SAN BERNARDINO MICROWAVE SOCIETY, Incorporated

FOUNDED IN 1955

A NON-PROFIT AMATEUR TECHNICAL ORGANIZATION DEDICATED
TO THE ADVANCEMENT OF COMMUNICATIONS ABOVE 1000 MC.

W6IFE Newsletter
March 2008 Edition

At the **6 March 2008 SBMS** meeting Doug, K6JEY will be talking about using the HP-410gl to measure sun noise. The SBMS meets at the American Legion Hall 1024 Main Street (south of the 91 freeway) in Corona, CA at 1900 hours local time on the first Thursday of each month. Check out the SBMS web site at http://www.ham-radio.com/sbms/.

REMINDER- NO PARKING IN THE CHURCH LOT

Last meeting- Dick, K6HIJ presented a good talk about noise and how we can measure noise figure/ temperature. As requested at the February 7th 2008 SBMS meeting, here are the references from the technical talk on noise measurement.
The Deep Space Network - Noise Temperature Concepts, Measurements, and Performance
C. T. Stelzried - JPL Publication 82-33 September 15, 1982
Noise Measurement and Generation - Paul Wade, QEX, November 1996 pp 3-12
Fundamentals of RF and Microwave Noise Figure Measurements - Agilent Application Note 57-1, 2000
Noise Figure Measurement Accuracy - The Y - Factor Method - Agilent Application Note 57-2, 2001
Fundamentals of RF and Microwave Power Measurements - Agilent Application Note 64-1C, 2001
JPL has provided a book that is directly applicable to noise, noise measurements, LNAs and antenna temperatures as they apply to microwave communications. It has a lot of good technical "meat" in it, and should clarify the subject. This book has almost everything you would like to know on the subject, and can be downloaded from the web site: http://descanso.jpl.nasa.gov/Monograph/mono.cfm
The book in question is Monograph 10, titled "Low Noise Systems in the Deep Space Network" (about a 12 MB download). Some of the other stuff on this site should be pretty interesting, also.
Dick K6HIJDick also showed his digital temperature meter Centech 92242 with probe from Harbor Freight for $20 there was discussion on having a Noise Party in the next few months to check out everyone’s noise head or measure preamps. Welcome to visitor Ed KE6FJU. The last award for the 2007 2 GHz and up contest was sent to the Northern Lights group. Dick, K6HIJ will be checking out IRS form 990N to keep SBMS in good standing. Pat, N6RMJ indicated that the 2 GHz and Up contest for 2008 is coming up in May. Current rules are in the SBMS web page. Larry. K6HLH indicated an estate sale at W6DTA home on 23 Feb. Dick, K6HIJ indicated progress is being made in the club kit for 3.4 GHz. 28 people present.

Scheduling
3 April Ed KE6FJU will talk about 1.7 GHz weather satellites.
1 May TBD
10-11 May 2 GHz and Up contest
5 June TBD
3 July TBD

"Wants and Gots for sale".
Want Bird 500C 100-250 MHz 500w slug Jeff Fort Kn6VR 760-948-7227
Want FM deviation meter and any waveguide transitions Dick K6HIJ 760-253-2477/ 5127
For Sale WR42 waveguide flanges $15 pair, WR22 waveguide flanges $20 pair, WR90 flanges $20 pair Joonho KG6MQS 626-333-3250
For sale HP 8551/851 10 MHz to 12 GHz spectrum analyzer $100 Bill WA6QYR bburns@ridgenet.net

Fellow SBMS Members: San Diego has a number of electronic 'junk' stores that often have some items of interest. This past week there have been some rather nice chunks of heat sink material show up. They are new aluminum stock. The over all size is: 8"L x 6"W x 2"H. Weight is 3 Lbs. The plate portion is 0.3" thick allowing plenty of stock for countersinking, milling, or drilling/tap mounting holes. There are 12 fins evenly spaced at 0.375". Some pre-existing holes have been drilled in the flange area of the plate.
I would be happy to pick some of these up and haul them to the next SBMS meeting if there is interest. California Metals sells aluminum by the pound, they are asking $7 per sink. Timing is important as items at the junkyard have a typical 48-hour lifespan before they loaded into a container headed to China. Thus, if you are interested please E-mail me off-line (GBailey@Mail.SDSU.Edu) by tomorrow. I have mounted a 1296 amplifier on one of the sinks. See Picture at: http://kahuna.sdsu.edu/~mechtron/HeatSink.jpg Greg K6QPV

