Communications Laboratory

DTTB Lab Tests Methodology & Results Summary

http://www.commslab.gov.au

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Overview

- Digital Television Objectives & Technology
- DTTB Transmission Technology
- The Australian Test Program
- Laboratory Tests - Test Rig
- Laboratory Tests - Main Results
- Field Test Objectives & Equipment
- Summary Field Test Results
- Selection Process & Criteria
- Selection Result & Future

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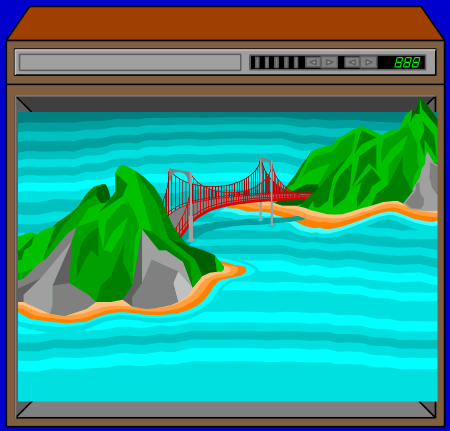
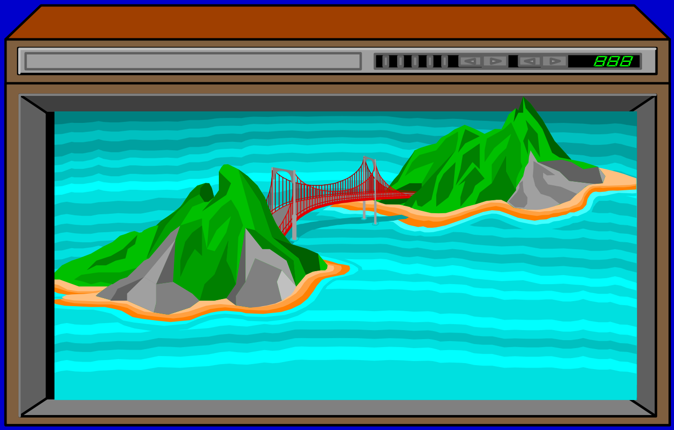
Digital Television

Why digital?

To Overcome Limitations of Analog Television

- Noise free pictures
- Higher resolution images Widescreen / HDTV
- No Ghosting
- Multi-channel, Enhanced Sound Services
- Other Data services.





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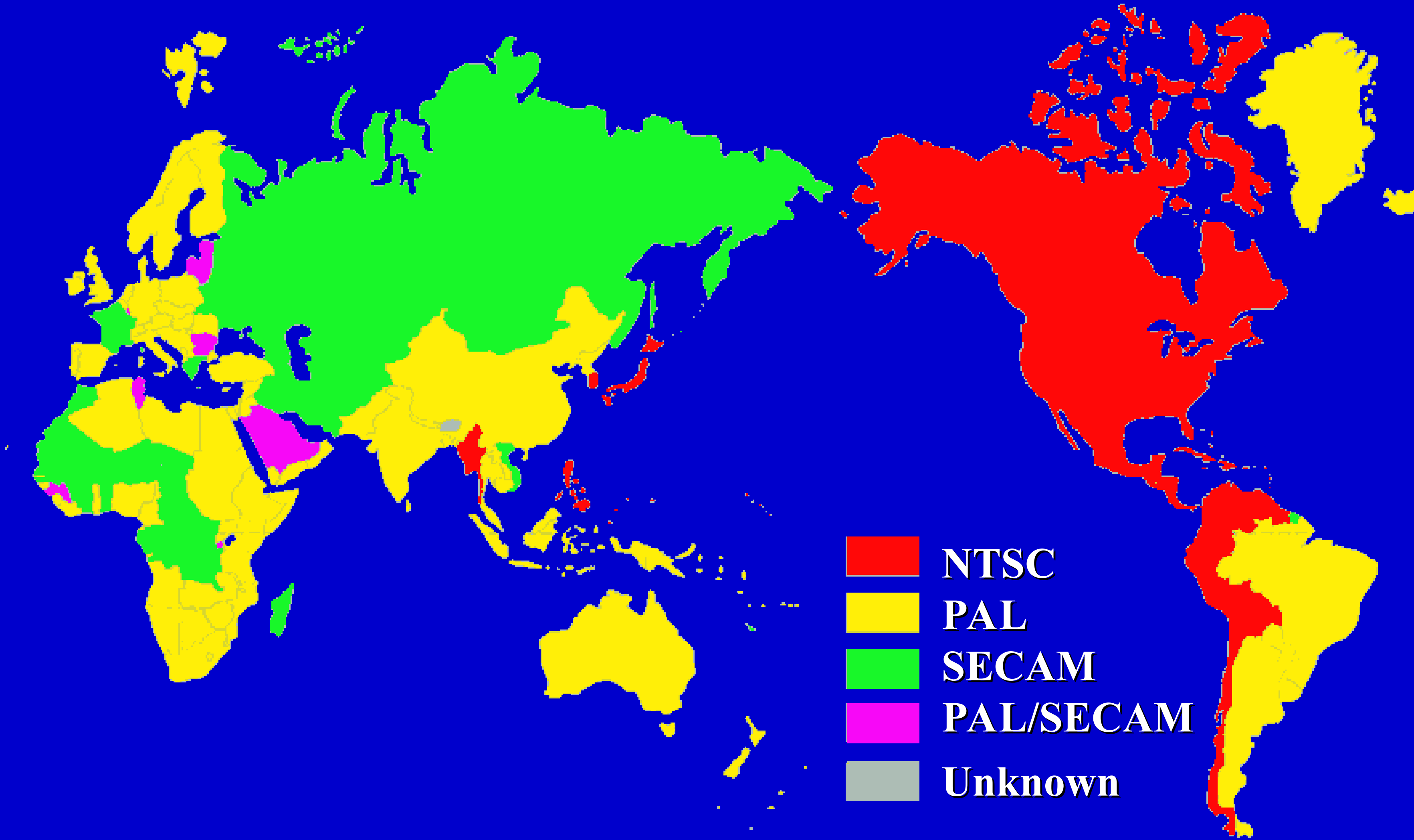
World TV Standards



Australia like China is PAL

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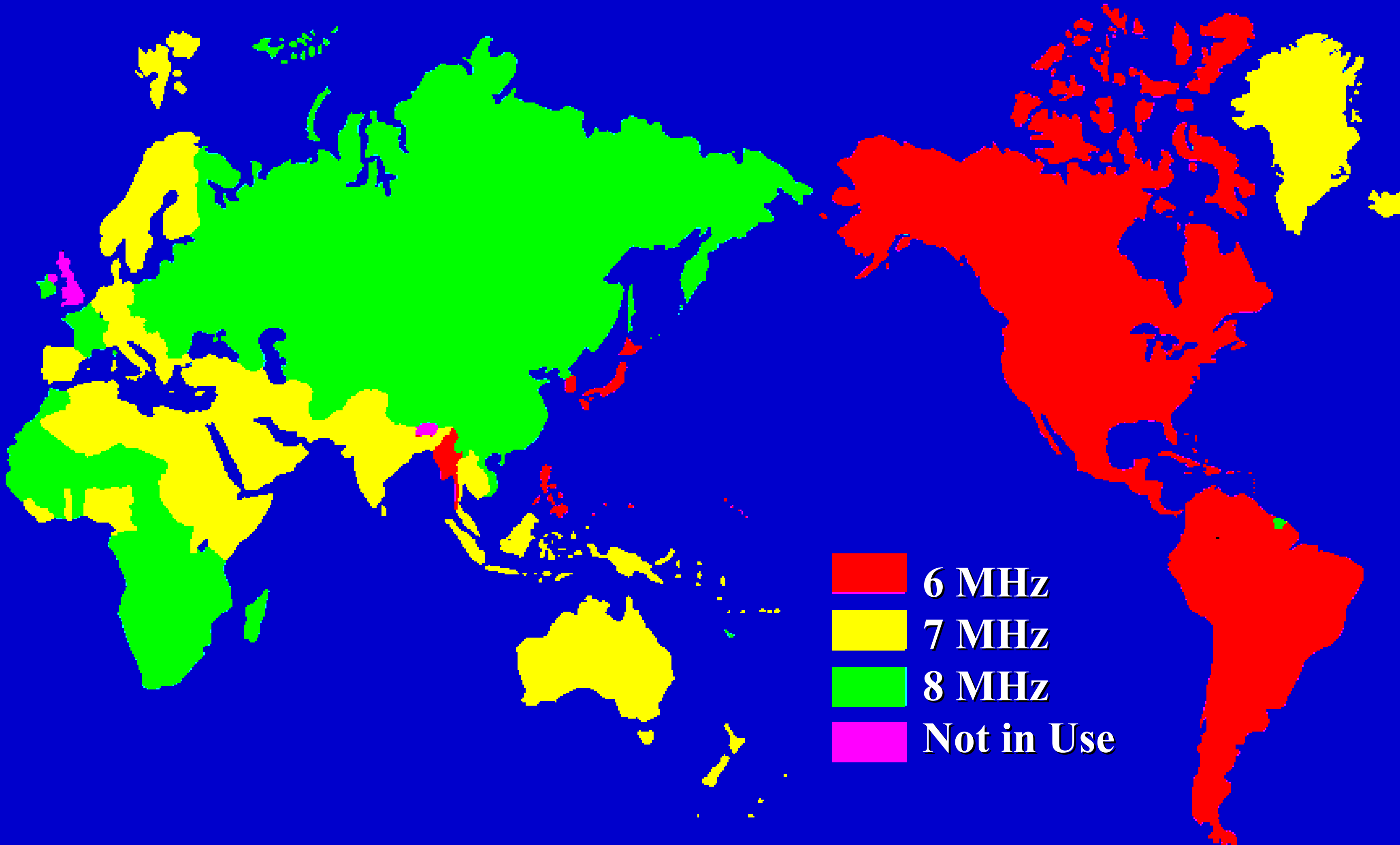
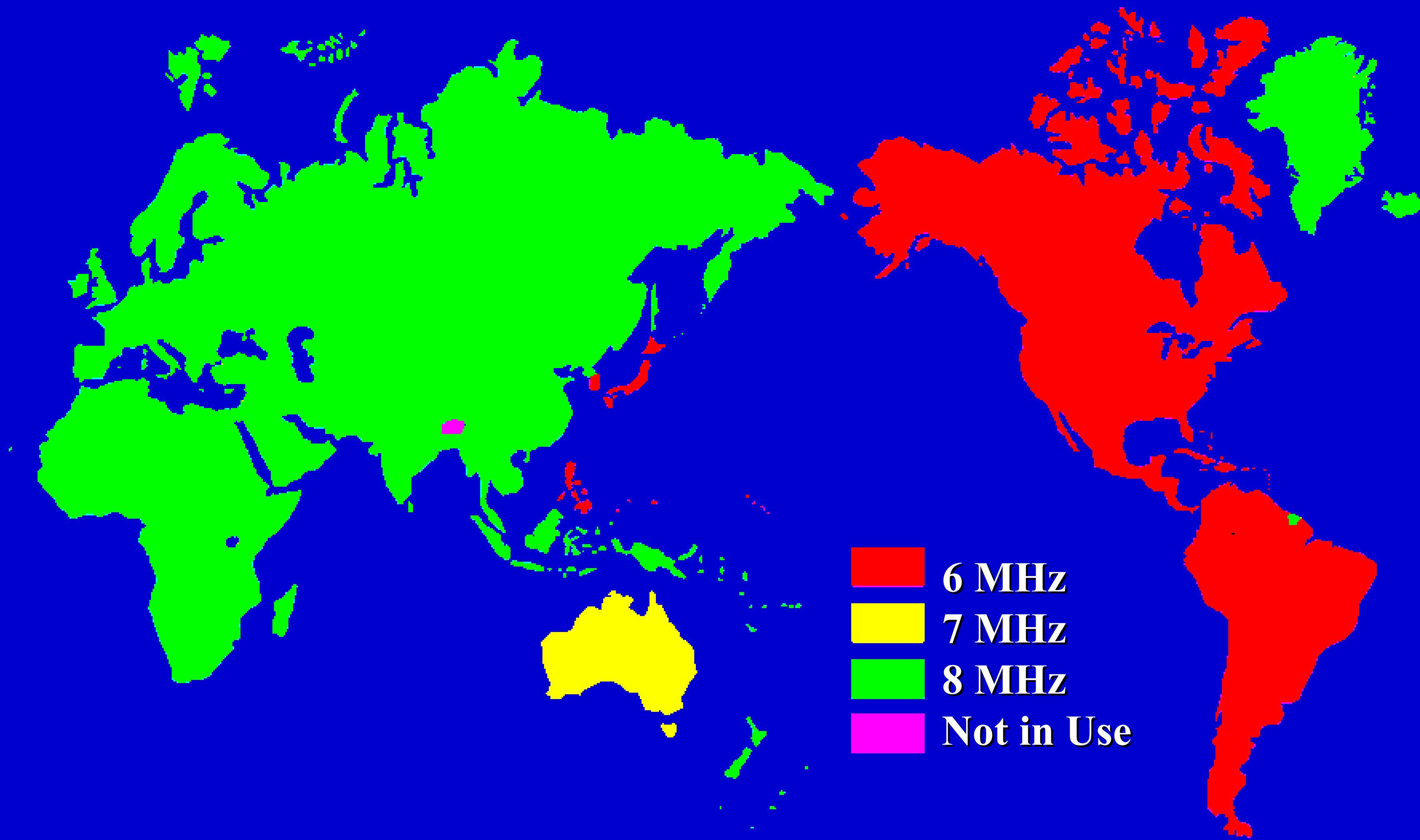
Transmission Bandwidth - VHF



Australia is 7 MHz, China is 8 MHz

Transmission Bandwidth - UHF



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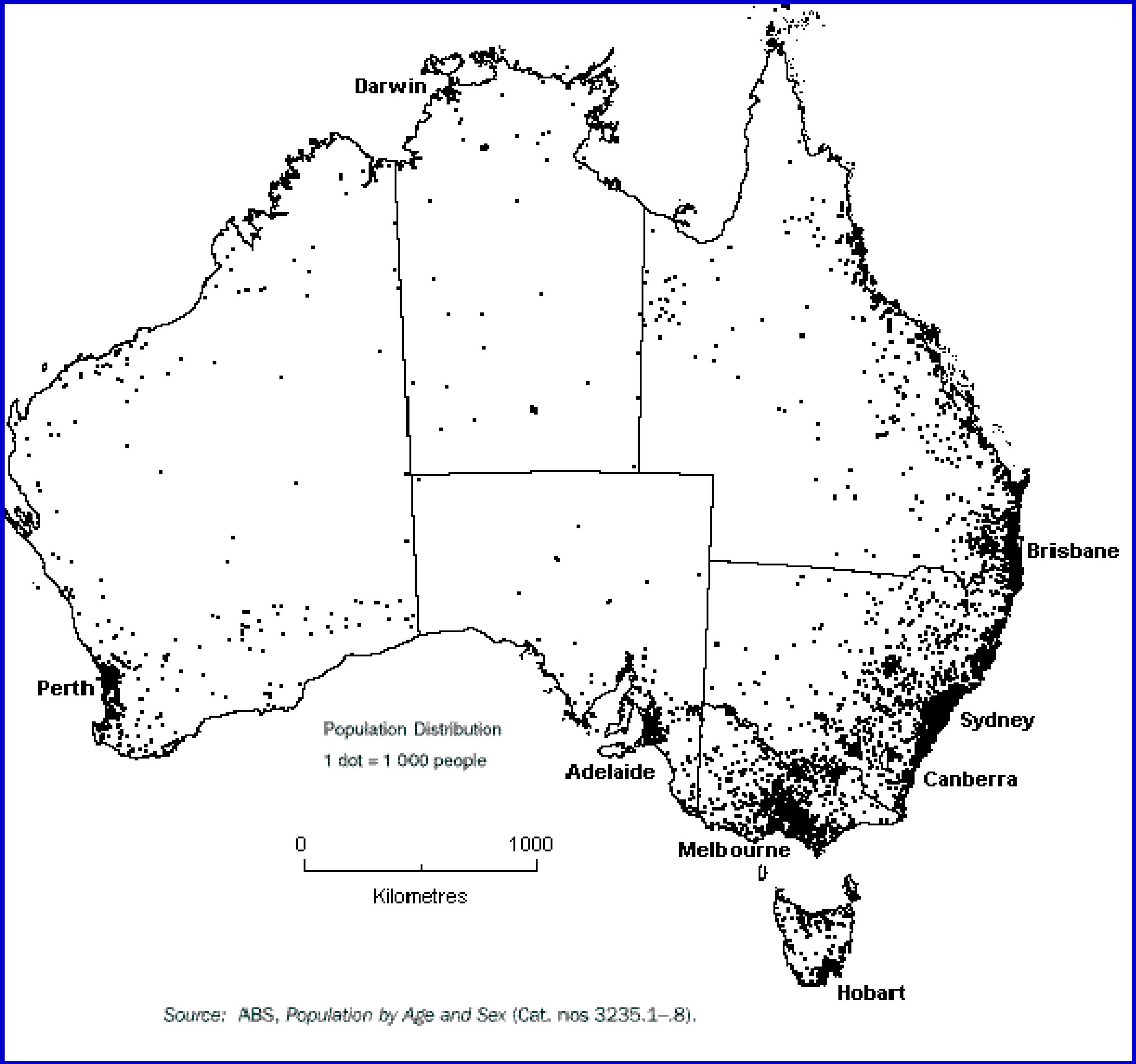
Australian Population Distribution



Uneven Population distribution

Wide areas where few people live

Noise Limited Transmission environment

Free To Air Television (FTA)

- 5 Networks - 3 Commercial, 2 Government
- Important part of Australian entertainment
- Majority of Australian audience is watching
- No television receiving licences
- National broadcasters funded from taxation

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Pay TV - Cable, MDS & Satellite

- Only a small business in Australia
- Less then 400,000 subscribers
- Less than 7% of households

Indoor reception

- Around 30% of Australians watch FTA using indoor antennas

Program Quality Vs Quantity

- Australians have a low number of available television channels
- Television program budget is spread between fewer programs
- Australians used to watching high quality programming at high technical quality.

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Enabling Technologies

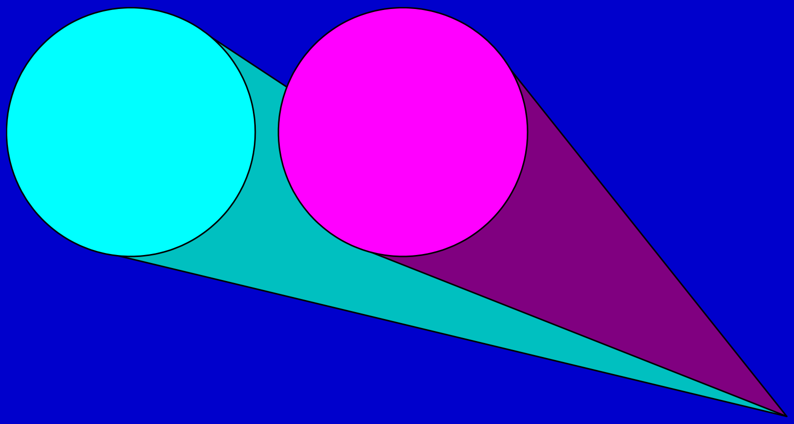
- Source digitisation (Rec 601 digital studio)
- Compression technology (MPEG, AC-3)
- Data multiplexing (MPEG)
- Display technology (large wide screens)
- Transmission technology (modulation)

Transmission Technology

- The transmission system is used to transport the information to the consumer.
- The system protects the information being carried from the transmission environment
- Current Australian analog television uses the PAL-B AM modulation system

Digital TV Transmission Technology

- The transmission system is a "data pipe"
- Transports data rates of around 20 Mb/s
- Transports data in individual containers called packets



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Digital TV Transmission Systems

Australia has been following Digital TV & HDTV

- Europeans - Digital SDTV
  - 8 MHz on UHF
  - DVB-T (COFDM)
- Americans - Digital HDTV
  - 6 MHz VHF/UHF
  - ATSC (8-VSB)
- Japanese - Integrated Broadcasting
  - ISDB (BST-OFDM)

8-VSB - USA

ADVANCED TELEVISION SYSTEMS COMMITTEE

- Developed by the advance television systems committee - ATSC
- Developed for use in a 6 MHz channel
  - A 7 MHz variant is possible.
- Uses a single carrier with pilot tone
- 8 level amplitude modulation system
- Single Payload data rate of 19.39 Mb/s
- Relies on adaptive equalisation
- Existing AM technology highly developed

COFDM - Europe

- Developed by the digital video broadcasting project group - DVB
- Uses similar technology to DRB
- Uses 1705 or 6817 carriers
- Variable carrier modulation types are defined allowing Payload data rates of 5-27 Mb/s in 7 MHz
- Developed for 8 MHz channels
  - A 7 MHz variant has been produced and tested
- Can use single frequency networks - SFNs
- New technology with scope for continued improvement & development

The Australian DTTB Test Program

- Australia is interested in a Digital HDTV Future
- Australia has a Unique Broadcasting Environment
- Overseas Digital TV Developments were interesting but the results could not be directly related to Australia.
- To make informed decisions we needed to collect information relevant to our situation.
- We had a few Questions.

