# RF

ORANGE COUNTY AMATEUR RADIO CLUB, INC.

VOL. LI NO. 6 P.O. BOX 3454, TUSTIN, CA 92781-3454 June 2010


## The Prez Sez.....

**by Kristin K6PEQ**

The month of Field Day is upon us! I am excited at the amount of newer hams who are planning on spending some time on the bands during field day. [See FD plans on Page 5.] I hope that if you aren't able to make it out to our field day that you are able to participate in another site or at least get on the air and make some contacts. Keep your fingers crossed for great weather and great band conditions!

We also have some great speakers lined up in the next few months so I hope that you are able to make it out to a meeting!

73,

Kristin, K6PEQ

## How to send a Newsletter Article to The Editor

Do you have an article or a picture you found that you think may be of interest to the OCARC members??

Just e-mail the article to:

**EDITOR@W6ZE.org**

Sending in JPEG files to the editor are best for pictures. Use WORD or .TXT files are best to send the articles to the "RF" editor.

### --- OCARC---
### June 18th Meeting

**The meeting for June 18th will be AMSAT area coordinator Clint Bradford - K6LCS speaking on**

**"Working Ham Satellites with your HT..."**

**Club members Attendees should download Clint's 4-page tutorial and radio programming matrix before the meeting from http://www.work-sat.com**

**Join Clint in the Red Cross parking lot, before the meeting for a great pass of the AO-51 at 5:37PM that evening.**

**In This Issue:** **Page**



The next general meeting will be:

**Friday, June 18th @ 7:00 PM**

We will be meeting in Room 208
In the east Red Cross Building

**ORANGE COUNTY AMATEUR RADIO CLUB**
**www.W6ZE.org**

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stevebrody@sbcglobal.net

## Monthly Events:

### General Meeting:
Third Friday of the month
at 7:00 PM
American Red Cross
601 N. Golden Circle Dr.
(Near Tustin Ave. & 4th St.)
Santa Ana, CA

### Club Breakfast:
Second Saturday of every
month at 8:00 AM
Jagerhaus Restaurant
2525 E. Ball Road
(Ball exit off 57-Freeway)
Anaheim, CA

## Club Nets (Listen for W6ZE):

28.375 ± MHz SSB
Wed- 7:30 PM - 8:30 PM
Bob AF6C, Net Control

146.55 MHz Simplex FM
Wed- 8:30 PM - 9:30 PM
Bob, WB6IXN, Net Control

145.400 MHz (-) PL 103.5 Hz
Thur – 8:00 PM – 9 PM
Nicholas AF6CF, Net Control

7.086 ± MHz CW **OCWN**
Sun- 9:00 AM – 10 AM
John WA6RND, Net Control

**VISIT OUR WEB SITE**

**http://www.w6ze.org**

for up-to-the-minute club information, the latest membership rosters, special activities, back issues of RF, links to ham-related sites, vendors and manufacturers, pictures of club events and much much more.

## Club Dues:

| | |
|---|---|
| Regular Members | ...$20 |
| Family Members* | ...$10 |
| Teenage Members | ..$10 |
| Club Badge** | …….$3 |

Dues run from Jan thru Dec and are prorated for new members.

*Additional members in the family of a regular member pay the family rate up to $30 per family.

**There is a $1.50 charge if you'd like to have your badge mailed to you.

# Dayton HamVention 2010

**by**

**Ken Diaz WB9YCJ**

The recent ham convention held in Dayton, Ohio was great!! Dayton Hamvention is a big retail event as well as social and educational. The outdoor flea market is educational as well as a great place to find retail bargains. This was my tenth journey to this yearly event. If you love ham radio and never been to Dayton Hamvention, I encourage you to attend next year. Booked in advance, attractive airfare is had from LAX or Orange County to Chicago or Indianapolis. Airfare is also available to Dayton and nearby Columbus, Ohio. Car rental seems a bit more price attractive at O'Hare airport which is about a 5 hour drive to Dayton, but you will also have a chance to explore Chicago.


**Hams gather outside the doors before the event opens**


**Plenty of buses were available for the event**

**The crowd heads for the flea market**

**Any booth might have exactly what you were looking for?**

**Classic ham rigs from two famous companies Collins and Heathkit**

**Take your choice of "dishes"!**

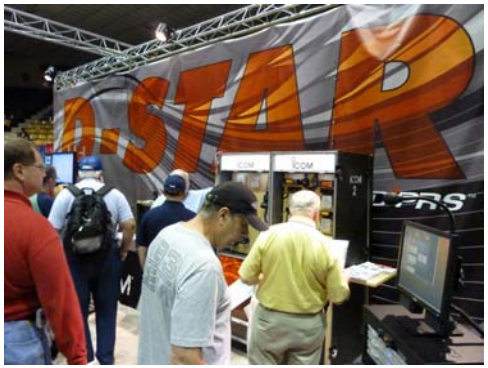
**Need some classic Hammarlund HQ-145 receivers?**


**Great price for microwave "hard-line" coax**

**Can you count the number of antennas on this truck roof?**


**Here is one of the indoor arenas (east) - "elbow-room only" often the norm**


**At the ICOM booth, IC-7800 on the left, IC-7700 on the right**




**Quite a few hams went to Dayton just to talk about D-Star**


**Friend of OCARC, Gordon West WA6NOA, was there working the W5YI Group booth**


**DownEast Microwave is famous for their microwave amplifiers**


**No ham convention is complete without a booth to check QSL cards for DXCC**

# OCARC Field Day 2010
# June 25, 26, 27

# Don't Miss It!!!

## Come Out to FIELD DAY and Have Some FUN!!!!

**1) FD Co-Chairmen**

Ken W6HHC and Doug W6FKX are co-chairmen for FD

**2) Band Captains**

The following people are the Band Captains

- 20M PH – Ken W6HHC
- 20M CW – Paul W6GMU
- 40M PH – Doug W6FKX
- 2M and UHF – Robbie KB6CJZ
- GOTA – Brett W6BAC (with Boy Scout Troop 788 )

**3) Field Day Site**

George N6VNI has obtained permission allowing OCARC to use Walter Knott Elementary School field in Buena Park this year for FD. See map and driving instructions on next page.

**4) Field Day Set-up Plans**

- Set-up is planned to begin at 1 PM on Friday afternoon, June 25
- Tear-down will begin at 11 AM Sunday morning.....we need YOUR help!

**5) Field Day Food**

The OCARC will be providing food for the main meals. Each participant who is eating will asked to donate $20 to help defray food costs for the entire weekend.

- Friday evening - "tri tips dinner and salad" catered.
- Saturday morning – no plans for meals
- Saturday lunch - some band captains will have special cook-up, some will have subway sandwiches
- Saturday evening – pizza will be brought in
- Sunday morning – Egg McMuffins, OJ, and coffee
- **Club will provide cold-iced water bottles**
- **Every FD participant should plan on bringing his own iced-tea, sodas, or Gatorade.**

Let us know if you can help the OCARC Field Day efforts.....