Activity reported at the February meeting Bill, N6MN reported being on 2 GHz 25 years ago and is now collecting parts again; Frank, WB6CWN had his Selene receiver for show and has been doing synthesizer work; Chuck, WA6EXV indicated finished with work on 10 and 24 GHz amplifiers and now needs a current limited power supply; bill, WA6QYR had one of the Mini-Circuits 1 W amplifiers (mentioned in last months email news) to show; Dug had a 24 GHz 10 w TWT available for OVRO propagation studies proposal; Jeff, Kn6VR had feeds for the 1 meter dishes built by K6HIJ and tested by WA6EXV; Wayne, N6NB had been doing low band stuff; Kurt, K6RRA has been doing 10 GHz work; Ed, KE6FJU has been doing 1691 MHz weather satellite work; Dave, WA6CGR moved his home near the "LAB" and worked Robin on 40 m; Pat, N6RMJ reworked his 10 GHz rig with WB6CWN help; Wayne, KH6WZ rebuilt his 10 GHz rig and had it to show; Charles, K6PIP built some WIFI antennas with good result; Dick, K6HIJ got a 5-31 MHz time division receiver, has the CNC mill back in operation and is building a 47 GHz test set for waveguide switches; Joonho, KG6MQS has a working power supply for his Endwave 24 GHz rig; Larry, K6HLH has been working on the W6DTA sale; Mel, WA6JBD worked Robin on 40m and passed his extra license; Dan W6DFW worked on Cactus hardware; John KJ6HZ did some Gunnplexers work; Jacob, KD5FEG has been doing some Gunnplexers experiments. There were two ATV checkins.

Email Threads
Traco dc-dc converter use
Actually I used two in my latest radio. I used one to drive the 24V relays and another provided the -12V for my amplifier bias. Since the Harris 3W amp needs about -3V, I used an LM7905 regulator to get a stable -5V and then a voltage divider to provide the required -3V. I don't have any photos at the moment but will try to shoot some in the next week or so for the newsletter if you like.
I think all of us are using these in our new radios. It sure beats those big ones we got from MPJA a few years ago for low current applications like relays. Wayne's idea of just gluing them to the 24V relays effectively makes them into 12V relays and they're cheap enough to put one on each relay. John

Here is a picture of Steve, W6QIW, Pat, N6RMJand Doug, K6JEY testing our rigs at Doug's place in Long Beach. We had a great time and learned a lot from each other.

The 2007 ARRL 10 GHz and Up contest results. Here it is sorted from highest to lowest.
Chris n9rin
6I2HWB 196,989, **4B2WB** 173,020 , XE2/K6NKC 169,895, 4C2WH 157,487, **KE6HPZ** 124,061
KH6WZ 76,984, N6DN 55,594, **N9RIN** 39,214, **N6TEB** 38,258, K6WCI 37,460, **N6RMJ** 34,296
KN6VR 31,211, **N6NB** 31,111, N9JIM 28,755, AF1T 27,629, **AD6FP** 27,125, **K6GZA** 25,104
N0IO 24,140, WB0LJC 23,775, **KJ6HZ** 22,992, **W6OYJ** 21,145, **K6JEY** 20,968, **WA6CDR** 20,587
W1MKY 20,567, **WA6QYR** 20,423, W1AUV 20,282, KA1OJ 19,809, **N6LL** 19,119, KB1VC 18,565
W6HCC/0 18,138, N0UK 17,585, W1GHZ 17,452, KC0P 16,822, N0YE 16,655, K2KIB 16,475
KE6RPY 16,467, KC6UQH 15,858, W9FZ 15,678, KC6QHP 15,422, KB8VAO 14,929, N0KP 14,783
W0ZQ 14,650, W0JT 14,603, K0HAC 14,317, **N6AX** 13,630, N0HZO 12,947, **AD6HT** 12,133, KI6LQV 12,065
K0RZ 11,691, KC0IYT 11,690, WA2VOI 11,504, **K6HLH** 11,425, KB1OEG 10,954, W6XD 10,907
W3SZ 10,610, VE3TFU 9,805, K1GX 9,581, KG6EDB 9,541, KC0LEF 9,347, VE3SMA 9,179, WT6K 9,013,
K2YAZ 8,908, AE6QU 8,315, W0GHZ 7,951, W1FKF 7,739, KO0JI 7,527, W3HMS 7,453, KB8U 7,108
WA8VPD 6,897, W0PHD 5,803, WA3PTV 5,716, W1JHR 5,694, VE3NPB 5,262, W6SZ 5,037, N1JHJ 4,852
WB6DNX 4,160, K3SIW 4,150, WA2BTR 3,989, WA1MBA 3,859, NE8I 3,774, AA9IL 3,547, W5LUA 3,437
W2KV 3,332, VE2JWH 3,159, WB8TGY 3,146, KE5HHU 2,950, NM5M 2,732, W6SR 2,612, W1RIL 2,311
K0SCC 1,984, W5GVE/R 1,743, KD0AR 1,652, NN9X 1,625, KI5WL 1,614, K1MAP 1,595, VE3FN 1,402
KM5PO 1,314, K5LLL 1,220, N8KH 1,106, KA5BOU 1,062, WA5YWC 1,049, K4HV 714, K9MK 607
KC0DIV 553, KI4OBE 553, KA0CRO 544, AA6HA 471, VE2PIJ 383, K7RJ 272, KA7OEI 272, K7HSJ 104
AG4V 102, VE3HHT 101

Pipe cap filters--Knowing that anything inside a cavity will lower it's Q, I would like to find a pipe cap as close to 2.3 GHz as possible to minimize the amount of screw intrusion needed to bring it down. On the other hand, if the cavity is too big, I won't be able to (easily) bring its resonance up. So I made a new PWB filter base and checked the pipe caps I had for resonance without any screw. Here are the results:
1 5/8: 5920 MHz
1 3/8: 6290 MHz
1 1/8: 7020 MHz
7/8: 10350 MHz
Interestingly, it looks like the 7/8" cap is almost good for 10.368. I will try to file it and see if I can bring it up some. It would probably work better (higher Q) than the 1/2" at 10.368.
The probe size was the same for all the tests (0.25") and spacing (~3/4") which made it hard for the 7/8" cap. So I did not try to measure Q or insertion loss.