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Aims of Australian DTTB Testing-1

Australia needed to know:

- How does DTTB perform with VHF PAL-B?
- What Protection does PAL require from the DTTB service for:
  - Co-Channel?
  - Adjacent Channel?
  - Is Signal level a factor?

→ Subjective Assessment

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Aims of Australian DTTB Testing-2

- How Quickly does the system degrade?
- What are the real system thresholds?
  - Signal Level
  - Carrier to Noise
  - Payload Data Rate in 7 MHz
- How does DTTB cope with Interference?
- What is a typical Noise Figure for a DTTB Rx

Aims of Australian DTTB Testing-3

- What Protection does DTTB require from the PAL-B service for:
  - Co-Channel?
  - Adjacent Channel?
  - Is Signal level a factor?

- What Protection does DTTB require from other DTTB services?

Aims of Australian DTTB Testing-4

- How does DTTB perform in a 7 MHz Channel Environment?
- How sensitive is DTTB to practical Transmission Equipment?

  How important is:

  - Transmitter Linearity?
  - Transmitter Precorrection?
  - Transmitter Output Filtering?
  - Combined Feeder/Antenna Systems?

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Aims of Australian DTTB Testing-5

- Is DTTB affected by Multipath Echoes?
  - Are Pre-Echoes a Problem?
  - What happens past the Guard interval?
- Is DTTB affected by Doppler Shift?
- Is DTTB affected by Dynamic Flutter?
- Is DTTB affected by Impulsive Interference?
- How does DTTB perform in the Field cw PAL

Lots of Questions but
Few Definitive Answers!

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Scope of Tests

- The test program began with the aim of answering these questions for DVB-T
- During the early stages of testing ATSC was floated as a Candidate Digital TV System
- The test program's scope was increased and a comparative focus adopted.
- All tests were designed to be as generally applicable as possible to any Digital TV Modulation System.

Order of Measurements

- FACTS Advanced TV Specialists Group directed the priority of Testing
- Laboratory Tests First
  1. DTTB into PAL protection
  2. DTTB System Parameters
  3. PAL into DTTB protection
  4. Other Interferers & Degradations
- Field Tests Later

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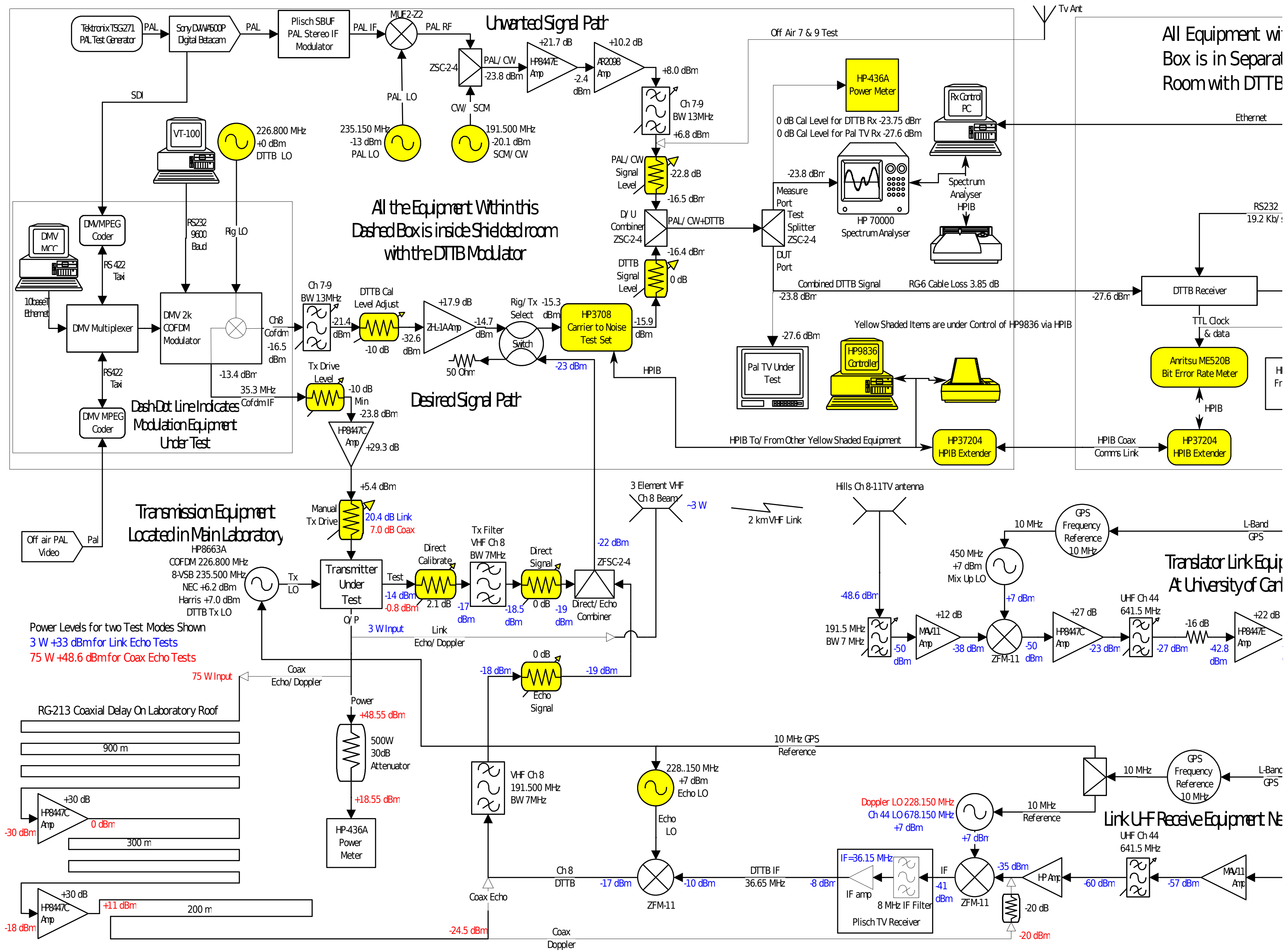
Unwanted Signal Path
Tektronix TSG271 PAL Test Generator
PAL
Sony DVW-500P Digital Betacam
PAL
Plisch SBUF PAL Stereo IF Modulator
PAL IF
MUF2-Z2
PAL RF
ZSC-2-4
PAL/ CW
-23.8 dBm
+21.7 dB
HP8447E Amp
-2.4 dBm
+10.2 dB
AR2098 Amp
+8.0 dBm
Ch 7-9 BW 13MHz
+6.8 dBm
PAL LO
235.150 MHz
-13 dBm
PAL LO
CW/ SCM
191.500 MHz
-20.1 dBm
SCM/ CW
226.800 MHz
+0 dBm
DTTB LO
SDI
VT-100
Tv Ant
Off Air 7 & 9 Test
HP-436A Power Meter
0 dB Cal Level for DTTB Rx -23.75 dBm
0 dB Cal Level for Pal TV Rx -27.6 dBm
Rx Control PC
Ethernet
All Equipment wi
Box is in Separat
Room with DTTB
PAL/ CW Signal Level
-22.8 dB
-16.5 dBm
D/ U Combiner ZSC-2-4
PAL/ CW+DTTB
-16.4 dBm
DTTB Signal Level
0 dB
-23.8 dBm
Measure Port
Test Splitter ZSC-2-4
DUT Port
HP 70000 Spectrum Analyser
Spectrum Analyser HPIB
RS232
19.2 Kb/
All the Equipment Within this Dashed Box is inside Shielded room with the DTTB Modulator
DMV MCC
DMV MPEG Coder
RS232 9600 Baud
Rig LO
RS 422 Taxi
10baseT Ethernet
DMV Multiplexer
DMV 2k COFDM Modulator
Ch8 Cofdm
-16.5 dBm
Ch 7-9 BW 13MHz
-21.4 dBm
DTTB Cal Level Adjust
-10 dB
-32.6 dBm
+17.9 dB
ZHL-1A Amp
-14.7 dBm
Rig/ Tx Select
-15.3 dBm
Switch
50 Ohm
HP3708 Carrier to Noise Test Set
-15.9 dBm
-23 dBm
Combined DTTB Signal
RG6 Cable Loss 3.85 dB
-27.6 dBm
DTTB Receiver
Yellow Shaded Items are under Control of HP9836 via HPIB
TTL Clock & data
-27.6 dBm
Pal TV Under Test
HP9836 Controller
Anritsu ME520B Bit Error Rate Meter
RS422 Taxi
DMV MPEG Coder
-13.4 dBm
35.3 MHz Cofdm IF
Tx Drive Level
-10 dB Min
-23.8 dBm
Dash-Dot Line Indicates Modulation Equipment Under Test
Desired Signal Path
HPIB
HP8447C Amp
+29.3 dB
HPIB To/ From Other Yellow Shaded Equipment
HP37204 HPIB Extender
HPIB Coax Comms Link
HP37204 HPIB Extender
+5.4 dBm
Manual Tx Drive
20.4 dB Link
7.0 dB Coax
Transmission Equipment Located in Main Laboratory
Off air PAL Video
Pal
HP8663A COFDM 226.800 MHz
8-VSB 235.500 MHz
NEC +6.2 dBm
Harris +7.0 dBm
DTTB Tx LO
Tx LO
Transmitter Under Test
O/ P
Test
-14 dBm
-0.8 dBm
Direct Calibrate
2.1 dB
-17 dBm
Tx Filter VHF Ch 8 BW 7MHz
-18.5 dBm
Direct Signal
0 dB
-19 dBm
-22 dBm
ZFSC-2-4
Direct/ Echo Combiner
3 Element VHF Ch 8 Beam
~3 W
2 km VHF Link
Hills Ch 8-11 TV antenna
GPS Frequency Reference 10 MHz
10 MHz
L-Band GPS
450 MHz +7 dBm Mix Up LO
Translator Link Equi
At University of Can
-48.6 dBm
+7 dBm
191.5 MHz BW 7 MHz
-50 dBm
MAV11 Amp
+12 dB
-38 dBm
ZFM-11
-50 dBm
HP8447C Amp
+27 dB
-23 dBm
UHF Ch 44 641.5 MHz
-27 dBm
-16 dB
-42.8 dBm
HP8447E Amp
+22 dB
Power Levels for two Test Modes Shown
3 W +33 dBm for Link Echo Tests
75 W +48.6 dBm for Coax Echo Tests
3 W Input
Link Echo/ Doppler
75 W Input
Coax Echo/ Doppler
0 dB
-18 dBm
-19 dBm
Echo Signal
RG-213 Coaxial Delay On Laboratory Roof
900 m
Power
+48.55 dBm
500W 30dB Attenuator
+18.55 dBm
HP-436A Power Meter
10 MHz GPS Reference
228..150 MHz +7 dBm Echo LO
Echo LO
VHF Ch 8 191.500 MHz BW 7MHz
10 MHz
GPS Frequency Reference 10 MHz
L-Band GPS
Doppler LO 228.150 MHz
Ch 44 LO 678.150 MHz
+7 dBm
10 MHz Reference
Link UHF Receive Equipment Ne
UHF Ch 44 641.5 MHz
+30 dB
HP8447C Amp
-30 dBm
0 dBm
300 m
+30 dB
HP8447C Amp
-18 dBm
+11 dBm
200 m
-24.5 dBm
Coax Echo
Ch 8 DTTB
-17 dBm
ZFM-11
-10 dBm
DTTB IF 36.65 MHz
-8 dBm
IF=36.15 MHz
IF amp
8 MHz IF Filter
Plisch TV Receiver
IF
-41 dBm
ZFM-11
+7 dBm
-35 dBm
HP Amp
-60 dBm
-57 dBm
MAV11 Amp
-20 dB
-20 dBm
Coax Doppler

Laboratory Tests - Test Rig

C/N Set & Attenuators EUT PAL & CW

Control Computer

Domestic Television Receiver

Modulator Control Computers

Spectrum Analysers

Plot & Printing

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Test Rig - Modulation Equipment

Power Meter

RF LO

COFDM Modulator

MPEG Mux

MPEG Mux

MPEG Encoder

MPEG Encoder

PAL & CW Interference Generators

8-VSB Modulator

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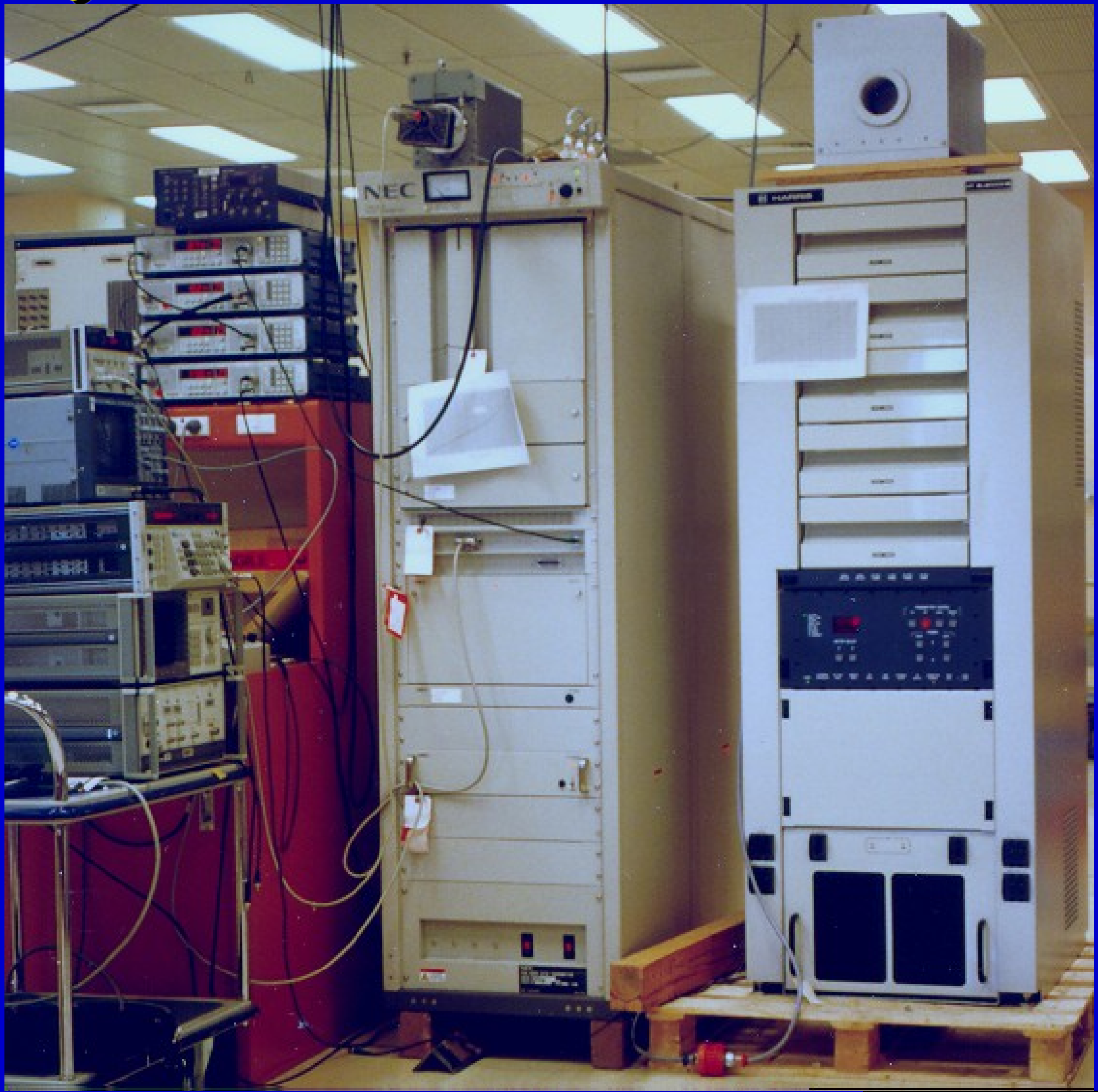
Laboratory Tests - Transmitters



Echo Combiner

Power Meter

Digital CRO

Tx LO

Spectrum Analyser

Loads

Harris 1 kW Tx

Harris Exciter

NEC 200 W Tx

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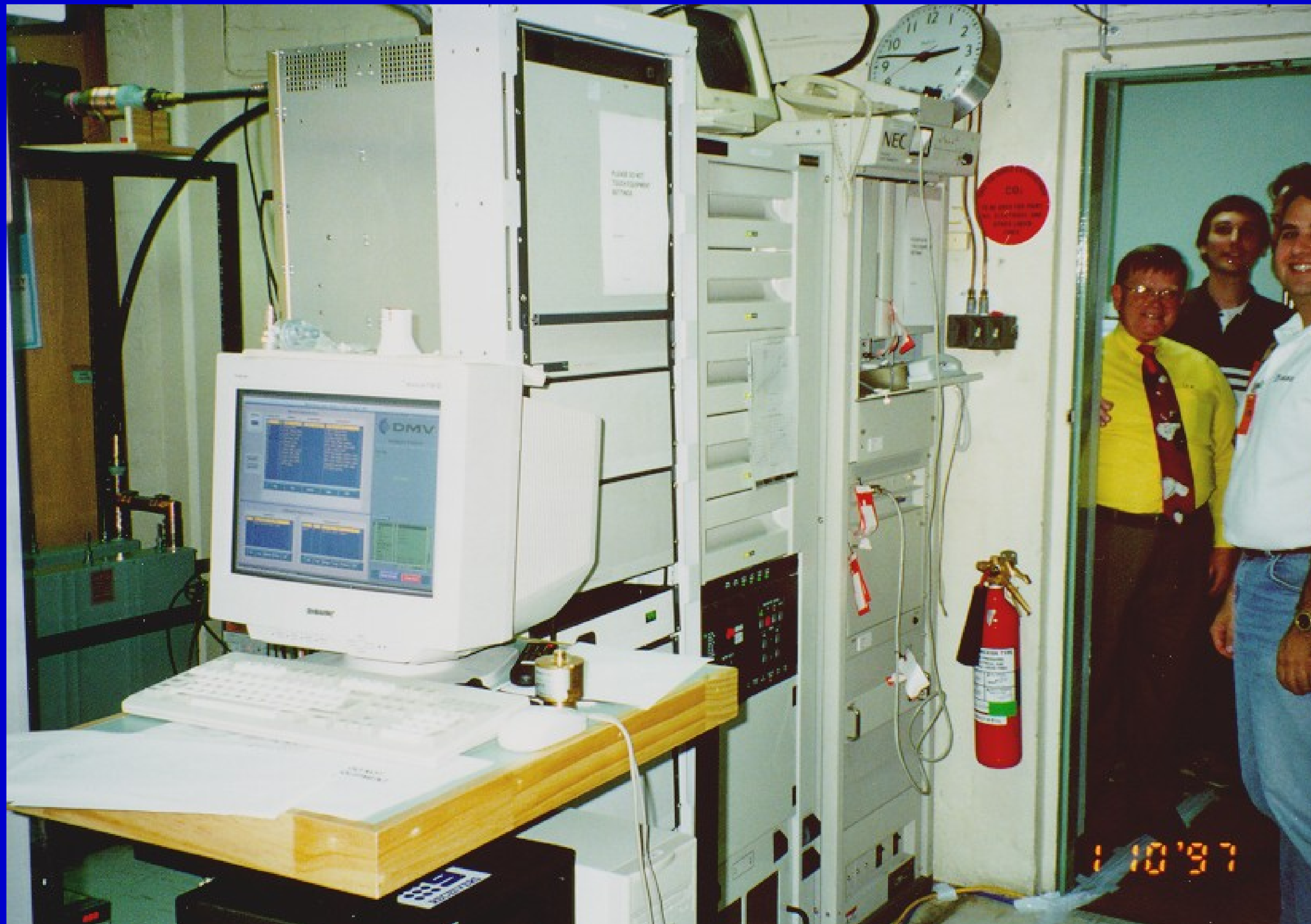
Digital Transmitters TCN-9 Sydney



