QEX May 39 1985 $1

The ARRL Experimenters' Exchange

FCC Issues Automatic Control NPRM

On April 11, 1985, the FCC released PR Docket No. 85-105, which proposes automatic control of Amateur Radio stations above 29.5 MHz. This was in response to a League petition (RM-4879) which requested permission for automatic operation of digital communications above 30 MHz. U.S. readers may obtain a copy of this NPRM by sending a self-addressed business-size envelope with 39 cents postage to ARRL Hq.

Spread Spectrum Day at the FCC

May 9 may be the day that the FCC authorizes limited use of spread spectrum under Parts 15 and 97 of the rules.

That afternoon, John P. Costas, K2EN, will give a talk on spread spectrum as part of the FCC Office of Science and Technology tutorial series.

Call for Articles

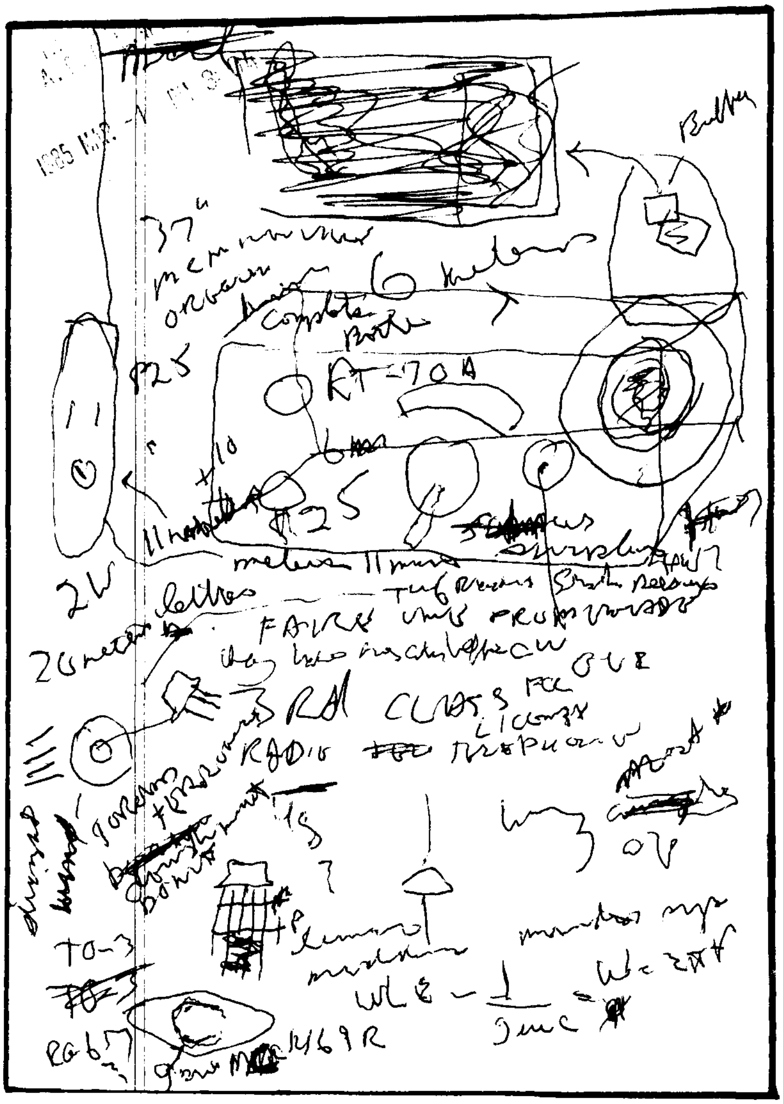
QEX is a vehicle for getting your ideas out to other experimenters -- fast. It is published monthly, and normally we publish material within a month or two of receipt. **QEX** is read by individuals who are involved with digital communication, VHF/UHF/microwaves, amateur satellites and other technical disciplines. So, if you want to get the word out, and get timely reactions from other experimenters, **QEX** is the way to do it. The form is flexible: We publish feature articles, columns and correspondence.

KA1DYZ Featured on QST Cover

Take a look at the May **QST** cover if you want to see the likeness of **QEX** Assistant Editor Maureen Thompson, KA1DYZ.

We Get Letters

ARRL Hq gets about 350,000 letters each year. All kinds. Here's a facsimile of one that should be of interest to experimenters:



Correspondence

Alphabet Soup

UHFN BNC SMA — Have you ever been bewildered by the alphabet soup of letters used to identify your coaxial connectors? Well, there are some interesting stories behind those letters.

Up until the 1930s, binding posts and parallel wires were used for feed lines. When the first RF coaxial cables wre marketed, the UHF connectors (PL259-SO239) were introduced for these new feed lines.