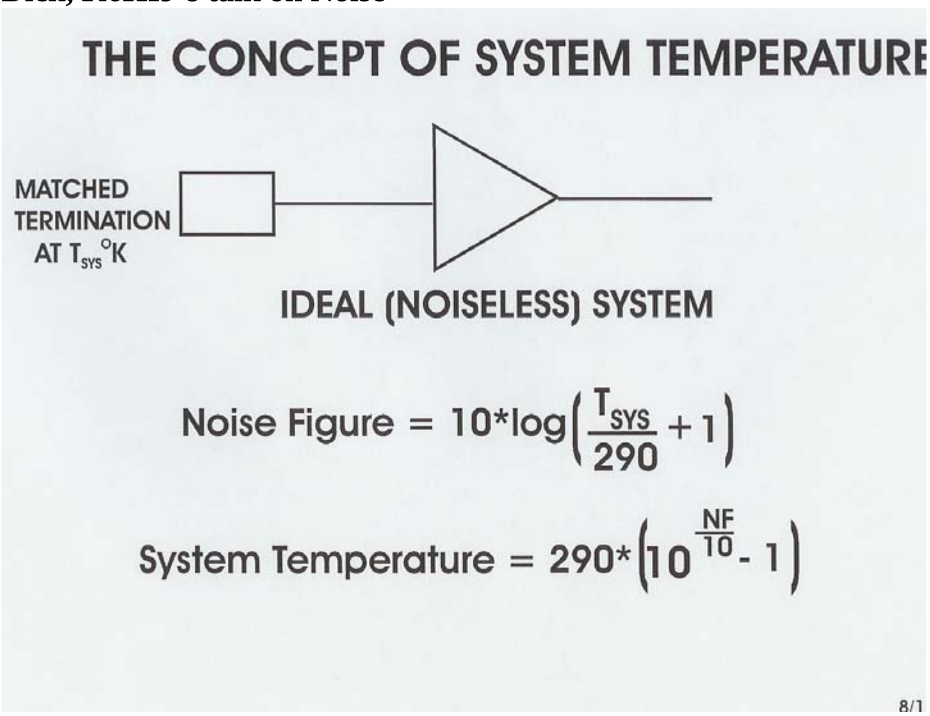
In any case, since the pipe caps were held with a C clamp, the Q was probably not very good anyhow.
I have pictures of the setup at: http://www.ko4bb.com/ham_radio/Pipe_cap_filters
So it seems even the largest will need a good size screw to bring it down to 2.3 GHz.
Now heading to the hardware store...Didier KO4BB

I have a typical high-resolution plot of a 2.2 GHz filter on my web site http://www.ko4bb.com/ham_radio/Pipe_Cap_Filters/ I believe the data scales well at other frequencies.
This particular design has about 0.5% bandwidth at -3dB and 15% at -30dB,which I think is typical of that design.
The bandwidth is adjusted by varying the probe length. When you increase the probe length, the bandwidth increases and the insertion loss decreases, but the optimum trade off for most ham applications will be typically with not more than a few % bandwidth and2-4dB insertion loss. When the probe length is increased significantly, the response develops many spurii, at least on my sample of two (1/2" and 11/2"). When the probe length is decreased significantly, the insertion loss seems to drop faster than the bandwidth narrows...
I will try to take similar plots of the 10 GHz filter made around a 1/2"pipe cap later this week-end.
The good news is that the placement of the probes does not seem to be critical, and it is quite possible to check the filter before soldering the pipe cap to the PWB, which allows adjustment and checkout of the probe length.
One of the pictures on my page linked above was taken with the pipe cap simply held in place with a C-clamp. I could not tell the difference when the pipe cap was soldered.
Before soldering the pipe cap, make sure the mating surface is smooth and flat, it will make soldering easier.
To solder the pipe cap, I simply lightly held the semi rigid cables in a vise, with the PWB resting on the top of the vise, I placed the pipe cap where I wanted it to be, I put a little bit of solder flux along the joint area and applied the butane torch to the top of the pipe cap. If you accidentally direct the torch to the PWB, you can guess what will happen. When the flux started boiling, I applied a small amount of solder to the joint. The solder quickly made a nice, thin and smooth joint and I was done. It only took a few seconds and the pipe cap did not move. Let it cool slowly, it will take a while. The same procedure was used with the 1/2" pipe cap and the 1 1/2" pipe cap.
Didier KO4BB