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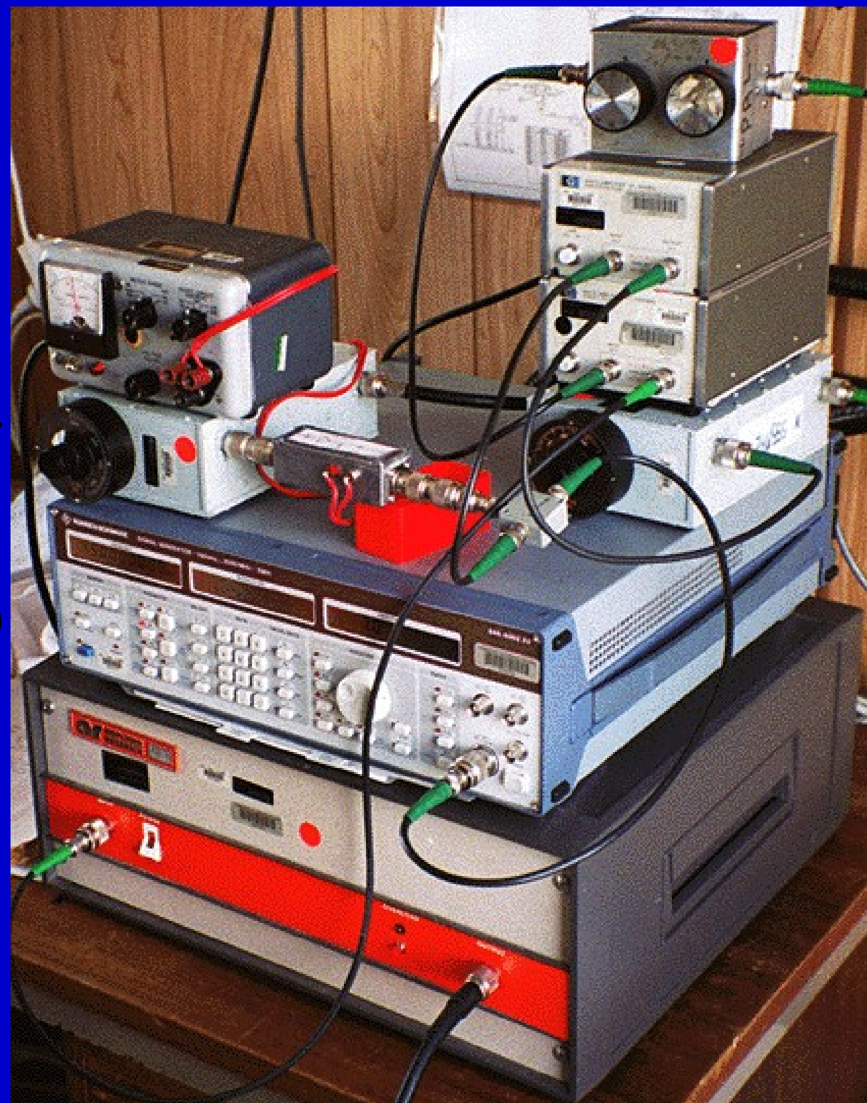
Lab Tests - VHF/UHF Transposer



Power Supply
VHF Input Filter
RF Amp
RF LO
10 Watt UHF Amplifier

Level Adjust
UHF Amps
UHF BPF Filter
Mixer

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COFDM - Commercial Receiver

- News Data Systems - System 3000

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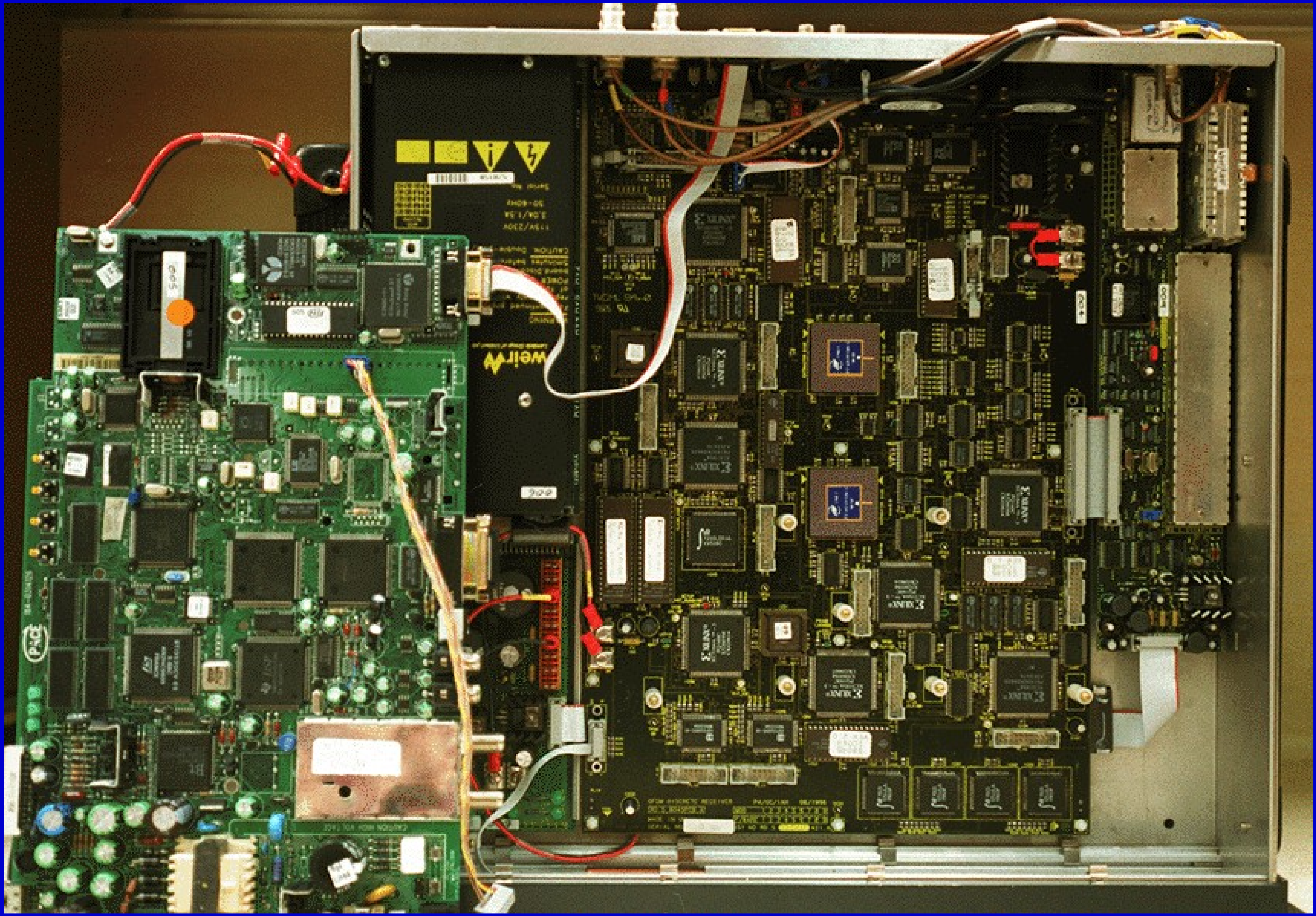
COFDM - Test Rx Hardware



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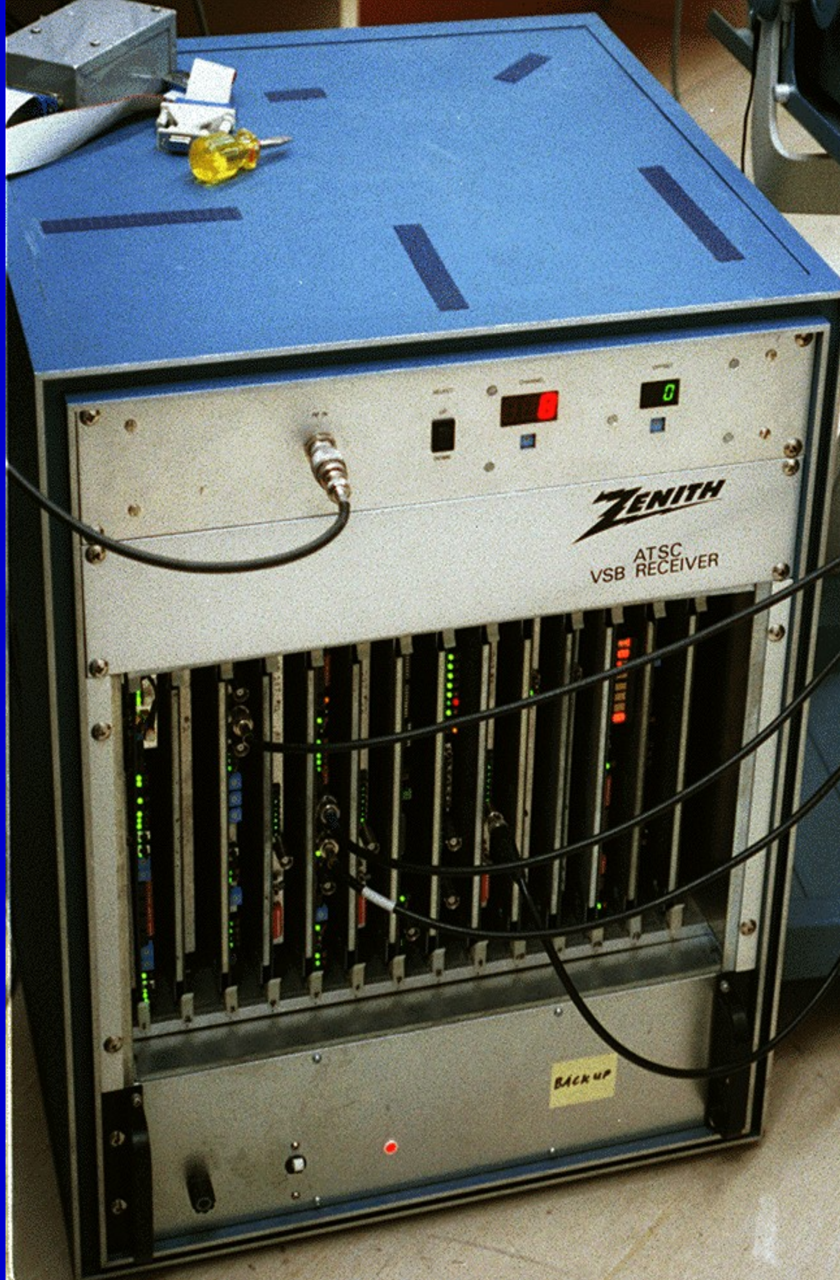

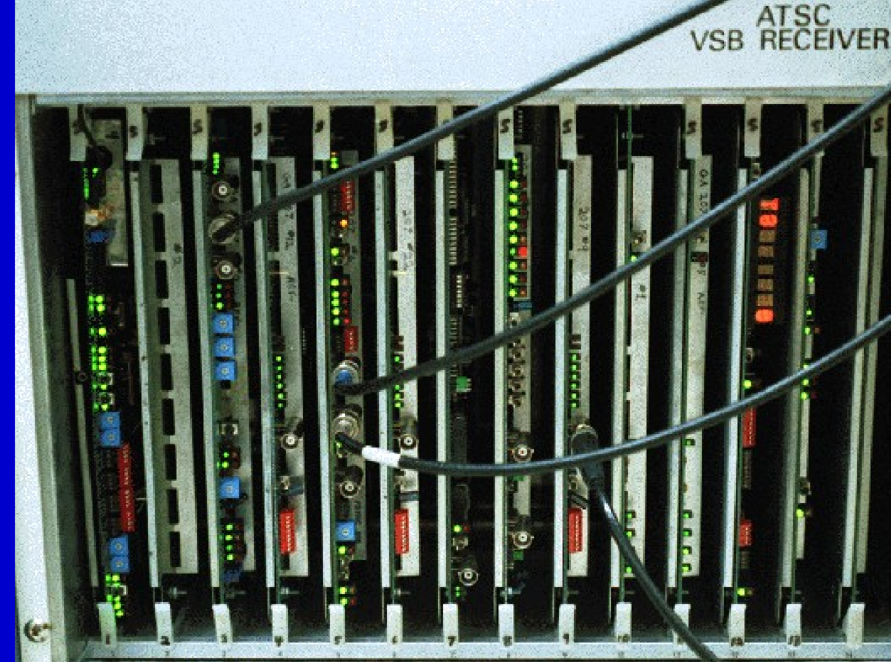

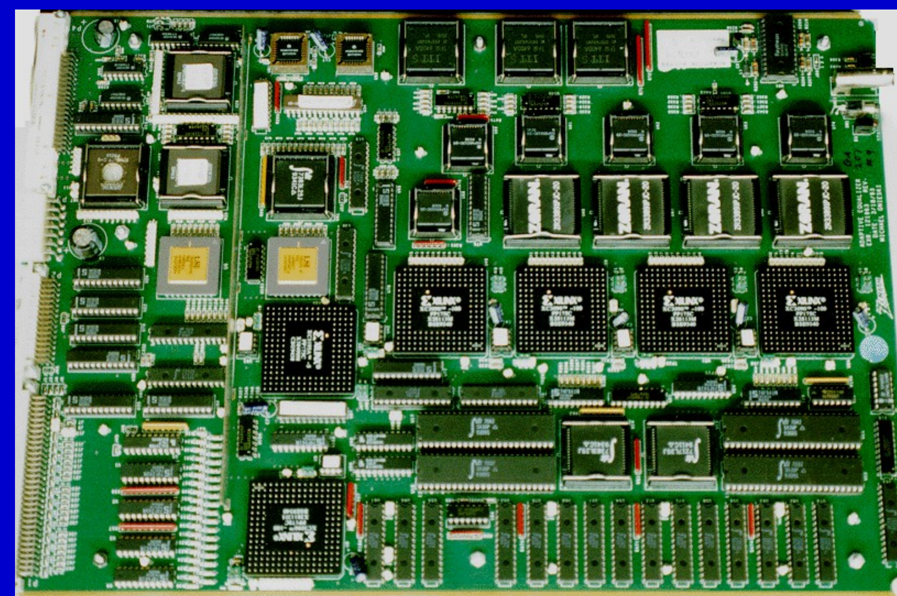

8-VSB - Test Receiver Hardware

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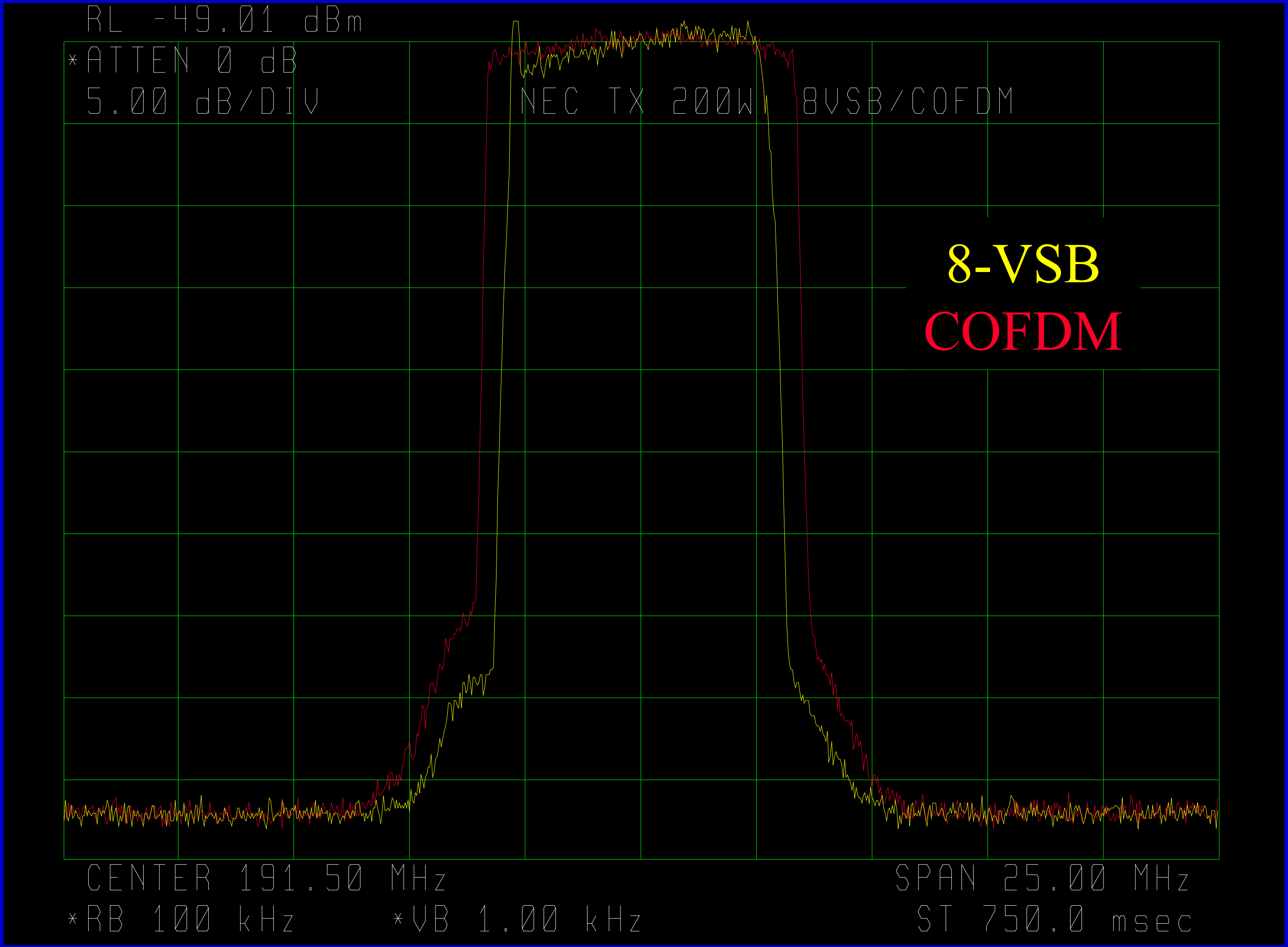
Main Results - Lab Tests

- C/N ATSC 4 dB better than DVB-T.
  This Advantage offset by Poor Noise Figure
- DVB-T is better than ATSC for Multipath
- ATSC is better than DVB-T for Impulse Noise
- ATSC cannot handle Flutter or Doppler Echoes
- ATSC is very sensitive to Transmission system impairments and IF translation
- DVB-T is better at handling Co-channel PAL
- DVB-T is better rejecting on channel interference (CW)

