Experimental Broadcaster's Newsletter

Volume 5, Number 5
May 1988

Here we are in the merry month of May. SPRING!...Ain't life grand...except perhaps for our friends in frozen Bridgeport, CT and other places where it SNOWED, rained or was otherwise inconvenient.

Speaking of inconvenient - there was a time when remote transmitter sites had to be checked on a regular basis. I remember this one site in Southern California. It was on a small mountain, at the top of course with an elevation of 2000 feet or so. The road was dirt and rock and had numerous switch-backs. Boulders often appeared which were as big as a small bull elephant, usually near the center of the road. There were no facilities at the site. No water, no phone, just electricity and the transmitter shack.

In summer months you had to kick the Rattle snakes away from the door so you could get in to see the transmitter. In winter months it was something else. Rain washed ruts bounced your 4-wheel vehicle like a jack-in-the-box. Low spots flooded so you were up to your axel in wet. Those bull elephant boulders would suddenly jump out of the mist. Lightening storms were so brilliant you could drive with your lights off!

Its late on a Monday afternoon in January. The sky is dark with heavy clouds. It's going to let loose any minute. The transmitter has not yet been checked this day however. Not to let rain nor sleet nor fleet of night interefere with his appointed rounds the CE buttons up his overcoat, climbs into the ol' 4-wheel and proceeds up the mountain.

The lightening flashes. The rain comes down in buckets. The transmitter checks out and the CE heads for home..... oooops, the truck won't start. No juice. Battery is cracked and leaked acid all over the place. It's 6 miles down slip and slide to warmth and help. Not to *Panic!* however.

CE's are known for their ability to make due with bits of wire, chewing gum and spit. It's back into the transmitter shack. Open the audio rack door. Remove the line amplifier lid to expose the circuits. Then, by carefully touching the high-gain audio stages to produce hum he taps-out a meaningless Morse code message. The studio people figured out something was wrong and dispatched help within minutes.

But SPRING! All the rest was worth the while just to see the wild flowers bloom.

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Mini-Lesson (Power Dividers)

