accomplished with maps and other references, but trying to find an unfamiliar location this way takes lots of time away from microwave operation. A big help with map use is to draw out compass directions to popular spots, giving forward and reverse compass bearings. Plan ahead! Know where the other fellow is going to operate from and determine the compass heading in advance. If you have big bucks, obtain a GPS receiver—it will give your location and tell you if you are in the end zone or eating popcorn in the first row. The cost of these devices range from $500 up, mostly *up*. An alternative to this system is LORAN. It's still a toy for me in this application, but an inexpensive toy.

LORAN Location System

Loran was in operation before GPS, and it can give very usable location data. It is not as accurate as GPS but it can tell position with accuracy to about a third of a mile. Its accuracy depends on how well it can receive its location transmitters and it can give results to about to about 2,000 feet or so. In actual practice, Kerry and I have observed the readout accuracy to be about 0.34 mile.

Why use Loran when GPS is available and provides much more accuracy? Price. We located a receiver in surplus and gave it a try. We became so excited by the results that we picked up the whole batch of receivers before they could be lost forever (see Photo A).

Putting the receiver into operation was not difficult. All that is required to put the board into operation is an IBM or compatible PC running BASIC, and a single com port (RS-232). A simple one-chip interface device (Maxim 232 chip) is needed to interface the Loran PC board and the RS-232 port on the computer. See Figure 2, a computer interface adaptor schematic using this Maxim chip.

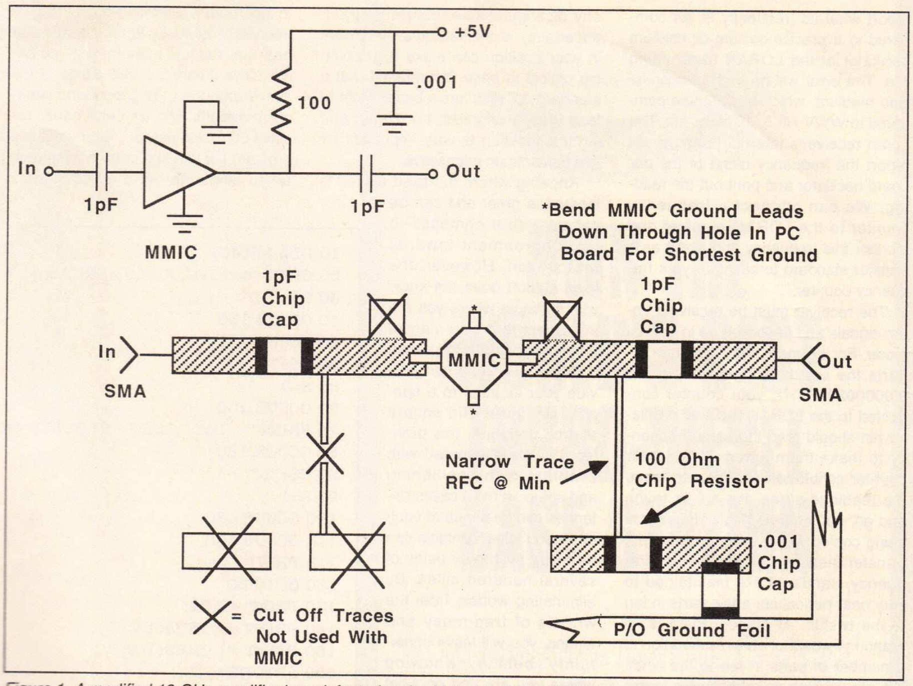

Figure 1. A modified 10 GHz amplifier board, featuring the Motorola MGA-86576 microwave MMIC. Gate bias circuit for FET is not required using MMIC. Circuit produced 20 dB gain at 1 GHz, and 13 dB gain at 10 GHz. Approximate noise figure was 3 dB.