8-VSB & COFDM - Spectrum



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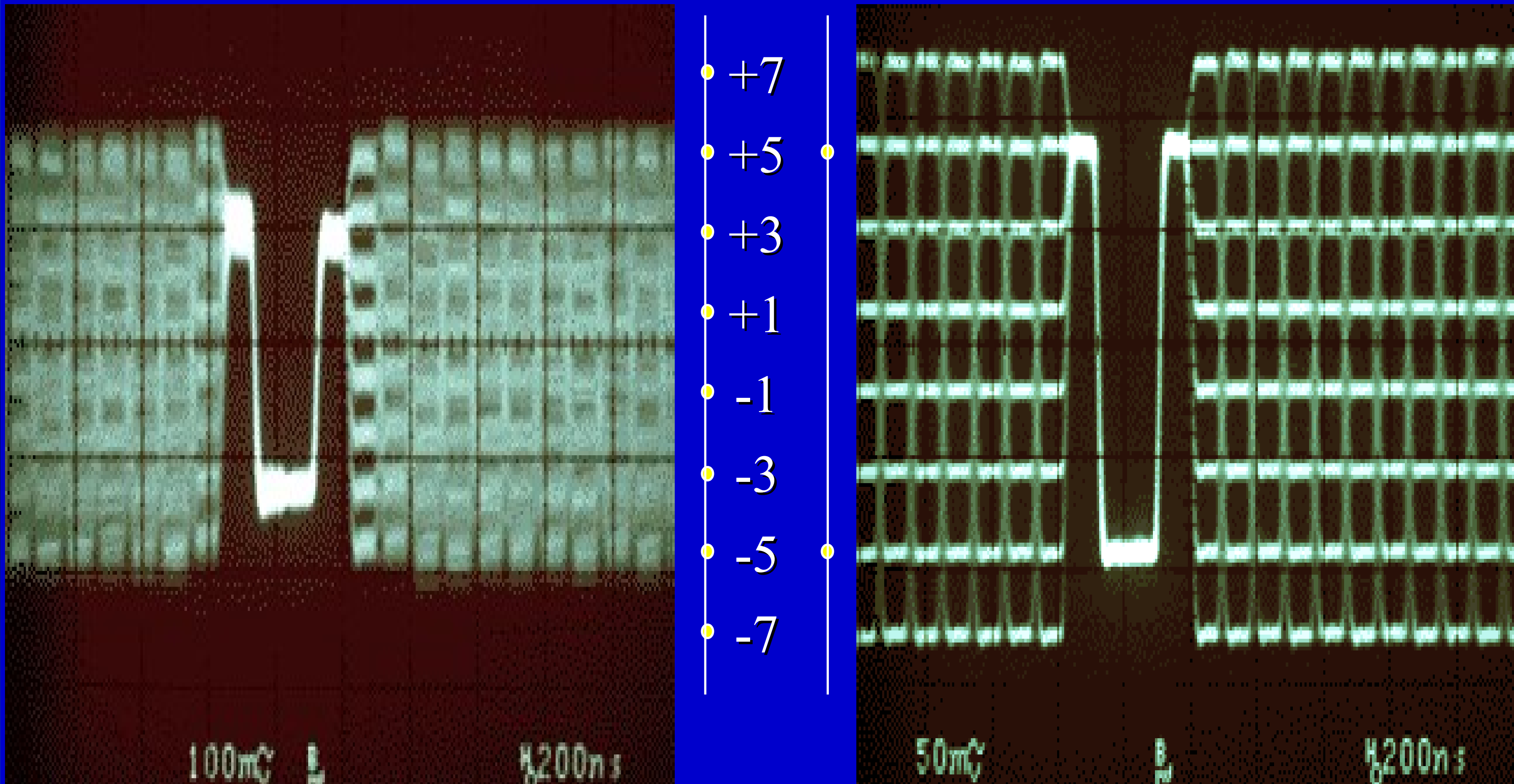
Digital Modulation - 8-AM



Before Equaliser

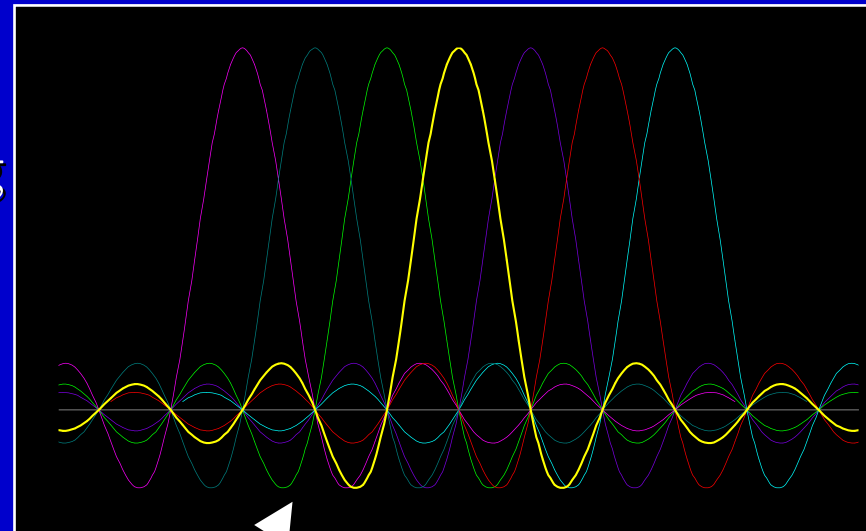
After Equaliser

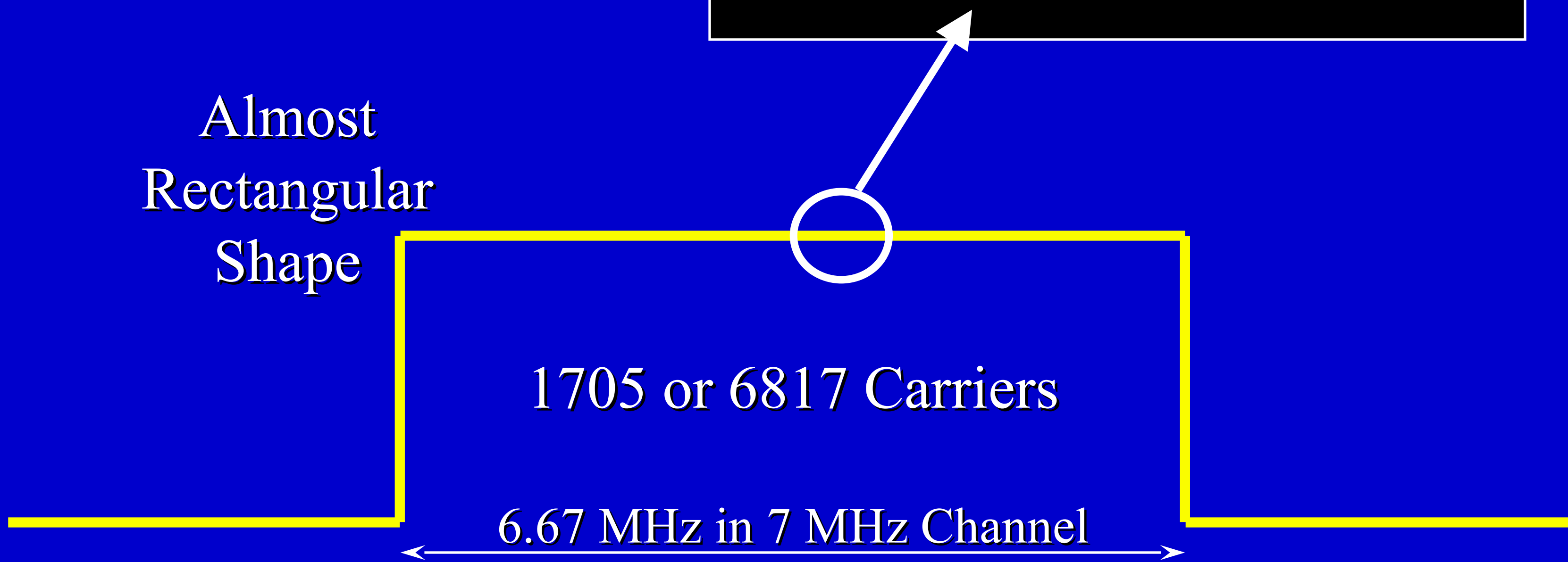
8-VSB - Coaxial Direct Feed through Tuner on Channel 8 VHF

3 Bits/Symbol

Spectrum of COFDM DTTB

7 MHz Carrier Spacing
2k Mode 3.91 kHz
8k Mode 0.98 kHz





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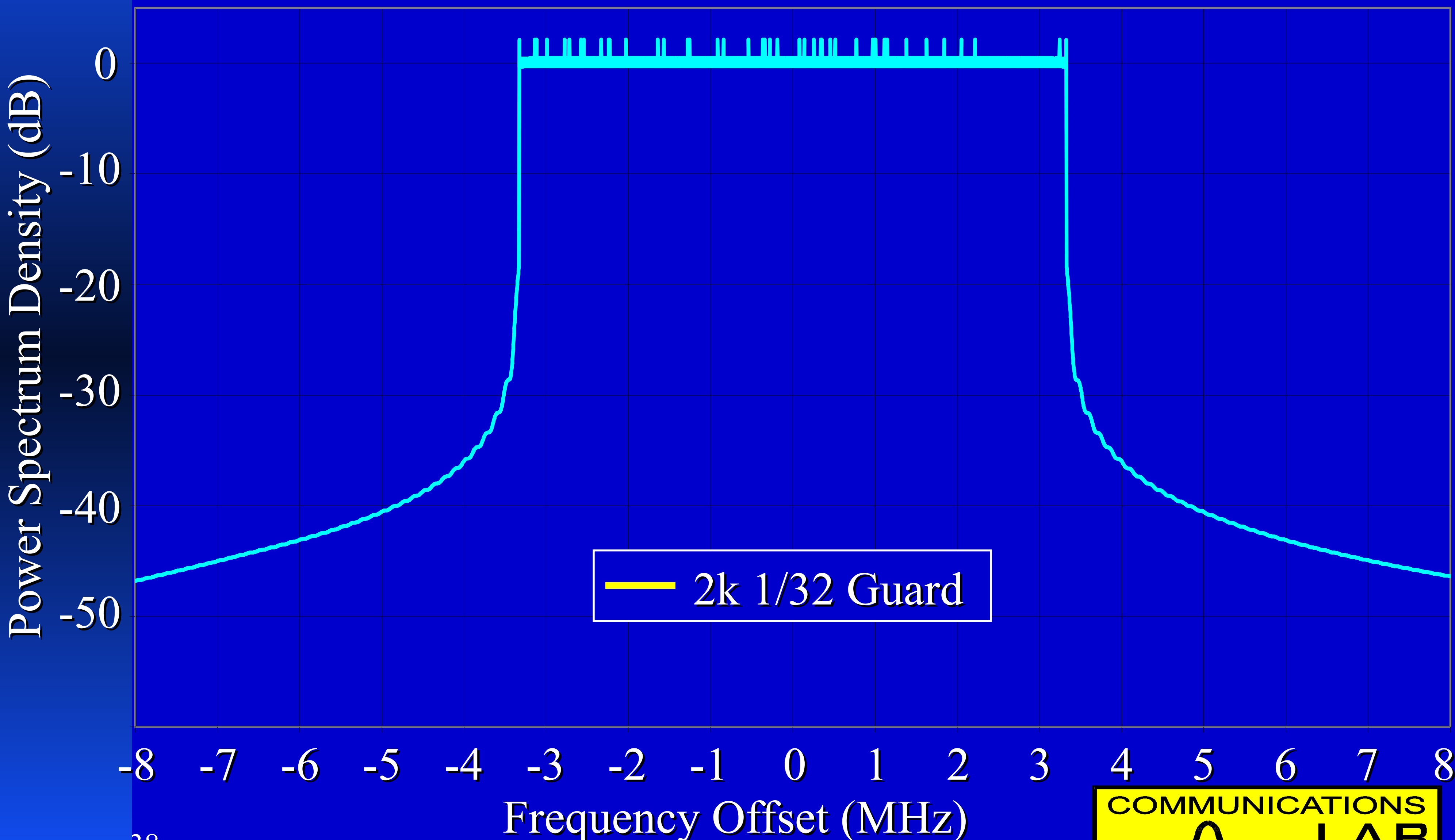
7 MHz COFDM Modulator Spectrum



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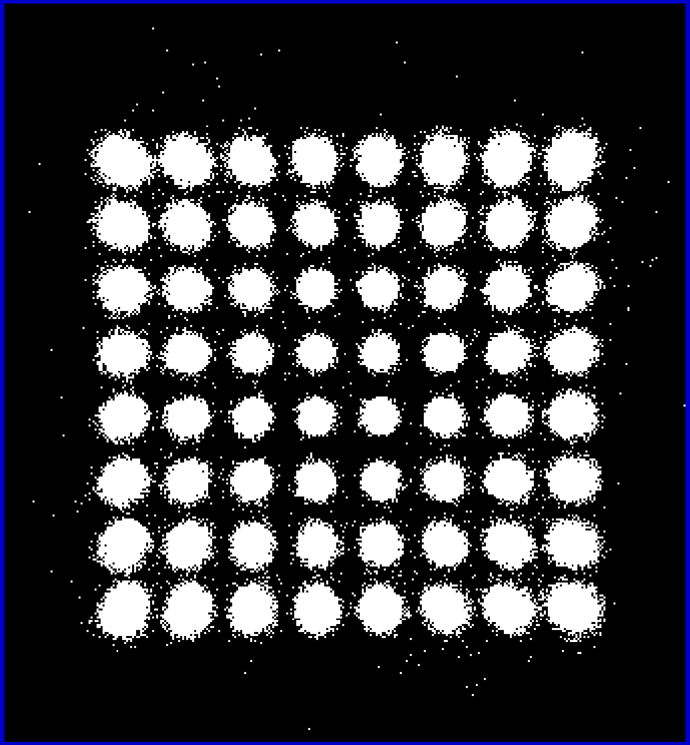
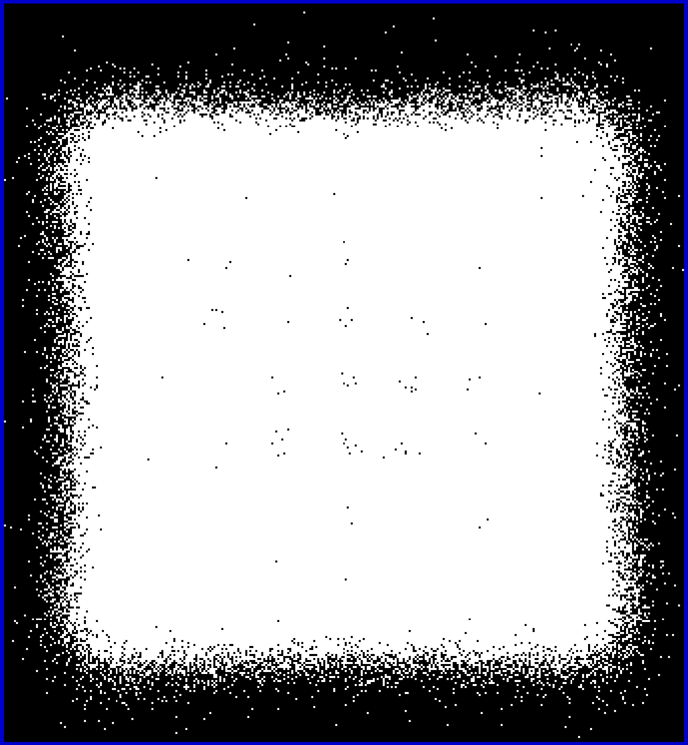
64-QAM - Perfect & Failure





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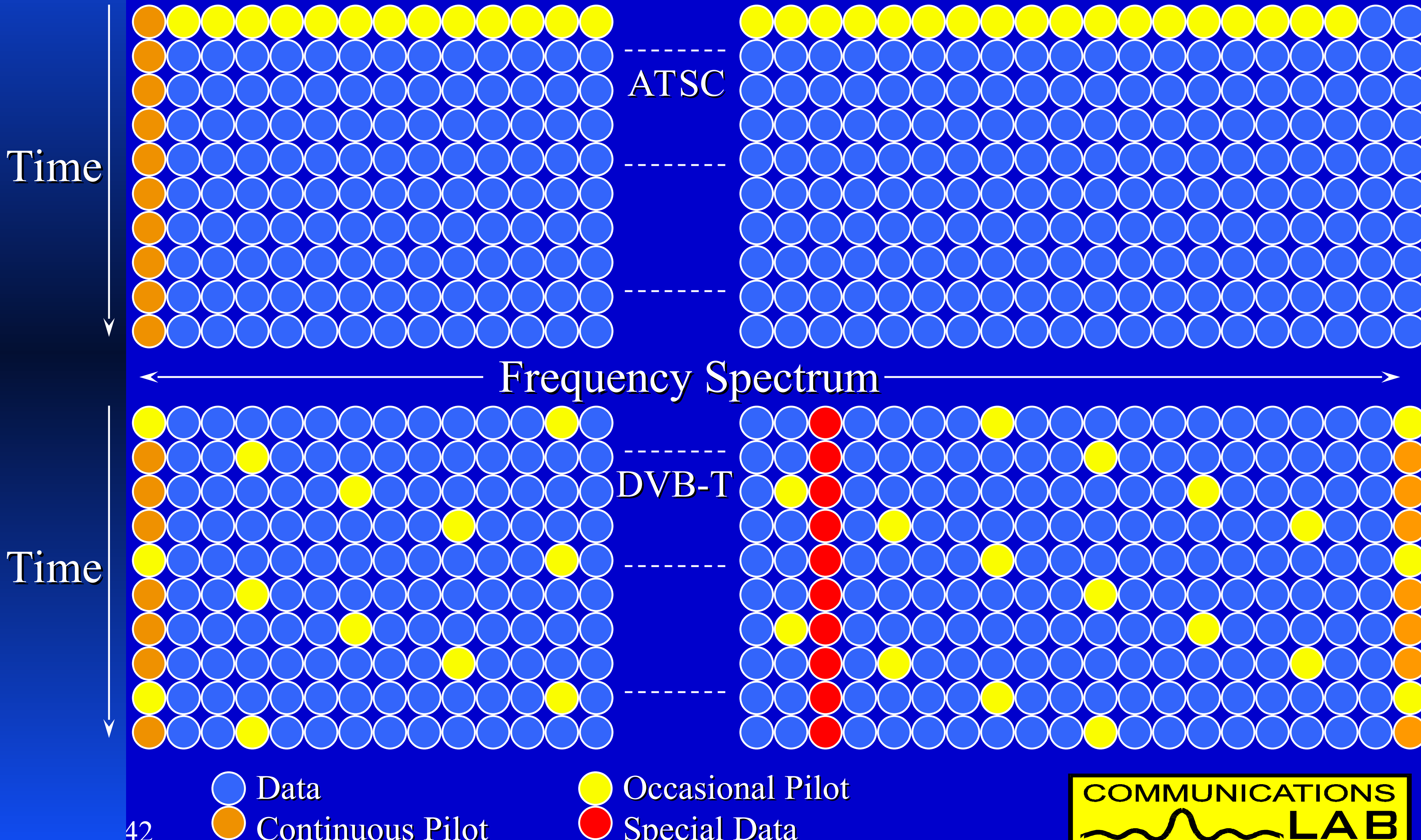
Channel Estimation & Equalisation



General Parameters - Aust Tests

Parameter	DVB-T	ATSC
Data Payload	19.35 Mb/s	19.39 Mb/s
Carriers	1705	1
Symbol Time	256 us	93 ns
Time Interleaving	1 Symbol	4 ms
Reed Solomon code rate	188/204	187/207
IF Bandwidth (3 dB)	6.67 MHz	5.38 MHz

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General Parameters

Parameter	DVB-T	ATSC
IF centre Frequency MHz	35.3 MHz	44.0
Receiver AFC range	11.5 kHz	359 kHz
Latency including MPEG coding SDTV 8 Mb/s	37 Frames	

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Payload Bitrate Mb/s

COFDM MOD TYPE	FEC Code Rate	Sys C/N (dB)	Min Sig Level (dBuV)	Calc Rx NF (dB)	Guard 1/4 (Mb/s)	Guard 1/8 (Mb/s)	Guard 1/16 (Mb/s)	Guard 1/32 (Mb/s)
QPSK	1/2	5.4	11.7	4.8	4.35	4.84	5.12	5.28
QPSK	2/3	6.6	13.2	5.1	5.81	6.45	6.83	7.04
QPSK	3/4	7.6	14.8	5.7	6.53	7.26	7.68	7.92
QPSK	5/6	8.7	16.8	6.6	7.26	8.06	8.54	8.80
QPSK	7/8	9.5	19.2	8.2	7.62	8.47	8.96	9.24
16-QAM	1/2	11.2	17.7	5.0	8.71	9.68	10.25	10.56
16-QAM	2/3	13.0	19.6	5.1	11.61	12.90	13.66	14.07
16-QAM	3/4	14.1	20.9	5.3	13.06	14.51	15.37	15.83
16-QAM	5/6	15.5	22.9	5.9	14.51	16.13	17.08	17.59
16-QAM	7/8	16.3	24.9	7.1	15.24	16.93	17.93	18.47
64-QAM	1/2	16.8	23.3	5.0	13.06	14.51	15.37	15.83
64-QAM	2/3	19.1	25.2	4.6	17.42	19.35	20.49	21.11
64-QAM	3/4	20.6	27.5	5.4	19.59	21.77	23.05	23.75
64-QAM	5/6	22.2	30.0	6.3	21.77	24.19	25.61	26.39
64-QAM	7/8	23.7	32.4	7.2	22.86	25.40	26.89	27.71
8-VSB	2/3	15.1	27.2	11.2	-	-	-	19.39