Fig #1

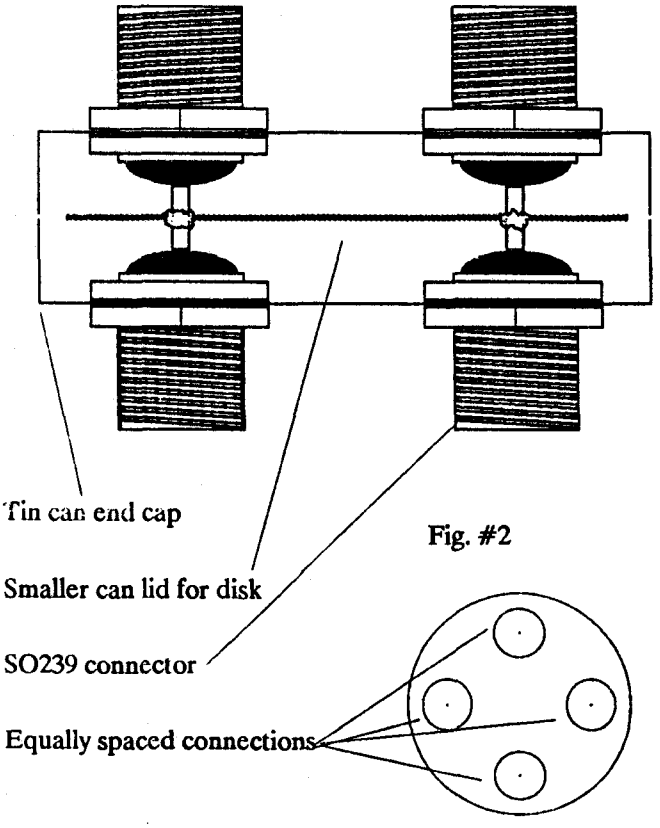


Fig. #2

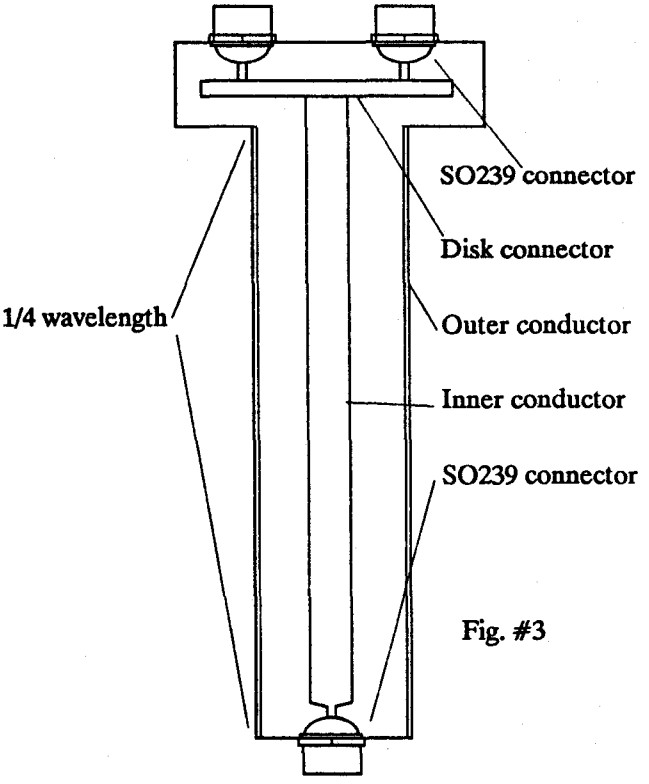


Fig. #3

Feeding more than one antenna at a time poses a problem in matching impedances. A single antenna may represent an impedance of 50 Ohms by itself. Connecting two of them however places them in parallel and the total impedance is halved to 25 Ohms. Three would total about 16 Ohms, four would total 12.5 Ohms, etc.

If you were to connect a 50 Ohm coax to two antennae in parallel, even if they are perfectly tuned, would give you an SWR (standing wave ratio) of 50/25 = 2 to 1. Three antennae would give an SWR of 50/16 = 3:1, and four would give an SWR of 50/12.5 = 4:1. Normally any value less than 1.5:1 is acceptable so obviously we must find some way to match impedances if 2 or more antennae are used together.

As it turns out a 1/4 wavelength of transmission line (coax) can act as a matching "transformer". This 1/4 wavelength of line however must be of the right impedance itself.

The 1/4 wavelength "transformer" impedance is the square-root of the product of feed impedance times the line impedance. For example:

Four 50 Ohm antennas are connected in parallel making a 12.5 Ohm feed impedance. We decide to use a 50 Ohm transmission line (coax). The impedance of the 1/4 wave transformer would be....

$50 \times 12.5 = 625, \quad \sqrt{625} = 25$ Ohms

It also turns out that two pieces of 50 Ohm coax connected in parallel will appear as one 25 Ohm coax. If those two pieces are made 1/4 wavelength long and are connected in parallel they can be used to match a 12.5 Ohm feed impedance to a 50 Ohm line.

Continued on Page 8

More on FME Upgrades

Recently built the FME500 Exciter. A good kit but we have some comments.

1. C31 has been specified as 2 uF or so to improve lows. This gives a sharp peak in audio response at 20Hz or so (greater than 10 dB). For flattest response (20 Hz on up) we used 22 uF with 470 Ohms in series to R24/R25 junction.

2. Stereo input (no pre-emphasis) cuts very sharpley at 20 kHz and above. Removing C1 makes response flat to 100 kHz +/- 0.2 dB. We used a switch to put C1 in as needed for mono.

3. R22 25kHz filter is marked as 1 Ohm. Should be 10 Ohms.

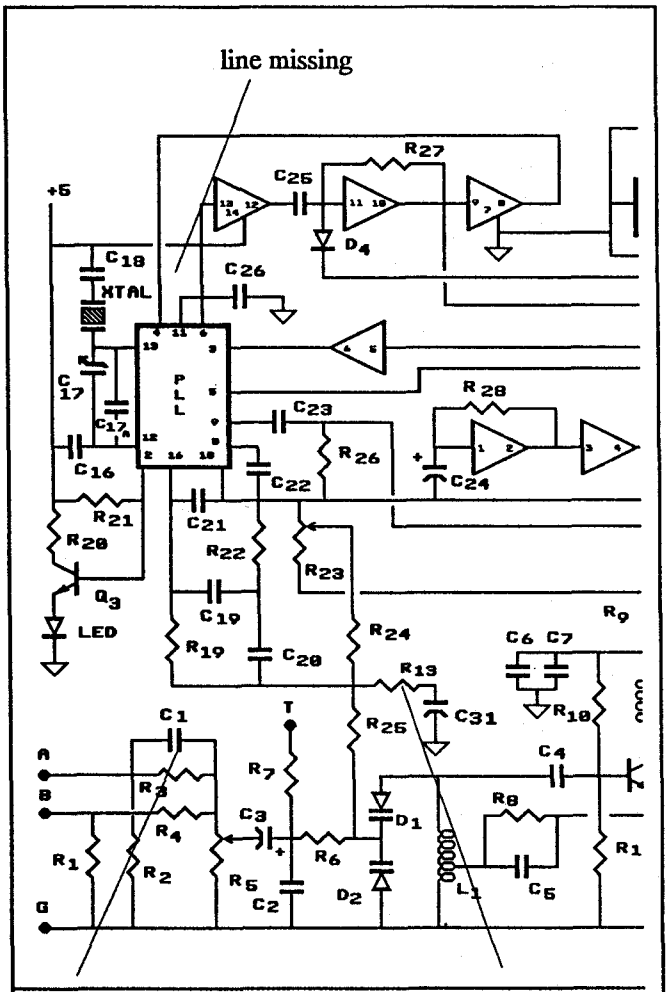
4. Microphonic osc was quited by RTV'ing {cementing} osc coil to the board.

