

# PAARAgraphs



The Official Newsletter of the  
**Palo Alto Amateur Radio Association, Inc.**  
Celebrating 78 years as an *active* amateur radio club—*Since 1937*



## What is Fusion, DMR and How is it Different from DStar Joel Wilhite, KD6W

Digital radio is nothing new but recently, a trend has started to develop in the amateur community. The introduction of yet another non-compatible radio format makes for interesting coffee talk but really? Do we really need another one? What does all this mean and what are all the main differences. Joel will present the main differences between the competing radio formats.

First licensed in 1982 In Phoenix (KA7TXV), Joel enjoys building and home brewing rigs and antennas and spends a fair amount of his time working in the microwave bands. Joel currently serves as the technical coordinator to PAARA.

## President's Corner

April 2015



What an exciting month it's been for PAARA! We've had two great events for our membership: PAARAshoot and the PAARAtrip to the Computer History Museum. There have been some fun contests to play in, with more on the way. Propagation hasn't been great, but there's still fun out there to be had. Also, we have Field Day coming up before long.

If you missed the PAARAshoot at the 10th Street Range in San Jose, then you missed out on some real fun. We had just the right number of people there so that the shooting positions were not overcrowded. Attendees brought all sorts of fun gear, including some firearms with real history. We got a demonstration of revolver side-blast from Dick, our rangemaster. There is a video of it available at my Smugmug page. As usual, the shotgunners had some fun shredding targets and cardboard. We also had some fine handgun demonstrations and practice. I enjoyed having my .17 HMR rifle place some groupings within about the size of a nickel at 25 yds. On top of all this, we had a great hamburger BBQ (buns included!) cooked up by Doug, KG6LWE. Thank you Doug! I'd also like to thank Chuck, N6VFH, for being our liaison,

*(President — Continued on page 6)*

## Upcoming Events

- April 3 PAARA General Meeting, 7:00 PM  
Cubberly Community Center, Room H-6  
400 Middlefield Rd, Palo Alto
- April 11 Flea Market
- April 15 Board Meeting, 7:00 PM  
Everyone welcome!  
Round Table Pizza Parlor in Menlo Park
- June 27-28 Field Day



## Directional Coupler Basics

By: Gary Barnes

Most amateur radio operators know the antenna system should have a low Voltage Standing Wave Ratio such as 1:1. Modern amateur radios have an output impedance of 50 ohms, therefore the antenna system should have an impedance of 50 ohms. Maximum power is transferred to the antenna from the transmitter when both impedances match.

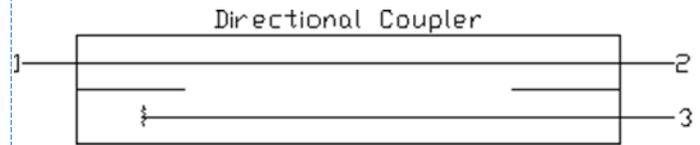
A Standing Wave Ratio (SWR) meter measures the ratio between the antenna and the 50 ohm system. The closer the ratio is to 1:1 the better the match and the greater the power supplied to the antenna. The problem with using a SWR meter is the transmitter has to be on and may cause interference with other radio operators, or potential transmitter damage.

An antenna analyzer can be used to make this measurement without using the transmitter. Unfortunately, an antenna analyzer's accuracy is not specified by most manufacturers, therefore the measurement accuracy is unknown. A vector network analyzer has enough accuracy but the cost to buy one is high.

The article discusses the use of a directional coupler to accurately measure the VSWR of an antenna system. For the purposes of the test, the equipment required to measure SWR are: a directional coupler, a radio frequency signal generator and a radio frequency power meter. The measurement power level is less than 1.0 milliwatt (0.001watts or 0.0 dBm).

Directional couplers come in two types: coaxial and waveguide, but they operate the same. The directional coupler [as shown in Figure 1] has a thru line where the signal starts at one end and then ends at the other end at the load or output terminal (from terminal 1 to terminal 2). The auxiliary line will sample the signal in the main line (terminal 3). The amount of signal sampled is called the coupling factor, and this value is in decibels. A directional coupler with 20 dB of coupling will have about 1% of the signal exit the auxiliary line and 99% of signal exit

the main line. A directional coupler with 30 dB of coupling will have about 0.1% of the signal exit the auxiliary line and 99.9% of signal exit the main line. When a directional coupler has a coupling factor of 3 dB, half the power will exit the main line and the other half will exit the aux-



**Figure 1**

iliary line.