During WWII the requirements for a better connector for radar use prompted two designs. The first was developed at Bell Labs by Paul Neill and was called the Type "N" connector. At the same time, another connector was developed by Carl Concelman. Named the Type "C" connector, it was the first designed as a true 50-ohm connector. By using "reactive cancellation," the inductance in the connector was balanced by changing the dielectric material used to fill the connector. Reactive cancellation allows the connector to have a low SWR well into the GHz regions.

Shortly after, Neill and Concelman collaborated on the design of a miniature bayonet locking connector. This was later known as the Bayonet Neill Concelman or BNC connector. An improved threaded version for airborne uses was developed later and called the Threaded Neill Concelman or TNC. (Ever notice how easily a male "N" fits on a female BNC or TNC?)

For precision microwave use, a series of subminiature connectors were developed -- the A, B and C. Of these three, the A, or Sub Miniature A (SMA) is the most popular.

Now you can show off when calling your local electronics emporium and ask, "Do you have a 220-MHz Rubber Duck antenna with a Bayonet Neill Concelman connector?" — Kent Britain, WA5VJB, 1626 Vineyard, Grand Prairie, TX 75052.

More on the ACSSB Packages

The circuit diagram of Fig. 5.6c incorrectly shows the bias connection through CR1 and R160, to U13 of pin 6. In reality, pin 5 is the bias control, and the audio board is so wired.

The CA3080E is a half dip packaged transconductance operation amplifier, or TCA. It is just a fancy name for an AGC control amplifier. There does not appear to be many alternate vendors for the CA3080. Has another purchaser of the ACSSB board been successful in locating a source?

To fully use the ACSSB for two-way satellite communications, we need an additional part of the RF board to be able to set up a full duplex transmitter path. Circuitry from the audio input at Q36 through to mixer, M1, will be needed. This 21-MHz signal can be mixed off board for use in a 70-cm transverter. — Dick Jansson, WD4FAB, 1130 Willowbrook Trail, Maitland, FL 32751.

Feedback

A typographical error crept into my request for help in designing a circuit for a very stable crystal oscillator (March 1985 **QEX**, p. 2). In the last sentence of the first paragraph, the unit is not encapsulated in about 10^{11} cubed styrofoam, but in 10 inches of cubed styrofoam. Some difference! -- John R. True, N4BA, 10322 Georgetown Pike, Great Falls, VA 22066.

BASIC Maidenhead

By Joseph Fleagle,* WØFY

The Maidenhead Grid Locator System (Jan. 1983 **QST**, p. 49; Sept. 1983 **QST**, p. 81) has gained widespread acceptance on the VHF bands. Nearly all stations know their four character locator, and many have taken the time and trouble to determine the optional fifth and sixth characters for their station location. The four character locator determines station location to about 110 x 69 miles (at 40^{o} latitude). The optional fifth and sixth characters refine the position down to about 4 x 3 miles. Grid information is useful for propagation studies, beam aiming, or just for the satisfaction of knowing how far away that last DX station really was!

The BASIC program presented here accepts Maidenhead grid information as input, and calculates bearing and distance from your station to the center of the selected square. Either four or six character grid designators may be input. The program checks for the correct number of characters, but in the interest of simplicity, it does not check to see that the characters are in the correct ranges. Thus, a typographical error, such as E4M8 instead of EM48, will be accepted, but the answer will appear incorrect.

The latitude and longitude values printed are the center of the input square in decimal degrees, with eastern longitudes and southern latitudes shown as negative numbers. This program will work between any two points on Earth, so it would also be useful for HF contacts.

The accuracy of the bearings and distance is, of course, dependent on whether four or six character grid information is used. The worst case distance error with four character input is about 75 miles, and about 2.5 miles when all six characters are used. At distances of over a few hundred miles, the bearing errors are negligible, even when only four character grid information is used. I have used this program to determine beam headings for meteor schedules, and have not had any problems.

This program was developed on a Commodore 64 computer, but it should run with little or no change on any computer which uses Microsoft type BASIC. A sample printout, using my location, is provided for reference in Fig. 1. Before using the program for the first time, be sure to change the latitude, longitude, and call sign information in line 40 to the values of your station.

```
BEAM HEADING PROGRAM

ENTER DESIRED MAIDENHEAD SQUARE
? EM44UF

CENTER OF SQUARE EM44UF IS AT

LATITUDE  34.2291667  LONGITUDE  90.25

BEAM HEADING FOR WOFY IS 177 DEGREES

DISTANCE IS  306 MILES

ANY OTHERS? N


73 AND GOOD DX
```