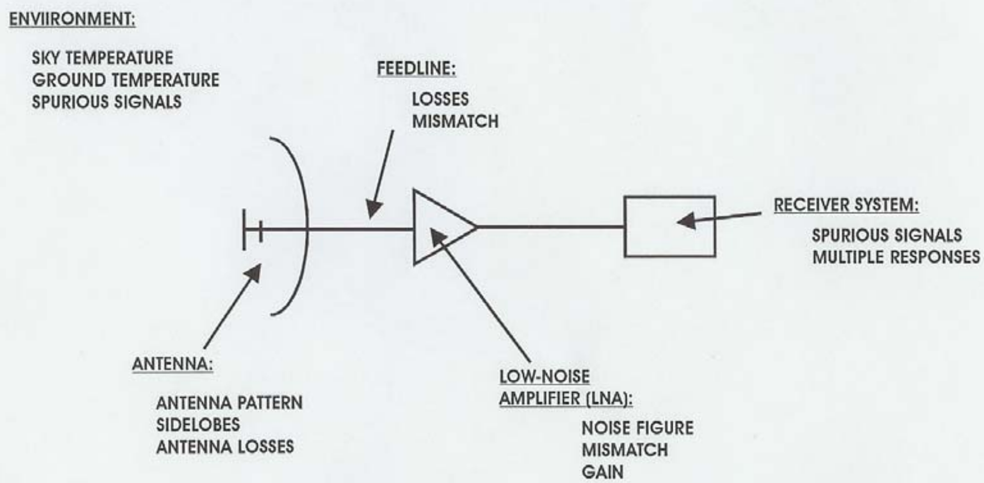
My promised paper on pipe-cap filters is now available on my web page: www.w1ghz.org/new/Pipe-cap_Filters_Revisited.pdf no link yet comments and corrections welcome Paul

I ran across this website which has some interesting calculators and humor.http://www.microwaves101.com/
Norman Gillaspie ngillaspie@gmail.com

Dick, K6HIJ's talk on Noise



FACTORS AFFECTING SYSTEM TEMPERATURE



MEASUREMENT OF SYSTEM TEMPERATURE

I. COMPARISON METHOD

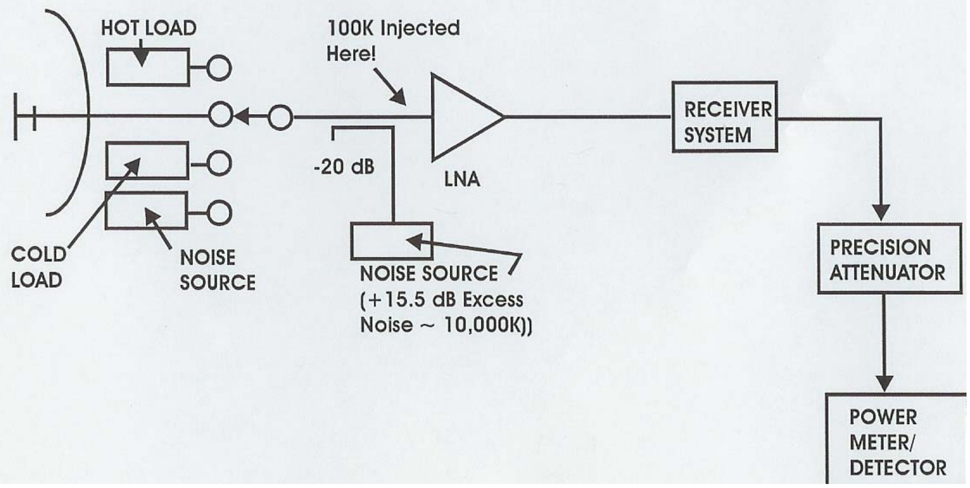
- This measures the difference between noise power outputs with two or more terminations (different temperatures) at the input of the system under test.
- Most Automatic Noise Figure Meters operate on this principle.
- One termination is generally at ambient temperature (~290K); the other termination should be very hot (~500 - 1000K or more) or very cold (10 - 100K) for good accuracy.
- Commercial Noise sources can have noise temperature of up to 10,000K, but calibration is an issue.

2. INJECTION METHOD

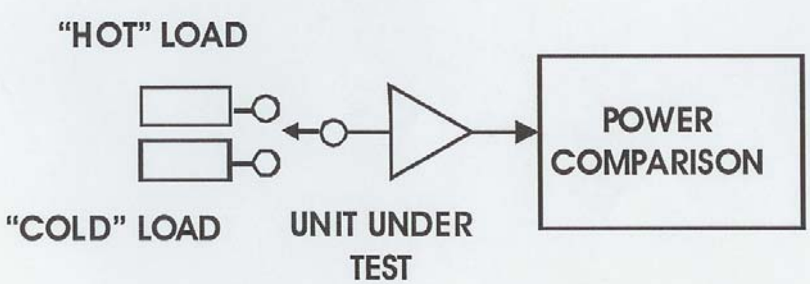
- A noise (or other) signal of known temperature is injected into the system under test.
- Use of broadband noise eliminates the need for accurate knowledge of the noise bandwidth.
- This method can be used to monitor the performance of an operating system.

