



CHEESE BITS

W3CCX
CLUB MEMORIAL CALL

ARRL
Affiliated
Club



Volume XLIX

September 2008

Number 9

PREZ SEZ:

I'm just back from the 13th EME Conference that was held in Florence, Italy. Jani and I had a wonderful time, hosted by the ARI group. There were 150 registrants and an additional 100 family and friends for the Saturday night banquet. The program started on Wednesday with tours of the walled cities of Siena, San Gimignano and Montereggiano, and Thursday's venue was to Lucca and Pisa. Plenty of sights, sounds and the great food and drink of the country. Other Pack Rats including Joe K1JT and Marc N2UO were there, as well as a good Pack Rat friend, Al K2UYH. All three gave excellent presentations. There was discussion about EME contesting rules and the potential of distinguishing the digital and analog modes, but there was no resolution. My challenge to the group was to assess the effects of the rules changes on the various EME contests and activity weekends. This may be my task for the next EME conference, to be held in 2010 in Dallas, under the sponsorship of W5LUA and the North Texas Microwave Society with assistance from VE4MA. Our final day tour included Villa Griffone, the home of Guglielmo Marconi, with an exciting display of his life and accomplishments, and live demonstrations of his spark-gap transmitters and coherer receivers. In the afternoon we made tracks to the radio telescope in Bologna, part of a network of deep space exploration facilities. After an excellent introductory slide show we were bussed to the 60' dish and the very long "T" shaped antenna array. Watch for our future monthly meeting where we'll present a slide show of the trip.

Our big focus for September is hosting the Mid-Atlantic States VHF Conference and HAMARAMA. Please check your calendars to

make sure that you can be available to help us get ready for these two events. As we want to arrange the space at the grange in advance and not distract from the conference, we need a crew to move tables Thursday evening, Sept 25. Hospitality will take place on Friday evening, Sept 26 at the Marriott Suites in Plymouth Meeting. The conference will get started on Saturday morning, Sept 27 at the Aetna auditorium in building 2, 1425 Union Meeting Rd, about a mile from the hotel. The buffet dinner will be held at a hall nearby. Please make sure you are registered early enough that we can get a good count for the meals, as the snacks, lunch and dinner are included in the package. You also get a discount if you are an early bird registrant. If there are folks that you know who are interested in learning more about VHF and up, we have a beginners' session in the afternoon of the conference at a reduced price. All details are on the club website.

Another of the club tenets is helping each other. To that end, we need to have crew to take down the tower and antenna of the late Gene Shillingford. It is a crank-up-tilt-over, and should be relatively easily accomplished if we have the required number of hands. This is tentatively scheduled for Sept 20 and being organized by KB1JEY, who has also arranged for the transportation of the gear to his QTH.

Under the leadership of our newly elected VP, Phil K3TUF, we have a great line-up of meeting speakers and activities. There are several changes and surprises, so be sure to make it on the third Thursday of the month to the Ben Wilson Senior Center at 8PM. As always, guests are invited, and your attendance and participation is what keeps the club an exciting group.

73, Rick, K1DS

Editor's Column

Pack Rats **CHEESE BITS** is a monthly publication of the
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FM29jw Philadelphia, PA
50.080 144.284 222.064 432.286 903.072 1296.245 MHz
2304.043 3456.207 5763.196 10,368.062 MHz (as of 1/08)

MONDAY NIGHT NETS

<u>TIME</u>	<u>FREQUENCY</u>	<u>NET CONTROL</u>
7:30 PM	50.145 MHz	K3EOD FM29II
8:00 PM	144.150 MHz	N3ITT FN20KI
8:30 PM	222.125 MHz	K3TUF FN10we
8:30 PM	224.58R MHz	W3GXB FN20jm
9:00 PM	432.110 MHz	WA3EHD FN20kd
9:30 PM	1296.100 MHz	K3TUF FN10we
10:00 PM	903.125 MHz	W2SJ FM29LW

Visit the Mt Airy VHF Radio Club at: www.packratvhf.com or
www.w3ccx.com

Next Meeting: September 18, 2008 At our usual site:
the Ben Wilson Senior Center, 580 Delmont Av, War-
minster PA. Our own **Paul Drexler, W2PED** has an
exciting presentation on his work in creating a 24 GHz
transverter.