Blue Payload Figures are 188/204 scaled from actual measurement

Red Figures are calculated from the 1/32 Guard interval data

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AWGN Receiver Performance

Parameter	DVB-T	ATSC
Carrier to Noise Threshold (in native system BW)	19.1 dB	15.1 dB
Simulated Theoretical C/N for optimum system	16.5 dB	14.9 dB
Minimum Signal Level	25.2 dBuV	27.2 dBuV
Receiver noise figure	4.6 dB	11.2 dB
Rx Level for 1 dB C/N Loss	34 dBuV	35 dBuV

Receiver Parameters

- Guard interval
  - Affects payload data rate and echo performance
  - No impact on general receiver parameters such as C/N & Signal level.
- COFDM Transmission Parameter Signalling (TPS) - receiver automatically determines the modulation type, FEC & Guard Interval

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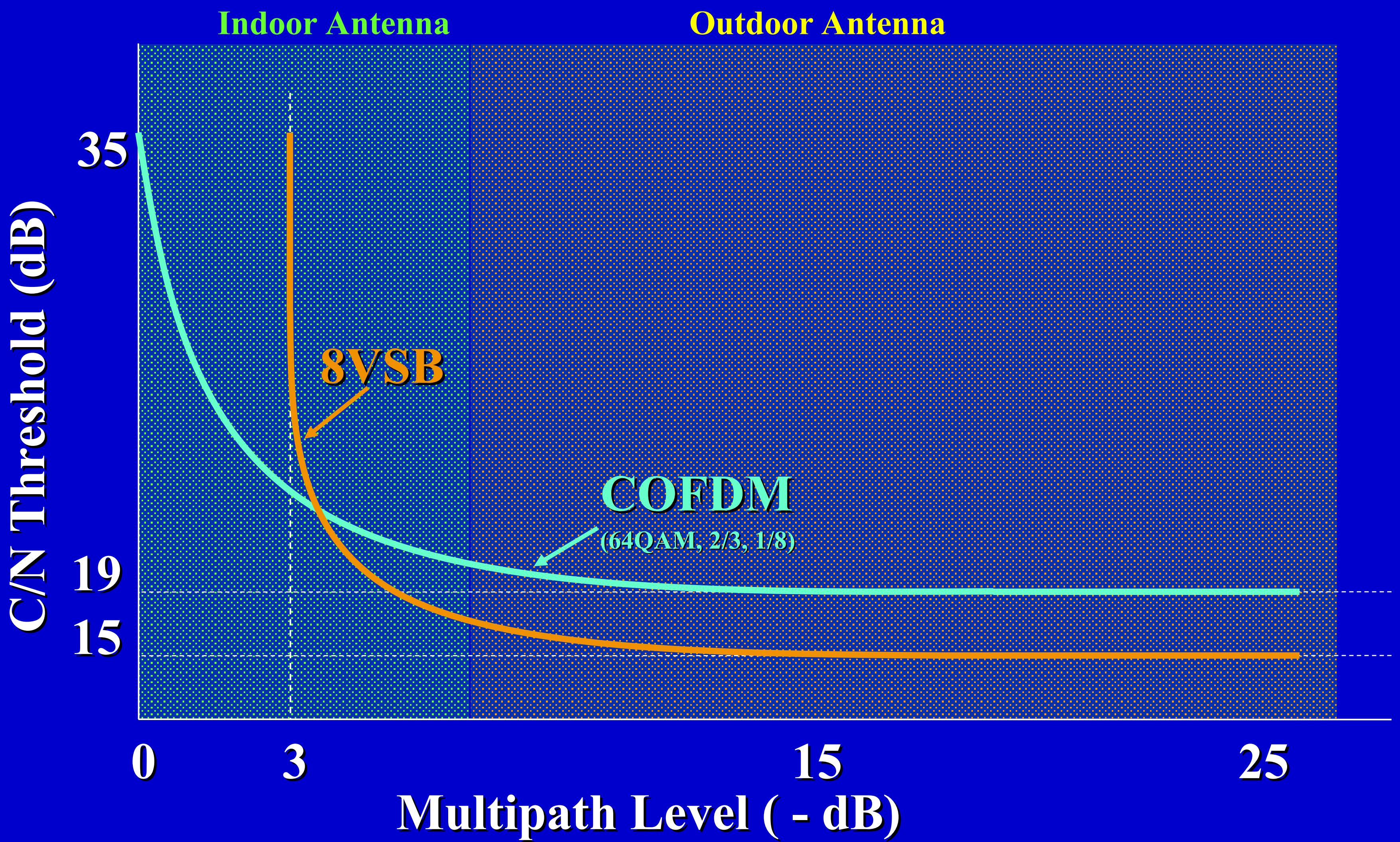
DTTB System Multipath Character



(Conditions: Static multipath, Equal Rx NF,
No Co-channel or impulse interference)

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AWGN Performance

- C/N 4 dB more power required for DVB-T to achieve the same coverage as ATSC.
- Better C/N performance ATSC offset by poor receiver noise figure
- ATSC C/N is very close to the theoretical DVB-T implementation is still over 2.5 dB higher than the simulated margin.
- Other DVB-T modes have different C/N Thresholds and Data Rates

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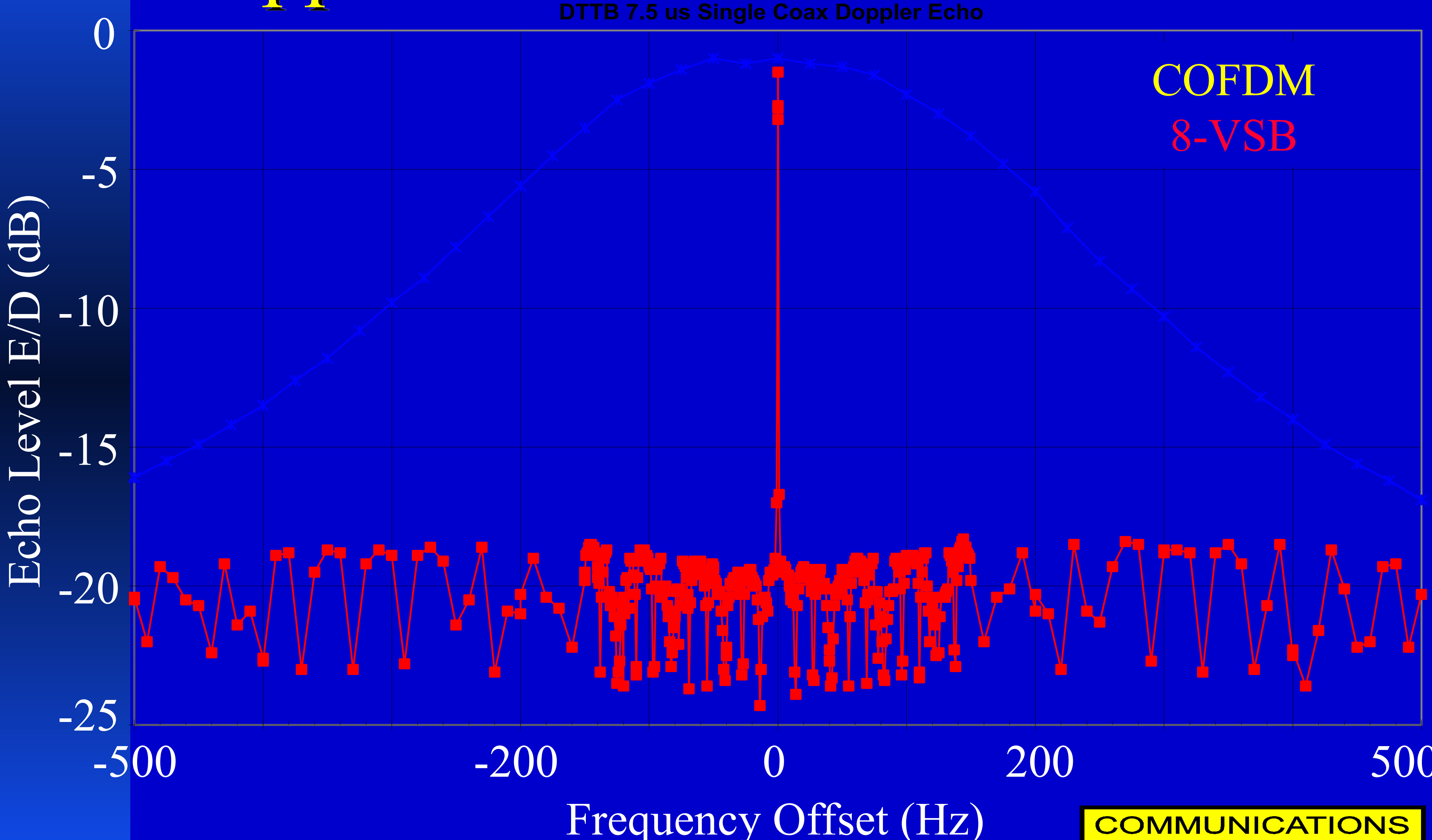
Multipath & Flutter Measurements

Parameter	DVB-T	ATSC
7.2 us Coax pre ghost	0 dB	-13.5 dB
7.2 us Coax post ghost	0 dB	-2.2 dB
Echo correction range	32 us	+3 to -20 us
Doppler single echo performance (-3 dB echoes)	140 Hz	1 Hz

Doppler Echo - 7.5 us Coax



Multipath & Flutter - Overview

- ATSC system 2 Equaliser modes
  - Rx Eq switches to fast mode when short variable echoes are detected.
  - Lab Tests - slow equalisation mode.
- 8 VSB degrades more rapidly when multipath echo exceeds -7 dB
- COFDM works up to 0 dB in a white noise environment but in this condition is very fragile.

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Transmitter Performance Sensitivity

Parameter	DVB-T	ATSC
Transmitter/Translator Linearity & Inter-mod Sensitivity	Low	High
Group Delay / Combiner / Filter Sensitivity	Low	< 50 ns

Transmission Strategies

Suggested Transmission System performance maintenance strategy

- DVB-T - Manual Maintenance same as PAL
- ATSC - Automatic Dynamic pre-corrector

Gap Fill coverage - System Strategy

- DVB-T - IF Translator, Digital Repeater or SFN
- ATSC - Digital Repeater

Transmission Performance - 1

- ATSC very sensitive to transmission impairments as it uses up correction capacity in the receiver equaliser.
- ATSC equaliser has to correct the response characteristic of the whole channel.
- DVB-T equaliser uses pilot carriers spread throughout the spectrum to equalise the channel in small 16-50 kHz sections.

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Transmission Performance - 2

- ATSC Dynamic Pre-corrector will be difficult to apply in the combined antenna systems used in Australia

- Zenith suggest transmission without using a transmitter output filter to avoid group delay problems with 8-VSB.

- ATSC 6 MHz system operating in a 7 MHz channel helps this situation.

Impulse Noise - Results

- Impulse Sensitivity (Differential to PAL grade 4)
  - **DVB-T** 9 -14 dB
  - **ATSC** 17-25 dB
- Difficult to measure & characterise.
- Mainly affects the lower VHF frequencies
- ATSC is 8 to 11 dB better at handling impulsive noise than DVB-T

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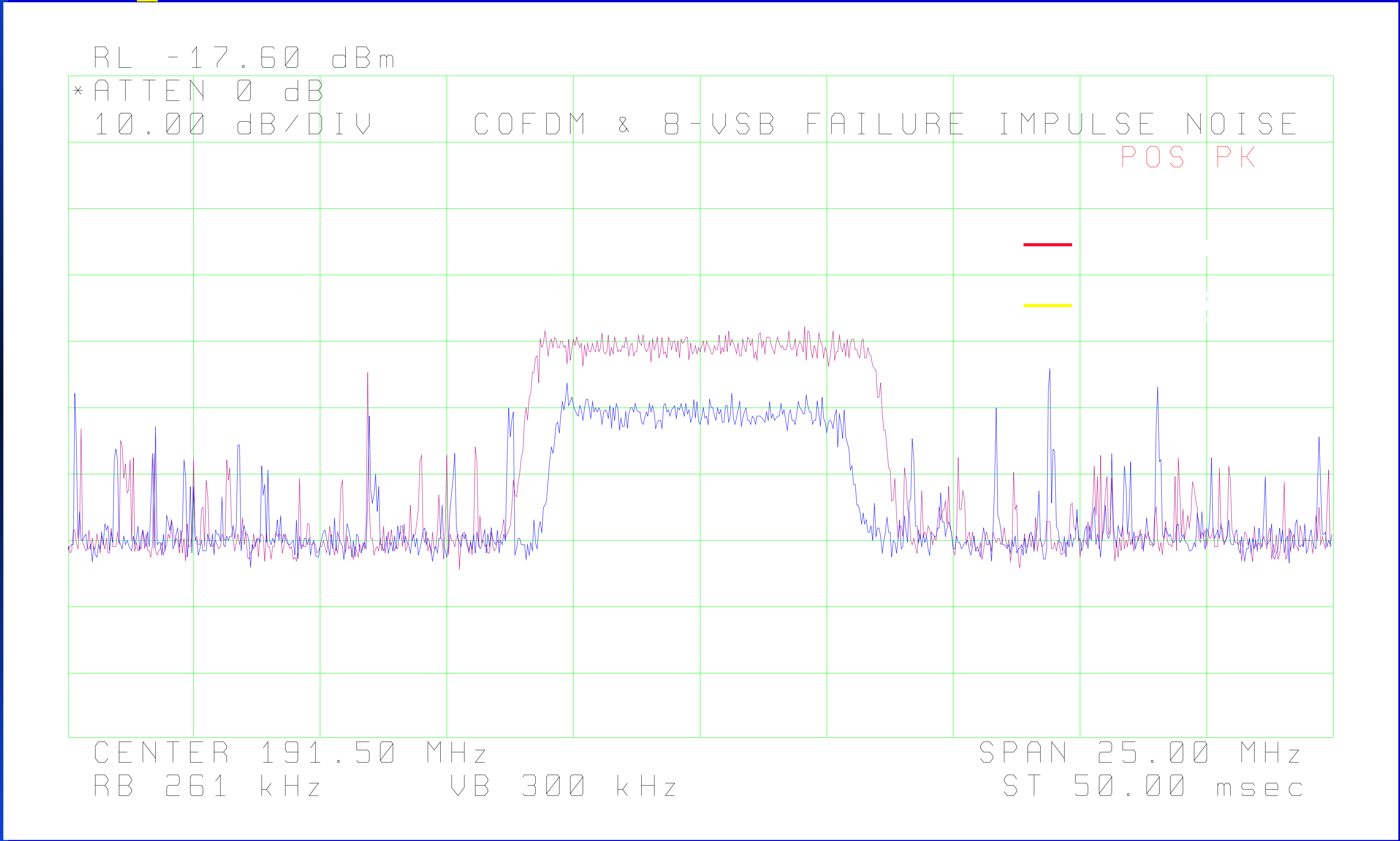
Impulse Noise - Plot



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Impulse Noise - Overview

- ATSC only has a few data symbols affected by any normal impulsive phenomenon
- The DVB-T COFDM demodulation (FFT) spreads the energy from a broad spectrum impulse across all carriers leading to massive data loss when the impulse is large enough.

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DTTB into PAL - Subjective

Grade

3

4

3

4

-9.5
35.8
-10.6
-5.3
41.1
-6.4
3.5
50.4
5.1

-7.0
38.7
-7.1
-0.9
45.5
-0.3
5.0
51.4
5.4

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DTTB into PAL - Overview

- DVB-T marginally less interference to PAL
- DTTB Co channel signals need to be kept at least 46 dB on average below the Wanted PAL level to ensure Grade 4 reception
- DTTB Adjacent channel signals need to be kept on average at or below the Wanted PAL level to ensure Grade 4 reception

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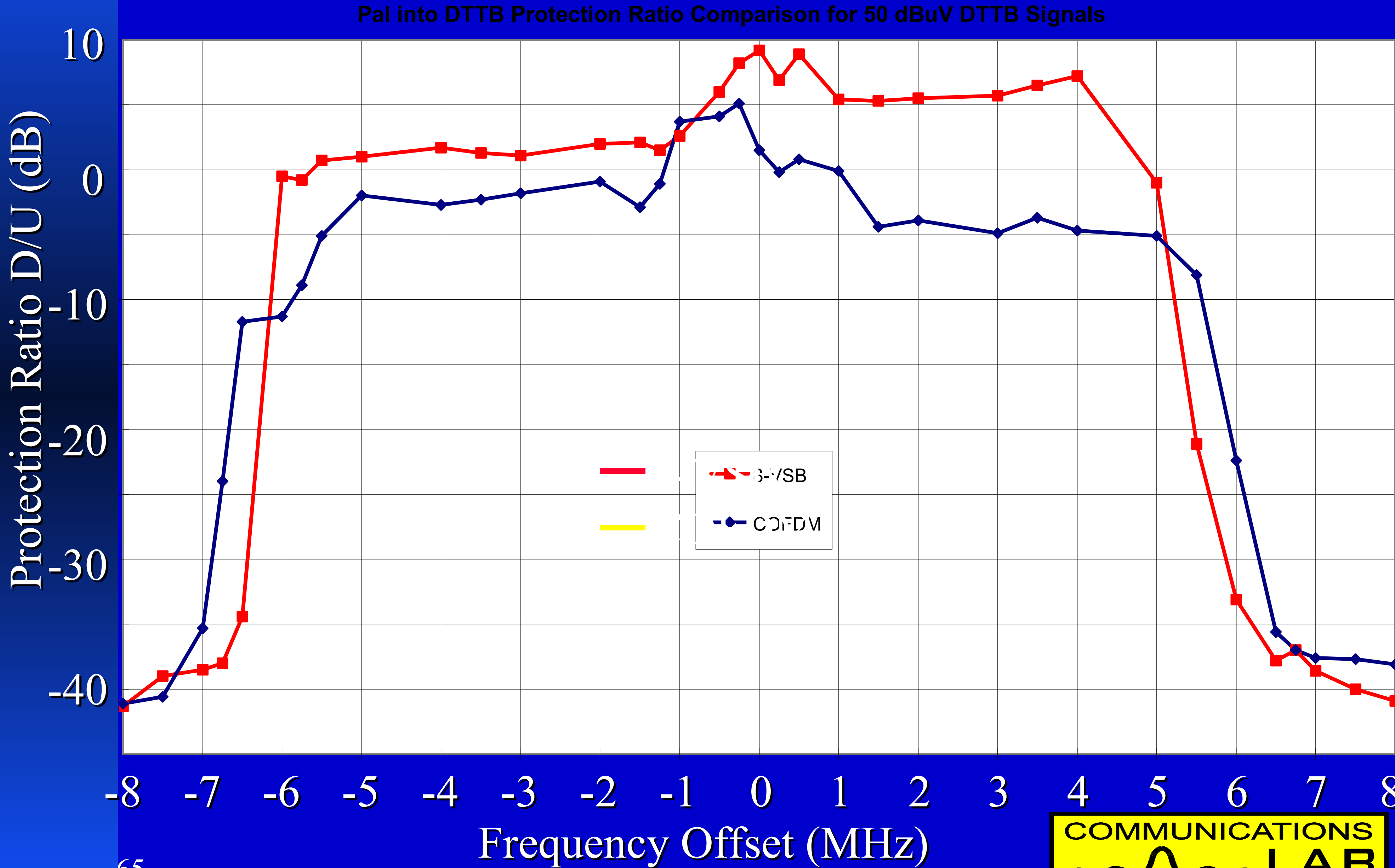
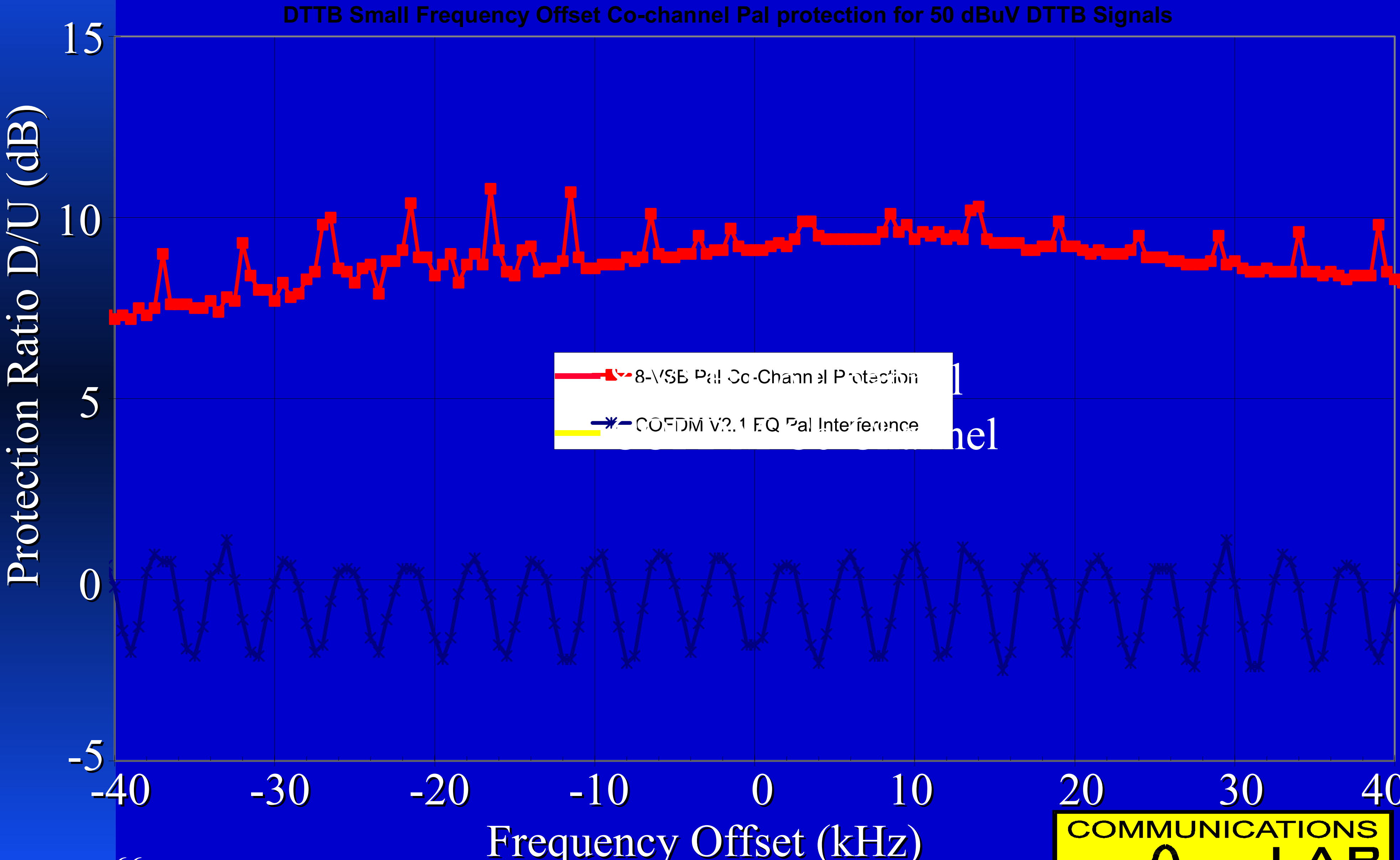
PAL into DTTB - Results