MEASUREMENT OF SYSTEM TEMPERATURE

(CONTINUED)

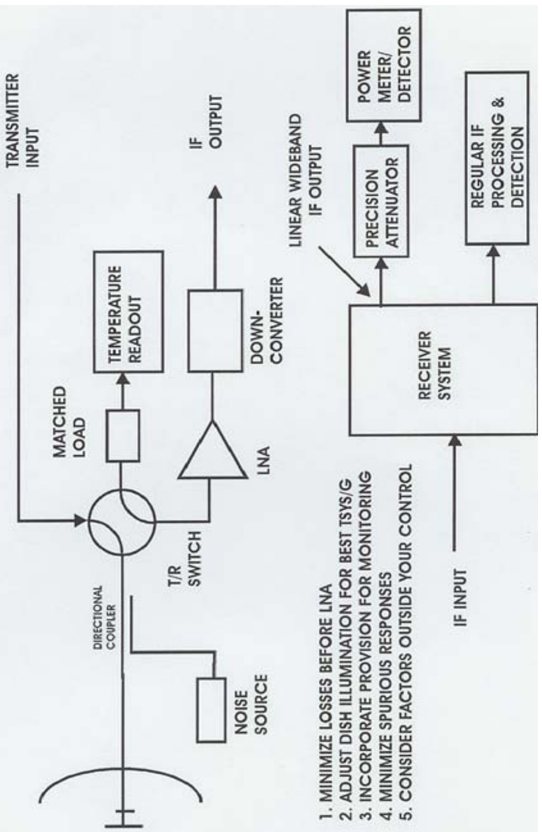


BASIC PROCEDURE FOR NOISE MEASUREMENTS



We need to know the "temperature" (Excess noise) of the hot load and the cold load. We need to measure the relative power change between connection between the hot and cold loads. (The Y-Factor)

DESIGNING FOR MINIMUM SYSTEM TEMPERATURE



1. MINIMIZE LOSSES BEFORE LNA
2. ADJUST DISH ILLUMINATION FOR BEST TSYS/G
3. INCORPORATE PROVISION FOR MONITORING
4. MINIMIZE SPURIOUS RESPONSES
5. CONSIDER FACTORS OUTSIDE YOUR CONTROL

Noise Figure in Decibels to System Temperature in Degrees Kelvin

Noise Figure (dB)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.
0	0.0	6.8	13.7	20.7	28.0	35.4	43.0	50.7	58.7	66.
1	75.1	83.6	92.3	101.2	110.3	119.6	129.2	138.9	148.9	159.
2	169.6	180.3	191.3	202.5	214.0	225.7	237.7	250.0	262.6	275.
3	288.6	302.1	315.9	330.0	344.5	359.2	374.4	389.8	405.7	421.
4	438.4	455.4	472.8	490.5	508.7	527.3	546.4	565.9	585.8	606.
5	627.1	648.4	670.3	692.6	715.5	739.0	762.9	787.5	812.5	838.
6	864.5	891.4	918.9	947.1	975.9	1005.4	1035.6	1066.4	1098.0	1130.
7	1163.4	1197.3	1231.9	1267.4	1303.7	1340.8	1378.8	1417.6	1457.4	1498.
8	1539.8	1582.4	1626.0	1670.6	1716.3	1763.0	1810.9	1859.8	1909.9	1961.
9	2013.6	2067.2	2122.1	2178.3	2235.8	2294.6	2354.8	2416.4	2479.5	2544.
10	2610.0	2677.5	2746.7	2817.4	2889.8	2963.9	3039.6	3117.2	3196.6	3277.
11	3360.9	3445.9	3532.9	3622.0	3713.1	3806.4	3901.8	3999.4	4099.3	4201.
12	4306.2	4413.2	4522.8	4634.9	4749.6	4867.0	4987.1	5110.1	5235.8	5364.
13	5496.3	5631.0	5769.0	5910.1	6054.5	6202.3	6353.5	6508.3	6666.6	6828.
14	6994.5	7164.1	7337.8	7515.5	7697.3	7883.3	8073.7	8268.5	8467.9	8671.
15	8880.6	9094.2	9312.8	9536.5	9765.4	9999.6	10239.3	10484.5	10735.5	10992.
16	11255.1	11524.0	11799.2	12080.8	12369.0	12663.8	12965.6	13274.3	13590.3	13913.
17	14244.4	14583.0	14929.4	15283.9	15646.7	16017.9	16397.8	16786.5	17184.2	17591.
18	18007.8	18434.0	18870.1	19316.4	19773.1	20240.4	20718.6	21208.0	21708.7	22221.
19	22745.5	23282.1	23831.1	24393.0	24967.9	25556.3	26158.3	26774.4	27404.8	28049.
20	28710.0	29385.5	30076.7	30784.1	31507.9	32248.5	33006.5	33782.0	34575.7	35387.
21	36218.8	37069.2	37939.4	38829.9	39741.1	40673.6	41627.8	42604.1	43603.3	44625.
22	45671.9	46742.5	47838.0	48959.1	50106.2	51280.1	52481.3	53710.5	54968.4	56255.
23	57572.6	58920.4	60299.6	61710.9	63155.1	64632.9	66145.2	67692.6	69276.2	70896.
24	72554.7	74251.5	75987.8	77764.5	79582.6	81443.1	83346.9	85295.1	87288.6	89328.
25	91416.1	93552.2	95738.0	97974.8	100263.7	102605.9	105002.6	107455.2	109964.9	112533.
26	115161.1	117850.3	120602.1	123418.1	126299.6	129248.2	132265.6	135353.2	138512.7	141745.
27	145054.3	148439.8	151904.2	155449.2	159076.9	162789.0	166587.6	170474.7	174452.3	178522.
28	182687.6	186949.7	191311.1	195774.1	200341.0	205014.3	209796.4	214690.0	219697.5	224821.
29	230065.2	235430.8	240921.5	246540.0	252289.4	258172.8	264193.1	270353.7	276657.8	283108.
30	289710.0	296465.0	303377.3	310450.6	317688.7	325095.4	332674.6	340430.3	348366.7	356487.