Fig. 1

*320 Green Trials Dr. So., Chesterfield, MO 63017

```
10 REM ***BY J.E.FLEAGLE, WOFY***
20 REM L1=OWN STATION LONGITUDE, L2=OWN STATION LATITUDE
30 REM CHANGE L1,L2 TO YOUR VALUES IN LINE 40
40 R=π/180:R1=3950:L1=38.658*R:L2=90.516*R:C$="WOFY"
50 DIM G1(6),G$(6)
60 PRINT"{CLR}":PRINT:PRINT:PRINT:PRINT"BEAM HEADING PROGRAM"
70 REM GRID SQUARE CONVERSION ROUTINE
80 PRINT: PRINT"ENTER DESIRED MAIDENHEAD SQUARE"
90 INPUT G1$
100 S=LEN(G1$)
110 IF S=4 THEN 130
120 IF S<>6 THEN PRINT"WRONG NUMBER OF CHARACTERS":GOTO 80
130 FORM=1TOS
140 G$(M)=MID$(G1$,M,1)
150 G1(M)=ASC(G$(M))
160 NEXT M
170 L4=160-20*(G1(1)-ASC("A"))+(ASC("9")-G1(3))*2+1
180 L3=(G1(2)-ASC("J"))*10+(G1(4)-ASC("0"))
190 IF S=4 THEN L3=L3+.5:GOTO 220
200 L4=L4+((ASC("L")-G1(5))*5)/60
210 L3=L3+(((G1(6)-ASC("A"))*2.5)+1.25)/60
220 PRINT: PRINT"CENTER OF SQUARE ";G1$;" IS AT"
230 PRINT: PRINT"LATITUDE ";L3;" LONGITUDE ";L4
240 L3=L3*R:L4=L4*R
250 REM BEARING AND DISTANCE CALCULATION
260 L=L2-L4
270 IFL>π THENL=L-2*π
280 IFL<-π THEN L=L+2*π
290 X=SGN(L):IF X=0THEN X=1
300 F=SIN(L1)*SIN(L3)+COS(L1)*COS(L3)*COS(L)
320 D=-ATN(F/SQR(-F*F+1))+π/2
330 D1=D*R1
340 G=(SIN(L3)-SIN(L1)*F)/(COS(L1)*SIN(D))
350 IF G>1THEN G=1
360 IF G<-1 THEN G=-1
410 B1=-ATN(G/SQR(-G*G+1))+π/2
420 B=B1/R:IF X=-1 THEN B=360-B
430 PRINT:PRINT"BEAM HEADING FOR ";C$;" IS";INT(B+.5);"DEGREES"
440 PRINT:PRINT"DISTANCE IS ";INT(D1+.5);"MILES"
450 PRINT:INPUT"ANY OTHERS";A$
460 PRINT"{CLR}":PRINT:PRINT:PRINT
470 IFA$="Y" THEN60
480 PRINT:PRINT:PRINT:PRINT:PRINT"73 AND GOOD DX"

READY.
```

Employment Opportunity

Two-way radio technician wanted. Trio-Kenwood Communications is seeking an experienced technician to service state-of-the-art Amateur Radio communications equipment, HF through UHF. A qualified candidate should be currently experienced with PLL synthesizers, microprocessors, transistorized RF, and must be able to service to the component level. Practical, working knowledge, acquired on the bench, is essential. If you would like to work with the industry's pace-setter, contact Trio-Kenwood Communications, Attn. Service Department, 1111 West Walnut St., Compton, CA 90220.

Testing Audio-Frequency Phase Quadrature: Is Your Circle Truly A Circle?

By G. W. Horn,* I4MK

When checking some audio frequency networks at certain frequencies, the operator should be aware of controlling the outgoing signal to see that it is in phase quadrature with respect to the input signal.[1] To do this, resort to the Lissajous pattern on an oscilloscope, which at phase quadrature is a perfect circle.[2] This check is performed by applying the two signals assumed to be at 90° to the X-Y input of an oscilloscope having identical horizontal and vertical channels. Perfect instruments of this kind, however, are unusual. Therefore, to use the average scope for this task, make sure the X input is accessible and that its internal dephasing may be neutralized by connecting a variable resistor in series with one of its inputs (usually the Y).[3]

Phase compensation is carried out by injecting one of the two signals to be controlled into both connected inputs of the scope, and adjusting the potentiometer until X and Y form a 45° straight line on the screen. Splitting of this line into a lengthened ellipse is a sign of dephasing. The potentiometer must be adjusted until this splitting disappears and the figure on the screen turns into a true straight line. Further, obvious presupposition for any phase measurement is that both scope channels are truly linear.

At this point, the two signals, the quadrature of which has to be checked, will be connected to the two input ports of the scope without further adjustment of the series potentiometer. If the two signals have the same amplitude and a relative phase of 90° exactly, a perfect circle will appear on the screen.

The test set shown in Fig. 1 can overcome these problems. It consists of two identical BIFET operational amplifiers having a gain of -10 (IC1a and IC1b), one of which is followed by a phase inverter (IC1c).