...de Ken W6HHC **W6HHC@W6ZE.org**

...de Doug W6FKX **W6FKX@W6ZE.org**

# OCARC FIELD DAY SITE AT WALTER KNOTT SCHOOL

**NORTH**
**(This is La Palma Avenue)**


**Field Day Location:** The Orange County Amateur Radio Club will be holding its 2010 Field Day event, the 24-hour simulated emergency communications operation, at the Walter Knott Elementary School, 7300 La Palma Avenue, Buena Park, CA 90620 (Orange County) The FD site is immediately to the West of Knotts Berry Farm.

- Head for Knott's Berry Farm
- Take the Beach Blvd (south) exit from the 91 or 5 FWY
- Turn right (west) on La Palma Ave, along the north edge of Knott's Berry Farm Park.
- Continue driving on La Palma, past the Park to 7300 La Palma Ave.
- The school will be on your left on the south side of La Palma. Use the second entrance.

The location of the OCARC FD site can be reached by driving along La Palma Avenue and turning South at the entrance to the school parking lot that is marked on the image of the site. From that point, head south until you reach the Field Day Site Entrance point. Parking will be available in and around the site. All Hams and visitors are welcome to the OCARC Field Day event. For a map of the 2010 Field Day Site, check out www.w6ze.org

# 2010 ARRL Southwestern Division Amateur Radio Convention

## September 17, 18 & 19

## San Diego, California

**Four Points, By Sheraton Hotel San Diego**
**8110 Aero Drive, San Diego CA 92123 Phone: (858) 277-8888**

http://www.sandarc.org/

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## Registration Form

***Please list additional Attendees – ALL ATTENDEES MUST BE REGISTERED***

***No charge for Children 16 or under when Accompanied by a Registered Adult***

**How did you find out about the Convention?**

☐ Radio ☐ Web search ☐ Ham Club ☐ News Paper ☐ Other _____

**Call Sign:** _____ **Last Name:** _____ **First Name:** _____

**Address:** _____ **City** _____

**State:** _____ **Zip Code:** _____ **E-mail:** _____

**Kids / Adults Call Sign Name (please print)**

____ _____ _____ _____

____ _____ _____ _____

____ _____ _____ _____

| | |
|---|---|
| **Early Bird Dated before May 31, 2010** | **$15.00 @ _____ ea. = $_____** |
| **Convention Pins Included (Limited Supplies)** | |
| **Pre Registration June 1, to Aug. 22, 2010** | **$18.00 @ _____ ea. = $_____** |
| **At Door Registration** | **$20.00 @ _____ ea. = $_____** |
| **Accompanied kids under 16 years Free** | |
| **DX Breakfast** | **$23.00 @ _____ ea. = $_____** |
| **Banquet Tickets Dinner ☐Beef ☐ Chicken ☐ Vegetable** | **$43.00 @ _____ ea. = $_____** |
| **Banquet Speaker: *To Be Announced*** | |
| **Convention Lunch** | **$25.00 @ _____ ea. = $_____** |
| **Lunch Speaker:** | |
| **2010 Convention Pins** | **$ 5.00 @ _____ ea. = $_____** |
| **2006 Convention Pins** | **$ 3.00 @ _____ ea. = $_____** |
| **2002 Convention Pins** | **$ 3.00 @ _____ ea. = $_____** |
| **QSL Card Checking** | **Totals_____** |

**Make Checks payable to:**

**PayPal is available on website at http://www.sandarc.org/convention2010/registration.html**

**SANDARC Convention**
C/O R. Boehme W2IRI
10340 Everell Pl.
Santee, CA 92071

***Web Form ver 1.04***

**Staff Use Only**

**Registrtion** _____
**Date** _____
**Amount** _____
**Check #** _____
**# Pins given** _____
**Receipt** _____
**Signed up** _____
**Other** _____
**Other** _____

## TechTalk 86

# Overview of DVB-T Modulation for Digital-ATV

**by Ken Konechy W6HHC**

Many of the earlier OCARC TechTalk articles about Digital-ATV have provided details about how DVB-S modulation works. DVB-S is currently the most popular modulation standard being used by hams for DATV. This month I will look at some of the technical details of DVB-T modulation.

The "T" in DVB-T means that it is designed to work well for terrestrial transmissions to your commercial DTV set at home. **Fig 1** shows a typical home terrestrial broadcast receiving station using a STB.

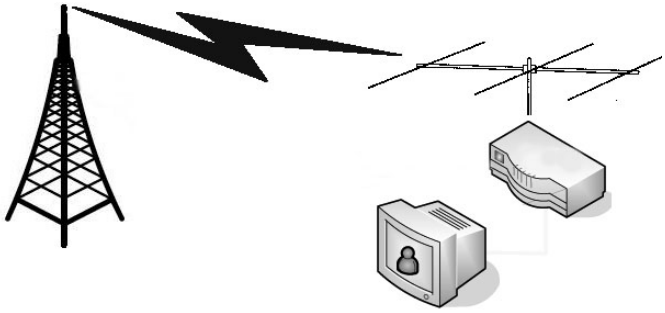

**Figure 1 - Terrestrial Reception using a Commercial Set-Top-Box (STB)**

DVB-T is used for home terrestrial reception in much of the world (Europe, Asia, and Pacific). In the United States and Canada, the competing DTV broadcast standard for terrestrial reception is called ATSC. A comparison table for the PROs and CONs between DVB-T and ATSC and DVB-S technologies can be found near the end of this article.

### Typical Transmitter Block Diagram

Groups and clubs of DATV enthusiasts have shown that DVB-T digital technology is possible for hams. **Fig 2** is a block diagram of a basic DVB-T transmitter used by several groups in Europe and Australia for DATV. The analog camera and video is compressed by a MPEG-2 encoder board. The TransportStream (TS) digital data is fed to the exciter board that does a lot of complicated data processing and then converts the digital data directly to modulated RF at a desired frequency. The small RF output signal of the exciter board is typically amplified by two stages of very linear RF amplifiers.

### Video Data-Rate and Compression

For DATV, the analog camera output is first digitized by the MPEG-2 Encoder board shown in **Fig 2**, and then compressed by the MPEG-2 algorithm. The reason the compressed video data rate varies in **Table 1** is that the small value means little motion in the video scene and the larger value means a lot of motion. MPEG-2 encoding can be used in two modes: (a) constant output mode per frame with null packets inserted as needed and (b) variable data per frame.

a) Encoding for DVB-T uses constant data rate with null inserts as needed
b) Encoding for DVD burning uses variable data per frame

Notice in **Table 1** that the digitized NTSC camera video data-bit-stream is 168 Mbits/sec before compression, and MPEG-2 will reduce this to a Net-Bit-Data-Rate between 1 and 3 Mbps, which is quite a reduction.