**Greetings Packrats! We've got a busy month com-
ing up.** There's the club sponsored Mid-Atlantic
States VHF Conference on the 27th. You can take
advantage of early bird registration until the 5th and
save a few bucks. See the ad at the end of this issue
for all the details.

On the 28th we've got Hamarama. Details and the url
for the Hamarama web site are also presented near
the end of this issue.

In addition the 2 meter and 222 MHz portions of the
fall VHF / UHF sprint events are scheduled for late
September with the remaining (432, 6 meter and mi-
crowave sprints) in October. Some details of the
sprints and details on how you can get complete
rules are presented later in this issue.

Finally for those who can make it on Sept 20th, we're
going to help dismantle the tower of Gene Shillingford
(SK). See Rick's "Prez Sez" for details or contact Mi-
chael KB1JEY.

This issue presents the first part of super article by
Paul Drexler, W2PED on a subharmonic mixer for the
24 GHz band. Paul explains the motivation behind
use of a subharmonic mixer and he shows the basic
architecture of such a device. Future articles will show
details of one of his designs and results from a mixer
he actually built. Thanks Paul!!

As always we welcome articles and news from all
club members and readers of Cheese Bits. If you
have a good idea for an article but feel your writing
skill isn't "ready for prime time" send in a rough draft
and Ed White WA3BZT or I will cheerfully whip it into
shape.

Hope to see everyone at the next meeting, and at this
months extra events.

73, Lenny W2BVH

A New Subharmonic Mixer for 24 GHz

Paul Drexler, W2PED

INTRODUCTION

It's often been said that the heart of any transverter is a good local oscillator (LO). If you're building your own transverter to get on one of the bands on 903 MHz or above, you know first hand that the LO is a big part of the trick to getting equipment to work reliably. This seems to be especially true at the higher microwave bands. If you've ever built a transverter from scratch or perhaps in kit form, then you probably realize that the construction of a suitable LO takes the most amount of time. I may have the best noise figure LNA, or gobs of transmit power capability, but if the LO is somehow marginal, or intermittent, then all bets are off in making the QSO!

Most of the transverters we use on the lower microwave bands use fundamental mode mixers – that is, the LO signal is at the necessary frequency for the math to work. For the 24 GHz band it seems to be “many dB harder” to generate a fundamental mode LO. For example, if you're using a 144 MHz IF rig, then an LO is needed operating at 24,048 MHz (24192 MHz – 144 MHz). Another approach (as described here) is to use a subharmonic mixer – a mixer that uses a lower frequency LO and then “internally multiplies” within the mixer hardware to get to the desired higher frequency. This has the advantage of making for simpler LO hardware. This is especially helpful in getting on a higher frequency band like 24 GHz.

Several Local Oscillator schemes for 24 GHz are shown below:

Figure 1 – Some 24 GHz LO Schemes

IF Freq	Fundamental LO	LO / 2 Scheme
144 MHz	24,048 MHz	12,024 MHz
432 MHz	23,760	11,880
1296 MHz	22,896	11,448



Figure 2 – A Commercial Subharmonic Mixer for Spectrum Analyzer Use

TRADEOFFS

Like anything else in life, this involves tradeoffs. Using a subharmonic mixer means a simpler LO, but somewhat more involved mixer hardware. The biggest tradeoff to using this type of mixer is that they're less efficient – the mixer conversion loss is usually a lot higher. The HP mixer pictured above, for instance, has ~20 dB conversion loss! This is partly because of its broadband operation, but even over narrower bands for amateur use, subharmonic mixers still have more conversion loss than do standard fundamental mixers. Fortunately, most of our work involves narrow band operation, and over narrow operating bands the circuit efficiency can be greatly improved. Published narrow-band x2-type subharmonic mixers for 24 GHz have typical conversion loss figures of 8-10 dB. In addition to higher conversion loss, a subharmonic mixer may have more undesired output frequencies and spurious signals due to the internal multiplication process. For commercial applications this can be a real challenge, but for amateur applications this is not usually a problem.