"Noisemanship"

The Art of Measuring Noise Figures
Nearly Independent of Device Performance

Almost everyone who has measured the noise performance of a sensitive amplifier or converter has found it possible to read noise-figure values considerably lower or higher than expected. The more exacting experimenters among us have refined their measurement techniques to eliminate such ambiguities and can even obtain accurate noise-figure values for the new, exotic, negative-resistance devices such as parametric amplifiers, masers, and tunnel diode amplifiers and converters. However, as yet, only a few astute practitioners have recognized the tremendous practical value of being able to read noise-figure values much lower or higher than actual. For example, when evaluating their own devices, they can manage to read unusually low noise figures by following certain experimental procedures. (Do not be anxious about their results being much better than theoretical, since they can usually postulate some plausible explanation such as space-charge smoothing.) Conversely, when evaluating their competitors' devices, they can just as readily manage to read exceptionally high noise figures. (Here, however, they usually do the gentlemanly thing and make the magnitude of the noise figures inversely proportional to their competitors' abilities.) to encourage the practice of noisemanship, and thereby bring these very effective practical advantages to all those interested in advancing the state of the art of low-noise devices, we have compiled a partial list of the correct experimental procedures to follow in these two cases.

CASE: I PROCEDURES TO BE FOLLOWED FOR HIGH-NOISE-FIGURE READINGS

1) Use a post-receiver that is very nearly saturated this makes the output indication almost completely independent of the device under test. By varying the degree of saturation, this one technique alone can lead to almost any desired high noise-figure value.

2) Place a grid-dip meter or sweep generator near the receiver IF amplifier, this is not as effective as procedure 1), but less readily detected by unfriendly observers.

3) Use an argon-discharge noise tube, but use a calibration chart for a neon tube. Since the argon tube has about 3 db less effective output-noise power, an error of 3 db in your favor is easily obtainable. This technique is especially useful if skilled unfriendly observers are present, since the discharge is not visible in any commercial noise generator (because the noise lamp is always located inside a waveguide or coaxial structure) and, therefore, they cannot tell the type of discharge present from its characteristic color.

4) Use a noise generator having the biggest possible difference in source impedance at the two reference noise levels (assuming that a Y-factor measurement is made, which is generally true above a few hundred megacycles where noise diodes are no longer useful). This causes a difference in the gain of the device for the two reference conditions. Here, however, one must be careful that the gain decreases when the higher reference temperature is connected. One should also allow sufficient time between the two reference readings so that the output indicator drifts well down scale before the high temperature reference is connected. The use of a badly mismatched noise generator may also cause an unstable device to break into oscillation, if so, an immediate victory is scored.

5) Orient the noise generator for Maximum TV, FM and police radio pickup.

6) Assume that the device has at least three equal spurious responses and therefore, add 5 db to the measured-noise-figure value. This gives you knowledgeable air and usually impresses those present.

There are an unusually large number of these procedures, which are too numerous to list here. However, by the use of the few techniques listed above, one can readily pin the noise-figure indicator on the infinite end of the scale. For those pessimists who have only lately entered the low-noise arena, these techniques are guaranteed to lead to immediate positive results.

CASE II -- PROCEDURES TO BE FOLLOWED FOR LOW-NOISE-FIGURE READINGS

1) Undo procedures 1), 2) and 5) above.

2) Reverse procedures 3) and 4) above.

3) Neglect any spurious responses and quote only the radio-astronomy noise figure.

4) If the observers are aware of the above procedures, place a carefully measured 100 dB pad between the noise generator and the device under test. This will eliminate the gain variations caused by noise-generator mismatch but when 100 db is subtracted from the over-all reading, a low-noise figure is sure to result. An alternate procedure is to use a post-receiver with a 100 db noise figure and then carefully subtract its noise contribution.

Again there are too many of these procedures to list here, but if only the few above are followed, noise figures below 0 db can easily be obtained. This may be a little embarrassing in the presence of theoretically inclined antagonists, but again one can postulate some elaborate thermodynamic mechanism as the probable cause. (If you are anxious about such a procedure, use only one or two of the above procedures, and the noise figure indicator will rest just slightly above the 0 db mark, which is much more readily explained.) For those adventurers who have only lately entered the low-noise arena, these techniques guarantee an immediate entrance into the innermost ring.

In conclusion, techniques have been listed to encourage the rapid growth of noisemanship. Here, however, we think it appropriate to paraphrase Oscar Wilde, who noted that people only like to give advice they will not follow themselves, and with his characteristic wit denoted such advice as the depth of generosity.