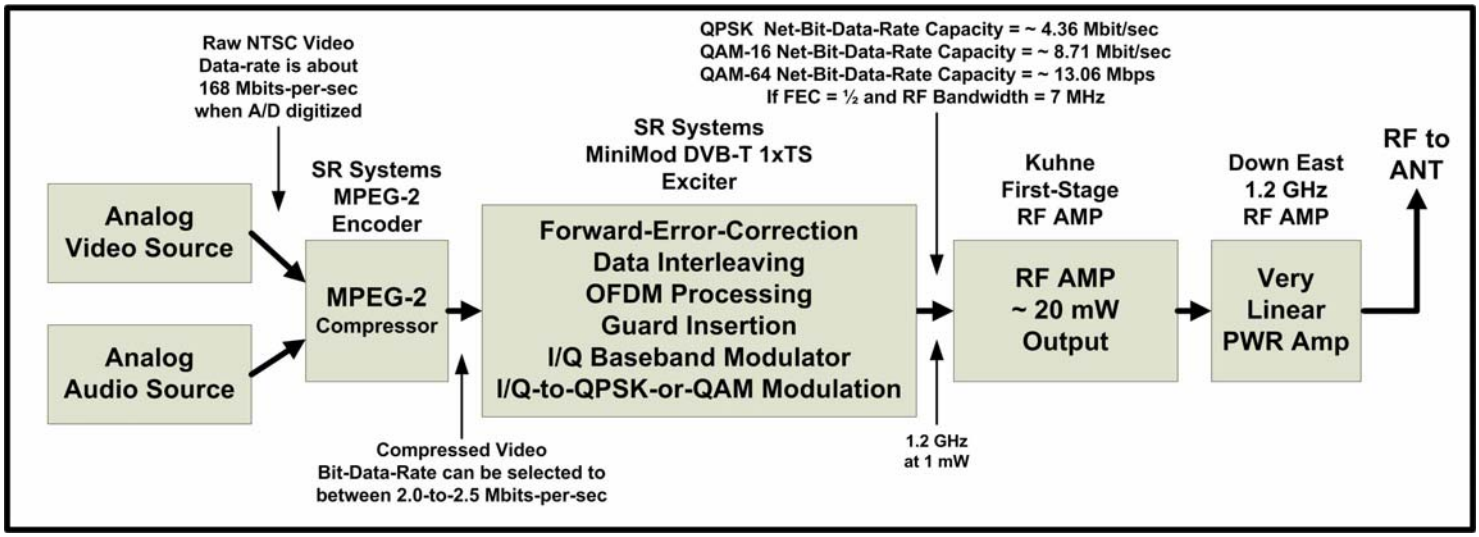


**Figure 2 – Block Diagram of Typical DVB-T Transmitter for DATV**

**Table 1 – Camera Video Data Streams and MPEG-2 Data Streams**

| Video Data Stream | Data-Rate | Notes |
|---|---|---|
| Analog NTSC camera | 168 Mbits/sec | A/D digitized, uncompressed |
| NTSC MPEG-2 | 2-3 Mbits/sec | compressed |
| VHS MPEG-2 | 1-2 Mbits/sec | compressed |
| Analog PAL camera | 216 Mbits/sec | A/D digitized, uncompressed |
| PAL MPEG-2 | 2.5-6 Mbits/sec | compressed |
| HDTV camera | 1-1.5 Gbits/sec | uncompressed |
| HDTV MPEG-2 | 15-60 Mbits/sec | compressed |
| HDTV MPEG-4 | 12-20 Mbits/sec | compressed |

The MPEG-2 encoder I use makes a direct measurement of the compressed video rate not practical. Discussions with many hams in Europe reveal that they plan for the MPEG-2 output payload data-rate to be set typically between 2.0 and 2.5 Mbits/sec for PAL with excellent results for D1 video resolution. My own DATV tests show that settings of either 2.0 or 2.1 Mbps provide excellent video quality for NTSC. [As a note: TechTalk85 provided a detailed look at how the MPEG-2 processing works.]

**FEC Inflation of Payload Data Stream Data-Rate**
Forward Error Correction (FEC) is a technology that not only can detect errors on the received signal, but adds enough redundancy of the data so that it can correct several wrong bits. But, there is a trade-off when choosing the amount of redundancy. Since redundancy inflates the data-rate of the output stream, the trade-off is between more redundancy or keeping the inflated data-rate smaller. As we will see a little later in this article, the larger the inflated output data-rate, the higher the required symbol rate. Higher symbol rates may force you to a wider-bandwidth or a more noise-sensitive modulation scheme. So at some point the FEC algorithm will not have enough redundancy to correct too many errors, and the DATV receiver screen will go blank or freeze.

The DVB-T commercial television standard uses a combination of two different Forward-Error-Correction (FEC) algorithms together in order to provide protection against noise errors and multipath errors. The first FEC algorithm is called the inner-Punctured-Convolutional-Code by the DVB-T specification (and typically called Viterbi in DVB-S articles). The second FEC algorithm is called Reed-Solomon. These two algorithms are the same as those used in DVB-S technology.

Convolutional encoding with Viterbi decoding is a FEC technique that is well suited to a channel in which the transmitted signal has been corrupted by Gaussian noise. The inner-Punctured-Convolutional-Code FEC algorithm can be configured for different levels of error correction. These different Puncture-Table redundancy settings are usually called: 1/2, 2/3, 3/4, 5/6 and 7/8. Where the first number (“1” in the case of configuration 1/2) is the number of input bits. The second number (“2” in the case of configuration 1/2) is the number of output bits from this FEC algorithm.

So the MPEG2 output data stream is “inflated” 100% by this $FEC_{viterbi}$ algorithm configured for 1/2. That is...for every bit going into the FEC engine, two bits come out. A $FEC_{viterbi}$ algorithm configured for 3/4, for example, would inflate the MPEG-2 output data stream by 33%. So FEC levels can really inflate the data-bit-rate going to the RF modulator; the MPEG-2 algorithm compresses the video stream, but the FEC algorithms start to expand the required data-bit-rates again.

The second algorithm that is used, the Reed-Solomon FEC algorithm, has a fixed configuration. Its data stream “inflation rate” is 188/204. So for every 188 bits going into the $FEC_{reed\text{-}solomon}$ algorithm, 204 bits come out...an additional FEC inflation of 8.5%.

**Digital Modulation Symbols and Symbol-Rates**
Digital modulation technology like BPSK (for example PSK-31), QPSK (Quad Phase Shift Keying – like DVB-S and DVB-T) and QAM-256 (Quadrature Amplitude Modulation with 256 “constellation points”) have the ability to put more information into a more narrow frequency spectrum than analog modulation. The complexity of the digital modulation scheme, allows us to pack more “data bits” into each SYMBOL. **Table 2** lists out how many data bits can be packed into a symbol for several well known digital modulation technologies.

DVB-T technology users can choose between QPSK, QAM-16, or QAM-64 modulation schemes (shown in BLUE) for the COFDM sub-carriers discussed latter.

**Table 2 – Symbol Bit-Packing for Various Digital Modulation Technologies Modulations in BLUE can be selected for DVB-T**

| Modulation Scheme | Data Bits per Symbol (Me) |
|---|---|
| BPSK | 1 |
| GMSK | 1 |
| **QPSK** | **2** |
| 8-VSB | 3 |
| **QAM-16** | **4** |
| **QAM-64** | **6** |
| QAM-256 | 8 |

The higher-order modulations schemes, like QAM-16 and QAM-64) can "pack" more bits into the symbol rate than QPSK. But, the complexities for QAM-16 and QAM-64 modulation make them more susceptible to noise and interference. **Fig 3**, **Fig 4**, and **Fig 5** are intended to give an appreciation of the increasing complexities for these three modulation schemes.

