

SCTE CABLE-TEC
EXPO[®]'13
OCTOBER 21-24 / ATLANTA, GA

VALIDATING AND TROUBLESHOOTING OFDM

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What's the same?

The Fundamentals

- ▶ Levels
- ▶ Shielding
- ▶ Inside wiring
- ▶ Consistency

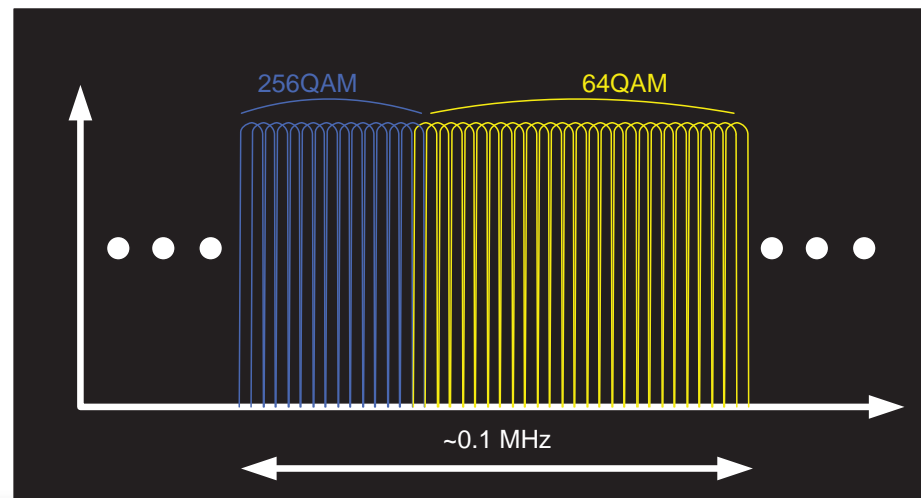
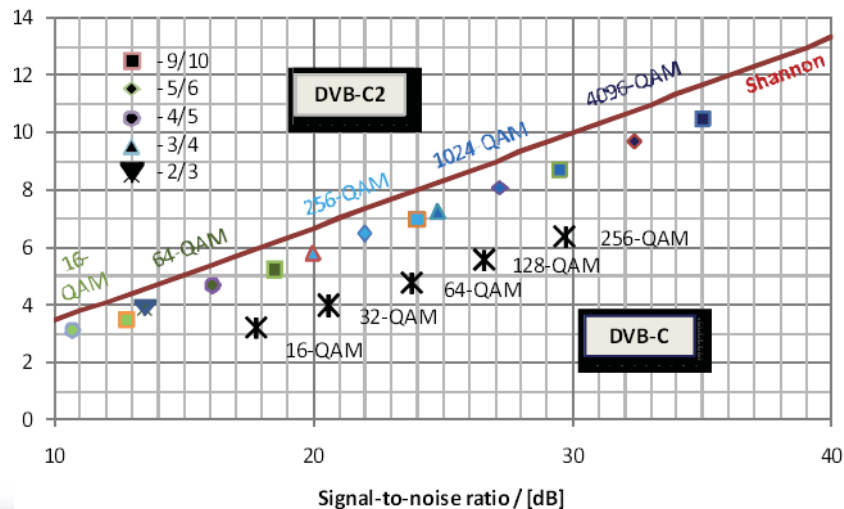
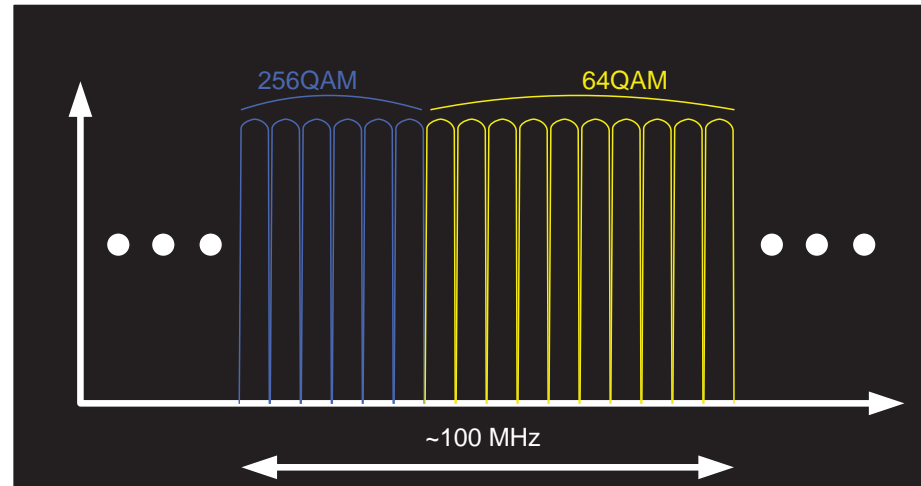