5.. Hum on carrier was greatly reduced by using a 7812 regulator for 12V. Even good power supplies had too much hum.

6. Our audio response is now flat 20 Hz to 100 kHz +/- .2 dB and it sounds great. Audio response was checked using HP 8902 modulation analyzer.

Congrats on a good design.

R. M. Florida



C1: remove if not using mono. Add R13 = 470, C31 = 22uF

Thanks for the input R. M. Note that R13 has been added to FME schematic. For others that wish to update their schematic - extend a vertical line from pin 11 of the PLL straight up to the horizontal line (+5 volts). It was left out of the schematic somehow. Ed.

News Tidbits

The FCC is now making available lists of the most common-rule violations for which they impose fines. FO-17 for Cable Systems and FO-18 for Broadcast Servciescna be had by calling (202) 632-5050

When is a booster not a booster? The general thought I thought was that a booster was a low power device used to extend coverage of an FM station into a "shadow" area that would normally be within its coverage area. Not so apparently as the FCC has permitted WBZN, 50 kW, Jazz, in Milwaukee to install a 2k booster to increase signal 25 miles north of Racine.

Letters

The broadcast industry is spread far-afield, contains many interesting areas, many of which we can only keep in touch with through trade-related materials. Fortunately we have interested individuals which can supply EBN subscribers with their first-hand experiences. We gratefully acknowledge Bill McFadden's conribution to this issue.

The 1988 National Association of Broadcasters Convention

Bill McFadden

Introduction

This report is a brief summary of some of the more interesting aspects of my visit to the 1988 NAB convention. First, a little background. I am an electrical engineer for Tektronix working in TV Measurement systems. Every year TV Division introduces new products at the NAB show, and most of the engineering staff attends. This is my third NAB, and since most readers of EBN probably never get a chance to attend, I thought you would enjoy hearing about the show.

This year's NAB show was held in the Las Vegas Convention Center from April 8 to April 12. The attendance was over 46,000, the greatest for any NAB show to date. There were 680 exhibitors displaying equipment for TV, radio, and audio, occupying 380,000 square feet of floor space, up 21% from last year.

President Reagan spoke Sunday, but I did not make it to the show until Monday. His address was videotaped using high definition television equipment and was shown repeatedly during the rest of the show. He made some pretty funny wisecracks during his speech, in which he reiterated his opposition to the fairness doctrine and spoke a little about foreign policy. He finished up by asking support for a new law he wants to pass limiting the number of commercials that could be shown during reruns of his old movies!

Television Exhibits

The television equipment was spectacular, as usual. Sony and Ampex were the two largest exhibitors and showed their array of cameras, videotape recorders (analog and digital), editing equipment, monitors, and so on. Other companies showed video graphics equipment, signal generators, test equipment, satellite equipment, transmitters, lighting equipment, video processors, accessories, etc.

Several companies had what I like to call the "wall of TVs" to draw attendees' attention. Sony's was the biggest, including an array of 32 TV screens 15 feet high and 30 feet wide. Below them were an equal number of VTRs all synchronized to one another and playing different material. The result was a giant synchronized display touting the virtues of Sony's equipment line.

One company showed a 110 inch rear-projection television. I sure wouldn't want to try getting that one in my living room! The biggest screen at the show, however, was a direct-view model (believe it or not). It was so large it had to be shown outdoors. I'd say it was about 30 feet high and 40 feet wide and was easily visible in direct sunlight at a distance of hundreds of feet. Each pixel was several square inches in size!