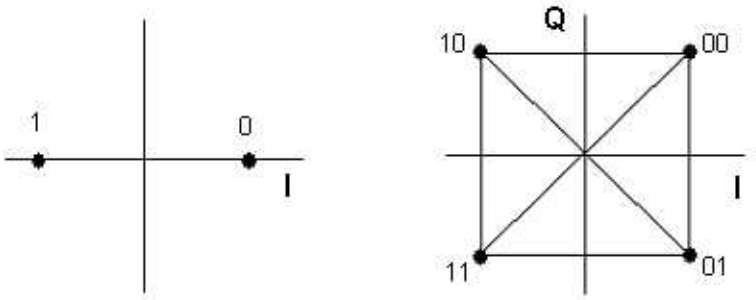


**Figure 3 – The constellations of BPSK (on the left) with two states and by QPSK with four states.**

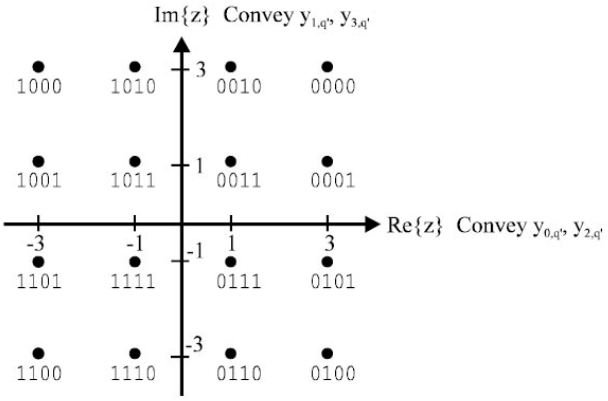


**Figure 4 – The constellation for QAM-16 modulation contains 16 states. Each state defines four bits of data.**

Notice in **Fig 4** that not only is the angle from the origin to the state important, but the amplitude from the origin is critical, also. The I-axis amplitude of the signal can have four different values. The Q-axis (shown as the R-axis in this drawing) can also have four amplitude values.

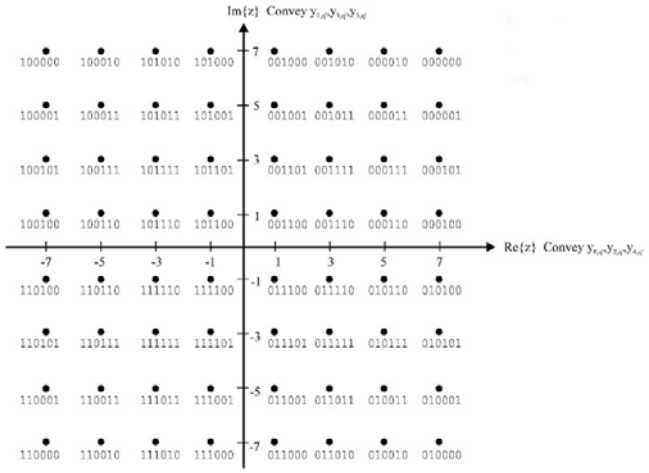


**Figure 5 – The constellation for QAM-64 modulation contains 64 states. Each state defines six bits of data.**

I use **Fig 3** and **4** and **5** to help me to visualize the differences between the complexities of QPSK, QAM-16 and QAM-64 modulation technologies. There is a balance between the rate at which data can be transmitted and the signal-to-noise ratio that can be tolerated. The lower order modulation schemes like QPSK do not transmit data as fast as the higher modulation formats such as QAM-64, but they can be received better when signal strengths are weaker.

**COFDM**

The DVB-T technology adds a process to the modulation of the RF signal that is very different form either DVB-S or ATSC modulations. The negative effects of multipath reflections can be reduced, by using 16QAM modulation with a low effective bitrate per carrier. To reduce the effective bitrate per carrier, DVB-T spreads out the bitrate over a large amount of carriers. This spreading out will result in 1,705 closely spaced sub-carriers (using COFDM.....aka Coded Orthogonal

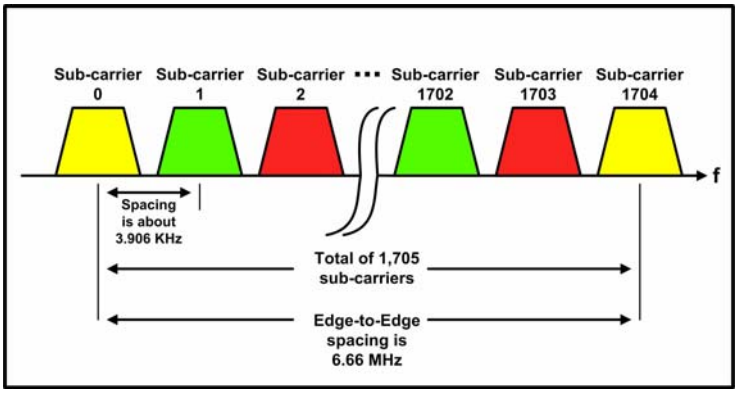


**Figure 6 – COFDM spreads the DATV signal over 1705 sub-carriers (7 MHz bandwidth is shown)**

Frequency Division Multiplexing) to create a bandwidth that can be chosen to 6MHz or 7MHz or 8MHz wide. **Fig 6** shows an example where there 1,705 sub-carriers spaced at about 3.906 KHz apart...to create a 7MHz bandwidth signal.

Normally these sub-carrier signals would be expected to interfere with each other, but by making the signals orthogonal to each another there is no mutual interference. This is achieved by having the carrier spacing equal to the reciprocal of the symbol period. This means that when the signals are demodulated they will have a whole number of cycles in the symbol period and their contribution will sum to zero - in other words there is no interference contribution.

When I read different articles on DVB-T technology, I observed that some articles use the term COFDM, and other articles use the term OFDM. What is the difference?? Wikipedia just says "they are the same" for DVB-T articles?? Hans Hass DC8UE was kind enough to dig up a better explanation for the difference between COFDM and OFDM. He found the following information

**COFDM**
**Coded Orthogonal Frequency Division Multiplex**
**C**=Coded – means it uses FEC
**O**=Orthogonal -means no cross talk between sub-carriers
**FDM**=Frequency Division Multiplex – means distribution of datastream over a lot of sub-carriers

So OFDM just is a similar communication protocol that does not use Forward-Error-Correction (FEC). In a way, Wikipedia is correct, the use of FEC does not affect the number of sub-carriers or the frequency bandwidth...FEC just changes the amount of data overhead added to the datastream. So many technical details stay the same between COFDM and OFDM.

Actually, COFDM can be chosen for 1,705 sub-carriers called the 2K mode, or for 6,816 sub-carriers, called the 8K mode. Stefan Reimann DG8FAC of SR-System explained that ham radio DATV only uses the 2K mode of DVB-T. Stefan DG8FAC detailed that the 8K mode is only used in commercial DTV broadcasts to create Single-Frequency-Networks (SFN) where two or more transmitters carrying the same data operate on the same frequency (to provided geographically overlapping coverage) without causing interference to each other. This SFN concept is too complex for ham radio applications and also the size of the FPGA needed for the 8K mode becomes larger and more expensive than the current MiniMod board design.