<http://www.reddit.com/r/cablefail>



What's different?

1. Number of carriers
2. Configurability
3. Error correction



Number of carriers is greater

- ▶ SC-QAM: 1 carrier
- ▶ OFDM: 1000's of carriers
 - MoCA = 224
 - **DVB-C2 = 3,208**
 - ISDB-T = 5,617
 - DVB-T2 = 853 to 27,265
- ▶ Each OFDM carrier is narrow in bandwidth
 - DVB-C2 = ~2 kHz bandwidth
- ▶ One OFDM channel can have more digital carriers than the whole CATV downstream



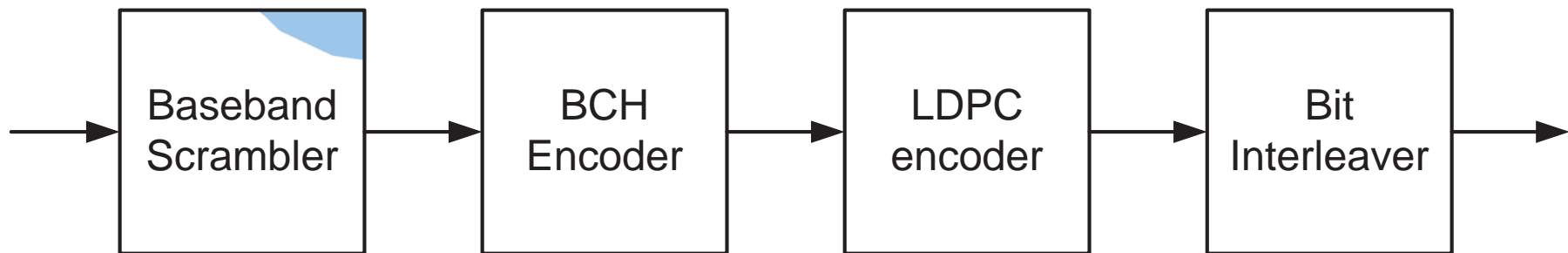
Configurability is greater

- ▶ SC-QAM (J.83 Annex B)
 - 64QAM or 256QAM
 - Interleaver
- ▶ OFDM (DVB-C2)
 - For each PLP (up to 255):
 - 16QAM, 64QAM, 256QAM, 1024QAM, or 4096QAM
 - FEC code rate
 - FEC frame rate
 - Guard interval 1/64 or 1/128
 - Time Interleaving Mode
 - PLP bundling



Modern error correction

- ▶ SC-QAM:
 - Reed-Solomon (+Trellis with J.83B)
- ▶ OFDM:
 - DVB-T2/C2, DTMB: BCH+LDPC



Our Favorite Measurements

How does this change:

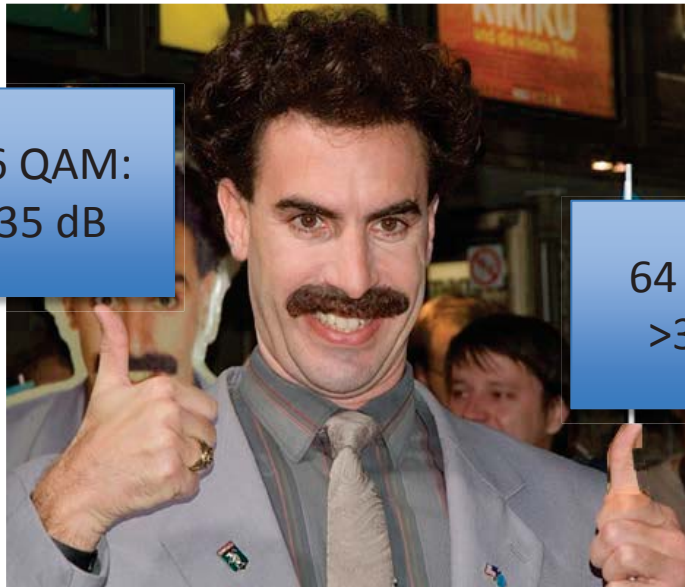
- ▶ MER
- ▶ BER
- ▶ Constellation
- ▶ Equalizer



MER

- ▶ “Good” MER depends on QAM and FEC types
 - More rules than thumbs

QAM	FEC	SNR @ 1e-6 + 6 dB Margin
4096	9/10	40
4096	5/6	38
1024	9/10	36
1024	5/6	33
1024	3/4	31
256	9/10	30
256	5/6	28
256	3/4	26
64	9/10	24
64	4/5	22
64	2/3	20
16	9/10	19
16	4/5	17