As you can see from Figure 2, only the Maxim chip and a few capacitors and voltage regulators are required. Minimum connections are necessary to your RS-232 port as only the serial receive and transmit lines are required, making this adaptor easy to duplicate. When your adaptor is constructed, a simple checkout is all that is needed. I blew my adaptor up by not being careful—I had reversed the +5 and +15 volt lines. Don't you make the same error—check your work over before applying power. You can check three times, but you can only apply power wrong *once*! Repairing my wiring error and replacing the chip solved the circuit problem.

Check it out with a voltmeter. You should have about +10 volts on pin 2, and -10 volts on pin 6 of the Max-232 chip. Current draw is 250 mA at 5 volts and 100 mA at 15 volts. You will need to heat-sink the 5 volt regulator to keep it cool at this current. See Figure 2 for interface pinouts on the LORAN PC board. Only a few pins are actually used. Pin 1 is +15 volts, pin 2 is +5 volts, pins 3 and 5 are grounded. Pins 10 and 12 are the communication ports on the LORAN PC board, with pin 10 a receive command line and pin 12 the transmit line. The schematic diagram also includes a pinout for those computers that use a 9-pin connector for the RS-232 port, like my Tandy 1400 LT.

The computer used was running DOS 3.3 and GWBASIC. The BASIC program sends a data message to the PC board via the RS-232 port instructing the Loran receiver to do a task. The command is: Send the capital letter "A" "carriage return" "line feed" and the receiver will respond with data on position in respect to latitude/longitude, and a certainty factor in decimal on what accuracy or error distance the program calculation has determined to be the maximum error. Kerry put this format into a BASIC program; the listing for this program is shown in Figure 3.

The additional steps at the end of the program are part of a routine to read the Loran receiver oscillator and

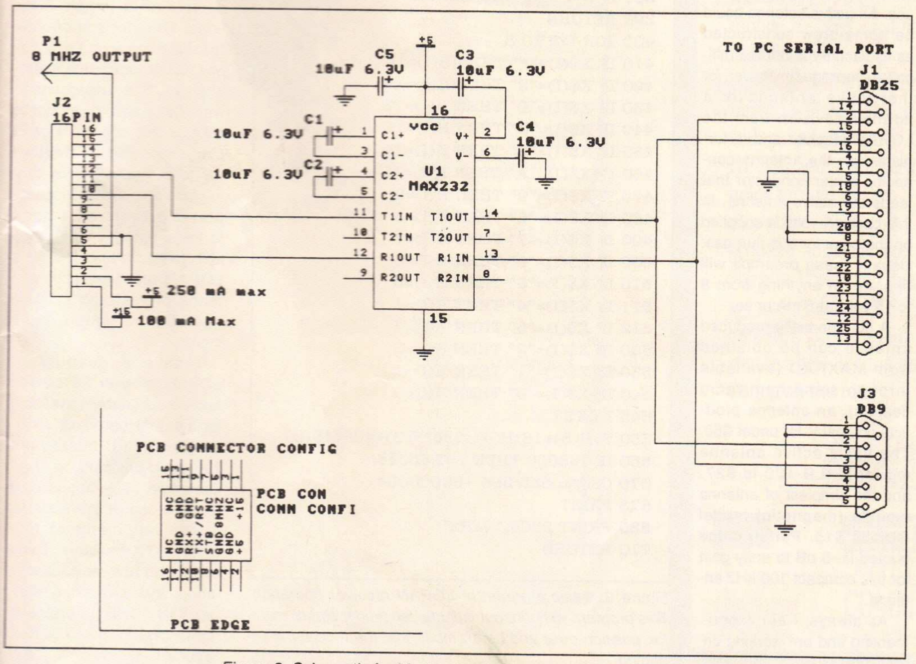

Figure 2. Schematic for Maxim-232 RS-232 PC-LORAN adaptor.

report what its frequency is, as compared to a precise cesium or ribidium oscillator at the LORAN transmitting site. The error will be in the transmission medium, which is minimum compared to WWV HF 5, 10 MHz, etc. The Loran receiver's internal program will report the frequency offset of the onboard oscillator and print out the reading. We can connect a frequency counter to the LORAN receiver and monitor this frequency and use it as a transfer standard to calibrate your frequency counter.