A final point about COFDM in DVB-T is that the sub-carriers, as shown in **Fig 6**, can all be modulated with either QPSK or with QAM-16 or with QAM-64.

**The Role of the DVB-T Guard Insertion.**
Wikipedia explains that the purpose of the guard interval is to introduce immunity to propagation delays, echoes and reflections, to which digital data is normally very sensitive. In COFDM, the beginning of each symbol is preceded by a guard interval. As long as the echoes fall within this interval, they will not affect the receiver's ability to safely decode the actual data, as data is only interpreted outside the guard interval.

Longer guard periods allow more distant echoes to be tolerated. However, longer guard intervals reduce the channel efficiency. With DVB-T, four guard intervals are available (given as fractions of a symbol period):

1/32 1/16 1/8 1/4

Therefore, choosing a guard interval of 1/32 gives lowest protection from long echoes and the highest data rate. A guard interval of 1/4 results in the best protection but the lowest data rate.

**Table 3** provides details of Guard Interval delay times for 6 MHz and 7 MHz configurations

**Table 3 – Details of Guard Interval timing for 6 MHz and 7 MHz Bandwidths**

| | 6 MHz - 2K Mode | | | | 7 MHz - 2K Mode | | | |
|---|---|---|---|---|---|---|---|---|
| **Guard Interval** | **1/4** | **1/8** | **1/16** | **1/32** | **1/4** | **1/8** | **1/16** | **1/32** |
| **Duration of Symbol w/o padding** | **2048 x T 298.67 uSec** | | | | **2048 x T 256 uSec** | | | |
| **Duration of Guard Interval** | **74.67 uSec** | **37.33 uSec** | **18.67 uSec** | **9.33 uSec** | **64 uSec** | **32 uSec** | **16 uSec** | **8 uSec** |
| **Guarded Symbol Duration** | **373.3 uSec** | **336.0 uSec** | **317.3 uSec** | **308.0 uSec** | **320 uSec** | **288 uSec** | **272 uSec** | **264 uSec** |

**Modulation and RF Bandwidth with DVB-T**

As discussed earlier, DVB-T transmissions can be chosen to use QPSK, QAM-16, or QAM-64 for modulation. In addition, the transmitter can be chosen for 6 MHz, 7 MHz or 8 MHz bandwidth. The choice of the modulation does not affect the RF bandwidth because the carrier has been divided into so many evenly-spaced sub-carriers (1,705 sub-carriers for DATV). **Fig 7** shows the typical spectrum analyzer view of a DVB-T transmission with 8 MHz bandwidth.

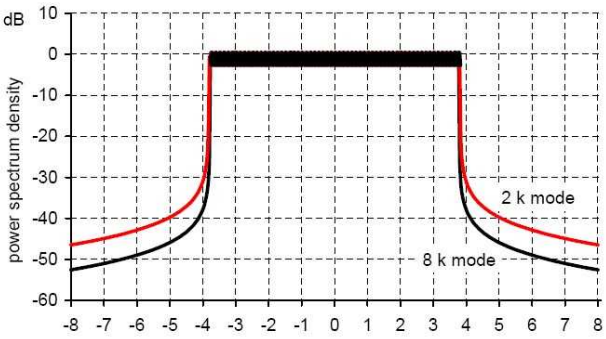


**Figure 7 – Theoretical spectrum for an 8 MHz wide DVB-T signal**
**(NOTE: bottom axis is labelled in MHz)**

The only difference in the choice of modulation is the amount of payload for Net-Data-Bit-Rate that is available in the transmission, for a given bandwidth. The Net-Data-Rate that the transmission can provide is shown in **Table 4**. For a given bandwidth, the efficiency that is available is affected by the FEC setting and the Guard Interval setting. Notice that QAM-64 modulation in **Table 4** provides approximately 50% more payload (NDBR) than the same settings for QAM-16 modulation. Also, QPSK modulation provides approximately 50% less payload than QAM-16 modulation.

**Table 5 – Example of DVB-T Transmission "Payload" for different Modulation Schemes**

| | Net-Data-Bit-Rate for FEC=1/2 Guard = 1/4 | |
|---|---|---|
| **Modulation** | **6 MHz BW** | **7 MHz BW** |
| **QPSK** | **3.74 Mbps** | **4.36 Mbps** |
| **QAM-16** | **7.46 Mbps** | **8.71 Mbps** |
| **QAM-64** | **11.20 Mbps** | **13.06 Mbps** |

**Table 5** is a sample of "payloads" (NDBR) for different modulation schemes using same FEC setting and same Guard Intervals. If you remember that NTSC MPEG2 TS can be selected to be around 2.0 Mbps NDBR (see **Table 1**), then you can see that two video TS can be carried by a single QPSK 7 MHz carrier. QAM-16 and QAM-64 can carry even more TS videos at the same time. Essential, this how commercial DTV broadcast stations can carry six DTV "sub-channels" on the same transmitter.

I wondered why wider bandwidths provided a higher payload data-rate, if each bandwidth used exactly the same number of sub-carriers?? Then, I remembered that the Symbol-rate for each bandwidth is adjusted based on the spacing of the sub-carriers to provide the orthogonal interference protection. So, narrower bandwidths do require the use of slower Symbol-rates.