Another specification for the directional coupler is called directivity. This is the ratio of the forward signal to the reverse signal when the coupler is used to monitor the reflected power. This is used to measure return loss, and then VSWR is calculated. The greater directivity of the directional coupler, then the more accurate the measurement. When signal generator is connected to terminal 2. A short is placed at terminal 1 and the power level in dBm is measured and recorded at terminal 3. Then the short is replaced with the load and the power level in dBm is recorded again. The difference is the return loss in dB.

If you look down the main line of a waveguide directional coupler, you will notice a series of holes drilled between the main line and auxiliary line. Increasing the number of holes will cause an increase in the coupling to the auxiliary line. The load on the auxiliary line is factory selected for the best performance to the directional coupler. The coaxial directional coupler's coupling factor is controlled by the distance between the main line and auxiliary line and length. The load resistance is factory selected part for the best performance.

A second auxiliary line can be added to the directional coupler [as shown in Figure 2]. One will monitor the forward power or incident power and the second one will monitor the reverse power or reflected power

Both auxiliary line loads are factory selected for

*(Basics — Continued on page 3)*

(Basics — Continued from page 2)

Dual Directional Coupler



Figure 2

best performance. The main line have terminals 1 and 2, while terminal 3 will provide the forward power level and terminal 4 will provide the reverse power level or reflected power.

Picture 1 shows a Hewlett Packard 778D Dual Directional Coupler. It has a frequency range from 100 to 2000 Megahertz. The coupling fac-



Picture 1 — HP 778D Dual Directional Coupler

tor is 20 dB and the directivity is 36 dB to 1000 Megahertz and 32 dB to 2000 Megahertz. A signal generator is connected to the terminal on the left side and the load to be tested is connected to the terminal on the right side. The input power is monitored at the upper-left terminal and the reflected power is monitored at the lower-left terminal.

Picture 2 shows a Hewlett Packard X785D Waveguide Directional Coupler. It has a frequency range from 8.2 to 12.4 Gigahertz. The coupling factor is 20 dB and the directivity is 40 dB. A signal generator is connected to the terminal on the left side and the load to be tested



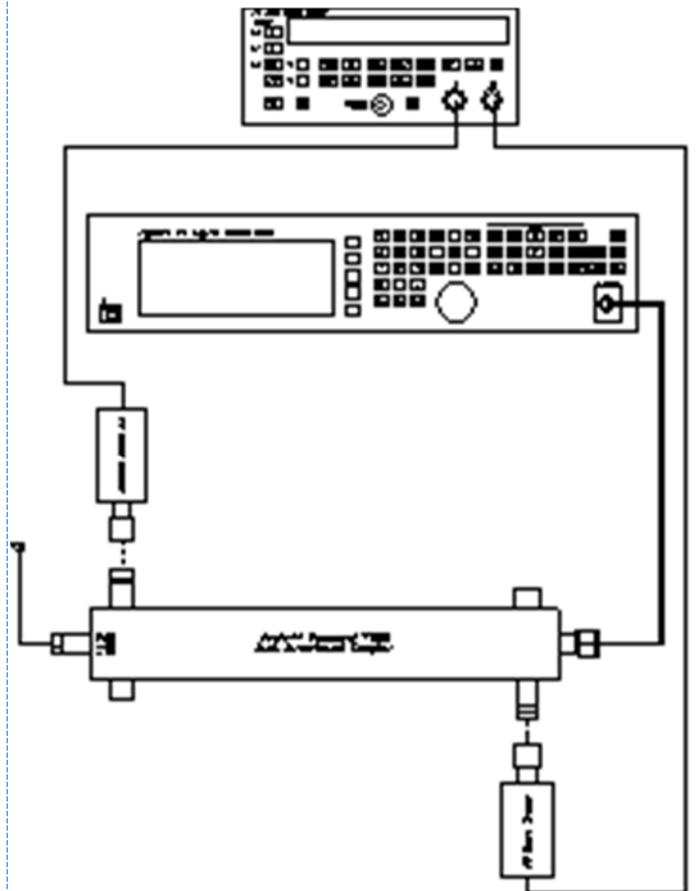
Pict. 2 — HP X785D Waveguide Directional Coupler

is connected to the terminal on the right side. The reflected power is monitored at the lower-left terminal.