256 QAM:
> 35 dB

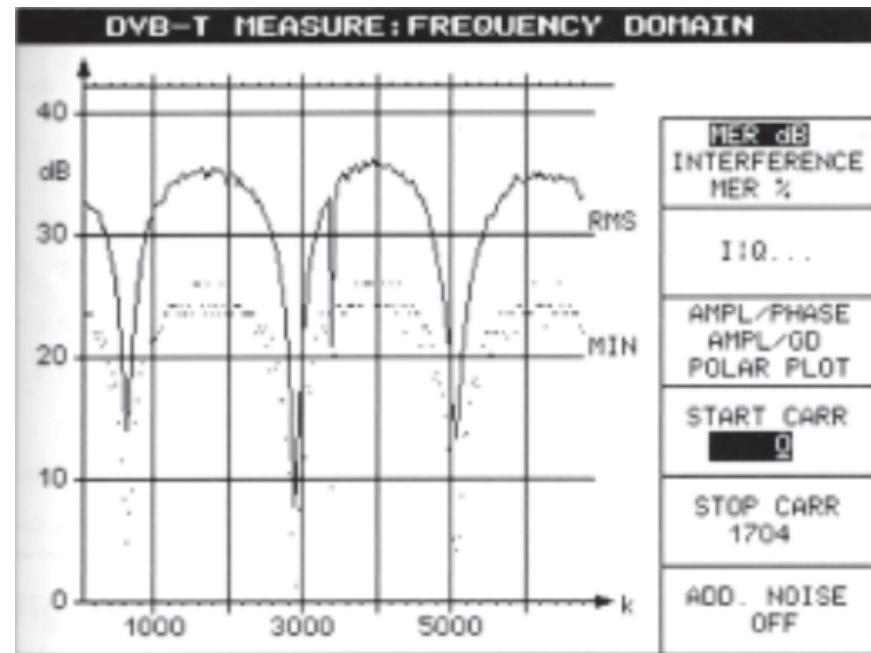
64 QAM:
>30 dB

Photo: Michael Bulcik / SKS Soft GmbH Düsseldorf



MER

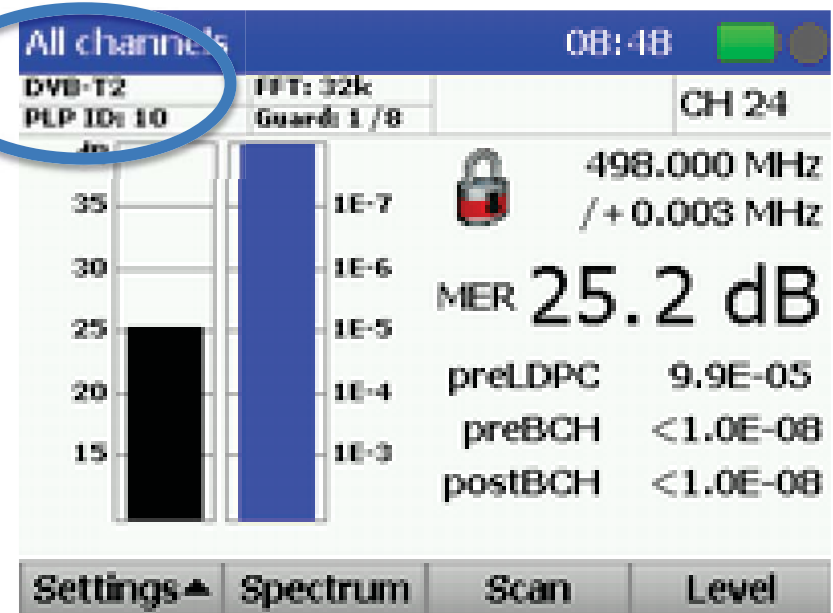
- ▶ Each subcarrier has its own MER
 - Show all in plot format
 - Histogram
 - Min/max/avg MER
- ▶ Other considerations



BER

- ▶ Multiple modulation/FEC combinations can be present

- DVB: PLP ID
- ISDB-T: Layer



- ▶ Each has its own BER

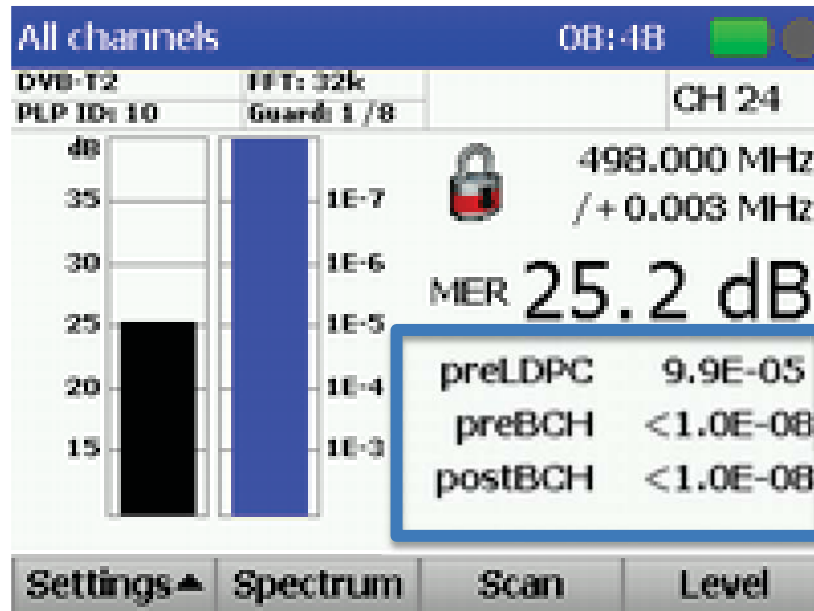
- Validation/troubleshooting: pick most sensitive
- Monitoring: round robin



BER

► New FEC with Inner and Outer codes

- ISDB-T: CCR+RS
- DVB-x2: BCH+LDPC



► Pre-, Post- and... in between



Constellation

► Must choose Layer/PLP first

ISDB-T CH 070

503.000 MHz
Layer A QPSK

MER 30.6 dB

BER 1.0E-9

Mode 3
GI 1/16
Segments 12/13
CCR 3/4
Interleaver 2

ISDB-T CH 070

503.000 MHz
Layer B QAM64

MER 30.5 dB

BER 1.0E-9 PRE

Mode 3
GI 1/16
Segments 12/13
CCR 3/4
Interleaver 2

503.000 MHz
Layer A QPSK

503.000 MHz
Layer B QAM64

Digital measurement

Plan: Channel template Frequency, MHz: 506.000 Channel: 25

Types: Auto

PLP: 0

Synchronizations: Lock

Value
T5
on
SISO
no
8k
off
1/32
off
QPSK
1/2
LDPAC 16k
750
S18
PP4
TX post info size
Pilot pattern
TX ID availability
Cell ID
Network ID
T2 system ID