**Table 4 – Net-Data-Rate for a Chosen RF Bandwidth and Modulation Scheme**
**(Table courtesy of SR-Systems)**

| Modulation | FEC Coderate | Channel bandwidth/Kanalbandbreite (MBit/sec) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 8 MHz | | | | 7 MHz | | | | 6 MHz | | | | 5 MHz | | | |
| | | Schutzintervall/Guard | | | | Schutzintervall/Guard | | | | Schutzintervall/Guard | | | | Schutzintervall/Guard | | | |
| | | 1/4 | 1/8 | 1/16 | 1/32 | 1/4 | 1/8 | 1/16 | 1/32 | 1/4 | 1/8 | 1/16 | 1/32 | 1/4 | 1/8 | 1/16 | 1/32 |
| QPSK | 1/2 | 4,98 | 5,53 | 5,85 | 6,03 | 4,36 | 4,84 | 5,12 | 5,28 | 3,74 | 4,15 | 4,39 | 4,52 | 3,11 | 3,46 | 3,66 | 3,77 |
| | 2/3 | 6,64 | 7,37 | 7,81 | 8,04 | 5,81 | 6,45 | 6,83 | 7,04 | 4,98 | 5,53 | 5,86 | 6,03 | 4,15 | 4,61 | 4,88 | 5,03 |
| | 3/4 | 7,46 | 8,29 | 8,78 | 9,05 | 6,53 | 7,25 | 7,68 | 7,92 | 5,60 | 6,22 | 6,59 | 6,79 | 4,66 | 5,18 | 5,49 | 5,66 |
| | 5/6 | 8,29 | 9,22 | 9,76 | 10,05 | 7,25 | 8,07 | 8,54 | 8,79 | 6,22 | 6,92 | 7,32 | 7,54 | 5,18 | 5,76 | 6,10 | 6,28 |
| | 7/8 | 8,71 | 9,68 | 10,25 | 10,56 | 7,62 | 8,47 | 8,97 | 9,24 | 6,53 | 7,26 | 7,69 | 7,92 | 5,44 | 6,05 | 6,41 | 6,60 |
| 16-QAM | 1/2 | 9,95 | 11,06 | 11,71 | 12,06 | 8,71 | 9,68 | 10,25 | 10,55 | 7,46 | 8,30 | 8,78 | 9,05 | 6,22 | 6,91 | 7,32 | 7,54 |
| | 2/3 | 13,27 | 14,75 | 15,61 | 16,09 | 11,61 | 12,91 | 13,66 | 14,08 | 9,95 | 11,06 | 11,71 | 12,07 | 8,29 | 9,22 | 9,76 | 10,06 |
| | 3/4 | 14,93 | 16,59 | 17,56 | 18,10 | 13,06 | 14,52 | 15,37 | 15,84 | 11,20 | 12,44 | 13,17 | 13,58 | 9,33 | 10,37 | 10,98 | 11,31 |
| | 5/6 | 16,59 | 18,43 | 19,52 | 20,11 | 14,52 | 16,13 | 17,08 | 17,60 | 12,44 | 13,82 | 14,64 | 15,08 | 10,37 | 11,52 | 12,20 | 12,57 |
| | 7/8 | 17,42 | 19,35 | 20,49 | 21,11 | 15,24 | 16,93 | 17,93 | 18,47 | 13,07 | 14,51 | 15,37 | 15,83 | 10,89 | 12,09 | 12,81 | 13,19 |
| 64-QAM | 1/2 | 14,93 | 16,59 | 17,56 | 18,10 | 13,06 | 14,52 | 15,37 | 15,84 | 11,20 | 12,44 | 13,17 | 13,58 | 9,33 | 10,37 | 10,98 | 11,31 |
| | 2/3 | 19,91 | 22,12 | 23,42 | 24,13 | 17,42 | 19,36 | 20,49 | 21,11 | 14,93 | 16,59 | 17,57 | 18,10 | 12,44 | 13,83 | 14,64 | 15,08 |
| | 3/4 | 22,39 | 24,88 | 26,35 | 27,14 | 19,59 | 21,77 | 23,06 | 23,75 | 16,79 | 18,66 | 19,76 | 20,36 | 13,99 | 15,55 | 16,47 | 19,96 |
| | 5/6 | 24,88 | 27,65 | 29,27 | 30,16 | 21,77 | 24,19 | 25,61 | 26,39 | 18,66 | 20,74 | 21,95 | 22,62 | 15,55 | 17,28 | 18,29 | 18,85 |
| | 7/8 | 26,13 | 29,03 | 30,74 | 31,67 | 22,86 | 25,40 | 26,90 | 27,71 | 19,60 | 21,77 | 23,06 | 23,75 | 16,33 | 18,14 | 19,21 | 19,79 |

Die angegebenen Datenraten gelten für den 8k-, 4k- und 2k-Modus und beziehen sich auf 188-Byte DVB Pakete.

The specified data rates are valid for 8k, 4k, and 2k modes and apply for 188 bytes DVB packets.

An interesting note about DVB-T RF Bandwidth is that SR-Systems has designed their MiniMOD exciter boards to allow for selection of DVB-T transmission bandwidths of 8, 7 ,6, 5, 4, 3 MHz and down to only 2 MHz BW. These narrow bandwidths of 5 –to– 2 MHz are not covered by the commercial DVB-T standard. But, as Stefan DG8FAC explains "...we transmit on 70cm with 2MHz in QAM-16, 1/2FEC and 1/4 Guard, and this works perfectly." The NIM receiver boards that are available from SR-Systems, have modified firmware used with the DiBcom7000 chip used in the NIM DVB-T board to receive the 2 MHz BW. But, this "not-normal" bandwidth choice will not work with commercially available SetTopBoxes that were not intended to be used with a 2 MHz bandwidth.

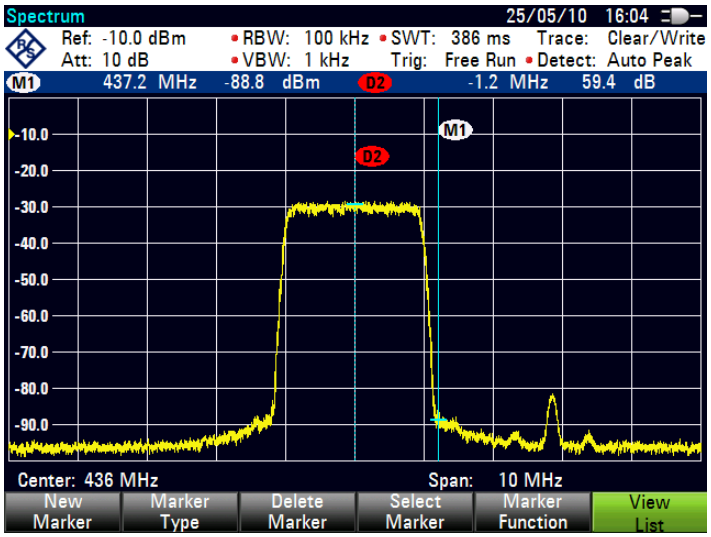


**Figure 8 – A DVB-T MiniMOD exciter output transmission is seen on a Spectrum Analyzer**
**(Courtesy of Stefan DG8FAC)**

**Fig 8** shows a DVB-T transmission spectrum produced at the output of a MiniMOD exciter board. This picture shows the direct resemblance to the theoretical DVB-T spectrum shown in **Fig 7**.

The spectrum display in **Fig 9** looks quite different than the theoretical shown in **Fig 7.** Peter Cossins VK3BFG who has contributed much to the VK3RTV repeater DATV progress explains "...The DVB-T spectrum from the final amp sampled via a directional coupler to a dummy load is quite rectangular. This spectrum **[Fig 9]** tapers off with increasing frequency ....it should be fairly flat on the top! The spectrum photo I have provided is live off a 49 element J beam ....I checked a local commercial UHF on the same antenna which is very close in freq and it looks somewhat similar, but a bit more rectangular as it should be. The repeater antenna up the hill is the original analogue one optimized for 444.25 MHz, not 446.5 Mhz.

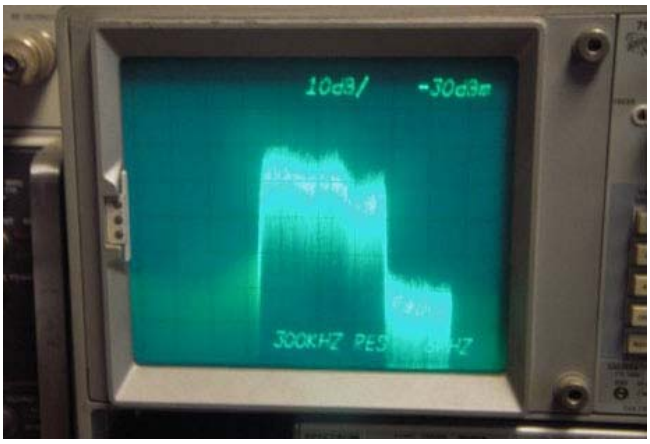


**Figure 9 – DVB-T transmission as seen on a Receiving Station shows effects of VK3RTV Transmit Antenna tuned off-frequency**
**(Courtesy of Peter VK3BFG)**

This seems to be confirmed as 'performance' is better at the bottom end rather than the top end. The repeater antenna is quite OK to about 4 MHz+ so it was satisfactory for the analogue system.