While the IC1a output feeds the scope's Y input directly, its X input through the voltage follower IC1d, is periodically switched from the output port of IC1b to that of IC1c. Therefore, the analog switch, IC2, inverts any eventual phase error (from the exact quadrature) at the rate of the astable IC3. It follows that, on the screen, the circle distorts itself at this rate in opposite directions. If the two signals are instead at 90° exactly -- not only in this case -- the figure remains perfectly steady.

The schematic diagram of the test set is reported in Fig. 2. The two Zener diodes Zd1 and Zd2 share the supply voltage of IC2 (analog switch) and IC2 (astable multi) between +7.5 V and -7.5 V. For best linearity, this is done because the analog switch's input ports must be biased at Vcc/2.

The test set allows you to detect phase errors from quadrature to within minutes of a degree. It is useful and almost essential when a wideband AF quadrature network has to be examined. A network of this kind, made of a pair of active "tripletts," is shown in Fig. 3. It is characterized by a maximum phase error between 300 and 3000 Hz, theoretically $\pm$ Ø$^{\circ}$ 4.473' only, and an amplitude error (see footnote) of theoretically Ø dB. Applications include generation/detection of

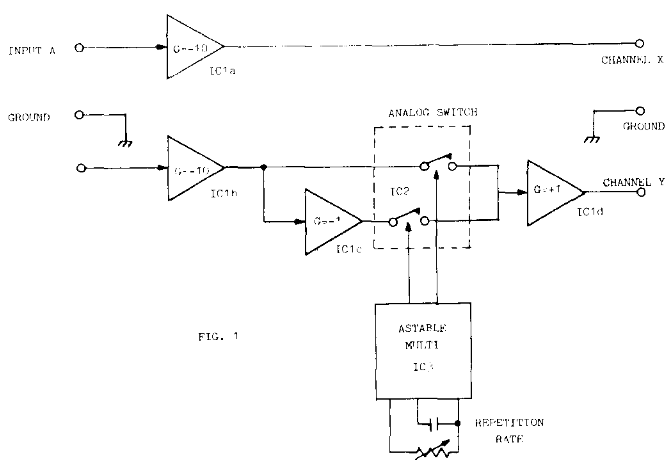
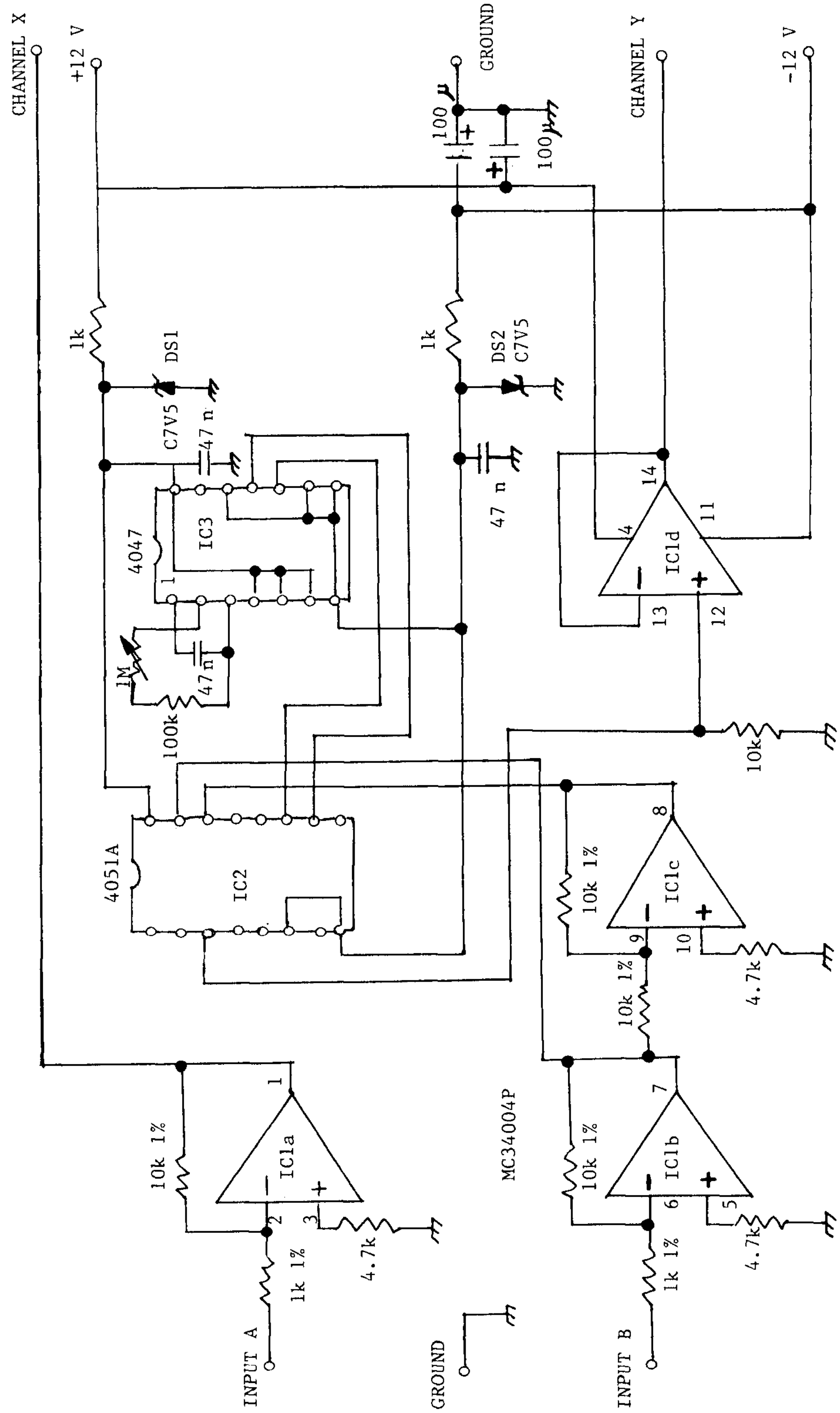