A HIGHER ORDER MIXER

Over the last year or so I set out to design a subharmonic mixer for 24 GHz, that instead of using a x2 scheme, uses a **x4** LO scheme. My thought was that this would make a 24 GHz transverter easier to build by requiring only a 6012 MHz LO for the typical 144 MHz IF scheme. I feel it's easier to generate a 6 GHz signal than it is to generate 12 GHz. So a lower frequency LO is a good thing, but here again a x4 subharmonic mixer has several downsides: 1) the design is more complex, and 2) we expect the higher order mixer (x4) would have more conversion loss.

The mixer topology that I used for this design is based on work described in the IEEE literature by Madjar shown below.

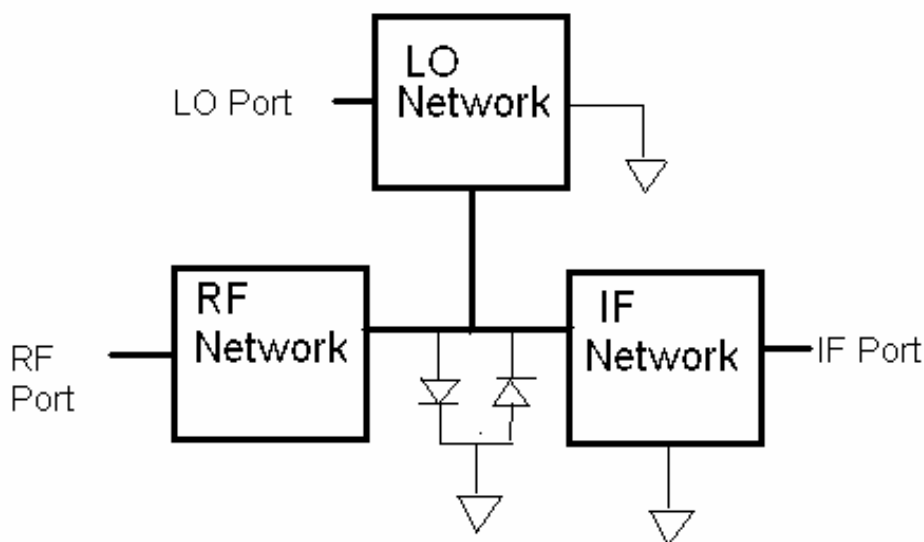


Figure 3 – Subharmonic Mixer Scheme

There are several keys to making the mixer work as a subharmonic mixer. The first is that two diodes are used, placed back-to-back to ground: the so-called “anti-parallel” diode. This allows the mixer diodes to give a frequency response that will work using a lower frequency LO input. The second key involves the filters that are used at the RF, IF, and LO ports of the mixer.

Like most high frequency circuits, the best performance is obtained by keeping all the parasitic inductance and capacitances as low as possible. This implies a *very* small component. It's also beneficial to use diodes that are well matched in their DC characteristics. Fortunately, some of the commercial semiconductor manufacturers have recognized the above and have made low cost, high frequency schottky diodes available to the industry. One such anti-parallel diode is the M/A Com MA4E1318, shown on the following page

Footnote 1: A. Madjar, “A Novel General Approach for the Optimal Design of Microwave Subharmonic Mixers,” IEEE MTT Transactions, Nov 1996