The receiver must be receiving Loran signals and be locked up in normal mode. For example, if the program reports the oscillator frequency to be 8.00000234 MHz, your counter connected to the LORAN receiver oscillator pin should read the same frequency to make them agree. Adjust your counter calibration oscillator to make the readings agree. It's a little touch and go, but when LORAN signals are being copied well it gives an excellent transfer standard. Loran master frequency standards are maintained to very near perfection, a few parts in ten to the twelfth. At present there is no reason you cannot obtain calibration to a number of parts in ten to the ninth. We are working on refinements to this step to obtain better frequency transfer results and will report on future findings as they happen.

Let's get back to horizontal dish position and where you are in respect to your horizontal horizon. The LORAN receiver receives a complex signal from a string of stations on 100 kHz and uses the timing and coding pulses to enable the receiver to determine where it is located. This data is part of the serial data that is displayed on the PC computer as the latitude/longitude information for your location. This data could be inserted into one of several grid square programs to allow you to calculate just where you are situated and display the latitude/longitude information as a six-figure grid square location, like DM12LT. The grid square program would have to be modified to accept the data directly from the LORAN receiver. This has not been done at present, but it is a future project. For the time being, operation will have to be manual. Perhaps someone reading this column will incorporate this feature and report back.

The information from the LORAN receiver can be of great benefit to a rover who is working fast-paced contacts to a series of fixed microwave stations operating in contests similar to the ARRL 10 GHz contest. After a set of contacts is made, the rover packs up and moves on to another location 10 miles farther down the road. All equipment and antennas are mobile-mounted, making setup fast. The benefit LORAN would present is determining, with good accuracy, when you are positioned in the area you think you are. For most locations this data can be confirmed by simple map interpolations compared to your surroundings. But when the distance between any distinguishable feature is great, uncertainly is the real answer. Errors in your position can make dish pointing critical at best. Considering that a standard 30" dish has a beam width of less than 3 degrees, horizontal and vertical location is very important for fast contacts on microwave.

Knowing where the fixed station is located is great and can be set up with a compass to good agreement towards that station. However, the fixed station does not know with certainty where you are in respect to a very narrow dish's beam width (less than 3 degrees). If you can provide your location to a specific six-figure grid square and be accurate, this problem can be eliminated with accurate dish positioning and setup. In most cases antennas can be aimed at each other and initial contacts can be made even over paths of several hundred miles. By eliminating wobble from the wheels of frequency and aiming, you will leave uncertainty behind. Knowing where you are and on what frequency provides nearly armchair-quality performance. It's almost like shooting fish in a barrel.

One question remains, I suppose, and that is: How do you take a 100 kHz antenna into the field and make it portable? Well, these systems are made to operate on very short active antennas that have a high-gain preamplifier connected to a short receive antenna for mobile use. An active antenna could be home-brew constructed as its circuitry is not too difficult to reproduce. Power for the active antenna is a normal provision from the LORAN receiver and is furnished on the antenna connector center conductor that feeds the active antenna. In this case 15 volts is supplied up the coax for this purpose. Usually these preamps will operate on anything from 8 to 15 volts at 5 mA or so.

A commercially-produced antenna can be obtained from MAXRAD (available through some ham radio dealers), an antenna products company, for under $50. The basic active antenna model MXLB-100 is $27, and the simplest of antenna mounts (magnetic) model GBN is $15. Performance quoted is -5 dB to unity gain for this compact 100 kHz antenna.