The above directional couplers are for low level testing and not for transmitters. The waveguide directional coupler can only handle a maximum of 1-watt of power. However, high power directional couplers are available.

The following is an example of a test for VSWR for a 2-meter mobile antenna. The equipment I used was an Agilent radio frequency signal generator, Hewlett Packard power meter with power sensor, and a Hewlett Packard 778D Dual Directional Coupler. My directional coupler has two ports, with one port for forward power and the other port for reflected power. I connected a power sensor to each port of the directional coupler so I could measure both forward and reverse power to improve measurement accuracy.

Connect the equipment as shown in Figure 3.



(Basics — Continued on page 4)

Figure 3 — Antenna Test Setup

(Basics — Continued from page 3)

The use of two power sensors is to improve return loss accuracy measurement. Turn on the equipment for at least 30 minutes. Zero and calibrate the power sensor(s) per the owners manual. Then, start recording the data for each test point or frequency.

After the power sensor(s) are zeroed and calibrated, connect them to the directional coupler. Record the test frequencies. With a short connected to the directional coupler, set the RF signal generator to the first test frequency and record the power meter indication(s) in dBm. Change the RF signal generator to the next test frequency and record the power meter indication(s) in dBm. Repeat for each test frequency.

Replace the short with the antenna to be tested. Set the RF signal generator to the first test frequency and record the power meter indication(s) in dBm for each test point.

Subtract the shorted readings from the load reading. Table 1 shows the data which results from the testing the MFJ 2-meter antenna.

$$\begin{aligned} \text{Return Loss} &= \text{Power}_{\text{Shorted}} - \text{Power}_{\text{Load}} \\ \text{rho} &= 1/10^{(\text{return loss}/20)} \\ \text{VSWR} &= (1+\text{rho})/(1-\text{rho}) \end{aligned}$$

Figure 4 is a plot of the VSWR vs frequency

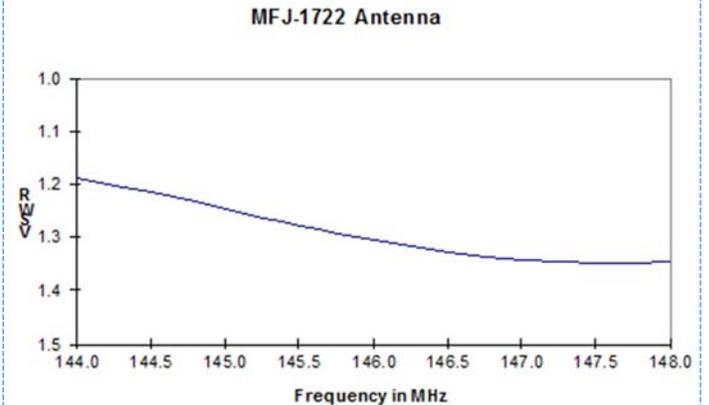


Figure 4 — VSWR vs Frequency

from the Table data.

The MFJ 2-meter antenna has a good VSWR response for a magnetic mount.

Every antenna system should be checked for VSWR on a regular basis about a once or twice a year. The new test results should be compared to the initial readings. If the VSWR changes between measurements, the antenna should be thoroughly examined, and the problem(s) corrected.

Gary, KI6HIG

Table 1 — MFJ 2-Meter Antenna Test Results

Test Frequency (MHz)	Forward Port Level	Reflected Port Level	Return Shorted	Reflection Load	Loss (dB)	Coefficient (rho)	VSWR
	(dBm)	(dBm)	(dBm)	(dBm)			
144.0	-23.30	-23.29	-23.63	-44.86	21.24	0.0867	1.190
144.5	-23.29	-23.27	-23.61	-43.84	20.25	0.0972	1.215
145.0	-23.25	-23.26	-23.59	-42.86	19.26	0.1089	1.244
145.5	-23.24	-23.24	-23.57	-41.82	18.25	0.1223	1.279
146.0	-23.22	-23.23	-23.55	-41.12	17.56	0.1324	1.305
146.5	-23.21	-23.21	-23.53	-40.57	17.04	0.1406	1.327
147.0	-23.19	-23.20	-23.51	-40.26	16.74	0.1455	1.341
147.5	-23.16	-23.19	-23.49	-40.14	16.62	0.1476	1.346
148.0	-23.14	-23.16	-23.47	-40.18	16.69	0.1464	1.343