J. C. GREENE
Airborne Instruments Lab.
Division of Cutler-Hammer, Inc.
Melville, N. Y.

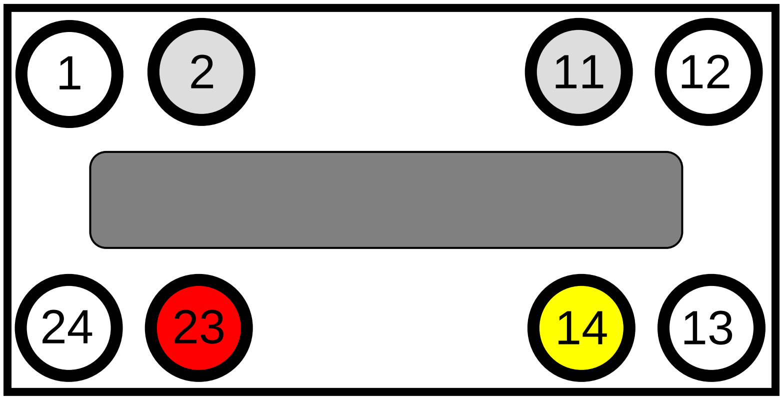
* Received by the IRE, March 27, 1961.

Members look over the goodies to be had at the W6DTA estate sale. The **San Bernardino Microwave Society** is a technical amateur radio club affiliated with the ARRL having a membership of over 90 amateurs from Hawaii and Alaska to the east coast and beyond. Dues are $15 per year, which includes a badge and monthly newsletter. Your mail label indicates your call followed by when your dues are due. Dues can be sent to the treasurer as listed under the banner on the front page. If you have material you would like in the newsletter please send it to Bill WA6QYR at 247 Rebel Road Ridgecrest, CA 93555, bburns@ridgecrest.ca.us, or phone 760-375-8566. The newsletter is generated about the 15th of the month and put into the mail at least the week prior to the meeting. This is your newsletter. SBMS Newsletter material can be copied as long as SBMS is identified as source.

San Bernardino Microwave Society newsletter
247 Rebel Road
Ridgecrest, CA
93555
USA

TRACO DC-DC Converter Module:

A Follow-Up from the September 2007 SBMS Newsletter Item



INPUT 9-15 V	**OUTPUT**
Pin 2 = Input -9V to -15V	Pin 9 & 16 = Common
Pin 23= Input +9V to +15V	Pin 9 to Pin 11 = Neg 12V
	Pin 16 to Pin 14 = Pos 12V
	Pin 11 to Pin 14 = Pos 24 V

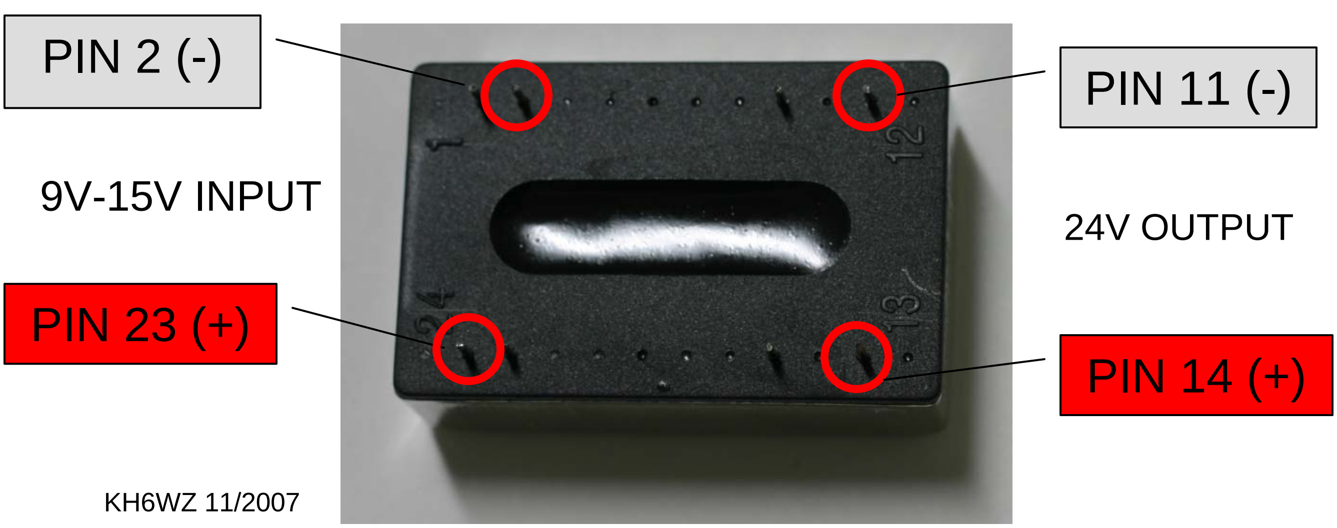
How to use for 12V in, 24V out converter:

1) Input: Plus 9V to 15V to Pin 23, Pin 2 to ground.

2) Output: Plus 24V at Pin 14, Pin 11 is ground.