FIG. 1

*17, via Pio IX, 40017 S. Giovanni Persiceto (Bologna, Italy)



CHANNEL X
+12 V
GROUND
CHANNEL Y
-12 V
100 µ
100µ
1k
DS1
C7V5
47 n
DS2
C7V5
47 n
4047
IC3
1
1M
47 n
100k
4051A
IC2
14
4
11
IC1d
13
12
10k
8
IC1c
10k 1%
9
10
4.7k
10k 1%
1
IC1a
10k 1%
2
3
4.7k
1k 1%
MC34004P
7
IC1b
10k 1%
6
5
4.7k
1k 1%
INPUT A
GROUND
INPUT B

Fig. 2

SSB signals by the phasing method, synchronous demodulation, and scrambling processes.[4,5]

Unlike the M-derived networks, the proposed one can be aligned, step after step, by adjusting the trimmers of $R_{11}...R_{23}$ until the single stages of the two chains dephase 90^{o} exactly at their respective "quadrature frequenices,"[6,7,8] which are:

Test Points		$f(90^{o})$
A	B	675 Hz
B	C	94 Hz
C	D	2,821 Hz
A'	B'	1,334 Hz
B'	C'	9,587 Hz
C'	D'	319 Hz

The above test points have to be connected to the test set's input ports A and B (see Fig. 2), according to the reported sequence. Once this is done, an AF signal will be fed into the test set's audio input. It is of paramount importance to use a very low distortion generator because any signal distortion will impair the phase situation. A further word of caution: be sure, before taking any measurements, that the scope's internal phase delay is correctly compensated.

In order to obtain a zero amplitude error (see footnote), the gain of each stage of the two chains must be exactly one (i.e., $R_1 = R_2$). This condition can be checked by using a precision resistance bridge, otherwise, trim either R_1 and R_2 until $E_{out} = E_{in}$ in each stage. For this task, use a good ac DVM.

The overall dephasing, because of the three cascaded stages in both chains, is, in effect, the sum of three single and independent phase differences. Therefore, checking that of two consecutive stages at a particular frequency, a complete 180^{o} phase reversal will occur. At this frequency, two orthogonal perfect straight lines at 90^{o} to each other will appear on the screen of the scope. This situation will occur at the following frequencies:

Test Points		$f(180^{o})$
A	C	252 Hz
B	D	514 Hz
A'	C'	3,576 Hz
B'	D'	1,749 Hz

If the test set is connected between the input of the first stage and the output of the third of the single chains, the 180^{o} phase-reversal frequencies will be two, i.e.:

Test Points		$f(180^{o})$
A	D	223 Hz and 1,494 Hz
A'	D'	602 Hz and 4,034 Hz

Finally, the network's global phase response may be checked (test points D and D') between its frequency limits 300 and 3000 Hz. If the alignment has been correctly carried out, it will be in agreement with that reported in the diagram of Fig. 4.

The phase error, with respect to 90^{o}, will be zero at the following frequencies:

$$f_a = 314 \text{ Hz}$$
$$f_b = 435 \text{ Hz}$$
$$f_c = 720 \text{ Hz}$$
$$f_d = 1{,}249 \text{ Hz}$$
$$f_e = 2{,}067 \text{ Hz}$$
$$f_f = 2{,}865 \text{ Hz}$$

while it will reach its maximum value ($\emptyset^{o}$ 4,473') at:

$$f_1 = 300 \text{ Hz } (f_{min})$$
$$f_2 = 358 \text{ Hz}$$
$$f_3 = 553 \text{ Hz}$$
$$f_4 = 948 \text{ Hz } (f_o = \sqrt{f_{min}\, f_{max}})$$
$$f_5 = 1{,}627 \text{ Hz}$$
$$f_6 = 2{,}514 \text{ Hz}$$
$$f_7 = 3{,}000 \text{ Hz } (f_{max})$$

Footnote

In the SSB signal generation using the phasing method, opposite sideband attenuation[4] is given by:

$$A_{dB} = 20 \log (\tan \delta/2)$$

δ is the maximum phase error when the amplitude error is zero, and zero phase error:

$$A_{dB} = 20 \log (A - B)/(A + B)$$

A and B is the maximum and minimum, respectively, of the signal amplitude. $2(A - B)/(A + B)$ is the maximum amplitude error.