## March 18, 2015 Board Meeting Minutes

The March Board Meeting was held at the Menlo Park 'Round Table Pizza Parlor, commencing at 7:43 on March 18<sup>th</sup>, 2015. In attendance were Kristen McIntyre, K6WX (President), Marty Wayne, W6NEV (V.P.), Jim Thielemann, K6SV (Secretary/Membership), Ron Chester, W6AZ (Treasurer), Darryl Presley, KI6LDM (Dir), Larry Rebarchik, N6DB (Dir), Rob Riley, KI6INR (Dir) and non-Board Members, Joel Wilhite, KD6W (Technical Coordinator), Doug Teter, KG6LWE (Field Day Coordinator). A quorum was present.

President's Report: Kristen, K6WX, commented on the lack of HF operating reports from the members during that segment of the meeting. A short discussion ensued regarding possible reasons for lack of participation in HF operating and possible ways to generate interest. Rebar, N6DB, mentioned that the NCCC has also seen a downturn in the number of comments regarding HF operating. Some mention was made regarding the proliferation of hams that seem compelled to act unprofessionally during DXpeditions. This exact topic was in a recent issue of QST.

Kristen indicated her reserve of stories is always in need. Have you committed to a story but not submitted it, do you have any projects, like those for home brew night in January, technical articles, hints n kinks, DX, setting up your station or antenna, on the air experiences that might be of interest? It's time to put pen to paper or exorcise the demons out of your word processing program and get one submitted to Kristen.

Vice President's Report: Marty, W6NEV, reported that the speaker for April will be Joel Wilhite, KD6W. He will be talking about DMR (Digital Mobile Radio) and the differences between it and D-Star and other digital forms of transmission. This timely talk is a prelude to the club's possible installation of a DMR repeater.

Marty also announced that there were 43 people who paid for the field trip to the Computer History Museum, in Mountain View, on March 21<sup>st</sup> at 10 AM. He hoped everyone was going to have a good time but due to family matters wasn't able

to make it.

Marty is working on the PAARA special edition 2015 Field Day shirts. They will be red this year as the board agreed that that was the better color between the ARRL grey and red shirts. Keep your ears open for more information on the shirts and be ready to pre-purchase one as they will not be on sale for very long.

Marty also reported that he has speakers lined up into June. He is still looking for ideas from the membership for speakers to fill out the rest of the year. He got some good ideas from those attending the meeting but can always use more.

Secretary's report: Jim, K6SV, reported that the cut has been made on members who hadn't renewed for 2015. 2014 members will receive a post card in place of PAARAgaphs reminding them that their membership has lapsed and suggesting how to renew. The current membership stands at 129. So far there have been 92 renewals via PayPal through the Club website. He also reported there were no new members in February.

Treasurer's Report: Ron, W6AZ, reported that the club's finances were in fine shape. He also reported the income for the first two months was on par with the average. Some areas of costs and income were a little higher some lower but the bottom line was slightly less than last year at this time.

Under Old Business, Doug, KG6LWE, showed the board a couple of samples of badge "flags" which would be added to current board member's or past board member's badges. He will go back to the engraver to get a little more information before the board decides on a course of action.

Marty, W6NEV, reported that the PACIFICON station plans are slowly moving forward. Marty reminded the board that the event has been authorized to use the W1AW/6 call sign during Pacificon. He hopes using that call will encourage club members to come and participate in making contacts. The current plan is to have the station in full operation from sometime Friday (October 16<sup>th</sup>) through Sunday (October 18<sup>th</sup>)

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about noon. Contact Marty if you wish to operate or lend a hand.

Rebar, N6DB, mentioned that he still has a very interested party wishing to purchase the clubs PE -95 generator. Pictures have been taken and provided to the interested party. The board provided input as to the sale price. Rebar will be seeing the interested party in the next several weeks with the hope of negotiating a deal.

Doug, KG6LWE, mentioned planning for Field Day has started. There was a conversation regarding which class, operating modes, and antenna configurations. More discussions are needed before the plan is worked out. There will likely be at least one antenna party before the June 26<sup>th</sup> through 27<sup>th</sup> event. Doug still needs someone to cover the Satellite contact. Please contact Doug if you're interested or know someone who can make the contact for us or have a general interest in helping out for the event.