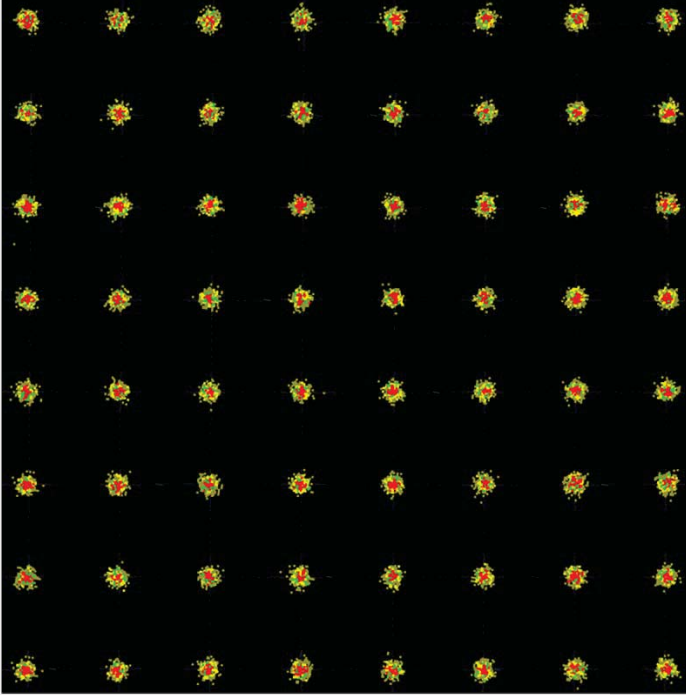
MER, dB: 31.0

preBER: 1.1e-4

postBER: <1.0e-8

Errors: 0 00:00:16

Tune error, MHz: 0.000



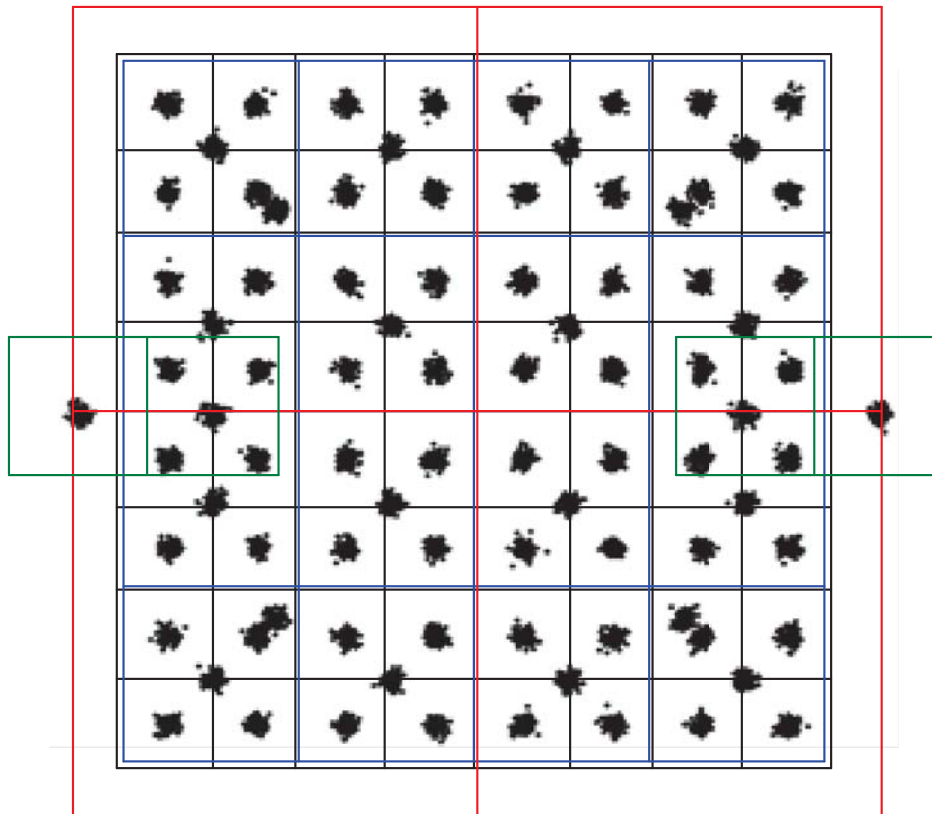
Reading of constellation diagram 0%

PLP:

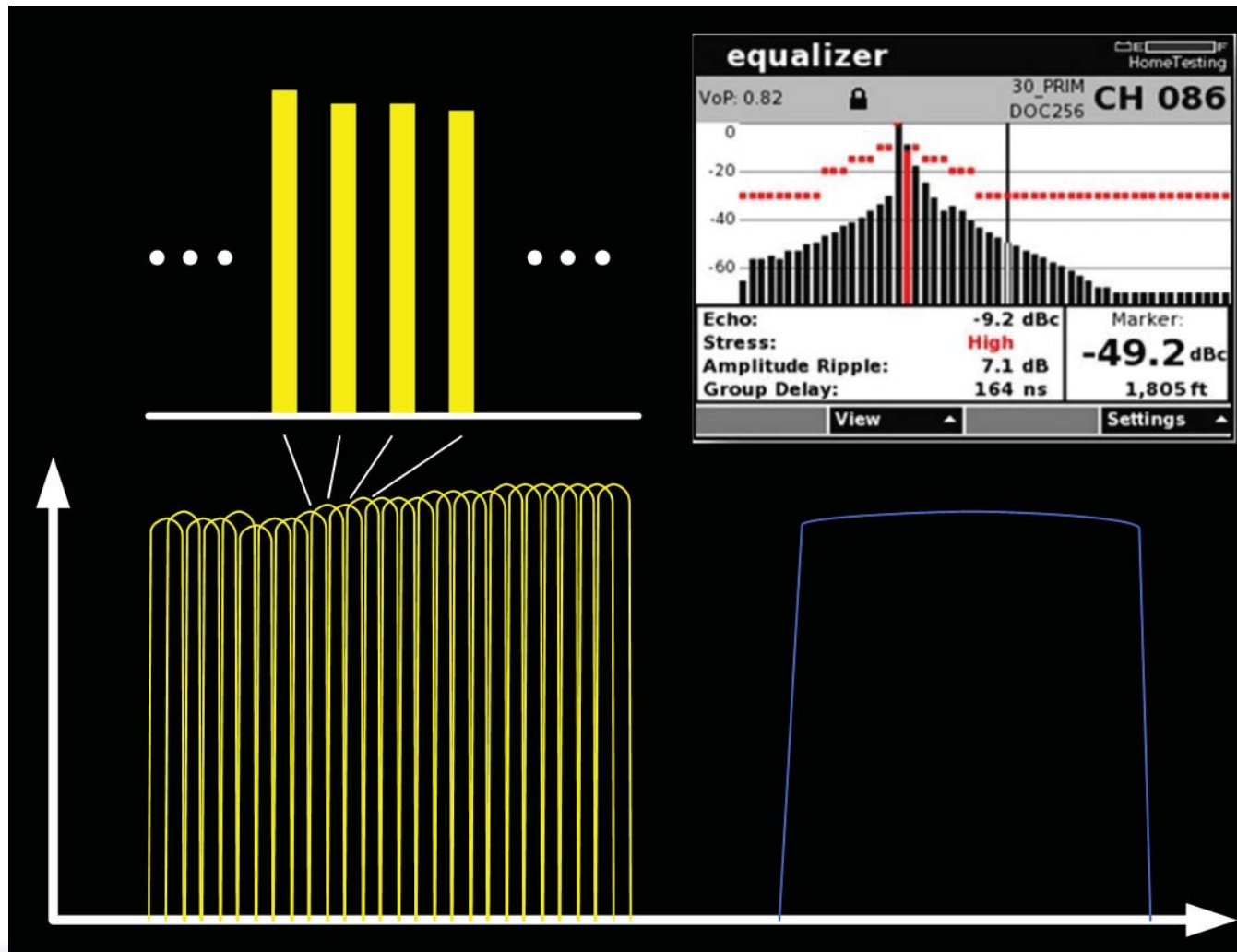
0

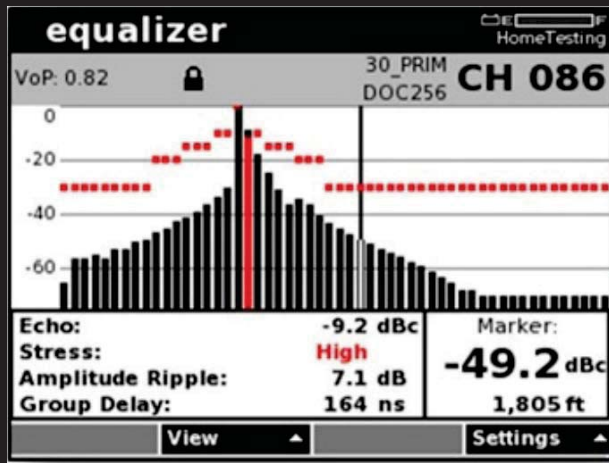
Constellation

► Or show them all...

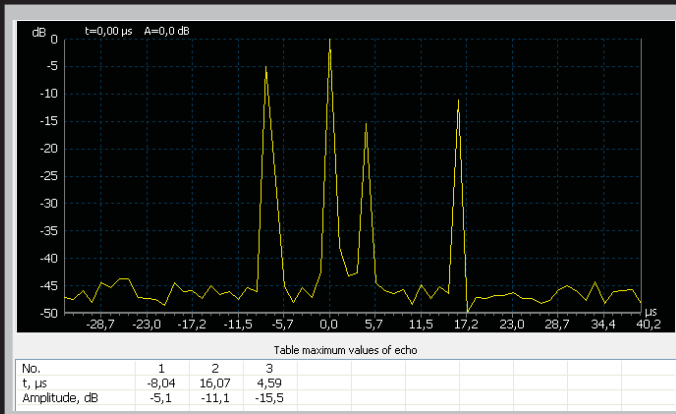