MA4E1317, MA4E1318, MA4E1319-1, MA4E1319-2, MA4E2160



GaAs Flip Chip Schottky Barrier Diodes

M/A-COM Products
Rev. V3

Electrical Specifications @ + 25 °C

Parameters and Test Conditions	Symbol	Units	MA4E1317			MA4E1318		
			Min.	Typ.	Max.	Min.	Typ.	Max.
Junction Capacitance at 0V at 1 MHz	Cj	pF		.020			.020 ³	
Total Capacitance at 0V at 1 MHz ¹	Ct	pF	.030	.045	.060	.030 ³	.045 ³	.060 ³
Junction Capacitance Difference	DCj	pF					.005	.010
Series Resistance at +10mA ²	Rs	Ohms		4	7		4	7
Forward Voltage at +1mA	Vf1	Volts	.60	.70	.80	.60	.70	.80
Forward Voltage Difference at 1mA	DVf	Volts					.005	.010
Reverse Breakdown Voltage at -10uA	Vbr	Volts	4.5	7				
SSB Noise Figure	NF	dB		6.5 ⁴			6.5 ⁴	

Figure 4-A – MA/COM Single and Anti-Parallel Mixer Diode Specifications.

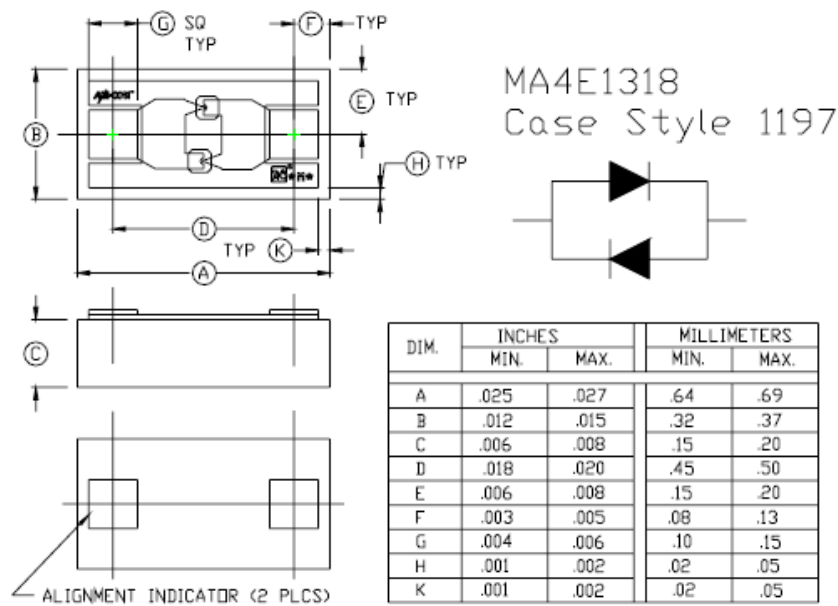


Figure 4-B – MA/COM Anti-Parallel Mixer Diode Package

The good news here is that these diodes are at least offered in tiny surface-mount type packages, so no fancy wire-bonding equipment is required. The bad news is that they're only 0.026 inches in length... really small! You need a microscope or high-powered magnifier to work with these components. A conductive epoxy is used to attach the diodes to a small printed circuit board.

MIXER THEORY OF OPERATION

The mixer consists of the anti-parallel diodes, the RF Filter, LO Filter, and IF Filter networks (see above block diagram). The mixer works as both a receiver mixer and a transmit mixer but we'll refer to it as a receiver mixer to keep things straight. Perhaps the best way to understand the mixer operation is to start at the LO input. An external 6012 MHz LO is fed to the LO input connector. To make the numbers a little easier, we can just think of the LO as a 6 GHz signal.

The LO network is a narrowband filter centered at 6 GHz. It filters the incoming LO energy, but perhaps more importantly, it looks very reflective to all other frequencies. When the incoming LO energy hits the diode pair, LO harmonics are internally generated. The harmonic that is four times the LO input frequency (6 GHz x4) becomes our desired high frequency LO within the mixer. In addition, LO harmonics are generated at x2 and x3. All of these are reflected back towards the mixer to improve the efficiency. The LO network also includes a small microstrip transmission line matching section to match from 50 ohms into the low impedance of the diodes.