Perhaps the most impressive, according to image quality, was the high definition equipment. This equipment offers a wide screen picture (like movies) and twice the resolution of regular TV. Let me tell you, this stuff looks better than 35mm motion picture film.

Although we are close to a production standard, we still have a long way to go before HDTV is broadcast to the home. To broadcast HDTV as it exists in the studio would take more than six regular TV channels, spectrum we just don't have.

No less than 13 different (and incompatible) systems have been proposed to allow HDTV to be broadcast into the home. At least three of these manage to squeeze the entire HDTV signal into a single 6 MHz TV channel. This doesn't come for free, however; you have to make sacrifices to achieve this amount of compression. Usually these sacrifices amount to reduced resolution and blurred motion. Studies have shown that the eye is less sensitive to detail in moving objects than in stationary ones. So, most compression schemes reduce the frame rate of the fine detail to reduce the bandwidth required.

All the compression schemes fall into three categories: those that use one channel, those that use one and a half channels, and those that use two channels. In addition, they fall into two other categories: compatible and non-compatible. Compatible means that viewers don't need to buy a new TV set to watch HDTV broadcasts; they continue to receive the lower quality picture they get today. They only need to replace their set when they want to upgrade to a better picture. (This is similar to the way a black and white TV can receive color broadcasts and display them in black and white.) About half the proposed systems are compatible, and it is my opinion that the FCC will require whatever system it finally approves to be compatible.

One of the more impressive systems shown was a single channel system developed by NBC. I had the opportunity to see a special demonstration of this system in a nearby hotel. This picture had about 410 lines of vertical resolution and 480 lines of horizontal resolution. (Normal television is about 330 lines in each direction). The picture had a wide (16:9) aspect ratio like motion pictures and none of the artifacts we associate with TV (e.g., flicker, cross-color, and cross-luminance, aka. the "Johnny Carson effect"). There was some blurring of motion however, but the difference between ACTV I (as they called it) and regular TV (NTSC) was outstanding.

Next, they showed an improved two channel system called ACTV II. This system is compatible with both NTSC and ACTV I, meaning a TV station could upgrade to ACTV I and later ACTV II without leaving its viewers out in the cold. ACTV II fixes the problems with ACTV I, namely motion rendition and resolution. The motion was crystal clear and the resolution had increased to 650 lines lines of vertical resolution and 750 lines of horizontal resolution. This is pretty close to the studio production standard. In addition, there is room in the second channel to add digital audio and data transmission.

Because there are so many proposals for broadcast HDTV, the Advanced Television Systems Committee (ATSC) was formed to study and compare the systems. Their conclusions will help the FCC decide which system wins. This will take some time, though, so don't expect advanced television (ATV) in the home for another five years or so.

Radio Exhibits

Less spectacular, but still impressive, was the radio equipment shown. Among the equipment shown were transmitters, exciters, microwave STLs, audio processors, automation controllers, on-air mixing consoles, accessories, etc.

The latest development on FM broadcasting, although not new, is the FMX system. This system promises to make stereo broadcasts nearly as quiet as mono, which will extend a station's stereo coverage area dramatically. In addition, the system reduces the effects of multipath distortion. This is especially important for car radios, where multipath causes the familiar "picket fencing" phenomenon.

I was able to take part in an on-road demonstration of the system, which did indeed reduce multipath. (FMX exciters had been installed in a couple of Las Vegas stations last December.) The multipath was still there, but switching to mono did not reduce it any further. Hence, I concluded that FMX made stereo reception quality almost as good as mono in all circumstances.

What is needed to implement FMX? First, a radio station needs to replace its FM exciter with an FMX exciter or install an FMX module in its present exciter (some exciters have this provision). Next, the

Making an Effective Experimental Broadcaster's Newsletter

We were blessed this month with a report of the NAB convention and with two studio pictures. It is greatly appreciated. We still need more input from our readers however. Tell us what's happening at your recording studio, cable station, C-C station, commercial station, or pirate activity - share with others! If there is something in the way of a mini-lesson you would like to see, let us know. Trying to come up with something meaningful each month is a royal pain - your editor needs help!

Be sure to check your address label and renew your subscription before it expires. If you do miss a few isues just let us know and we can start your renewal with the last issue you missed. Renewals are $18.00/year. New Subscriptions are $20.00/year.