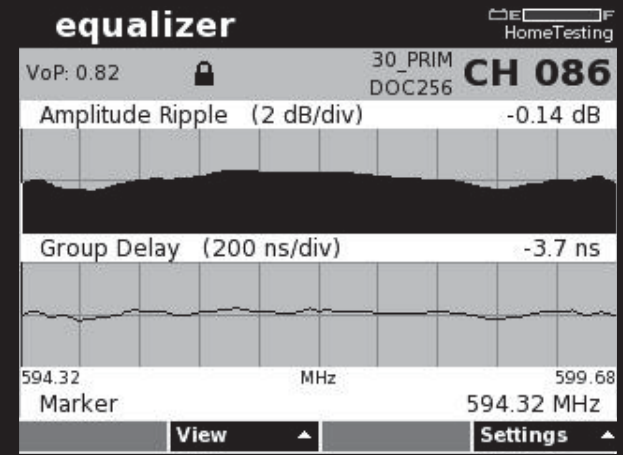
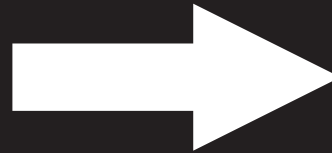


Equalizer

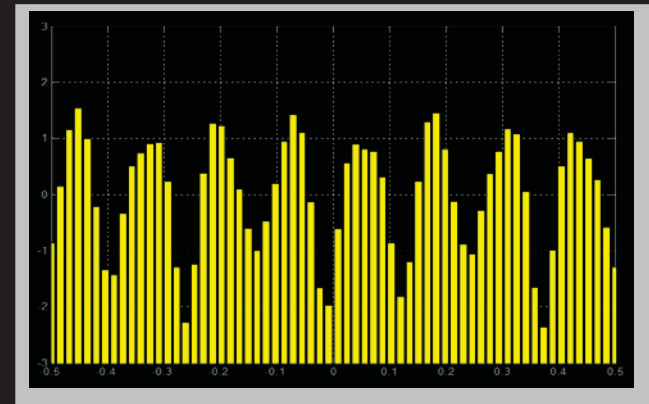
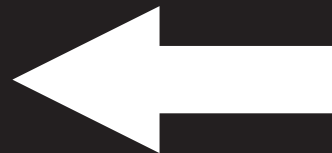