I think what you are seeing is the variations in gain performance of both antennas over the bandwidth... "

### De-rating the PA Output

It is finally worth noting that DVB-T is more sensitive to non-linearity of a power amplifier than DVB-S technology. This is because the QAM modulations have a very large "Peak-to-Average Ratio" called PAR. The graph in **Fig 10** shows that OFDM (think QAM-64) is very much worse than QPSK. Because you can not allow distortion from "flat-topping" the power peaks, the average power out of the amplifier will be set low.

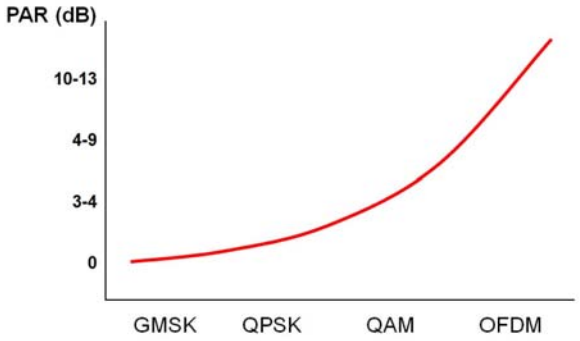


**Fig 10 – PAR for amplifier output power when processing signals with various digital modulation technologies**
**(Graph courtesy of Robert Green – Keithley Instruments, Inc.)**

Peter VK3BFG confirms by explaining "...Digital television [DVB-T] requires extremely linear RF amplifiers and hence it was necessary to bias the module close to Class A. This is an extremely inefficient mode with a maximum efficiency of 50%. The actual efficiency obtained for DVB-T was about 14 % !!!.

Driving the amp is extremely non-linear and the spectrum growth occurs at an alarmingly fast rate after a certain point has been reached...."

Hans Hass DC8UE has experience as a satellite communications engineer at a commercial TV station and has access to good communications instrumentation. Hans explains that "...On measurements with my own DATV DVB-T transmitter, I can operate the linear 6Watt PA only at 300mW (in QAM-16 mode). That is 13db below saturation or 5% from the possible FM-power (not DC-input power). If I increase the power, the MER [digital Modulation Error Ratio] will get poor values."

Stefan DG8FAC wrote: The exciter power output settings in DVB-T mode with a 6W Power Amplifier are made with ETL measuring equipment as follows:
GAIN = 08 yields MER 40dB [good] at 100mW OUT
GAIN = 10 yields MER 39dB [acceptable] at 250mW OUT
GAIN = 13 yields MER 34dB [poor] at 500mW OUT

On the web site from Alberto (DGØVE) you can read (in German): All amplifiers can also be used for DVB-S and DVB-T with reduced power. You will notice that in the DVB-S mode only about 20% to 25% of the maximal power (P-1dB) can be used. Working in the DVB-T mode you will get only approximately 8% to 10% of the P–1dB power level.

## Comparing DVB-T with DVB-S and ATSC

**Table 6** goes though an exercise of PROs and CONs for each of the primary technologies considered for ham DATV. Many hams see the primary disadvantage of DVB-T for DATV as squeezing the fixed bandwidth of normally 6 MHz or wider into crowded band plans. But, on the opposite side of the coin is the DVB-T capability to easily carry more than one video picture simultaneously on the same carrier. Choosing a DATV technology really depends on your requirements.

## Conclusion

DVB-T technology offers many interesting concepts and capabilities for ham DATV. There can be no doubt that its design to deal with multi-path noise is impressive. My main reason for selecting DVB-S for my home station was to take advantage of the narrow bandwidth offered for DATV. But, I enjoy studying the competing DATV technologies and understanding how they work. My philosophy in this TechTalk article is that it is good to know the strengths and weaknesses of each DATV technology.

**Table 6 – Comparing PROs and CONs between DVB-S, DVB-T and ATSC DATV Technologies**

| | DVB-S | DVB-T | ATSC |
|---|---|---|---|
| PROs | Bandwidth can be as small as 2 or 3 MHz<br><br>Cheap FTA Set Top Boxes (STB) on eBay<br><br>Wide-spread experience and knowledge is provided by European hams on the Internet | Excellent multipath interference immunity<br><br>Cheap Set Top Boxes (STB) on eBay<br><br>6 MHz bandwidth can support multiple video streams | Excellent multipath interference immunity<br><br>Cheap Set Top Boxes (STB) in USA<br><br>6 MHz bandwidth can support multiple video streams |
| CONs | Multipath interference immunity not as strong as DVB-T or ATSC, but plenty of FEC correction is available | Standard 6, 7, or 8 MHz fixed bandwidth is no advantage over analog-ATV<br><br>High Peak-to-Average of power for QAM modulation requires very linear power amps and large de-rating of average output power.<br><br>Typically DVB-T exciter board is 100% more expensive than DVB-S | 6 MHz fixed bandwidth is no advantage over analog-ATV<br><br>Dolby audio AC3 encoder licensing issue unfeasible for hams<br><br>Current ham transmitter boards for ATSC cannot provide AC3 audio (Dolby)<br><br>Use of substitute MPEG-2 audio does not work with ATSC STBs, but can (may?) work with cable-ready DTV receivers |

## Interesting DATV Links

- Digital Video Broadcasting organization (DVB commercial standards) – see **www.DVB.org**
- Digital Video Broadcasting standard for DVB-T – see ETSI EN 300 744 V1.6.1 specification
- TAPR PSR Quarterly Journal Issue 111 on DVB-S Modulation – see **www.TAPR.org/psr.html**
- British ATV Club - Digital Forum – see **www.BATC.org.UK/forum/**
- German portal for DATV streaming repeaters and downloads – see **www.D-ATV.net** (in German)
- AGAF D-ATV components (Boards) – see **www.datv-agaf.de** and **www.AGAF.de**
- Lechner DATV Boards - **http://lechner-cctv.de/d-atv-dvb.151.de.html?mwdSID=9agn7phuiu46fvm2ok3aueltf3**
- Complete ready-to-go DATV transmitters – see **www.d-atv.org/D-ATV-Modulator.pdf**
- SR-Systems D-ATV components (Boards) – see **www.SR-systems.de**
- DGØVE microwave amps, up-converters, down-converters – see **www.DG0VE.de**
- Kuhne Electronics (DB6NT) RF Amplifiers – see **www.Kuhne-Electronic.de**
- Charles Brain G4GUO blog on programming SDR for DVB-T transmitter – see **http://G4GUO.blogspot.com/**
- Melbourne DATV Repeater VK3RTV – see **www.VK3RTV.com/latest.html**
- Orange County ARC newsletter entire series of DATV articles – see **www.W6ZE.org/DATV/**
- Wikipedia on DVB-T – see **http://en.wikipedia.org/wiki/DVB-T**
- Wikipedia on Guard Band – see **http://en.wikipedia.org/wiki/Guard_interval**

# OCARC

## General Meeting Minutes

## May 21, 2010

The OCARC May General Meeting was held at the Red Cross complex in Santa Ana at 7:00 pm on Friday evening May 21, 2010. There were a total of 43 members and visitors present. There were nine club officers present for a quorum.