1988 NAB Convention, McFadden, Continued

listener needs to buy an FMX radio, of course. (FMX is compatible, so he can still receive regular FM stereo until he wants to upgrade.)

There were four or five FMX car radios and an equal number of FMX home tuners shown. All but one of these were prototypes, but it does show some level of commitment by manufacturers. In addition, a single-chip FMX decoder had been developed which will be made by Sanyo and Sprague. Total parts cost to the manufacturer to add FMX decoding to a receiver should be a dollar or two, I'm told.

AM radio was also alive and well at the show (if not elsewhere). Harris showed its DX-25 all solid-state 25 KW digital AM transmitter. This transmitter uses 10-bit quantization at a sampling rate equal to the carrier frequency. The digital-to-analog converter (DAC) is made from ten RF power sources, each having twice the output power of the previous one. The audio, which has been converted to digital, switches these RF amplifiers on and off, and hence AM modulates the RF output directly.

A recent development in the fight to save AM radio is a standard developed by the National Radio Systems Committee (NRSC). The NRSC standard has two parts. The first part is a standard 75 µS pre-emphasis of the audio, the same as is used for FM. The second part is a sharp 10 KHz low pass filter.

The goal of this standard is to improve audio quality while reducing interference between stations. This is especially important for nighttime reception, which has become a nightmare since the FCC deregulated nighttime power levels several years ago.

One reason AM radio sounds so lousy is because we are using lousy receivers. To prevent adjacent channel interference, manufacturers have reduced the bandwidth of their radios, resulting in a frequency response of 3 KHz or so. Radio stations, in response, have been boosting their high frequencies to sound better, causing splatter into adjacent channels. (This was shown on a newly developed AM splatter monitor.) So, the manufacturers reduce their radios' bandwidth even further to reduce the interference.

What we have here is a problem that is getting worse, not better. The NRSC standard works well and will allow manufacturers to return to making wide band radios if everybody implements it. That's the problem. As it stands, the standard is voluntary, and only about 20% of the AM stations have implemented it so far. Thus, the NRSC is pushing for the FCC to make the standard mandatory for all AM stations. The NRSC is awaiting a reply from the FCC.

Perhaps the biggest black spot on the AM industry has been stereo broadcasting. As most of you know, Kahn and Motorola are still battling it out while the industry sits back and waits for a clear winner. Meanwhile, manufacturers are losing interest in AM stereo because so few stations are broadcasting it. This has been a real chicken and egg problem, and if something isn't done soon, many feel AM stereo is doomed.

At the Motorola booth I saw a sign that claimed Motorola's C-QUAM system as the de facto standard. At the Kahn booth I saw a sign that claimed Kahn was going to file suit against Motorola. I was intrigued, so I had a chat with Leonard Kahn. He was more than happy to tell me about his plans.

Mr. Kahn told me that Motorola has a patent on multisystem receivers that are capable of receiving both Kahn and C-QUAM transmissions. Motorola recently sent a letter to Sony saying Sony would be infringing on Motorola's patent if Sony continues to make multisystem receivers without a license. Further, Motorola refused to license the technology to other companies, effectively stopping the manufacture of multisystem radios. This is in Motorola's best interest since the only single system radios on the market are for C-QUAM. Radio stations won't want to use Kahn's ISB system if nobody is making radios that can receive it.

Mr. Kahn then told me that Motorola's patent is fraudulent and he can prove it. He says he filed for a patent six months before Motorola filed its patent. He also says that his patent covered some of the same ideas as Motorola's. In addition, he says Motorola knew about his patent but filed its patent anyway. So, says Kahn, Motorola's patent is fraudulent. He asked the US patent office to investigate this and says the patent office feels there is enough evidence to look into it further.

When I mentioned that Motorola undoubtedly has a lot of money to back its case, Mr. Kahn smiled and said, just think how much I'll get in damages when I win! I'll have to hand it to him, the man's a real fighter.

Another question I had for Leonard Kahn had to do with his ongoing troubles with the industry publication, Radio World. Last month, Radio World printed a guest editorial by Mr. Kahn that, I think, projected Mr. Kahn in a less then favorable light.

When I asked Mr. Kahn about the editorial, he said he never wrote a guest editorial for the publication. He told me what he did was send Radio World a copy of a letter he had mailed to customers in which he accused the publication of bias. The next thing he knows, they've printed it as a guest editorial. "I never gave them permission to do that," Mr. Kahn said. "I just don't believe in calling someone a liar behind his back, so I sent them a carbon copy of my letter." He told me not to believe what I read in Radio World, I told him it's a fool who believes everything he reads.