The purpose of the RF network is several-fold. In general, it looks like a low loss, wideband bandpass filter centered at 24 GHz. It provides some degree of out-of-band rejection, but more importantly it keeps the various LO signals from radiating out the RF input of the mixer. It looks reflective to the LO energy which is reflected back towards the diodes. The RF network includes an impedance matching section to improve the energy transfer into the diodes.

Lastly, the IF section of the mixer passes the mixer's desired IF output energy, and just as in the other portions of the mixer, reflects the LO energy back toward the mixer diodes. This is done using high-Q *idler circuits* consisting of open circuited microstrip transmission lines. Each is resonant at the required frequency and reflects energy back towards the diodes with the correct *phase* signal for low mixer conversion loss.

The next installments in this article will go over the design in more detail and present some results from a prototype mixer. --W2PED

Announcing the 2008 Fall VHF/UHF Sprints

Here are the basic details of this years Fall VHF/UHF sprints.

The Southeastern VHF Society is again sponsoring the Fall VHF/UHF Sprints. All amateurs are encouraged to participate, even if only in a small way. They are meant to get everyone on the air. The rules encourage rover, microwave operation and the casual operator new to VHF/UHF.

Sprints are held on different days for each band except for the Microwaves (902 and up) that are held together. The operating time for each Sprint is short (like a sprint :-)) and meant to compress the activity into a shorter time span.

Please notice that, except for rovers, the scoring is like the ARRL VHF contest is now. This will allow computer programs to both generate the logs and check the logs. Rover scoring is intended to encourage activation of many grids!

Down East Microwave is again supporting the Fall Sprints by sponsoring two participation award drawings. One for drawing from log submissions for the 222 MHz sprint and one for log

Fall VHF/UHF Sprints continued....

submissions for the Microwave bands. The two drawing winners will each receive \$100 gift certificates for DEMI products. The awards are being sponsored to encourage amateurs to get active on 222 MHz and the Microwave bands.

Dates for the sprints are as follows:

- The 144 MHz Sprint will be from 7 PM to 11 PM local time on Monday September 22, 2008
- The 222 MHz Sprint will be from 7 PM to 11 PM local time on Tuesday September 30, 2008
- The 432 MHz Sprint will be from 7 PM to 11 PM local time on Wednesday October 8, 2008
- The 50 MHz Sprint starts 2300 UTC Saturday, October 18, 2008 and ends 0300 UTC Sunday, October 19, 2008
- The Microwave (902 MHz and above) Sprint will be from 6 AM to 12 PM local time on Saturday October 25, 2008

For complete details and contest rules see http://www.svhfs.org/fall_sprint_rules.htm

Skeds for the Fall VHF/UHF Sprints

Phil, K3TUF and Claire, KA3TUF report that they will be working the fall sprints from FN10we. They have 10 bands available and will be booking skeds for the sprints. Contact them via their email address printed in the club roster.

Like K3TUF / KA3TUF you can solicit skeds for your station via the packrats email reflector.

WA3QPX EME!!

Paul WA3QPX reports his **first EME** on 2 Meters on the morning of August 26 using 200 watts! He worked F8DO, UA4AQL, HA0HO, KB8RQ.

Way to go. Congratulations Paul!!

Hopefully some additional details will appear in these columns in a future issue.

Riley Hollingsworth, K4ZDH Retires

Riley Hollingsworth, K4ZDH, the FCC's "Special Counsel for Amateur Radio Enforcement" has retired from his post after 35 years with the organization. He spent the last 10 of those years working exclusively in amateur radio rules enforcement.

As noted in this month's QST, Hollingsworth said that he quote "has loved working at the FCC ... but this one [assignment] involving the Amateur Radio Service has been the most fun and I have enjoyed every day of it. I've worked with the best group of licensees on earth, enjoyed your support and looked forward every day to coming to work. The Amateur Radio Enforcement program will continue without missing a beat, and after retirement I look forward to being involved with Amateur Radio every way I can. I thank all of you for being so dedicated and conscientious, and for the encouragement you give us every day."

Your editor believes that Hollingsworth's effort on behalf of all hams; in responding to our complaints and concerns has resulted in more usable bands for all of us.