Kristin K6PEQ opened the meeting to with the Pledge of Allegiance. She then introduced our guest speaker – Charles Basham – N6DZW, Public Safety Manager of Southern California Edison.

Since the 1940's the Edison Amateur Radio Network has been active. The W6SCE network is on 144.33 and 446.00. Charles started his discussion with this thought "**Safety is a choice and often just common sense**". He pointed out that when working with electricity a basic thought is "Plan the Work, Work the Plan". This plan has something of value for each of us. In the planning of each electrical project – be prepared to organize your project, have emergency plans ready to go in the event of an accident.

One of his important points was "Call before you dig – dial 811". This is a free service available for Southern California Edison to prevent digging into power lines. Remember if you dig without calling "811" and hit underground power lines you are liable!

His Field Day safety suggestions are:

- Look up for power lines
- Locate antennas far away from power lines
- Never throw antennas, guide wires
- Never set up antennas in the dark
- Be aware of power lines touching trees

Charles N6DZW shared some invaluable information and hopefully everyone left with a better awareness of the dangers of electricity. Common sense safety is the answer.


**Fig 1 – Charles N6DZH of SCE presents on Electrical Safety**

After our guest speaker we had Roll Call and introduction of members and visitors. We had five new members and our sixth was a former member who renewed. Welcome to all!
Kristin reminded the membership that OCARC is scheduled for two days at the Orange County Fair – Wednesday, July 21st and Saturday, August 7th. Please contact Kristin to sign up and have a day at the OC Fair. The Amateur Radio booth is lots of fun and you get to share your experiences with everyone. It is a rewarding experience.

Ken W6HHC and Doug W6FKX discussed the upcoming Field Day plans. They are still in need of volunteers for set up, operating the radios and tear down. If you have time available and a pick up truck contact Ken or Doug. Plan on visiting Field Day at Walter Knott School – June 25-27th.

Kristine KC6TOD reminded everyone of the early bird sign up for the 2010 ARRL Convention in San Diego September 17, 18 & 19th. Check out their website for more information: http//www.sandarc.org. The convention is being held at the Four Points Sheraton Hotel & Convention Center in San Diego.

The next OCARC Board meeting is being held on Saturday, June 12 at 8:15 am the Jagerhaus Restaurant 2525 East Ball Road, Anaheim.

For SHOW & TELL – Clem WØMEC shared his experience with the Morse Code, his Telegrapher experience for the railroad and his own personal key. He reminded everyone of Samuel Morse's birthday on May 24th. Clem had some interesting handouts as well as passed around his QSL cards collected for many years (some of which brought back memories to several members). Thank you Clem.

**Fig 2 – New member Clem WØMEC provided a short talk on American Morse Code**

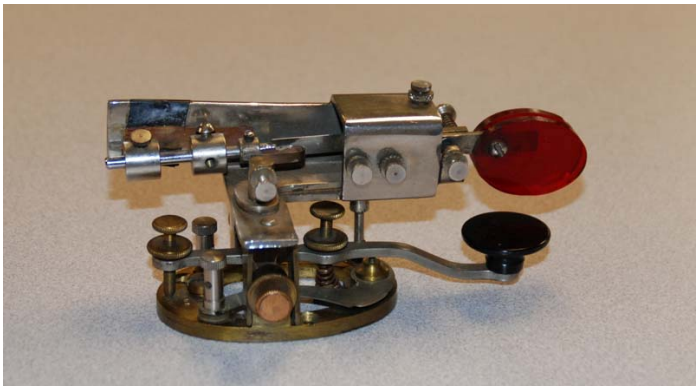

**Fig 3 – Clem WØMEC provided a show-and-tell on an unusual key**

It was with great pleasure that Kristin presented a check from OCARC to Tom KI6GOA as a thank you donation to the Red Cross for allowing us the use of the facilities in Santa Ana for our meetings

**Fig 4 – OCARC President Kristin K6PEQ presents Tom KI6GOA of American Red Cross with a donation check**

It was a great meeting and everyone was looking forward to the raffle. Motion to adjourn by Nicolas AF6CF and seconded by Larry K6YUI. Meeting adjourned at 8:45 pm.

**Respectfully submitted:**

**Kristine Jacob KC6TOD – OCARC Secretary**

# OCARC Board Meeting Minutes
# May 08, 2010

The ORARC Board meeting was held at the JagerHaus Restaurant, 2525 East Ball Road, Anaheim, at 8:15AM Saturday, May 8, 2010. There were a total of 6 directors and 2 visitors – Diane Konechy & George Jacob N6VNI. There was a quorum with the directors' present.

**DIRECTOR REPORTS**:

- President Kristin K6PEQ – confirmed the May speaker – Charles Basham N6DZW from SCE
- Treasurer Ken W6HHC –Balance on hand $5,995.
- Kristine –KC6TOD – reminded that K6VDP has the equipment from the silent key donation and we need to notify the club of the availability of the equipment.
- Membership Loran AF6PS confirmed that we have 80-85 members, 3 new and flyers are at HRO
- Nicholas AF6CF shared the successful Baker to Vegas experience
- Larry K6YUI – none

**OLD BUSINESS:**

- **RF Newsletter " Rotating" Editors – thank you to all who volunteer!**
  - June – Ken W6HHC
  - July - Paul W6GMU
  - August – Kristin K6PEQ
  - September – Bob AF6C
  - October - Kristine KC6TOD
  - November – TBD
  - December - TBD
- **2010 Field Day Plans –**
  - Location WALTER KNOTT SCHOOL
  - Ken W6HHC and Doug W6FKX – co-chairmen
  - Organization of Band Captains – we are looking for volunteers
    - 20 Meter phone – Ken W6HHC
    - 20 Meter CW – Paul W6GMU
    - 40 Meter Phone – Doug W6FKX
    - 75/15M Ph -50% commitment by the Catalina Repeater group [note: they can't make it]
    - 2M (and 6M… maybe UHF) Robbie KB6CJZ
    - Looking for additional team captains

  .The Chuck Wagon will be volunteers – sandwiches and pizza, beverages refilled, etc. Very simple. (See inset with up to date Field Day plans) Need runners for food.

- **Eyeball Cards** – Project in process - Robbie KB6CJZ and Nicolas AF6CF handling.

**NEW Business -** Orange County Fair - OCARC days are July 21st and August 7th. Need list of volunteers to be sent in for Megan's Law.

**GOOD OF THE CLUB** – comments on the new ARRL website, not as user friendly.
OCARC Field Day information needs to be updated on ARRL website.

Motion made to adjourn meeting by Nicolas AF6CF and seconded by Ken W6HHC.
Meeting adjourned 8:50 AM
Respectfully submitted:
*Kristine Jacob KC6TOD*, Secretary