DVB-T-7	COFDM 64-QAM	2/3	-35.4	1.4	-37.5
ATSC-6	8-VSB 8-AM	2/3	-38.6	9.1	-38.7

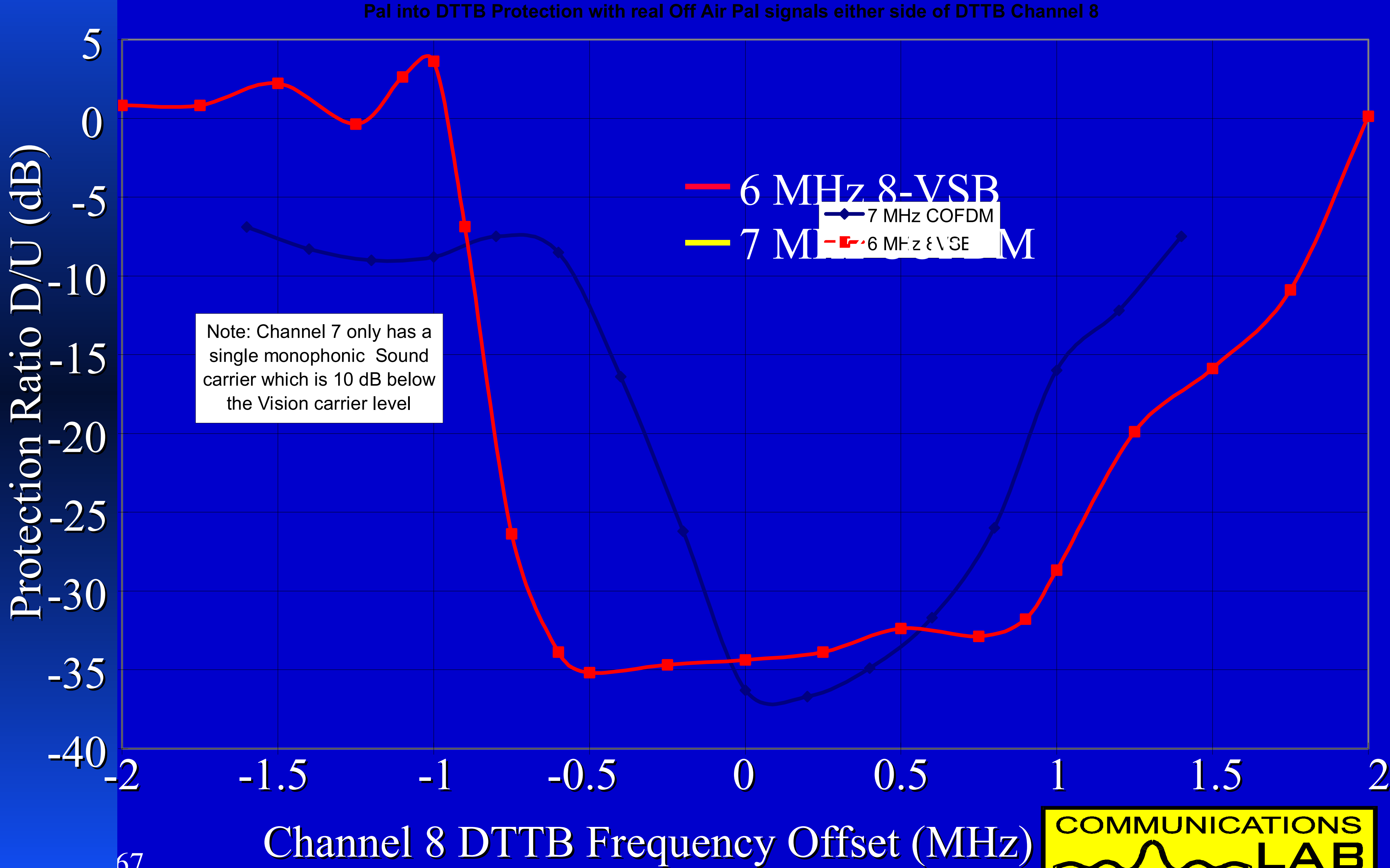
PAL into DTTB - Protection Plot



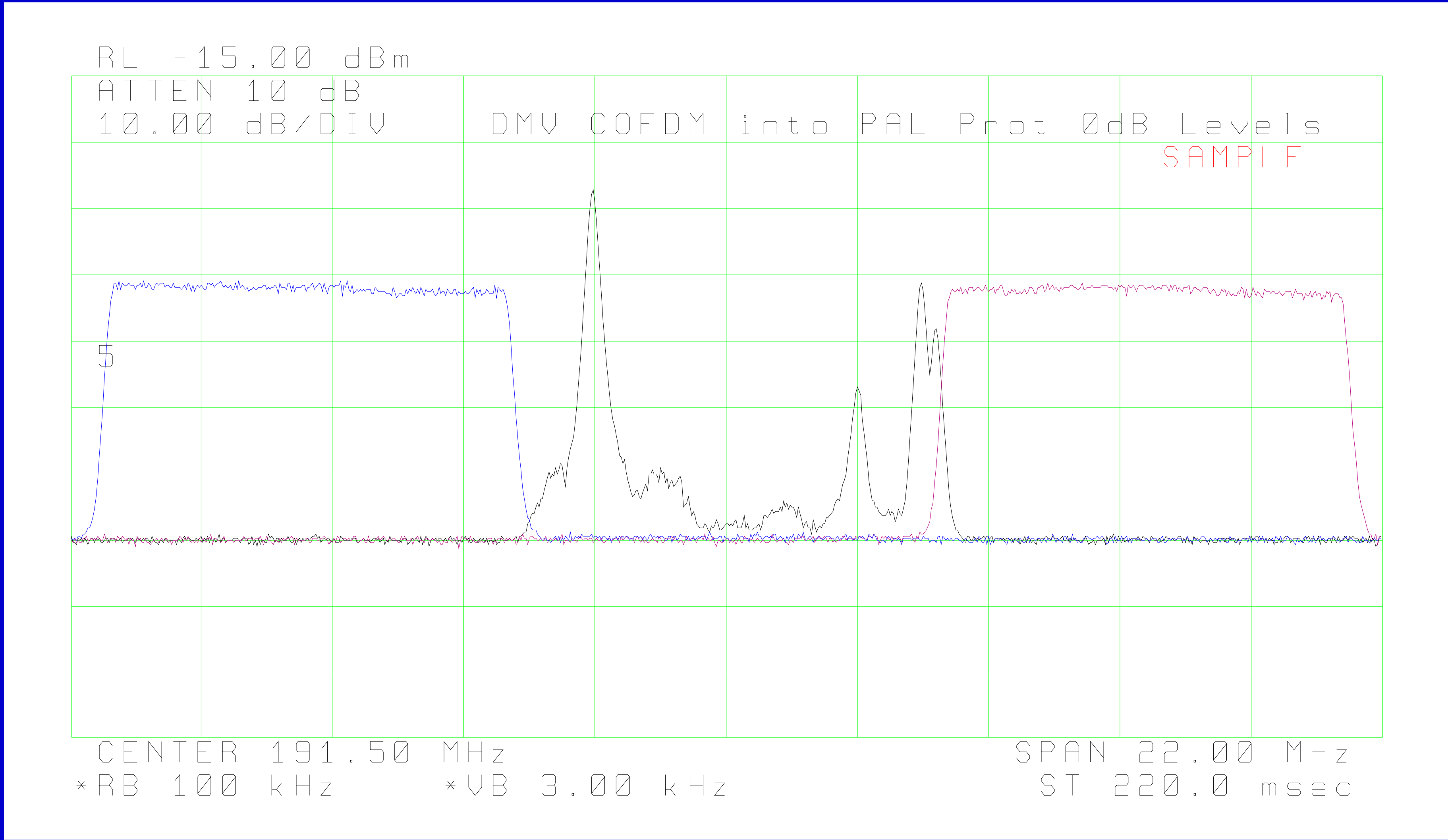
Co Channel PAL into DTTB - Plot



Off Air PAL into DTTB - Plot



DTTB & PAL in Adjacent Channels



0 dB Relative Levels - PAL/DTTB

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PAL into DTTB - Overview 1

- The narrower ATSC system achieves very similar out of band / adjacent channel performance to DVB-T.
- ATSC is nearly 8 dB worse than DVB-T when subjected to interference from Co-Channel PAL transmissions

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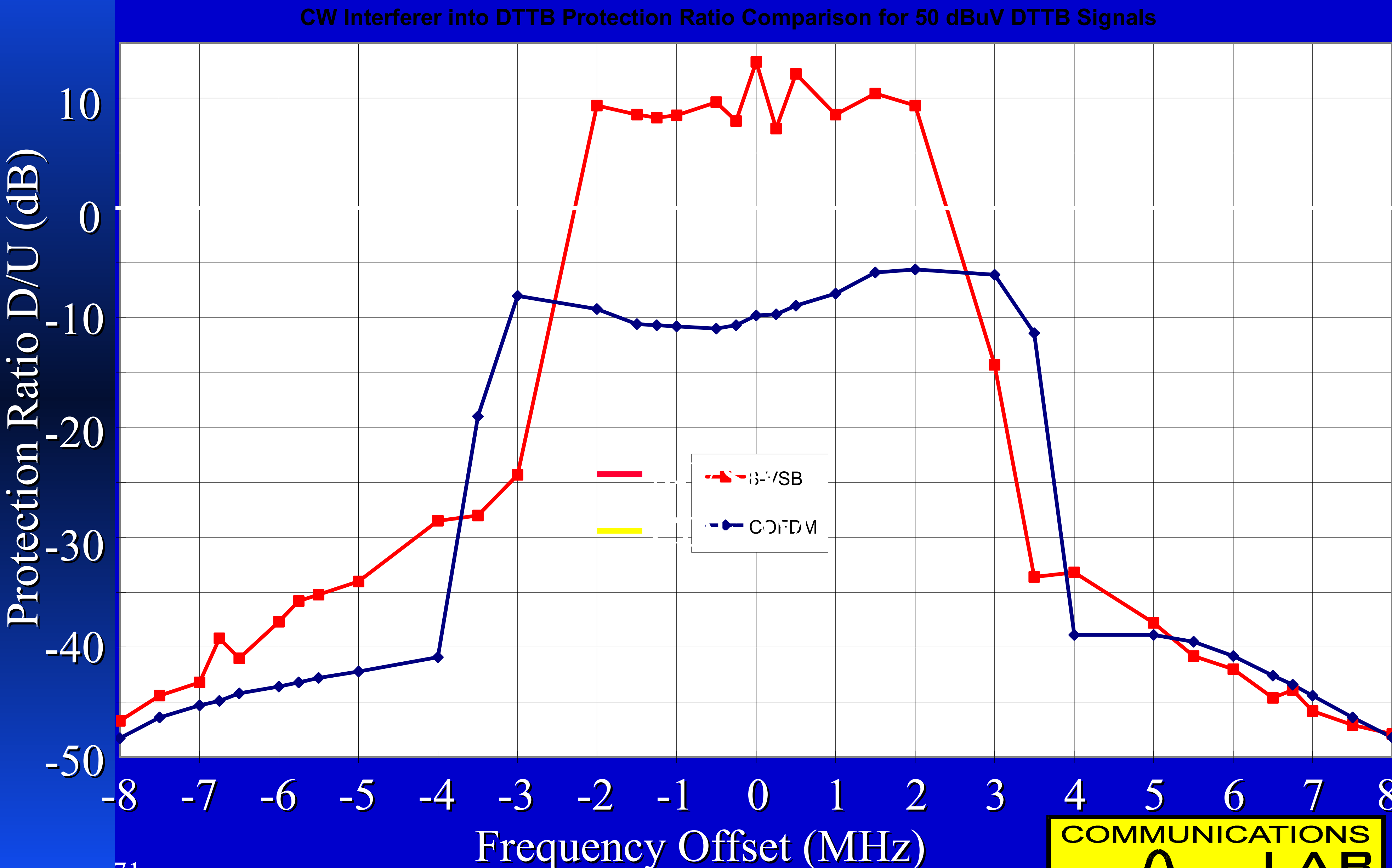
PAL into DTTB - Overview 2

- In situations where Co-Channel DTTB and PAL signals exist the DTTB into PAL interference will be the dominant factor, providing directional antennas are used.
- If a DTTB frequency offset was being considered for use, the data indicates that moving up in frequency is preferable to moving down.

CW into DTTB - Protection Plot



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CW into DTTB - Summary

- DVB-T is on average 15.5 dB less sensitive across the channel to general CW type interferers than ATSC
- The DVB-T orthogonal carrier spacing is evident for DVB-T in this measurement with a variation of over 8 dB. If known CW interferers are likely then a frequency offset of less than 4 kHz may assist system performance.

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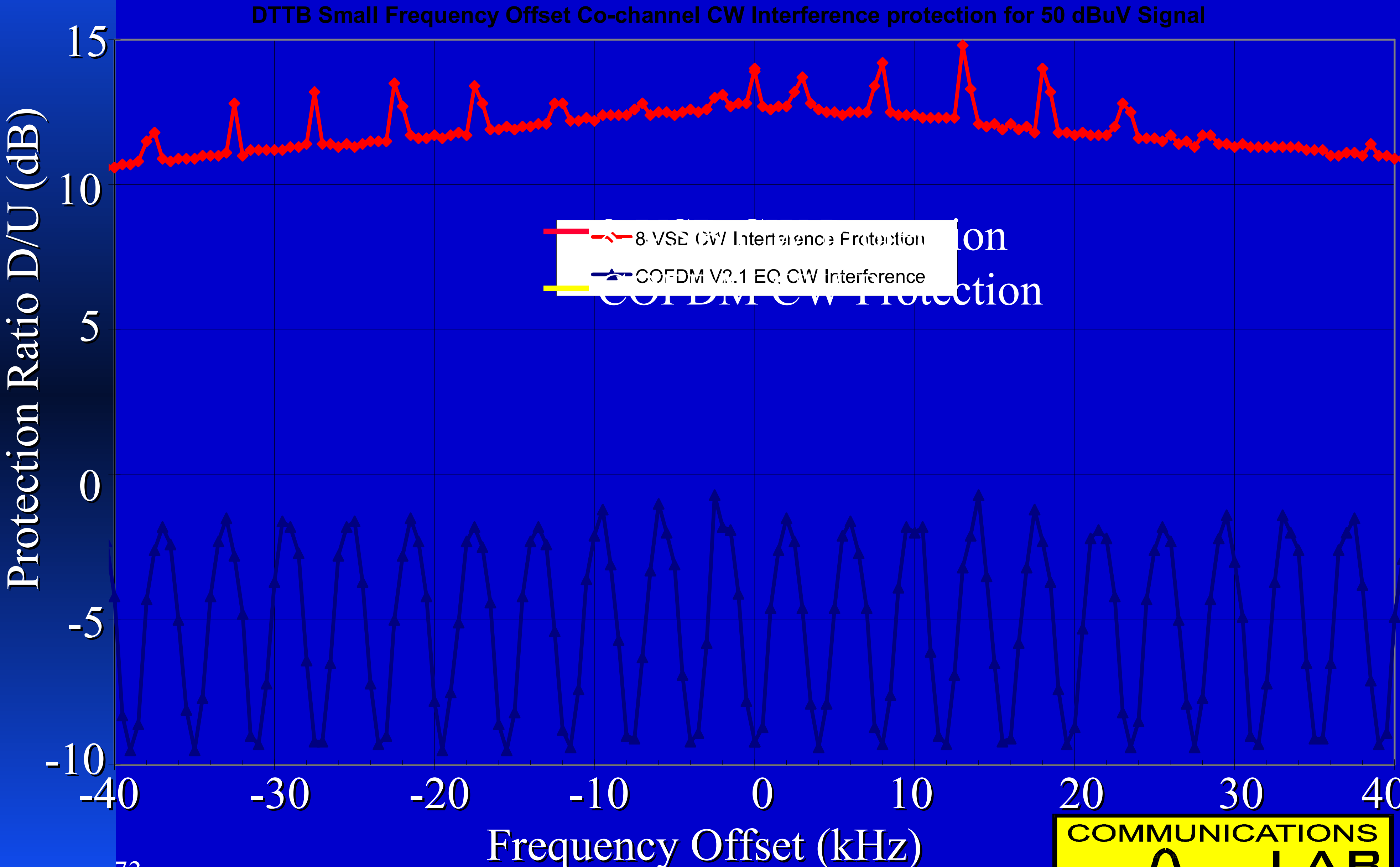
CW into DTTB centre channel



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CW into DTTB - Comment

- ATSC has occasional peaks due to critical equaliser responses.
- The DVB-T response above was obtained from the improved equaliser which was provided near the end of the tests.

DTTB into DTTB - Overview

DTTB TYPE	Ch 7 Lower Adj Ch (dB)	Co Channel (dB)	Ch 9 Upper Adj Ch (dB)
DVB-T-7	-28.3	20	-28.5
ATSC-6	-30.4	14.6	-32.2

- Adjacent channel performance of ATSC is better than DVB-T
- The Co-channel protection of both digital systems approximates to the system carrier to noise threshold.