I'm not saying I agree or disagree with Leonard Kahn; I just like to hear both sides of the issue. Anyway, as one well known radio journalist often says, now you know the rest of the story.

Audio Exhibits

Much new audio equipment was shown including mixers, effects processors, amplifiers, recorders, CD players, turntables, cart machines, microphones, accessories, etc.

Yamaha showed its new DMP7 digital mixing processor, an 8×2 console with digital EQ, three built-in digital effects processors providing 17 different effects each, and motorized faders that can be controlled manually, from memory, or from MIDI. Up to four DMP7s can be cascaded, allowing up to 32 input channels. In addition, the DMP7 is small and lightweight (7 lbs.). The price is around $4300, a tad expensive for the home studio. However, since this product is among the first of its kind, the price is likely to drop over the next several years. I spent about 20 minutes playing with the DMP7. I can't even begin to describe what it can do, but I can sum up my impressions in two words: very nice. If I only had the money....

There were at least a half dozen professional Digital Audio Tape (DAT) recorders shown, most of which allow recording at the 44.1 KHz sampling rate forbidden in consumer DAT recorders. Many of these DAT recorders allow editing using SMPTE time code, a standard developed to allow audio and video recorders to be synchronized to one another. As expected, the audio quality is excellent, at least as good as CDs, with up to two hours of recording time on a tape half the size of a cassette.

Tascam showed its new 238 Syncassette recorder that allows 8-track recording on a regular cassette using 3¾ IPS recording speed and dbx noise reduction. It has much the same versatility of an open-reel recorder at a fraction of the cost. Since the unit was new, a spec sheet was not available, but Tascam promised to send me one as soon as it is published. When I saw the 238, the first thing I did was eject the tape to see how they managed to squeeze eight tracks on a 1/8 inch record head. What I saw was two narrow heads with four tracks each, side by side and staggered, for a total of eight tracks. The erase head had all eight tracks in the same head, however. The price of the 238 is about $2400, which makes it really attractive to a home recording studio. I know I'm interested!

Several multidisc CD players were shown, but the record for the largest capacity goes to KIM with its CD-240 player that holds 240 discs. A pair of these players, under software control, can provide all the music programming for a radio station. The station's music director provides the play list, and the CD players automatically locate and cue each song, awaiting a start command from the DJ. Alternatively, the tracks can be selected by the DJ manually, or the whole system can be put on auto pilot for continuous unassisted programming. 24 hour experimental broadcasting anyone? Unfortunately, the price is a little out of the average EBN reader's range. But at $6500 each, these players are bound to find their way into all sorts of new uses. (Don't you want to be the first audiophile on your block to have one?)

Conclusion

There was so much to see at this year's NAB convention, I'm amazed I was able to see everything I wanted to see in the two days I was there. Every year I go, the show gets better and the new products more impressive. It would take dozens of pages to describe everything there was to see, but I hope this summary of some of the more interesting aspects of the show gives you a good idea of what is happening in the world of broadcasting.

Everyone liked this year's show so much, it is going to be in Las Vegas for the next five years, I'm told. And with so much to see, who has time to gamble?

Complaint Department

Dear EBN,

I thought I should bring to your attention that one of the advertisers listed in past issues of the EBN may be less than honest. I and a partner had dealings with that advertiser several years ago and are still bitter over the outcome and the loss of funds for services not rendered.

In my opinion that advertiser is a liar, a crook and a lazy incompetent who will likely cheat any of your readers he comes in contact with.

M.P.

Most publications inform their readers that their advertiser's integrity has not been ascertained prior to publication. While most advertisers are O.K. some others may be less than honest. In fact we have mentioned a few times that what appears in the EBN should not always be taken at face value. We of course have no control over whether or not an advertiser is honest . If we are reasonably sure however that an advertiser IS at fault we will certainly remove the ad.

A para-phrased version of the subscriber's letter appears to the left. Both the name of the advertiser and the nature of the transaction have been removed. Remember..always cover your rear in ANY business dealings.