As always, I am experimenting and am working on an active antenna and want to incorporate a ferrite element to give frequency immunity to out-of-band signals that seem to interfere with the basic active antenna circuit. Some of the active antennas are broadband wide-open circuits and as such could receive 60 cycles as well. To prevent this problem I would like to try a simple filter to eliminate out-of-band signals having the antenna resonate at about 100 kHz. A similar problem happened while trying to receive WWVB on 60 kHz. I used a longwire antenna and had so much interference it was not copyable. Placing a filter at 60 kHz in the antenna lead made a marked improvement in performance. I plan to attempt the same thing with the Loran antenna in addition to gain in the circuit. This is still speculative, but some further experimentation will prove or disprove the worth of this plan.

```
10 DIM X$(40)
20 OPEN "com1:1200,N,8,1,RS"AS #1
30 C$="OD"
40 GOSUB 130
50 GOSUB 180
60 C$="A"
65 S=0
70 GOSUB 130
75 PRINT"   LAT   LONG   ST POSER MODE"
80 GOSUB 180
90 C$="B"
95 S=1
100 GOSUB 130
110 GOSUB 180
115 PRINT
120 GOTO 60
130 PRINT #1,C$;
140 PRINT #1,CHR$(13);
150 PRINT #1,CHR$(10);
160 RETURN
170 GOSUB 180
180 D=0
190 X$(D)=INPUT$(1,#1)
195 IF S=1 THEN 210
200 PRINT X$(D);
210 FOR I=1 TO 100
220 NEXT I
230 V= EOF(1)
240 IF V=-1 THEN 280
250 D=D+1
260 GOTO 190
270 END
280 PRINT
281 IF S=1 THEN GOSUB 400
290 RETURN
400 FOR I=2 TO 5
410 IF X$(I)="F" THEN H(I)=15
420 IF X$(I)="E" THEN H(I)=14
430 IF X$(I)="D" THEN H(I)=13
440 IF X$(I)="C" THEN H(I)=12
450 IF X$(I)="B" THEN H(I)=11
460 IF X$(I)="A" THEN H(I)=10
470 IF X$(I)="9" THEN H(I)=9
480 IF X$(I)="8" THEN H(I)=8
490 IF X$(I)="7" THEN H(I)=7
500 IF X$(I)="6" THEN H(I)=6
510 IF X$(I)="5" THEN H(I)=5
511 IF X$(I)="4" THEN H(I)=4
512 IF X$(I)="3" THEN H(I)=3
520 IF X$(I)="2" THEN H(I)=2
530 IF X$(I)="1" THEN H(I)=1
540 IF X$(I)="0" THEN H(I)=0
545 NEXT I
550 T=H(5)+16*H(4)+256*H(3)+4096*H(2)
560 IF T>8000 THEN T=T-65536!
570 OSC#= 8*T/256 +8000000#
575 PRINT
580 PRINT OSC#;" MHz"
710 RETURN
```

Figure 3. Basic program of LORAN receiver operation. This program will print out latitude, longitude, status monitor, position error and Loran mode that the receiver is reporting.

Both Kerry and I have noticed severe interference to the LORAN receiver in tests where the unpackaged receiver was placed on top of or near the computer terminal that was running the BASIC program. Moving the unshielded PC board away from the computer some two feet seemed to cure the problem of the receiver not receiving the LORAN signals. The computer was radiating energy, blocking the receiver. The receiver was connected for these tests on the workbench without benefit of a shielded box or feed-through capacitors for the DC or computer port connections. This, like anything else, is not a finished product, but it is a starting point, and it provides the fun of picking through surplus material for toys to play with. (See Photo B.)

Well that's it for this month. I hope that the information provided here will assist you with microwave operations in remote locations. Whether you choose to use Loran or GPS for position accuracy is a matter of choice. We have operated without benefit of systems such as this and had a good time. However, it's another toy to put into the toy box for fun, and it offers operation improvement. I hope to have enough time to be able to report further on the LORAN receiver active antenna project and LORAN operation in general next month.

I have a quantity of LORAN receiver PC boards and will make them available for amateur purposes. Tested LORAN PC boards are $25 each postpaid, to U.S./Canadian destinations only (contact me at the address at the beginning of this column). As always, I will be glad to answer questions about this and other related VHF, UHF, microwave subjects. 73 WB6IGP Chuck. 73