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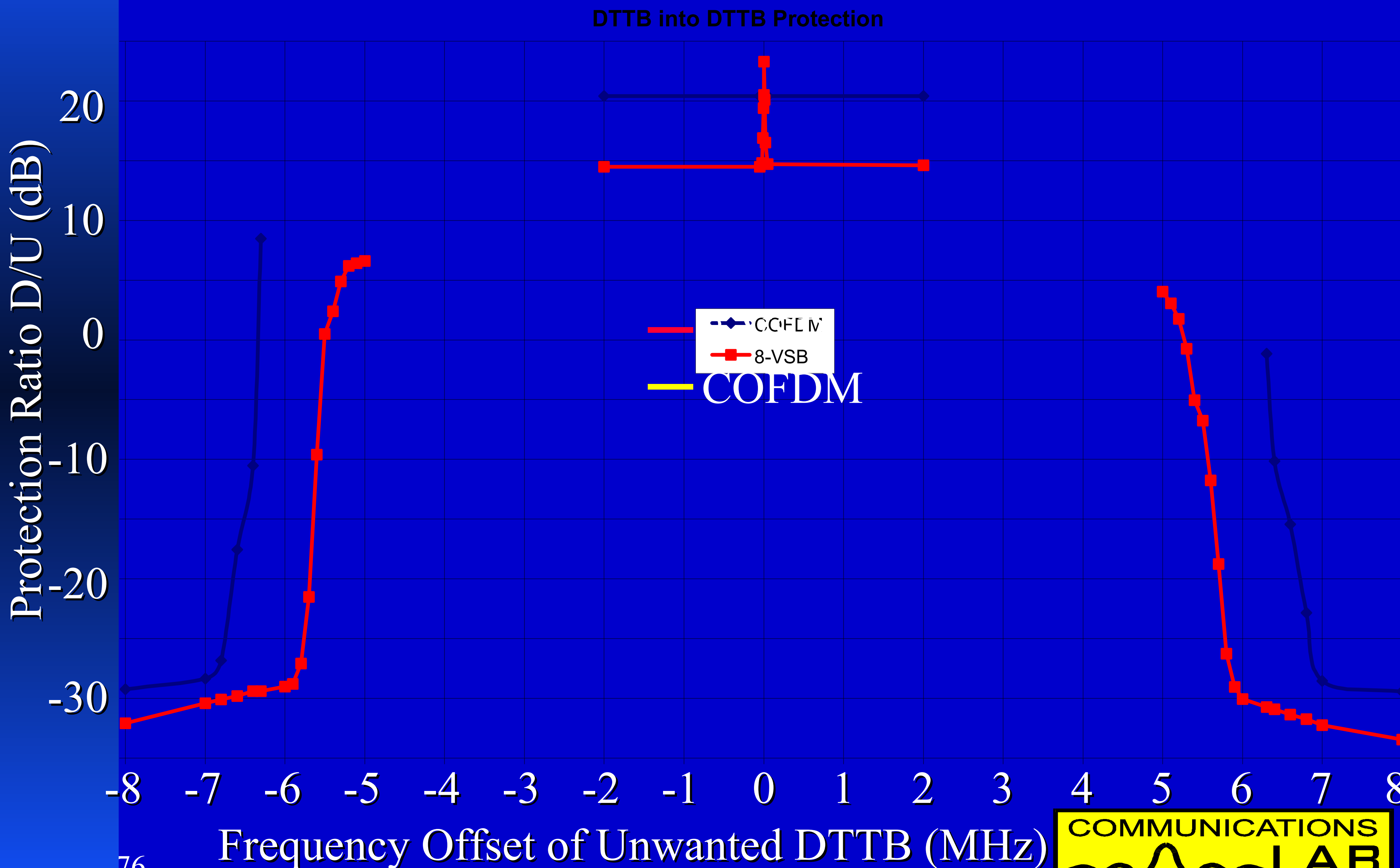
DTTB into DTTB - Protection Plot



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DTTB Field Testing Objectives

A DTTB Field Trial is study of Failure !!

In comparison with current PAL television

In various reception conditions :

- Investigate the difference in reception character for the two DTTB modulation systems.
- Provide information to DTTB system planners
- To provide Credible data.

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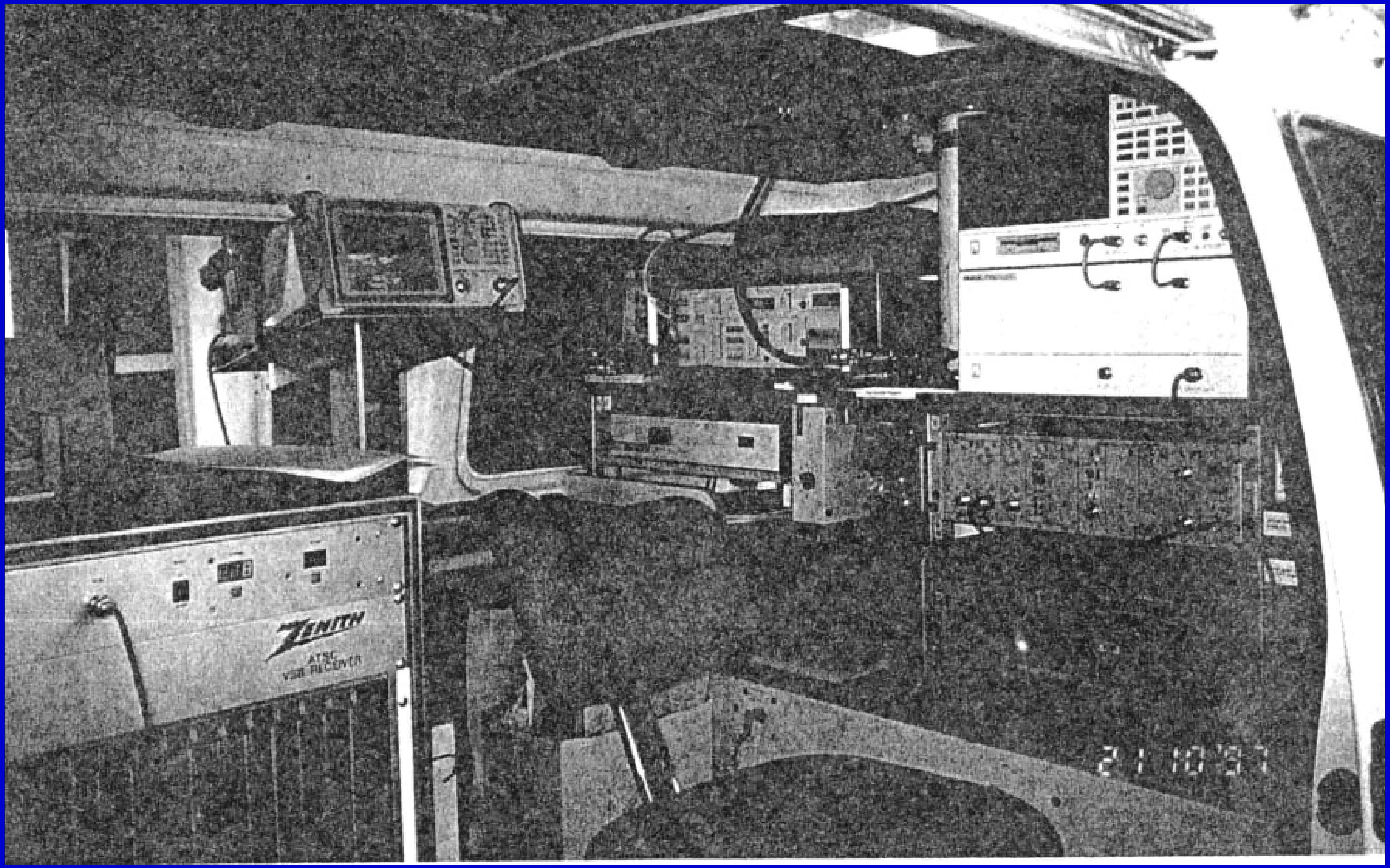
Field Testing - Van

- A field test vehicle was built in a small van.



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Field Testing - On the Streets

- Over 115 sites were measured

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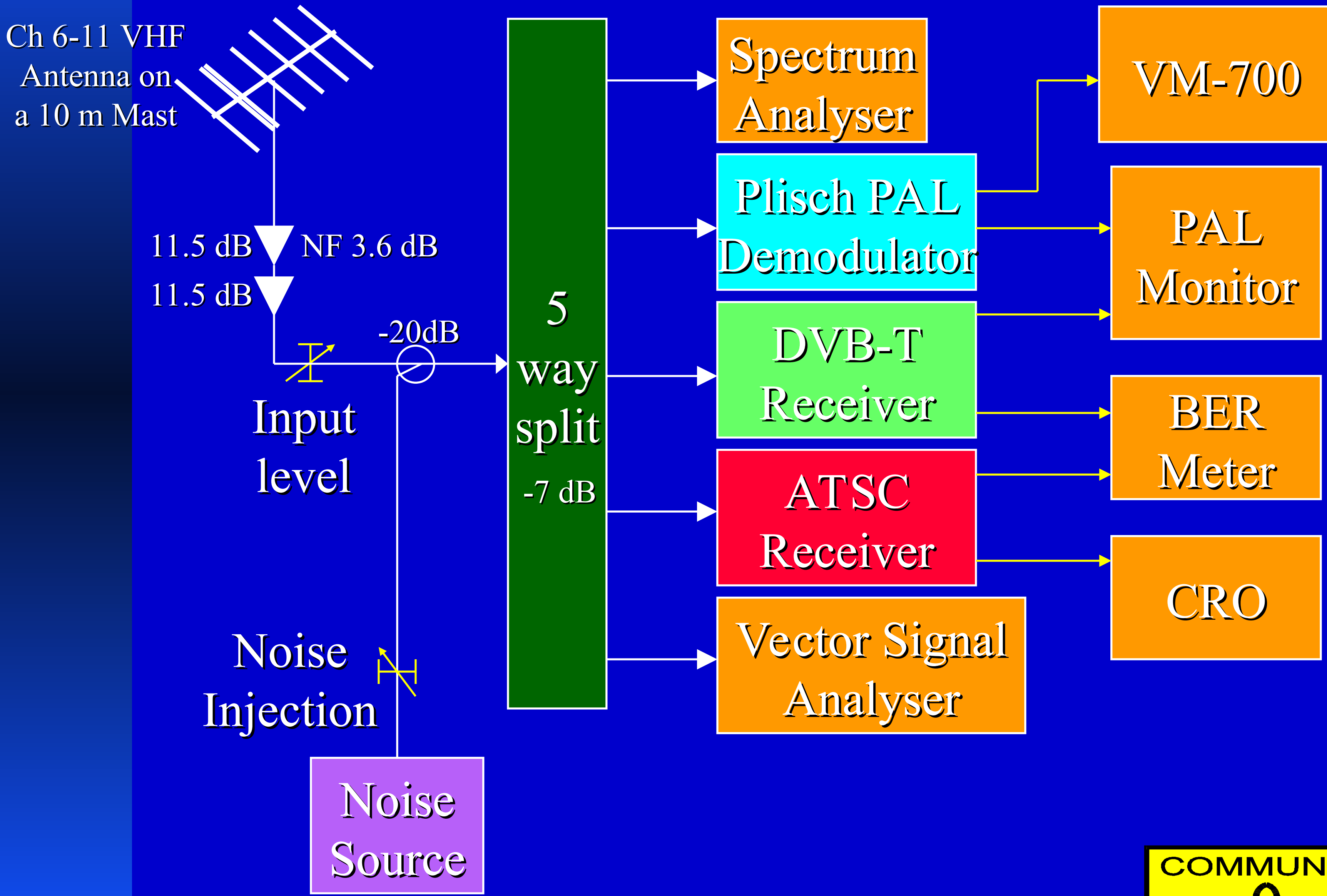
Field Test Vehicle Block Diagram



Field Testing - Method

- Field tests were conducted in Sydney over a 1 month period on VHF channel 8.
- Some simultaneous tests were conducted on VHF channel 6
- Power level for the field test was 14 dB below adjacent analog television channels 7 & 9
- Analog and digital television performance for both systems were evaluated at each site.
- Conducted by Independent Consultant & Mr Wayne Dickson of TEN

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Field Test - Data Collected each Site

- Common Masthead Amp used (NF ~ 3.6 dB)
- Analog PAL transmission character (7,9 & 10)
- Measure level, multipath, quality & Video S/N
- Measure DVB & ATSC reception (Ch 8)
- Record DTTB & Analog Spectrum
- Measure Noise Margin (C/N Margin)
- Measure Level Threshold (Signal Margin)
- Measure antenna off pointing sensitivity

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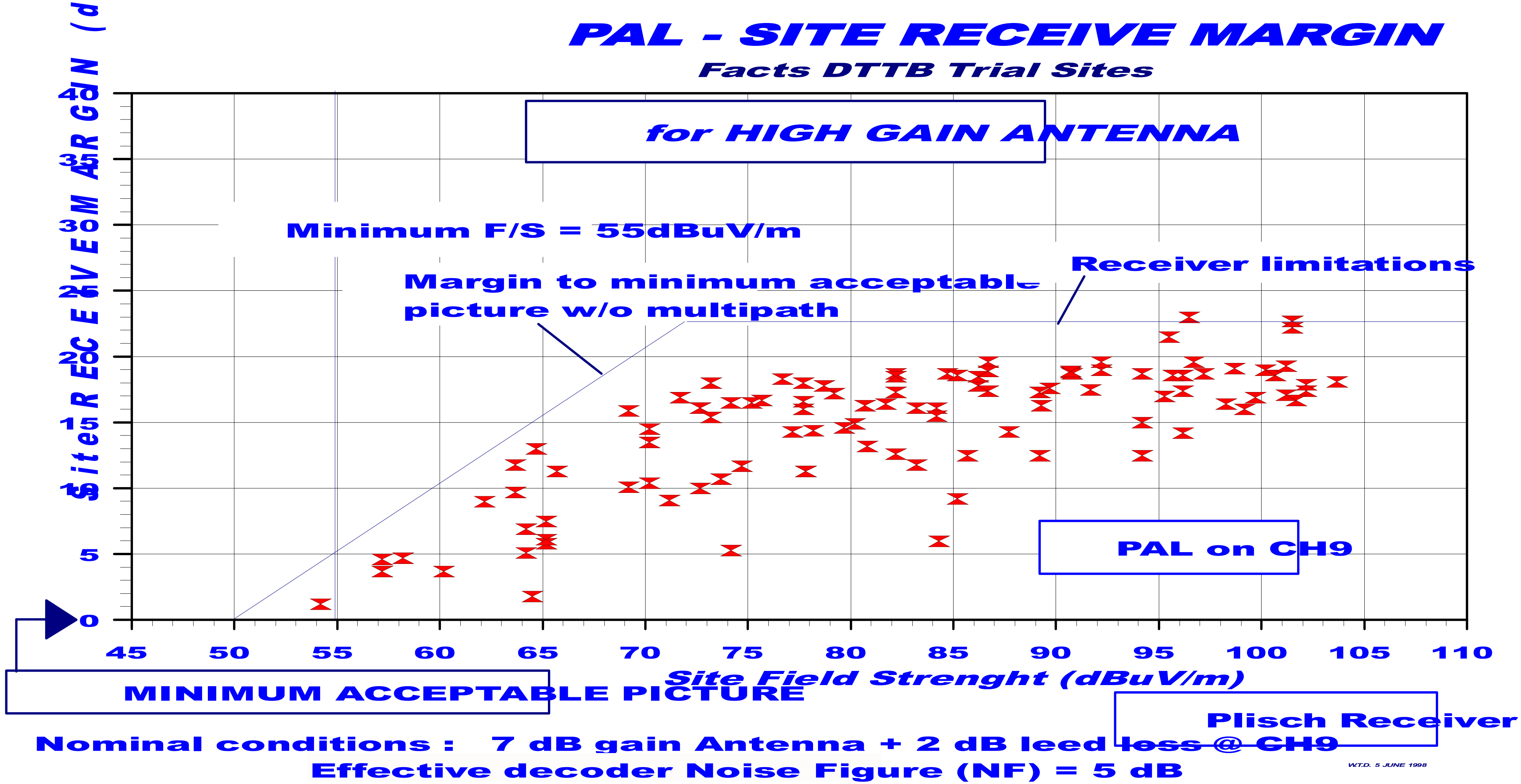
Australian DTTB Field Trial

PAL Receive Margin



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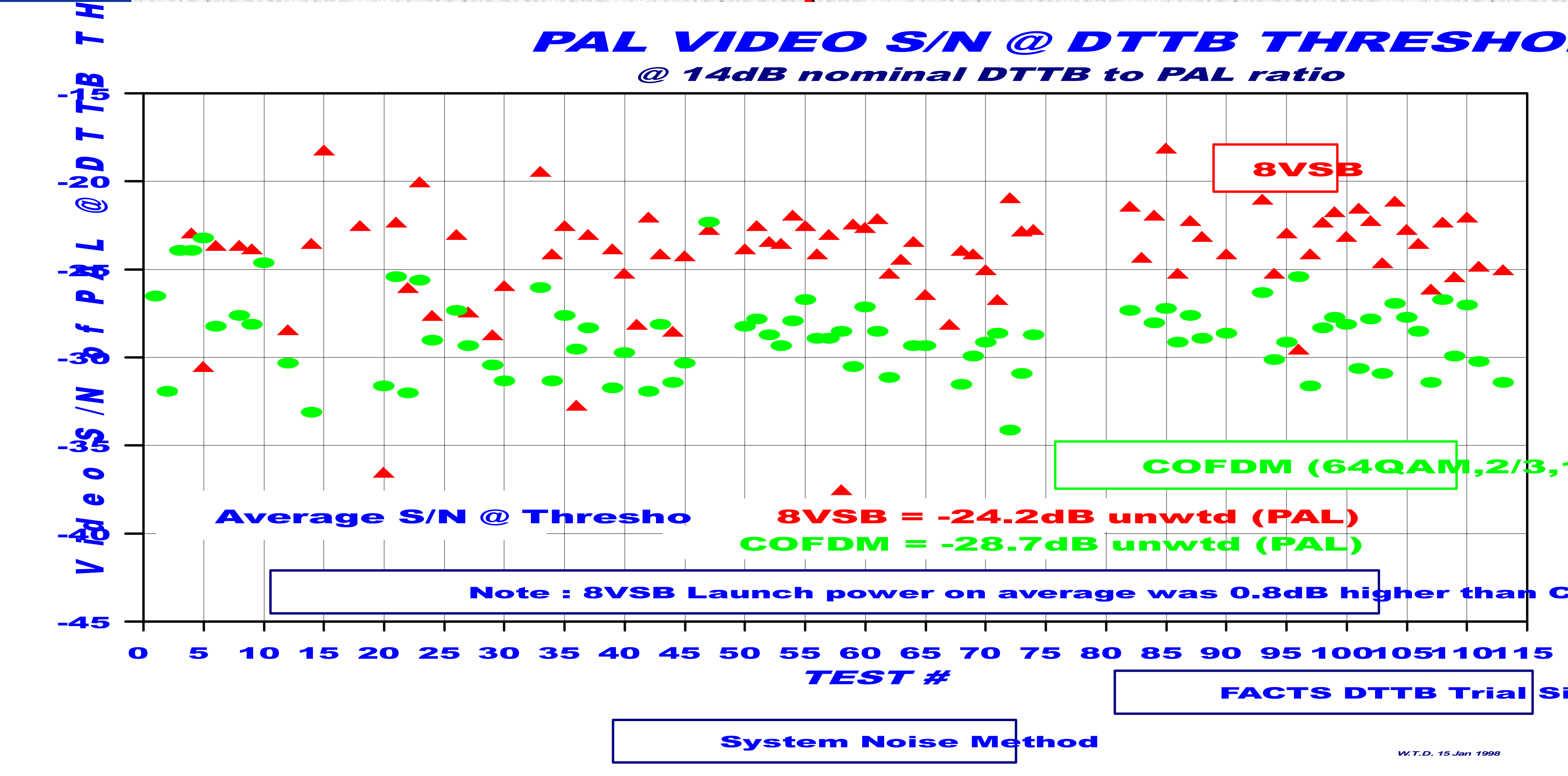
Australian DTTB Field Trial