Kristen, K6WX, mentioned that she's not been successful in setting up a meeting with Mikel, KN6QI, to discuss the ASVARO changes for the Flea Market this year and to answer the questions the PAARA board has. They exchanged emails but that's as far as things have gone. She will continue her quest to get a meeting scheduled.

Joel, KD6W, reported that Gerry, N6NV, Doug, KG6LWE, Jim, K6SV, and he went to survey the proposed repeater site. Everyone agrees that it has the most promise of any site Joel has checked out. The property owner is very open to us having our equipment there. Joel's coverage plots from the site are very impressive. Board members agreed to proceed with gathering information on the costs associated with setting up and getting the repeater on the air.

Under New Business, no new business was brought to the board.

The meeting was adjourned at 9:30.

Jim Thielemann  
 Secretary/membership  
 K6SV

*(President — Continued from page 1)*

and Carla, WA6UBE, for arranging everything with the Santa Clara Valley Rifle Club, as well as also being a rangemaster. We are looking forward to returning again soon, and perhaps even returning to the 200 yd Metcalfe Range. We'll keep you posted. If you want to see my pictures of the event, you can find them at <http://k6wx.smugmug.com/Events/PAARAShoot-March-2015/>.

At the time of this writing, I have just returned from the PAARAtrip to the Computer History Museum. What an incredible time we had there. There were almost 50 people at the event. It had been a long time since I had been there and much had changed. We started our tour with a demonstration of the IBM 1401, where we were brought back to about 1960 to scenes of IBM punch cards, chain printers, and vacuum column tape drives. That last one was my absolute favorite. I haven't seen one of those in many years (see my video of one in operation). I have a stack of punch cards and printouts from the 1401 for everyone on the tour, so please see me at a PAARA meeting to collect yours. Then we went into the Revolution exhibit and stopped at each pivotal innovation. Our docents (both hams) explained the significance of these machines and how they drove computing forward. I saw some of my favorite old machines, many of which were made by Digital Equipment Corporation, or DEC. Some of us stayed around for another demonstration - my favorite of all - the DEC PDP-1. The PDP-1 performed perfectly, playing some Morse code, polyphonic music, and finally Spacewars. It was a real trip seeing that old 12 bit machine in action. I was so inspired by this trip that I got the PDP-11 simulator that I wrote back into shape and got it to boot RT-11. I'm going to get my PDP-11/23 and 11/73 going too. Pictures and videos can be found here: <http://k6wx.smugmug.com/Events/Computer-History-Museum-2015/>. A big thanks to everyone at the CHM for taking such good care of us.

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Over the last month there were some of the spring contest season's best contests, including the ARRL DX CW contest and the CQWW WPX Phone. I hope you had a chance to play. Coming up are a bunch of state QSO Parties and some fun things like the CQ Manchester Mineira DX Contest. These are great chances to get on HF and work some DX. Don't miss it. Even if propagation is not great (and it hasn't been lately, with an X-class flare and other things), you can make your own propagation when those contest stations are activated. Get out there and enjoy.

Field Day planning is starting. Doug will be making the rounds soon for volunteers. We also need to find a full roster of OPs for our stations, particularly for the nighttime shifts. Please let us know if you'll be available in any capacity. We'd love to hear from you. Until next month, CU AT PAARA IN APRIL DE K6WX.

Kristen

A note found in my recently acquired book, 'Commercial Broadcasting Pioneer' provides the following information:

**"In a 1920 dispatch from Italy,**

**WIRELESS TELEPHONES TO SUPERSEDE PRESENT SYSTEM, MARCONI SAYS**

**'Within this present year vocal communication without wires will begin to replace the cumbrous system of today'**

**Wire investors were soothed by the Secretary of Commerce's assurance, That the use of the radio telephone for communication between single individuals, as in the case of the ordinary telephone, is a perfectly hopeless notion."**

de, N6NV

## April Raffle Prizes

1<sup>st</sup>

**Kenwood  
TM281A / 2m  
Mobile Transceiver**



- High Power 65W Output
- Large Front Speaker
- Vivid Amber LCD Display with 32-step brightness control
- 200 Memory Channels, plus one call channel

2<sup>nd</sup>

**Two Uniden  
FRS Radios  
with batteries**



- 22 Channels / 7 FRS / 15 GMRS
- Battery Strength Meter
- Channel Scan / Monitor
- Two Belt Holder Clips