FFT

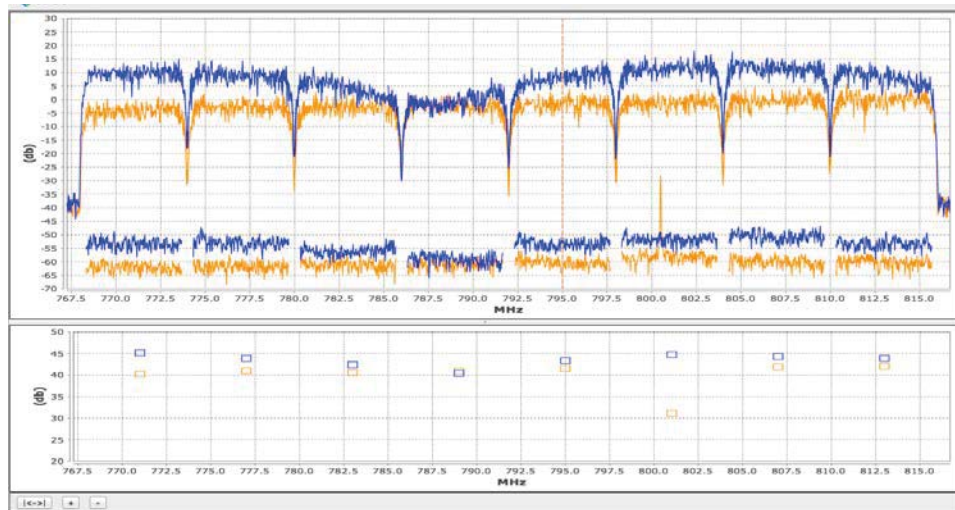


IFFT



Approaches for OFDM Testing

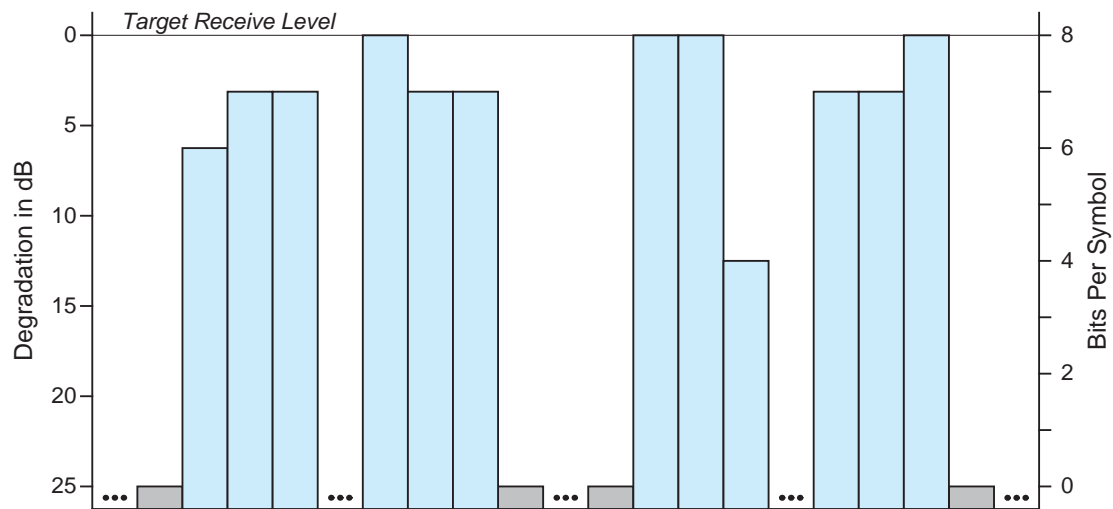
► Channel State Information



Approaches for OFDM Testing

► Bandwidth utilization

Subcarrier Contribution to Throughput

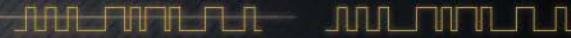


Throughput	Quality Score
$\leq 50\%$	0
60%	2
70%	4
80%	6
90%	8
100%	10



Approaches for OFDM Testing





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