Nice to Know Stuff

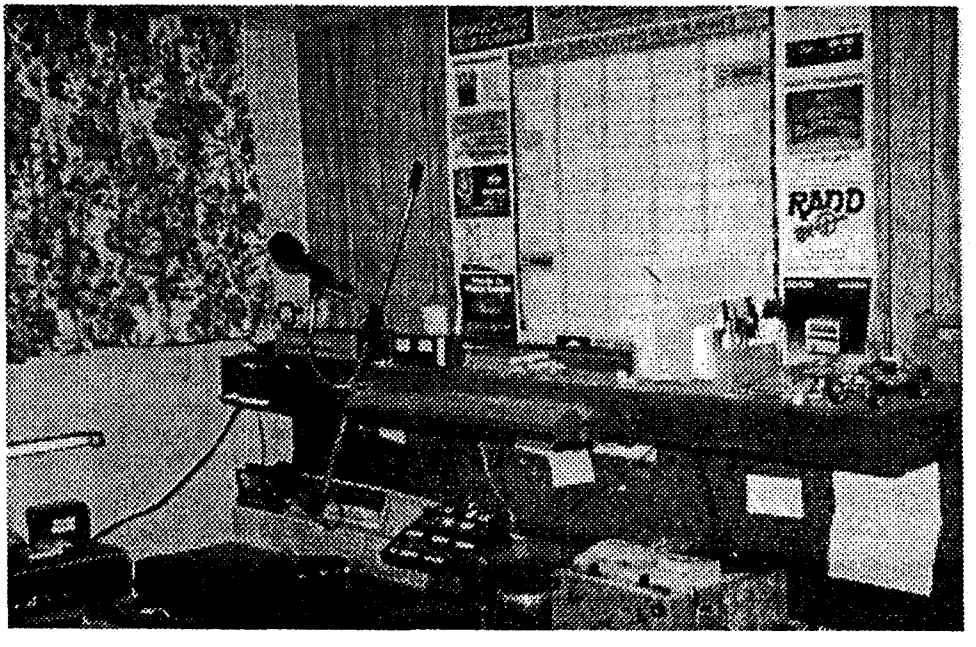
1/4 wavelength in coax is = 246V/f

Where f is the desired frequency, V is the velocity factor, answer is in feet

Letters, continued

This is a photo of D. B.'s studio that we couldn't fit in last month, but this is all the information we received.

How about telling us a little more about your setup D. B.?

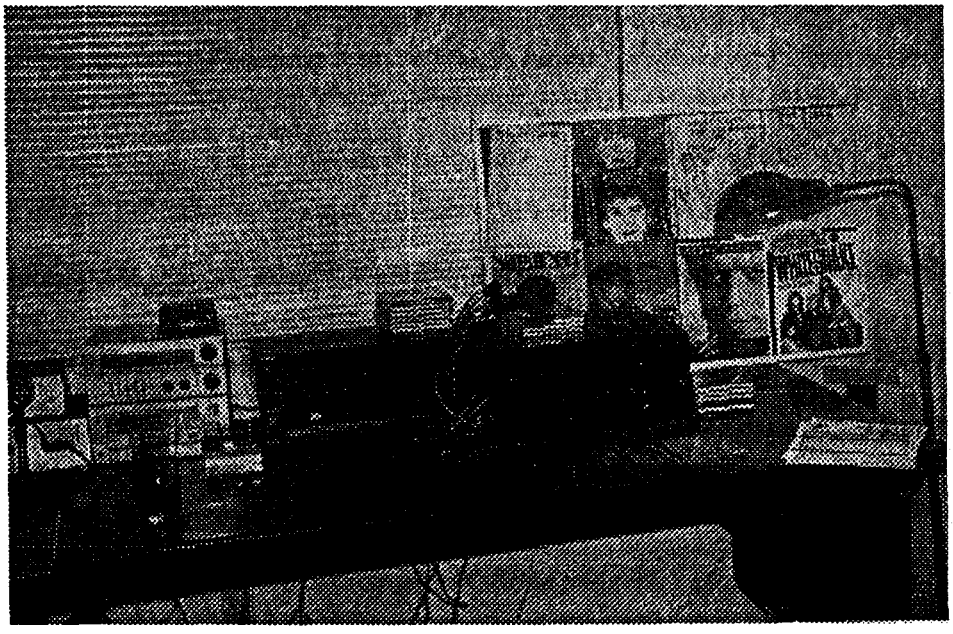


Letters , continued

THE VALLEY'S

107 FM

your album alternative



I just thought I would write you a short letter to let you know about an existing pirate here in Arizona. My equipment consists of two CD players, two cassette decks and several microphones. Our transmitter is a 20 mW oscillator with stereo generator on board and a homemade linear amplifier of about 8 watts.