3<sup>rd</sup>

**World Atlas Map Book**

4<sup>th</sup>

**RayoVac 5 LED Headlight with batteries / 50 Lumens**

5<sup>th</sup>

**Pocket Reference Book**

6<sup>th</sup>

**Q-Knot Multi Purpose Reusable Color Ties**

7<sup>th</sup>

**Bongo Ties**



## **PAARA 3/6/15 Raffle Prize Winners**

Front to back, Left to Right

- 7<sup>th</sup> Prize** Clark Murphy / KE6KXO / Bongo Ties
- 6<sup>th</sup> Prize** Paul Laughton / AC6B / Coax Wrap
- 2<sup>nd</sup> Prize** Michael Wimble / KM6WP / Battery Tender Junior
- 3<sup>rd</sup> Prize** Darryl Presley / KI6LDM / Two FRS Radios
- 5<sup>th</sup> Prize** Doyle Kisler / KG6YUN / USB Charger
- 8<sup>th</sup> Prize** Gary / Lemon Meringue Pie “thanks Lodema”
- 1<sup>st</sup> Prize** Rodney Broyles / KF6EDJ / Kenwood TM281A / 2m Mobile Transceiver
- 4<sup>th</sup> Prize** Michael Wimble / KM6WP / Tool Set (not shown)

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Station Trustee K6OTA.....	Ron Chester, W6AZ	
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## VE Exams

3rd Saturday each month, 10:30AM, 145.23- PL=100Hz  
 Redwood City Main Library, Community Conference Room  
 1044 Middlefield Road, Redwood City, CA  
 Contact: <http://amateur-radio.org> or Al, [WB6IMX@att.net](mailto:WB6IMX@att.net)

## Electronics Flea Market

Sponsorship by A.S.V.A.R.O. — Association of Silicon Valley Amateur Radio Organizations  
 Second Saturday of month, March-October, 6am-2pm  
 Howard M. Krawetz, N6HM 650-856-9761  
 Contact: <http://www.electronicfleamarket.com/>

## PAARA — Palo Alto Amateur Radio Association

Meets 1<sup>st</sup> Friday 7:00pm each month at Room H-6, Cubberley Community Center; Net 145.230 - PL 100Hz Mondays at 8:30. See our website at <http://www.paara.org> for more information or contact: Joel Wilhite KD6W, [KD6W@ARRL.NET](mailto:KD6W@ARRL.NET), 650-325-8239

## FARS — Foothills Amateur Radio Society

Meets 4<sup>th</sup> Friday each month at 7:30pm  
 Contact: <http://www.fars.k6va.org>

## NCDXC — Northern California DX Club

Meets 3<sup>rd</sup> Thursday 7:30pm each month,  
 Repeater for member info 147.360, Thursday 8:00PM  
 Contact: <http://ncdxc.org> or Mike Gavin W6WZ, (650) 851 8699

## QCWA Chapter 11

### Northern California Quarter Century Wireless Association

Meets third Wednesday monthly at Harry's Hofbrau in Redwood City @ 11:30 AM.  
 Guests are welcome. Saturday morning net on 146.850 MHz, PL 114.8

## 50 MHz & Up Group

Meets 1<sup>st</sup> Thursday each month at 7pm in the Texas Instruments Building E conference room in Santa Clara.  
 Contact: <http://50MhzandUp.org>

## SPECS

### Southern Peninsula Emergency Communication System

Meets each Monday 8:00pm on Net 145.27, 440.80 MHz  
 Contact: <http://specsnet.org> or Tom Cascone, KF6LWZ, 650-688-0441

## SCARES

### South County Amateur Radio Emergency Service

Meets 3<sup>rd</sup> Thursday 7:30pm each month, Belmont EOC, Belmont City Hall, One Twin Pines Lane, Belmont CA 94002. Net is on 146.445 [PL 114.8] & 444.50 (PL-100) 7:30 Monday evenings. Contact: President Gary D. Aden, K6GDA 650-743-1265 (D), 650- 595-5590 (N)  
 Web: <http://k6mpn.org> E-mail: [pres@k6mpn.org](mailto:pres@k6mpn.org)