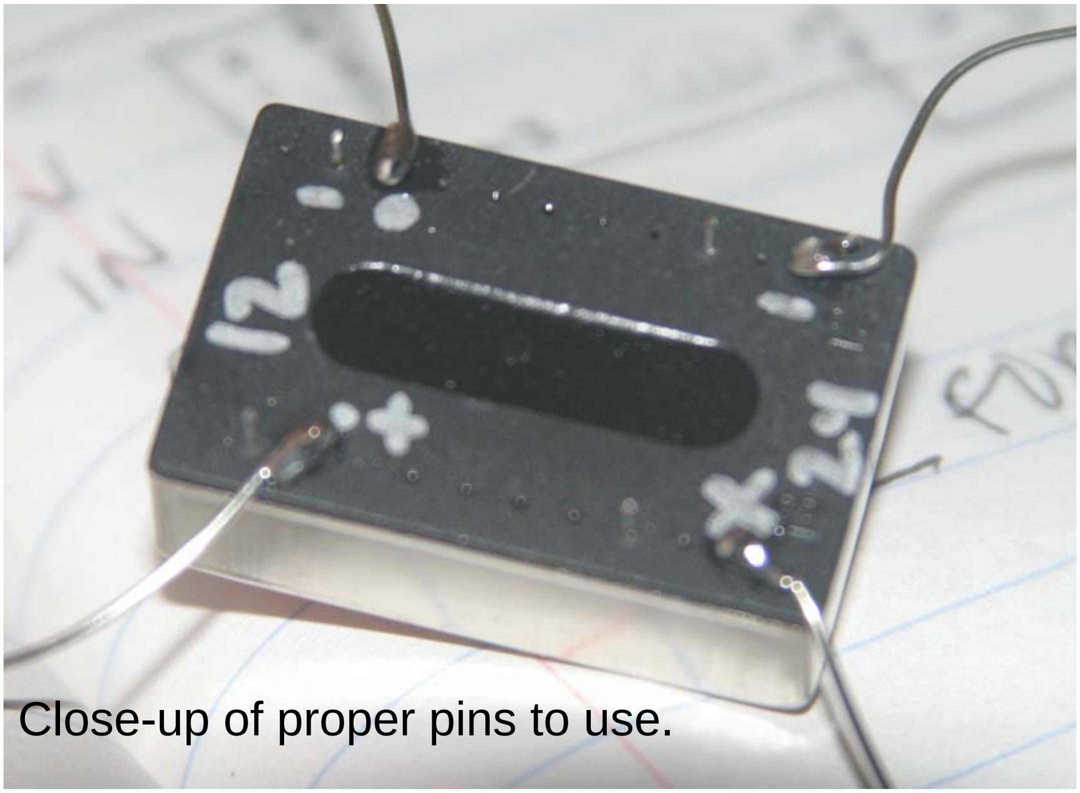
NOTE:

On some modules, pins 1, 12, 13 and 24 are “blanks,” so Pin 2 is “physically” the first pin coming out of the module, see photo below.

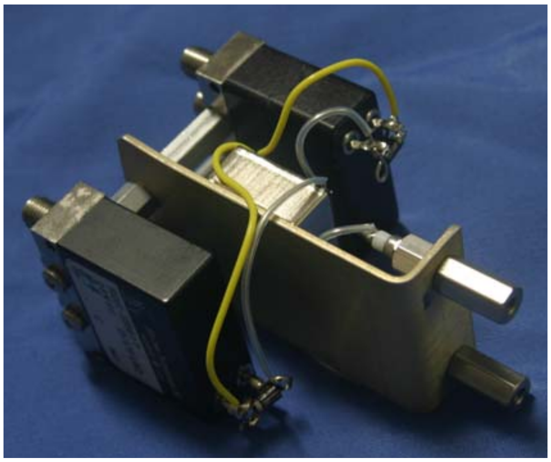


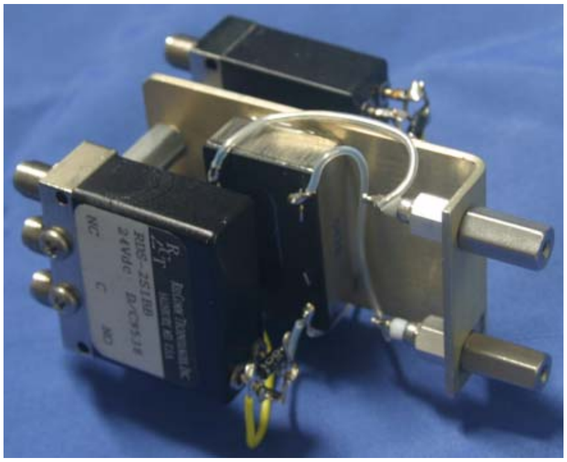
KH6WZ 11/2007

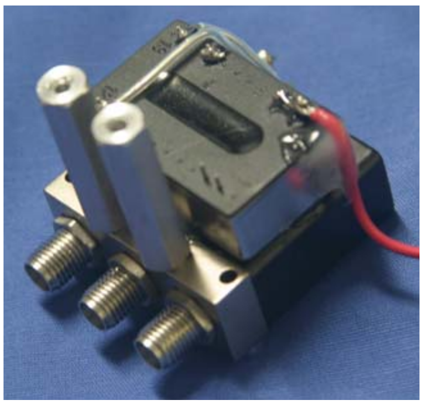
Typical Applications in KH6WZ Transverter Projects



Close-up of proper pins to use.







Above: Two-relay assembly used for high power IF radio input. An attenuator is inserted in the TX line (NO contacts), but by-passed while in RX mode (NC contacts).

Left: Single T/R relay. The module is glued to an SMA relay, and the red wire goes to plus 12VDC.

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