References

[1] Darlington, E., "Realization of a Constant Phase Difference," **Bell System Technical Journal,** Vol. 24, no. 1, p. 94.

[2] Terman, F. E., and Petit, J. M., **Electronic Measurments,** 2nd edition, p. 267, McGraw-Hill, 1952.

[3] Goodman, B., W1DX, "The Basic Phone-Exciter," **QST**, Jan. 1949, p. 11.

[4] Norgaard, D. E., W2KUJ, "The Phase-Shift Method of Single Sideband Signal Generation," **Proc. IRE**, Dec. 1956, p. 1730.

[5] Horn, G. W., I4MK, and Rapizzi, P., I1RPZ, "Synchronous Detection," **UIR Geneva**, Work Party A., Com.(T/A), 1971.

[6] Nibbe, G. H., W6BES, "Audio Phase-Shift Networks," **QST**, Jan. 1950, p. 42.

[7] Dickey, R. K., "Outputs of Op-amp Networks Have Fixed Phase Difference," **Electronics**, Aug. 21, 1975.

[8] Norgaard, D., W2KUJ, "Versatile Single Sideband Exciter," **CQ**, March 1949, p. 34.

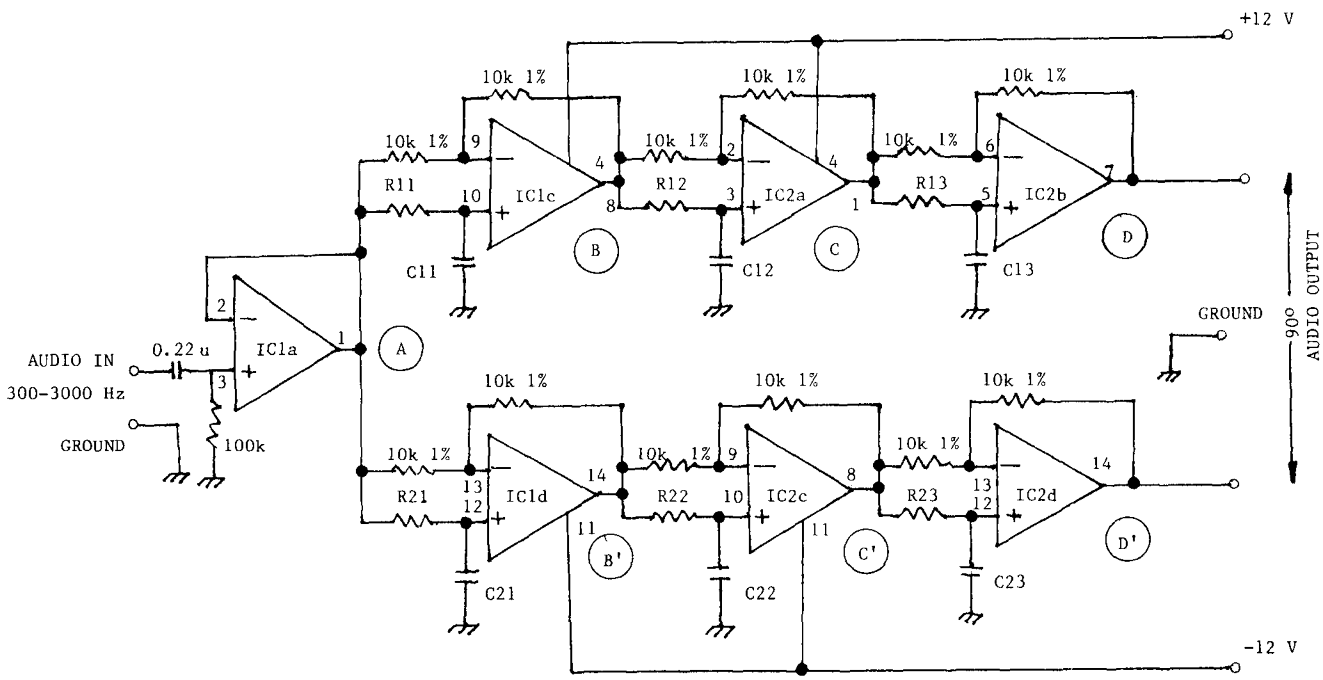


Fig. 3

C11-10nF polystyrene 0.625%	R11-23593Ω = 22kΩ + trim. 2.2kΩ
C12-100nF polystyrene 0.625%	R12-16954Ω = 15kΩ + trim. 2.2kΩ
C13-10nF polystyrene 0.625%	R13-5641 Ω = 5kΩ + trim. 1kΩ
C21-10nF polystyrene 0.625%	R21-11929Ω = 10kΩ + trim. 2.2kΩ
C22- 1nF polystyrene 0.625%	R22-16661Ω = 15kΩ + trim. 2.2kΩ
C23-10nF polystyrene 0.625%	R23-49891Ω = 47kΩ + trim. 4.7kΩ

IC1 MC34004P
IC2 MC34004P