## SCCARRA

### Santa Clara County Amateur Radio Association

Operates W6UU & W6UU/R, repeater 146.985-pl  
 Nets: 2m, 7:30pm Mon; 70cm, 442.425+ (pl 107.2) Thur.  
 Meets 2<sup>nd</sup> Mon each month @ 7:30 PM.  
 Contact: <http://www.gsl.net/sccara> or Clark Murphy KE6KXO 408-262-9334  
 ARRL/VEC license testing contact 408-507-4698

## SVECS — Silicon Valley Emergency Communications

Operates AA6BT repeater (146.115 MHz+)  
 contact: <http://www.svecs.net> or Lou Stierer WA6QYS 408 241 7999

## TEARS — The Elmer Amateur Radio Society

Dedicated to operational training, knowledge building & FCC exam testing.  
 KV6R repeater under construction.  
 Contact: [AA6T@ARRL.NET](mailto:AA6T@ARRL.NET)  
 Most members are Extra Class or VE's. See QRZ dot com/kv6r for class info

## WVARA — West Valley Amateur Radio Association

W6PIY six-meter repeater on 52.58MHz. Normally, six-meters is linked with 147 and 223, while 441 and 1286 repeaters are linked.  
 VHF: 52.58 (-500) 151.4 ctcss UHF:  
           147.39 (+600) 151.4 ctcss           441.35 (+5.0) 88.5 ctcss  
           223.96 (+1.6) 156.7 ctcss       1286.20 (-12m) 100.0 ctcss  
 Meetings are 3<sup>rd</sup> Wednesday of every month.  
 Contact: <http://wvara.org>, Bill Ashby N6FFC, 408-267-3118, [N6FFC@Juno.com](mailto:N6FFC@Juno.com), or [N6FFC@ARRL.NET](mailto:N6FFC@ARRL.NET)

## American Red Cross, Santa Clara Valley Chapter

Contact: <http://santacalaravalley.redcross.org> or Scott Hensley KB6UOO, (408) 967 7924  
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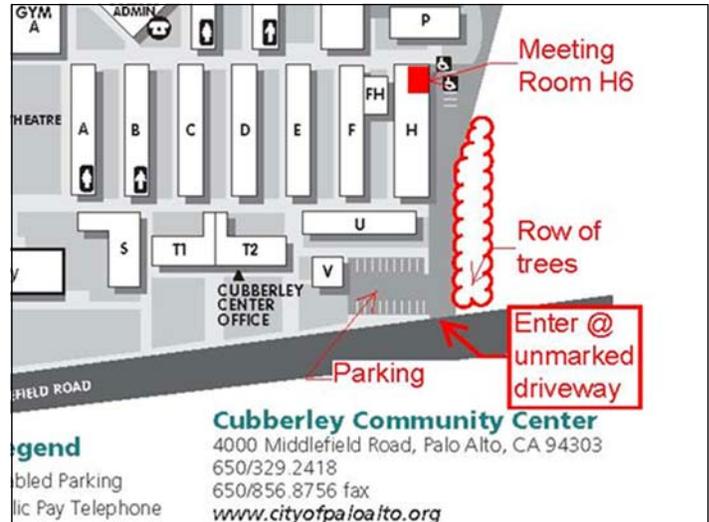
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## PAARA Weekly Radio Net

Info and Swap Session  
 every Monday evening at 8:30pm  
 on the N6NFI 145.230 MHz repeater

<u>Week</u>	<u>Control Operator</u>
1 <sup>st</sup>	Joel KD6W
2 <sup>nd</sup>	Doug - KG6LWE
3 <sup>rd</sup>	Jack - N1VSL
4 <sup>th</sup>	Marty - W6NEV
5 <sup>th</sup>	Rob KC6TYD

If you're interested in trying out at Net Control,  
 Contact Doug, KG6LWE. It's good practice,  
 and lots o' fun! Give it a try.



**Meeting Location — Middlefield Road  
 between San Antonio and Charleston in Palo  
 Alto. 4000 Middlefield Road**

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**Palo Alto Amateur Radio Association  
 P.O. Box 911, Menlo Park  
 California 94026-0911**

Club meetings are on the first Friday of each month,  
 7:00pm at the Room H-6, Cubberley Community Center.

Radio NET & Swap Session every Monday evening, at  
 8:30pm, on the 145.230 –600 MHz repeater, PL 100Hz.

Membership in PAARA is \$20.00 per calendar year,  
 which includes one subscription to PAARAgaphs  
 \$6 for each additional family member (no newsletter).

Make payment to the  
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