**SAVE THE DATE! JANUARY 17-18 2009
ARRL January VHF Sweepstakes**

HAMARAMA!
37th Annual Packrat Flea Market

Sunday September 28th 2008

Middletown Grange Fair Grounds

**Penns Park Road,
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General Admission \$6 — XYL / Harmonics under 13 free

Outdoor sellers \$10 per car extra

Indoor sellers \$15 extra for each 10 foot table – 120 spaces available on a first come first served basis

For details see

<http://www.packratvhf.com/Hamarama/hamarama.html>

Ham Radio URL of the Month

Go to <http://cebik.com> and take the simple steps needed to create a logon. You will be rewarded with (free) access to LB Cebik's W4RNL (SK) huge and wonderfully detailed web site. It contains articles on antenna design and modeling, matching, transmission lines and specific designs for all bands. Many designs include element dimensions and antenna performance info. Enjoy!

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Mid-Atlantic States VHF Conference

Saturday, September 27

Aetna Bldg 2 Auditorium
1425 Union Meeting Road
Blue Bell, PA
Between Jolly Rd and Harvest Drive.

Preliminary Program:

Digital Station Enhancements - presented by K3TUF
What's new for 24 GHz - presented by W2PED
Getting Started on EME - presented by K1DS
A Backpack Portable Station - presented by ND3F
Software Defined Radio Advancements - presented by N4HY
Portable EME - presented by K2UYH

In addition, a beginner's session in the afternoon will include gear selection, test equipment, beacons, operating modes, antennas, feedlines, microwave operating, contesting.

Early Bird Special Combo includes Friday night Hospitality, Conference, snacks, Sat Lunch, Triple Choice Buffet Saturday evening, CD proceedings, & ticket to HAMARAMA, the Annual Packrat Hamfest & flea market on Sun Sept 28. *Rate through September 5, 2008 - \$75.00 after that date \$80*

A la carte Registration as follows:

Conference Registration ONLY includes snacks & lunch - **\$45.00**

Triple Choice Buffet Dinner ONLY - **\$35.00**

Special Beginner's afternoon session ONLY with lunch - **\$25.00**

Questions? Contact Conference Committee:

Michael Davis, KB1JEY, kb1jey@arrl.net

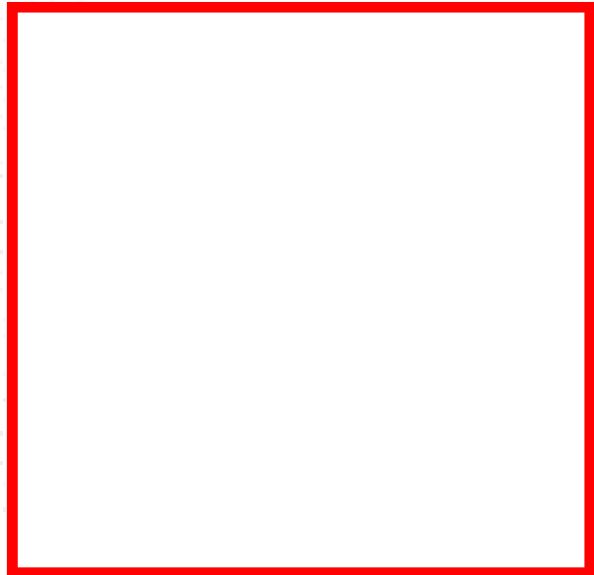
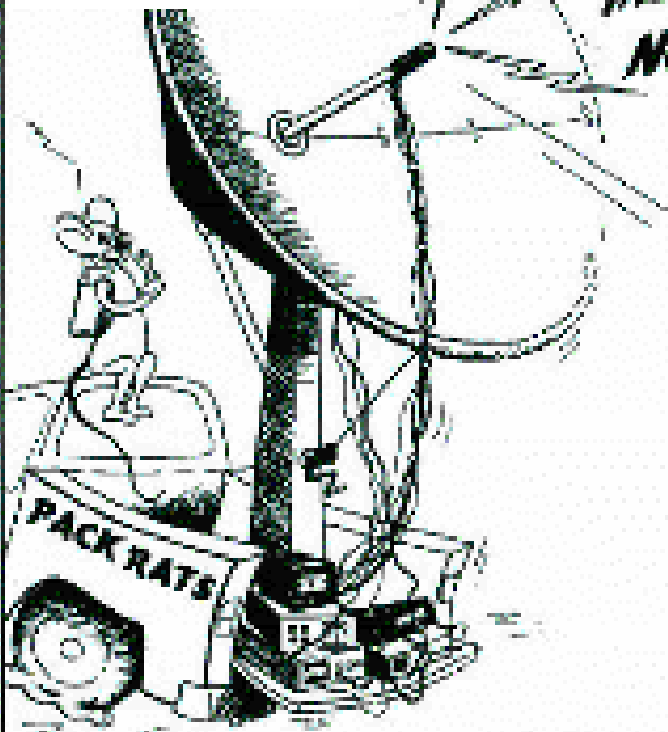
Jim Antonacci, WA3EHD, jjantonacci@verizon.net

