull configuration. A 7-pole Chebyshev filter was used at the amplifier output. The performance characteristics are: Power gain = 23 dB; Efficiency = 72.5 percent; Driving power = 288 mW; Spurious output is 70 dB or greater below peak cw power. Vdd = 28 volts. The rated gain of an MRF138 is 15-18 dB at 30 MHz and 10 dB at 175 MHz. Motorola is well into the power-FET market now, with components for 12, 28 and 50-volt operation.

QRP Mailbox

K3TKS informed ARRL Hq. recently that his QRP club has a cw "mailbox" on 7043 kHz. It can be accessed by sending a series of Vs, then K8IFZW. K8IF is the present of the club. This may be of interest to those of you who operate gnat- or mite-size rigs.

Error-Detection Basics

By Hal Feinstein,* WB3KDU

Noise

One of the laws of communication is that errors can be introduced by the medium.

Errors can be caused by disturbances introduced in a radio channel. In the radio medium, errors are often the result of man-made and natural interference (QRM and QRN).

Noise can be broken down into two common types. The first one is a single noise pulse which may recur randomly. This has been called "shot noise." An example might be heard in a radio receiver when someone turns on a light switch nearby. The second type is "burst" noise, consisting of a quick succession of individual single pulses which are highly correlated. This type of noise can be generated by an electric shaver.

Error-correcting codes can be devised to handle each of these types of noise. However, of the two, burst noise is the more complex to correct.

Information Rate

Every experienced radio amateur knows that, all other things being equal, some modes fare better in noisy channels than others. As examples: Ssb has an advantage over a-m, and cw can get through when other modes cannot. The reason why cw has this property is that the listeners need less information to decide what was sent than for other modes. In cw, the listener decides between a dot, dash and space. In International Morse, these elements form a limited character set of 26 letters, 10 numbers and a handful of other characters that most operators learn. Because the range of things to send is limited, the information rate is usually slow, and the decisions are limited to determining whether the transmitter is fully on or fully off, the listener is able to cope with a noisy channel.

An ssb voice signal, on the other hand, can transmit a large number of possible sounds. The human voice contains many subtle sounds which occur at low amplitude levels when compared to the peak output. Unfortunately, these relatively low-amplitude levels carry much information. Thus low-level noise can disrupt a voice circuit. This is eased somewhat whenever the range of possible things that a voice operator might say is limited and well known to the listener.

These properties have been studied under the general deading of "information theory," which was started in 1948 by Claude E. Shannon. Shannon originally called it "A Mathematical Theory of Communications." Information theory does not deal with the meaning of information but rather with the problem of its transmission.

Redundancy

Shannon introduced a number of important ideas of which one is that the simplest andmost fundamental element of information is the "yes" or "no" answer to a question. The answer can be represented by a single bit. A yes = 1, a no = 0. Therefore if you can express the information that you are sending in terms of a series of yes or no answers you need send only a 1 or 0 for each question asked.

The use of ones and zeros can be extended by using pairs of bits to stand for the answers to two questions and three bits for answers to three questions. When you string a number of bits together into a standard size, you produce a code word. Code words can be used to represent a limited number of answers to a question such as "What is the weather?":

Weather	Code Word
Sunny	00
Cloudy	01
Rainy	10
Foggy	11

In this example we would transmit a two-bit code word which can express only four answers. Also, we saved ourselves some transmitting by using the code word instead of the English word. The difference between the code word and the actual name is "redundancy." Redundancy encompasses all the unneeded additional symbols which go along with the basic information. Some redundancy can be helpful, while other redundancy is merely excess baggage.

Detecting Errors

By digital encoding, we have been able to reduce the message to a very few bits. But redundancy may help a listener to distinguish between a correctly received word and one which may contain an error. The goal in error detection is to add just enough redundancy to help the receiving station decide whether the information received is correct.

A Simple Error-Detection Code

One way to detect errors is to transmit a number of "check" bits after the message which depend upon the information bits. To calculate the check word, we could use the following procedure:

1. Add up the base ten value of each code word.
2. Consider the sum as a group of code words. From this group select the lower code word.
3. Append this lower code word to the information code words and transmit the information.

At the receiving end:

1. Add up the information code words received by their base ten value.
2. Take the lower code word of the sum and compare it with the lower code word sum sent.
3. If the two sums match, then the information probably was received correctly.