We are using an authentic dipole antenna measured to our frequency of 106.7 MHz and have an ERP of about 16.2 Watts.

Our format consists of old & new album cuts from "The Who" to "Men Without Hats". We have over 450 Compact Discs in our music library. We also feature several regular scheduled programs as follows:

Mondays	6pm	NEW CD REVIEW
	10pm	CLASSIC CD REVIEW
Tuesdays	6-8pm	50's-60's MUSIC SHOW
	8-9pm	THE BLOCK PARTY
Wednesdays	7-8pm	THE BEATLES HOUR
	10pm	BEATLES HOUR REPEATED
Thursdays	6pm	NEW CD REVIEW
	7-11pm	"SLOW DANCING"(MELLOW)
Fridays	6pm	CLASSIC CD REVIEW
	7-11pm	"POWERPLAY" (DANCE

We broadcast from 6pm-11pm Monday thru Friday only. A "normal" format is broadcast at times when regular "scheduled" programs are not being aired.

S. K.

Unclassified, Barter, Trade, Bulletins

WANTED: Help is needed in locating a schematic and manuals for MEISEI ELECTRIC Model CF-533D 10 Watt AM transmitter (front panel digital readout, mod/r.f. meters) and the CF-811 distribution unit (both are good quality, rack mount units). I have acess to several, but none work. I'll photocopy and return any material you can supply, or you copy and I'll pay for the photocopy charges. Scott Welch, 252 Star Hill Rd, Woodside, CA 94062

WANTED: Low powerer AM or FM transmitter in good condition: William M. Livingston, PO box 562, Saluda, SC 29138

Mini-Lesson (Power Dividers), continued from Page 2

Look at Fig. #1. A tin can is cut with tin snips to obtain two end caps. Four equally spaced 5/8" holes are made in one of the end caps, two 5/8" holes are made in the other end cap. The lid from a smaller can is used as a common connection for the center pin of each SO239 coax connector. After soldering each center pin to the inner disk the end caps are slipped onto the connectors to make a fully closed box. The SO239's are secured with nuts on the outside. The two end caps are then soldered together to close the box.

Each antenna is connected to one of the four coax connectors at the top of the unit (only two are shown in the drawing). ALL cables from the unit to an antenna must be the SAME LENGTH. Two 1/4 wavelength pieces of 50 Ohm coax are prepared and each is connected to one of the two coax connectors at the bottom of the unit. The other ends of the two are connected to a coax "T". A single 50 Ohm line goes from the "T" to the transmitter

Commercial power dividers are constructed similar to that of Fig. #3. Any number from 2 to 8 connectors may be attached to the common disk. The 1/4 wave transformer however is a specially made coax of the required impedance. The outer conductor of the coax is made from copper pipe. The inner conductor may be a smaller copper pipe or brass rod. The impedance is calculated from:

138 log B/A = Z

where B = inside diameter of outer conductor
and A = ouside diameter of inner conductor
and Z = impedance of the coax

(is it snowing yet?)

Let's take an example from a commercial broadcast power divider. The outer conductor is 1.5" copper pipe. The inner conductor is 1/2" copper pipe. The INSIDE diameter of the outer conductor is 1.5". The OUTSIDE diameter of the inner conductor is 5/8" (.625 decimal).

1.5/.625 = 2.4, log 2.4 = 1.38, 138 x 1.38 = 52.5 Ohms

This is the impedance of commonly used 1-5/8" rigid coax used by broadcasters. The 1 5/8" refers to the outside diameter of the 1-1/2" copper pipe.

To make a 25 Ohm coax we work things in reverse.

25/138 = .18 (which is the log of B/A)

the antilog of .18 = 1.52 (I cheat and use a calculator)

The ratio of B to A is therefore 1.52

As long as the inside diameter of the outer conductor is 1.52 larger than the outside diameter of the inner conductor the impedance should be about 25 Ohms. For example, a 1" copper pipe (inside diameter) for the outer conductor and a 1/2" copper pipe (.625" outer diameter) would give a ratio of 1/.625 = 1.6 which is close and might work ok The same 1" pipe with a 3/8" pipe inner conductor (.5" o.d.) would be better however as that ratio is 1.5/.5 = 1.5 (very close).

Remember that to find a 1/4 wavelength in coax you must include that coax's VELOCITY FACTOR in the calculation, typically .66 for poly insulation, .75 to .82 for foam, and larger coax (air insulation) .9 to .98..