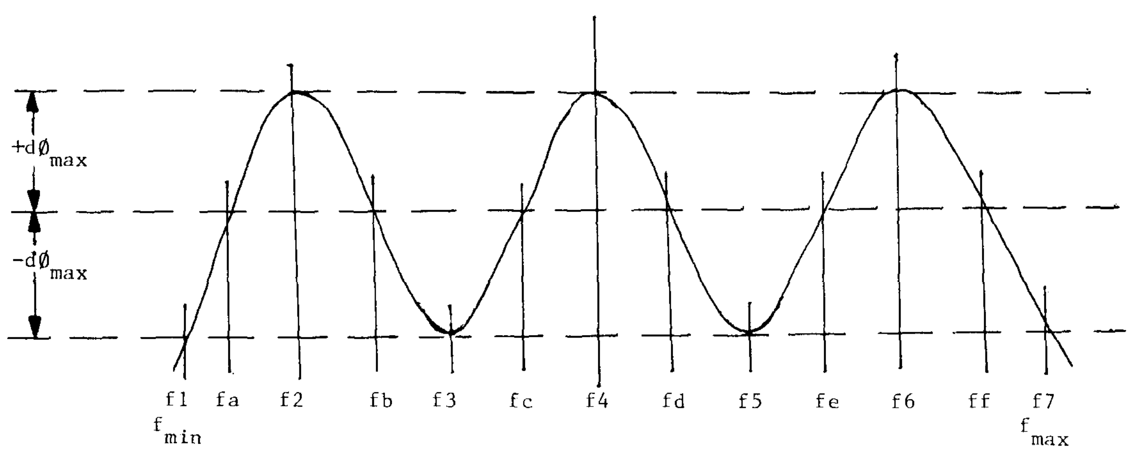


Fig. 4

Bits

IEEE International Conference on Communications 1985

It is that time of year once more when thousands of electronic engineers gather together to share their knowledge and concern of the industry they donate so much time to. This year the Palmer House located in Chicago, Illinois will host the IEEE Conference during June 23-26, 1985. The agenda features technical sessions held each day on topics in the communication areas of optical fiber systems, packet networks, satellites and digital applications. A complete schedule of the technical program appears below.

Because the Conference is being held during June, the committee members took into consideration that whole families will visit the area. To keep spouses and children entertained while tutorials and programs are in session, special tours and programs are available to places such as the Museum of Science and Industry, the home and studio of Frank Lloyd Wright in Oak Park, or a Let's Get Acquainted tour of Chicago itself. Children's entertainment includes a day at Six Flags Amusement Park or a Train Ride to Adventure.

For a complete brochure on the Conference, registration forms, hotel accommodations and transportation, write ICC '85, 445 Hoes Lane, Piscataway, NJ 08854.