Example: Suppose we wished to transmit the following list of code words for the word cat.

a 00001	b 00010	c 00011	d 00100	e 00101
f 00110	g 00111	h 01000	i 01001	j 01010
k 01011	l 01100	m 01101	n 01110	o 01111
p 10000	q 10001	r 10010	s 10011	t 10100
u 10101	v 10110	w 10111	x 11000	y 11001
z 11010	space 11011			

c - 00011 $16x0 + 8x0 + 4x0 + 2x1 + 1x1 = 3$
a - 00001 $16x0 + 8x0 + 4x0 + 2x1 + 1x1 = 1$
t - 10100 $16x1 + 8x0 + 4x1 + 2x0 + 1x0 = 20$
space - 11011 $16x1 + 8x1 + 4x0 + 2x1 + 1x1 = \underline{27}$

sum = 51

Because 50 cannot be coded into the above 5-bit code, let's build a longer string of bits and simply use the lower (5 bits of the) code word:

$\underline{1}\underline{11101} = 32x1 + 16x1 + 8x1 + 4x1 + 2x0 + 1x1 = 51$

^ lower five bits

At the receiving end, if any bits are changed by noise, the checks will not match. But there is no guaranty in this system against two or more errors cancelling themselves out in the checking process. Some people, referring to Murphy's Law, say that this technique ensures an even number of errors. The fact is that this error-detection technique can be very effective.

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Data Communications

Conducted by
David W. Borden,* K8MMO

HF Networking

My packet radio station will be available when I am in residence in the hamshack on 10 meters, 28,091.5 kHz. I suspect this method should result in transcontinental packeteering. I run the output of the Bell 202 modem (1200 Hz and 2200 Hz) into my IC-701 ssb transceiver. I tap off the speaker of the 701 to the modem and packet better than I do on 2-meter fm. To begin this noble effort, I shall program the main station computer to call CQ on the packet rig every eight minutes until someone connects up and says "hello." I cannot put a simplex packet repeater there because it is too low in frequency (repeaters are permitted only in the high end of the 10-meter band). I cannot run a beacon there because I do not have an STA, but I can run my normal packet station there legally and 10 meters seems to be propagating well lately.

The real intent of all this hf packeteering is to network across the United States. That problem could be large or could begin in a rather simple fashion with only a modest rule change on the part of the Federal Communications Commission. As the previous paragraph suggests, there is a small problem with packets (if packets bother anyone, and they shouldn't, think RTTY) on 10 meters. Networking can begin quickly with only cross-band repeating (regenerating, recycling, retransmitting - substitute your favorite word) from 10 meters to 2 meters. The local area networks as I write are all on 2-meter fm, simplex or duplex repeaters. Use of 10 meters could link these local area networks. But, ten meters has these strange rules.

The type of transmission concerned here is F1 (or F2j) frequency-shift keying. True, an audio tone goes in the mike jack of the ssb rig, but the end result is fsk, good old F1 of old. Then the Catch-22 gets us. F1 is allowed on 10 meters only from 28.000 to 28.500 MHz (Part 97.61 (a)). Now our packets are legal using F1 between 28 and 225 MHz with a sending speed not to exceed 1200 baud (Part 97.69 (b)(3)). But, our cross-band packeteering cannot be done because repeater operation begins at 29.5 MHz (Part 97.61(b)(13)(c)). Assume for the sake of this dissertation that we could cross-band our packets 10 meters to 2 meters, what would we gain?

Let's take the simple case of San Francisco and the Hank Magnuski, KA6M gang of packeteers running on their simplex repeater, about 35 people nightly on packet. If just one of these amateurs would build a two-port packet board and put one port on the 10-meter packet station and the other port on the 2-meter packet simplex repeater, other parts of the country could check in on their packet operation. They have a host computer on that repeater, which others could use. If someone in the Washington area for example would build the two-port packet board and put a port on 10 meters and the other port on one of the two 2-meter packet repeaters, linking would become a reality. Now the amateur in Washington need only call CQ in monitor mode, or try to connect to KA6M in San Francisco to establish cross-country packets. Both pockets of packet activity should establish a mailbox host computer (called a CBBS on the phone lines) since by the time I get home from work, 10 meters may be closed to California. I could check in our local mailbox computer if anyone in San Francisco left me any messages. I could leave my traffic for them in our mailbox for their pickup while I am at work. On weekends I could connect directly with my packet friends in San Francisco. Sounds promising, but at least one minor software change is required I think, in addition to the minor FCC frequency allocation change.

It has often been pointed out that our current use of a single-byte address is less then optimal. Members of the New Jersey packeteers and AMRAD have been discussing an amateur version of the X.25 protocol called AX.25 in which two address are supplied in every packet and ham callsigns are used instead of 8-bit numbers. Implementing this may take some time however. A simple interim kludge is needed (something like a software clip lead).

In an AMRAD modification to the VADCG software, the packet user is asked on signon what cw i-d speed is required by inquiring as to the line (packet) speed desired and setting the software in accordance with the operator response. An additional question could be added to that initial response query, WHAT ADDRESS WOULD YOU LIKE TO BE? In this way, no collision between Washington and San Francisco would occur since I am number 02 in Washington and KA6M/6 is number 02 in San Francisco. The monitor mode software could be simply changed to print a 2-digit received address in front of every packet received, and thus you would know whom you were monitoring. Another method might be easier, if you attempted to connect up with a person of the same address as yourself, a warning message would flash on your screen and an entry made to the change address code. A third method would be to automatically add one to your address if you attempt to connect to someone of the same address as yourself. All these schemes are less than ideal, but would work. Hank's suggestion is some new code that places the ham calls just at the beginning of the information frame. If Hank codes that solution up successfully (he claims to be 98% complete), then reburning ROMs in Washington and San Francisco may be in order as a good kludge until AX.25 is implemented on our local networks.