Rick Rosen, K1DS, rick1ds@hotmail.com

Info on Mail and Online registration is available at www.packratvhf.com by pressing the "VHF Conference Information" button . This link also provides driving directions to the accommodations, hospitality and presentation venues

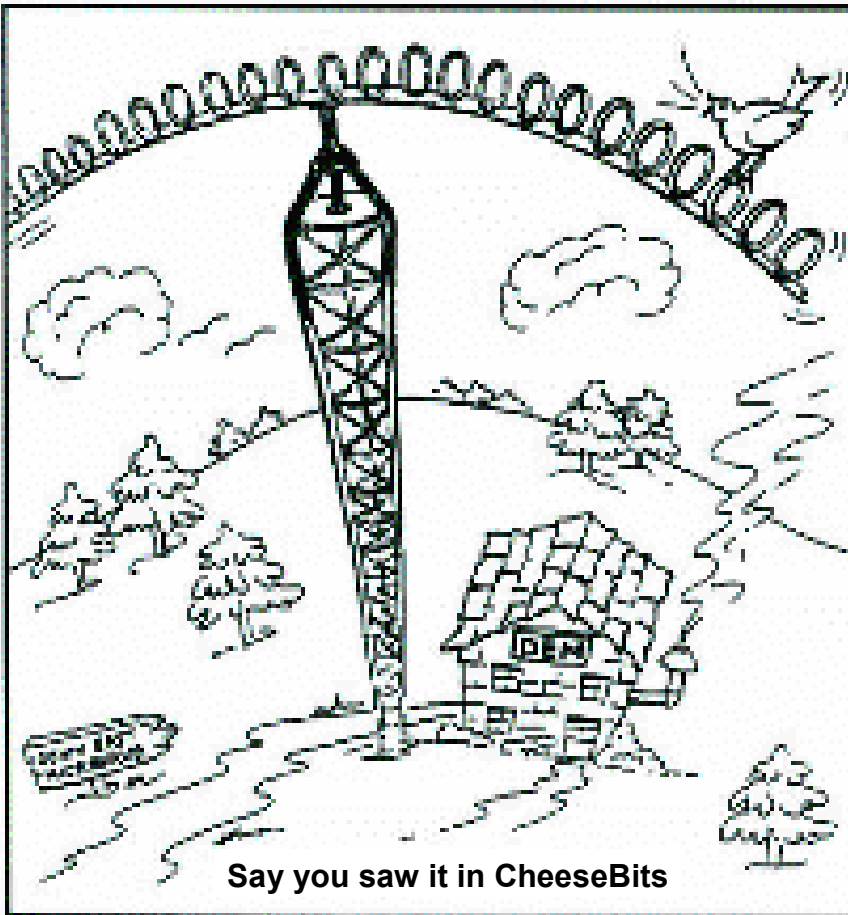
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