Technical Program

IEEE INTERNATIONAL CONFERENCE ON COMMUNICATIONS 1985

COMMUNICATIONS-FACILITATING THE KNOWLEDGE REVOLUTION

MONDAY JUNE 24 8:00 AM - 8:50 AM	Plenary Session								
MONDAY JUNE 24 9:00 AM - 12 Noon	1 *** NETWORKING WITH OPTICAL FIBER SYSTEMS	2 IMAGE PROCESSING	3 MULTIPLE RANDOM ACCESS COMMUNICATIONS SYSTEMS	4 QUALITY MANAGEMENT FOR QUALITY IMPROVEMENT	5 *** ADVANCES IN PACKET SWITCHING	6 DIGITAL TRANSMISSION SYSTEMS OPERATIONS	7 DESIGN AND IMPLEMENTATION OF SUBSCRIBER LOOP CARRIER SYSTEMS	8 SATELLITE MULTIPLE ACCESS TECHNIQUES	TUTORIAL: POST DIVESTITURE SWITCHING STANDARDS
MONDAY JUNE 24 2:00 PM - 5:00 PM	9 *** ISDN DESIGN AND IMPLEMENTATION	10 THEORETICAL ASPECTS OF LOCAL AREA NETWORKS	11 *** PACKET NETWORKS PERFORMANCE	12 NETWORK QUALITY ASSURANCE	13*** IMPACT OF NEW TECHNOLOGIES ON OFFICE COMM. ARCHITECTURE	14 SIGNAL PROCESSING TO ENHANCE SPEECH ENCODING / TOPICS IN VIDEO COMMUNICATIONS	15 DIGITAL RADIO: PROGRESS IN HIGH LEVEL MODULATION	16 *** DIGITAL SATELLITE TRANSMISSIONS	
TUESDAY JUNE 25 9:00 AM - 12 Noon	17*** OPTICAL FIBER SUBSCRIBER LOOP SYSTEMS / PERFORMANCE ANALYSIS OF OPTICAL FIBER SYSTEMS	18 MODULATION, DETECTION AND SYNCHRONIZATION	19 USAGE OF OSI STANDARDS	20 SWITCHING SYSTEM DESIGN AND RELIABILITY	21*** ADVANCES IN DATA COMMUNICATIONS	22 DIGITAL NETWORK OPERATIONS	23 *** POINT TO MULTIPOINT RADIO SYSTEMS	24 *** SATELLITE-BASED MOBILE SYSTEMS:PROSPECTS AND BENEFITS	TUTORIAL: LOCAL AREA NETWORKS
TUESDAY JUNE 25 12:15 PM-1:45 PM	Communications Users Panel Luncheon								
TUESDAY JUNE 25 2:00 PM - 5:00 PM	25 THE IMPACT OF DIVESTITURE ON TELECOMMUNICATIONS SOFTWARE	26 SPREAD SPECTRUM	27 *** DISTRIBUTED COMMUNICATION SYSTEMS	28 QUALITY MANAGEMENT FOR DESIGN IMPROVEMENT	29 *** PACKET SWITCHING FOR DIGITAL SPEECH SIGNALS	30 *** PANEL:INTEGRATED ACCESS--CHIPS, TECHNIQUES AND STANDARDS	31 ADVANCES IN DIGITAL MODULATION TECHNIQUES AND RADIO SYSTEMS	32 SYNCHRONIZATION IN SATELLITE COMMUNICATIONS SYSTEMS	TUTORIAL: LOCAL AREA NETWORKS
WEDNESDAY JUNE 26 9:00 AM - 12 Noon	33 *** UNDERSEA OPTICAL FIBER SYSTEMS AND CABLES	34 *** CCITT RECOMMENDATIONS ON ISDN	35 THEORETICAL ASPECTS OF MULTIPLE USER NETWORKS	36 DIGITAL NETWORK EVOLUTION AND SERVICES / SELECTED TOPICS IN COMPUTER COMMUNICATIONS	37 PROCESSING AND VLSI TECHNOLOGIES FOR LINE TRANSMISSION SYSTEMS	38 VOICEBAND ENCODING FOR TRANSMISSION	39 DIGITAL RADIO—COUNTERMEASURES FOR ENHANCED PERFORMANCE	40 *** SATELLITE AND MILLIMETER WAVE COMM. SYSTEMS	
WEDNESDAY JUNE 26 2:00 PM - 5:00 PM	41 LAND MOBILE RADIO / ADVANCES IN SINGLE FREQUENCY LASERS AND THEIR APPLICATIONS	42 NEW DIRECTIONS IN SWITCHING OPERATIONS	43 FUNDAMENTAL ISSUES IN COMPUTER COMMUNICATIONS	44 DIGITAL FACSIMILE TECHNOLOGIES AND SERVICES / ADVANCES IN COMMUNICATION TERMINALS	45 *** ISDN SUBSCRIBER ACCESS / SPEECH PROCESSING WITH VECTOR QUANTIZATION TECHNIQUES	46 TECHNOLOGICAL ADVANCES FOR ECHO CANCELLERS	47 PROPAGATION ON LINE-OF-SIGHT PATHS AND ITS EFFECT ON THE PERFORMANCE OF HIGH CAPACITY DIGITAL RADIO	48 COMPUTER MODELLING AND SIMULATION OF COMMUNICATION SYSTEMS	

Mini-themes:
- [shaded] Communications in the Post Divestiture Era
- *** Alternative Networks: Technology, Architecture and Services

QEX: The ARRL Experimenter's Exchange is published by the

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The purposes of QEX are to:

1) provide a medium for the exchange of ideas and information between Amateur Radio experimenters,

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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Both theoretical and practical technical articles are welcomed. Manuscripts should be typed and double spaced. Please use the standard ARRL abbreviations found in the January 1984 edition of QST. Authors should supply their own artwork using black ink on white paper. When essential to the article, photographs may be included. Photos should be glossy, black-and-white positive prints of good definition and contrast, and should be the same size or larger than the size it will be when printed in QEX.

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