It would be a happy condition to face either of these two problems:

1. The need to have unique addresses because we can now talk to San Francisco on packet.

2. The need to ask the FCC to change the 10-meter frequency rules slightly as we want to network with San Francisco.

The first step in this simple networking is the establishment of a circuit with some other local area on 10 meters. I will attempt to do that, assisted by Paul Rinaldo, W4RI who can work more 10 meters than I can as he is based at his home. If anyone wishes to participate, write or call Paul (703-734-0878) and set up a schedule. No new packet technology at first is required, just your normal packet station and a 10-meter ssb rig. We need something to cover the problem until AMSAT Phase III solves our medium problem for us. By that time 10 meters will be in lower in the sunspot cycle again, and we will not be able to use it as much.

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Components

Conducted by Mark Forbes,* KC9C

This month's column deals with several integrated circuits which combine what was in the past several circuit building blocks into one chip. This trend has been growing over the past few years, and as can be seen in the components presented here, entire circuits are now available on a single IC.

Texas Instruments TMS99532 Afsk Modem

The TMS99532 afsk modem chip contains all the circuitry on board the chip for modulation, demodulation and filtering for simplex, half- duplex or full-duplex operation. The chips operate up to 300 bits per second and are Bell 103 compatible. They may be coupled either directly to the line, through an approved data coupler, or can be acoustically coupled with the addition of only an R-C network, a speaker and a microphone.

Also of interest, the chips may be interfaced with 8- or 16-bit microcomputer buses. They also contain a loop-back circuit so the chip can be run in the self-test mode. The parts cost about $25, and information can be obtained from: Texas Instruments, Box 202129,Dallas, TX 75220.

Motorola MC145414 Low-Pass Filter

The Motorola MC 145414 low-pass filter IC consists of two 5th-order elliptic low-pass filters plus two uncommitted op amps. The filters are usable in the 1- to 10-kHz range, and being of CMOS construction, the power dissipation is only 30 mW maximum. The dynamic range is better than 80 dB, and the ripple is less than 0.3 dB. These ICs are priced in the $5 range and can be obtained from Motorola distributors or from Motorola Inc., 3501 Ed Bluestein Blvd, Austin, TX 78721.

RCA CDP 1805 CMOS Microcomputer

RCA has gone into production of an enhanced version of their popular 1802 CMOS microprocessor. The 1802, being the earliest, and up until recently the only 8-bit CMOS microprocessor, had found its way into a variety of low-power applications including AMSAT OSCAR satellites. The enhancements made to the 1802 to make the 1805 product are indeed welcomed by both hardware and software designers.

These enhancements are: on-board 64-byte RAM array, 8-bit counter/timer and 22 new instructions, which thankfully include the call and return instructions.

Like its predecessor, the 1805 has a 16 x 16 set of internal registers, 64k address space, DMA, serial I/O and a multiplexed address bus. Information on the 1805 is available from: RCA Solid State Division, Box 3200, Somerville, NJ 08876.

National LM2111 Fm Detector and Limiter

National's LM2111 is a direct replacement for the ULN2111A and the MC1357. Incorporated on a single IC is an i-f amplifier and limiter, fm detector and a buffer. A transformer and a coil are the only components needing alignment in the complete circuit. Sensitivity is 300 uV. For information, write to: National Semiconductor, 2900 Semiconductor Dr, Santa Clara, CA 95051.

National Dot/Bar Display Driver

The LM3914 is an 18-pin IC for use in driving the LED bar-graph type displays with up to 10 LEDs. The IC contains an on-board adjustable voltage reference and an accurate 10-step divider. This provides a linearity of 1/2 percent. When used in the "dot" mode, the previous LED fades into the current LED for a more uniform display. Other applications of the divider circuit are also possible in addition to its use as a display driver. The above address applies to information on the LM3914 as well.

Fifth Dimension Relays and Tilt Switches

Fifth Dimension, Inc. has available a large variety of mercury-film relays and tilt switches. These devices are used in some military applications, so good quality can be assured. Applications of the mercury relays include microprocessor I/O, modems, telephone switching and other control applications. The relays are available in three packaging styles and a variety of coil voltages.

The tilt switches are available in a large variety of trip angles from 15 through 70 degrees, with normally open as well as normally closed contacts. Typical applications could include control systems or elevation rotor circuits. Fifth Divension invites inquiries for their free applications brochure. The cost of these devices is about 50 cents for the tilt switch and about $2.50 for the relays (all single quantity). Information and orders should be directed to: Fifth Dimension, Inc, 801 New York Ave, Trenton, NJ 08638, 609-393-8350.

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2) document advanced technical work in the Amateur Radio field, and

3) support efforts to advance the state of the Amateur Radio art.

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