DTTB compared to PAL



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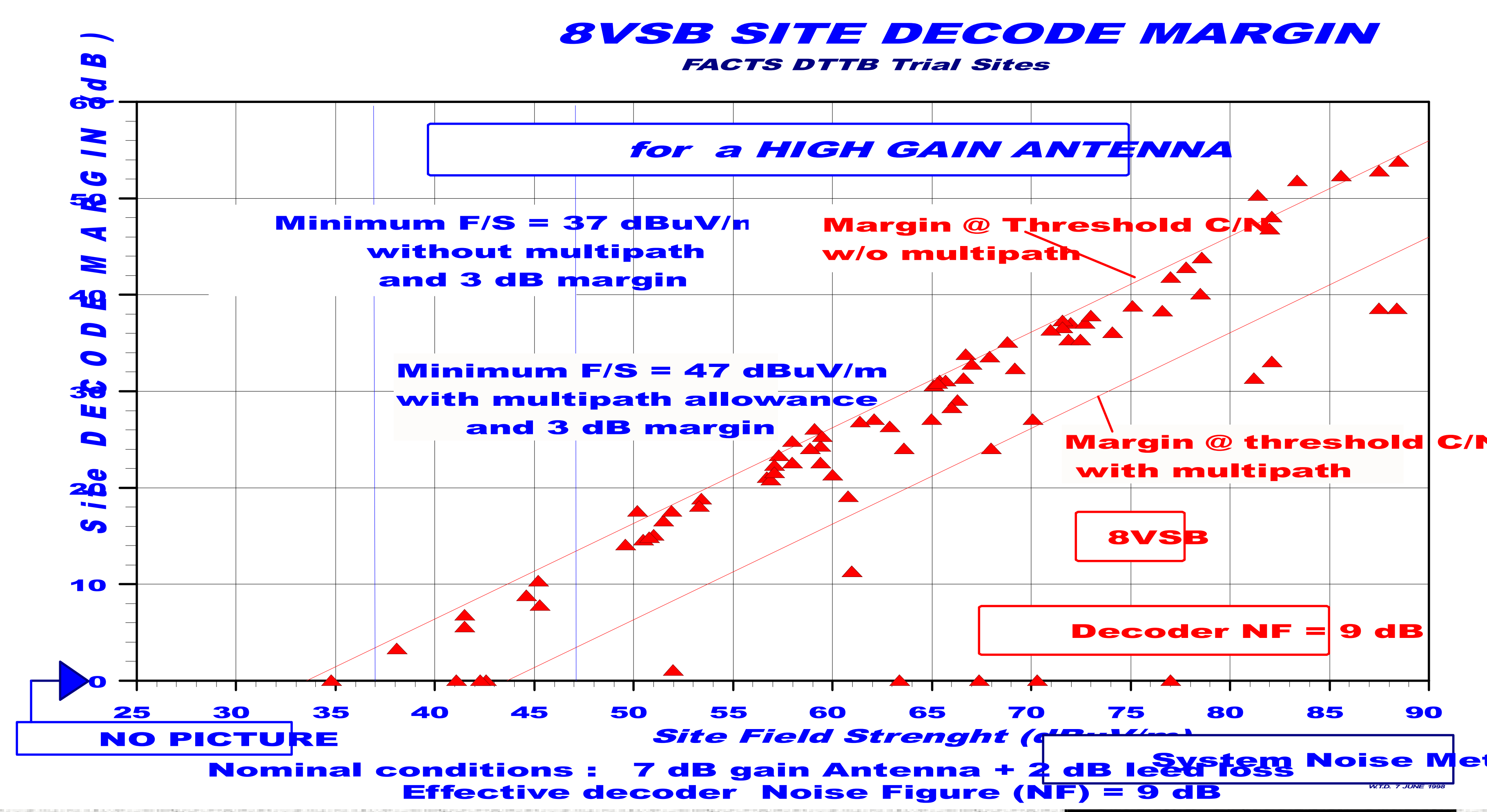
Australian DTTB Field Trial

8VSB Decoder Margin



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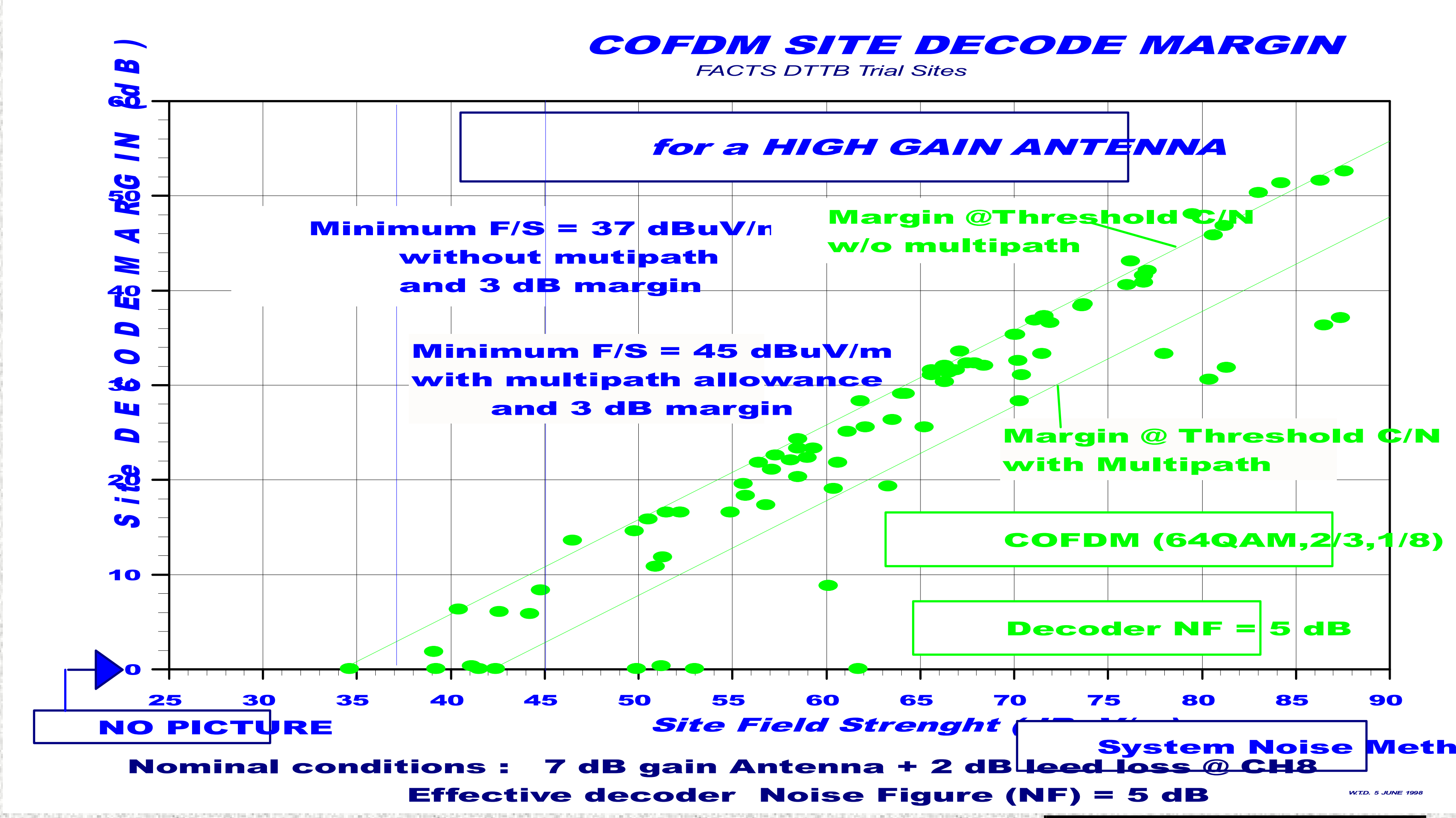
Australian DTTB Field Trial
COFDM Decoder Margin



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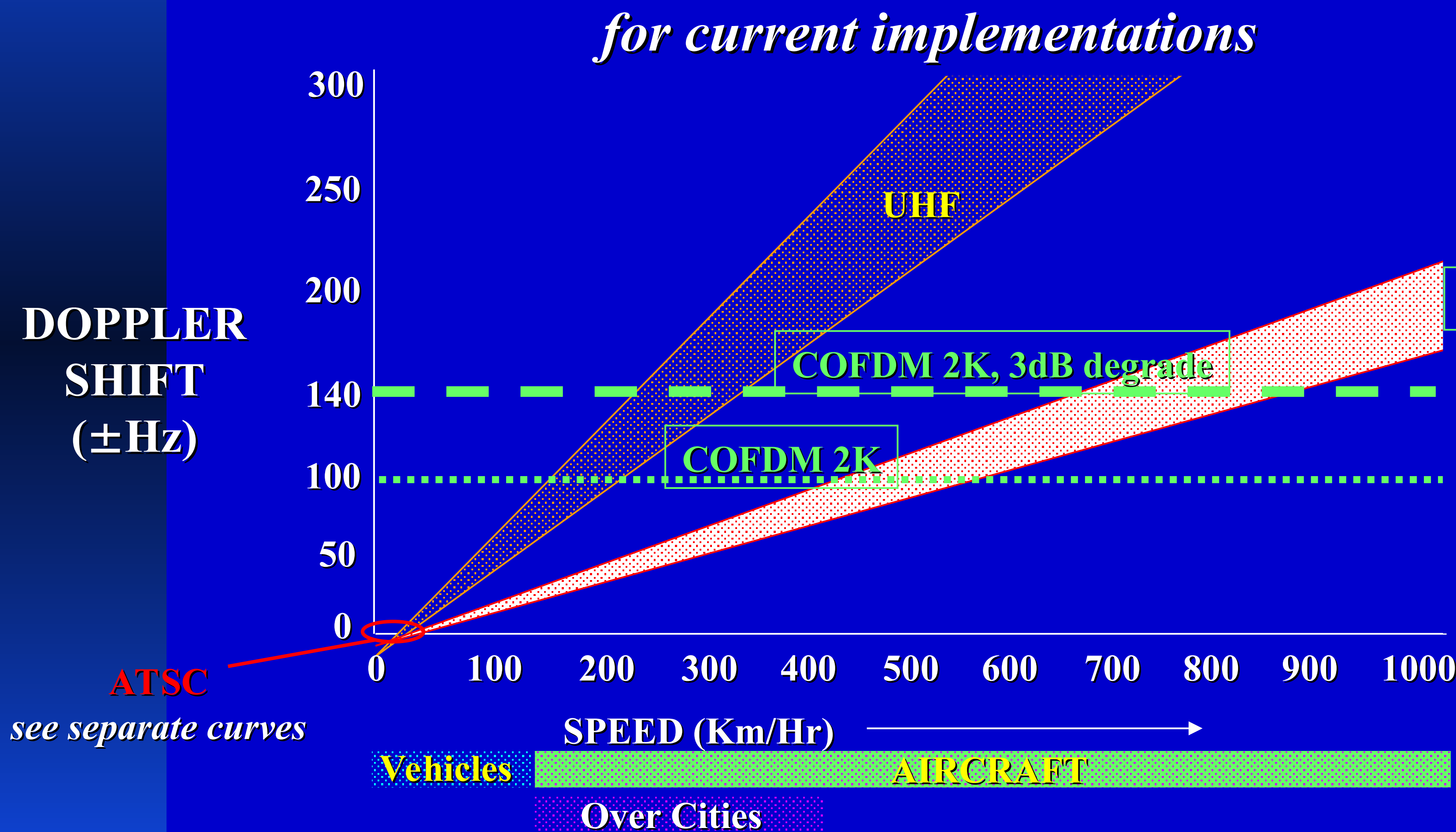
DTTB Systems Doppler Performance Limits



COFDM implementations will inherently handle post and pre-ghosts equally within the selected guard interval.

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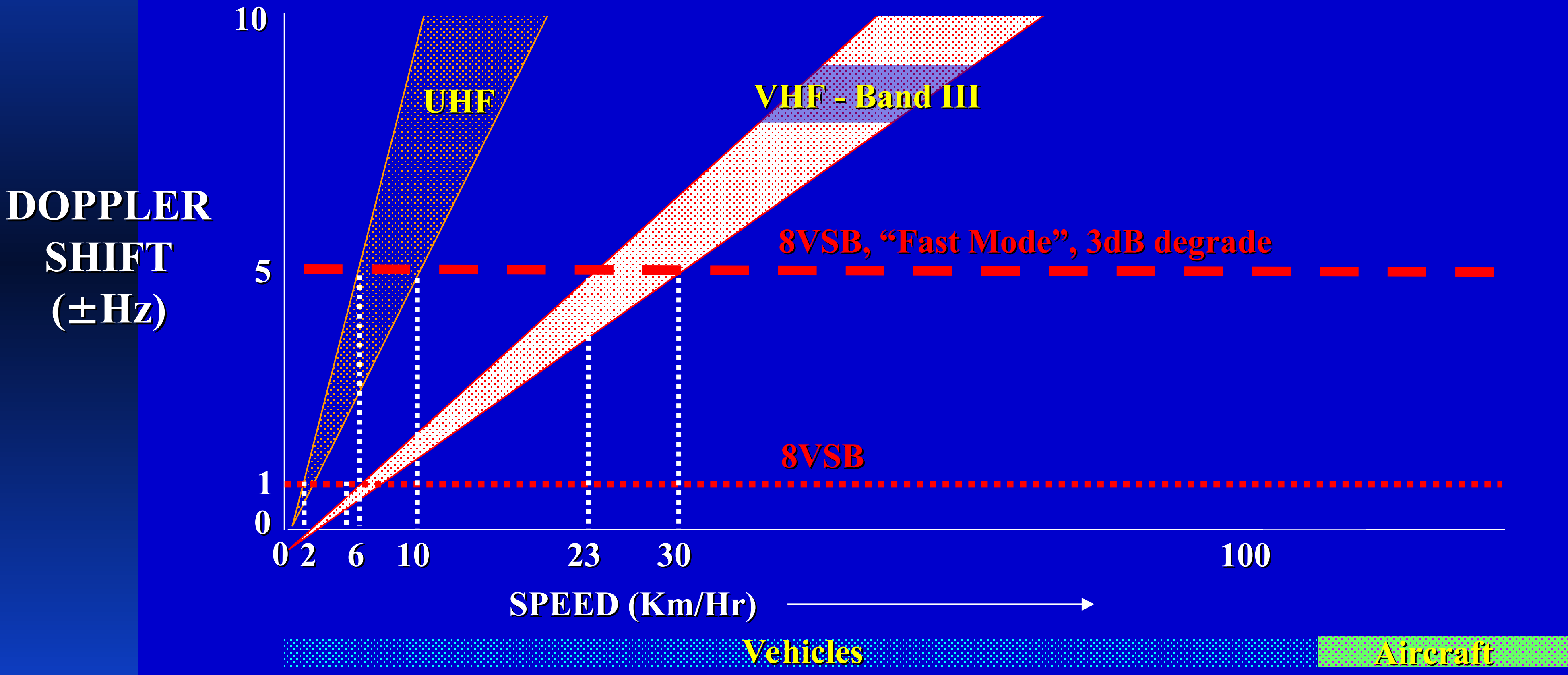
ATSC 8-VSB
Doppler Performance Limits

for current implementations



8VSB implementations of equalisers are likely to cater for post ghosts up to 30 uSec and pre-ghosts up to 3 uSec only.

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Field Test - Observations

- At -14 dB DTTB power when there was a reasonable PAL picture both 8-VSB & COFDM worked at the vast majority of Sites
- When PAL had:
  - Grain (noise) and some echoes (multipath), both 8-VSB & COFDM failed
  - Flutter, caused by aircraft or vehicles, 8-VSB failed
  - Impulsive noise & some grain, COFDM failed

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Results Conclusion

- The assessment of the results presented in this summary depends largely on the SPECIFIC system REQUIREMENTS of the broadcaster and the viewers.
- The implementation and performance of both digital terrestrial transmission systems are still being improved, however the DVB-T system shows more scope for achieving future advances.

The Selection Committee

- A selection committee was formed from FACTS ATV specialists group Representing:
  - National broadcasters (ABC and SBS)
  - The commercial networks (7,9 & 10)
  - The regional commercial broadcasters
  - The Department of Communications and the Arts
  - The Australian Broadcasting Authority

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Selection Panel - Responsibility

- Analysing the comparative tests and other available factual information
- Establishing the relevance of the performance differences to Australian broadcasting
- Recommending the system to be used

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Selection Criteria

- Derived a set of 50 selection criteria relevant to the Australian transmission environment
- Criteria were reduced to final 29 which could impact on the final decision
- The criteria were weighted and an overall average used to rank the selection criteria

Selection Criteria - Groups

- Most Important Criteria Groupings
  - Coverage
  - System Design Elements
  - Operational Modes Supported
  - Overall System
  - Receivers

Selection Criteria - Analysis

- Assessed each of the selection criteria elements for each modulation system
  - Some criteria were put aside as it was felt there was not enough information to factually score those criteria

Criteria - Coverage

- Inner and outer service areas
- Performance with Roof top antennas
- Performance with Set top antennas *
- Co-channel & Adjacent channel protection
- Mobile Reception
- Multipath (Ghosting, Doppler & Flutter)
- Immunity to impulse noise

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Criteria - System Design Elements

- Combining & use of common Tx Antenna
- Requirements for implementing translators
- Suitability for co-channel translators
- Ability to use existing transmitters

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Criteria - Operational Modes Support

- HDTV Support
- Support for closed captioning
- Multiple languages Audio
- Surround Sound Audio System

Criteria - Overall System

- Accepted HDTV system
- Performance within 7 MHz channel
- Number useful Mb/s in 7 MHz
- Ability to fit in existing infrastructure
- Overall Modulation System Delay
- System Flexibility, Upgrade Capacity & Future Development Capacity

Selection Criteria - Receivers

- Availability (for HDTV) MP@HL
- Receiver Features & Cost
- PAL and DTTB capability
- Degree of customizing for Australia
- Receiver Applications Software
- Lock up time
- Australian channel selection

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DTTB Choice Assessment Sheet

	GROUP1 – COVERAGE	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 1				
1.1	Percentage of A coverage pop. served				
1.2	Percentage of B coverage pop. served				
1.3	Set top antennas				
1.4	Mobile reception				
1.5	Co-channel performance				
1.6	Adjacent channel performance				
1.7	Multipath Performance				
1.8	Immunity to electrical interference				
1.9	Ability to be conveyed in MATV and cabled systems				

	GROUP 2 - SYSTEM DESIGN ELEMENTS	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 2				
2.1	Combining to use common transmit antennas				
2.2	Ease of use and cost of implementing translators				
2.3	Common channel translator capability				
2.4	Ability to use existing transmitters				

	GROUP3 - OPERATIONAL MODES SUPPORTED	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 3				
3.1	HDTV support				
3.2	Support for closed captions				
3.3	Support for multilingual audio				
3.4	Audio System				

	GROUP 4 - OVERALL SYSTEM	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 4				
4.1	Adoption of an accepted rather than unique (HDTV) system				
4.2	Performance within 7 MHz channel				
4.3	Number of useful Mbs/7MHz				
4.4	Overall encode/decode delay				
4.5	System upgrade & further development capability				

	GROUP 5 - RECEIVER ELEMENTS	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 5				
5.1	Receiver availability, features & cost				
5.2	Receiver and STB MP @ HL				
5.3	Receivers with both PAL and DTTB capability				
5.4	Receivers not specific design for Australia				
5.5	Receiver applications software				
5.6	Receiver lock-up time				
5.7	Ability to provide automatic channel selection for Australian channelling				

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DTTB Choice Assessment Sheet

	GROUP1 – COVERAGE	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 1				
1.1	Percentage of A coverage pop. served				
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1.5	Co-channel performance				
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1.7	Multipath Performance				
1.8	Immunity to electrical interference				
1.9	Ability to be conveyed in MATV and cabled systems				

	GROUP 2 - SYSTEM DESIGN ELEMENTS	ATSC	DVB	IMPORTANCE	
				Element	Group
Element	Group 2				
2.1	Combining to use common transmit antennas				
2.2	Ease of use and cost of implementing translators				
2.3	Common channel translator capability				
2.4	Ability to use existing transmitters				

Selection Result - June 1998

- The selection committee unanimously selected the 7 MHz DVB-T modulation system for use in Australia

- The criteria that were set aside would, however, not have changed the selection decision

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Overall Selection Influences

- A single system for All Free to Air Broadcasters
- Ability to meet Governments objectives for coverage
- Able to deliver the HDTV quality objective
- Availability of consumer products at acceptable costs
- Solid support from proponent
- Interoperability with other digital video platforms
- Confidence in the system meeting the business objectives

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More Selections

- Sub-committees formed to investigate:
  - Service information data standard
  - Multichannel audio system
  - HDTV video production format
- July 1998 3 further recommendations
  - SI data standard be based on DVB-SI
  - AC3 multichannel audio is the preferred audio encoding format
  - 1920/1080/50 Hz interlaced 1125 lines is the preferred video production format

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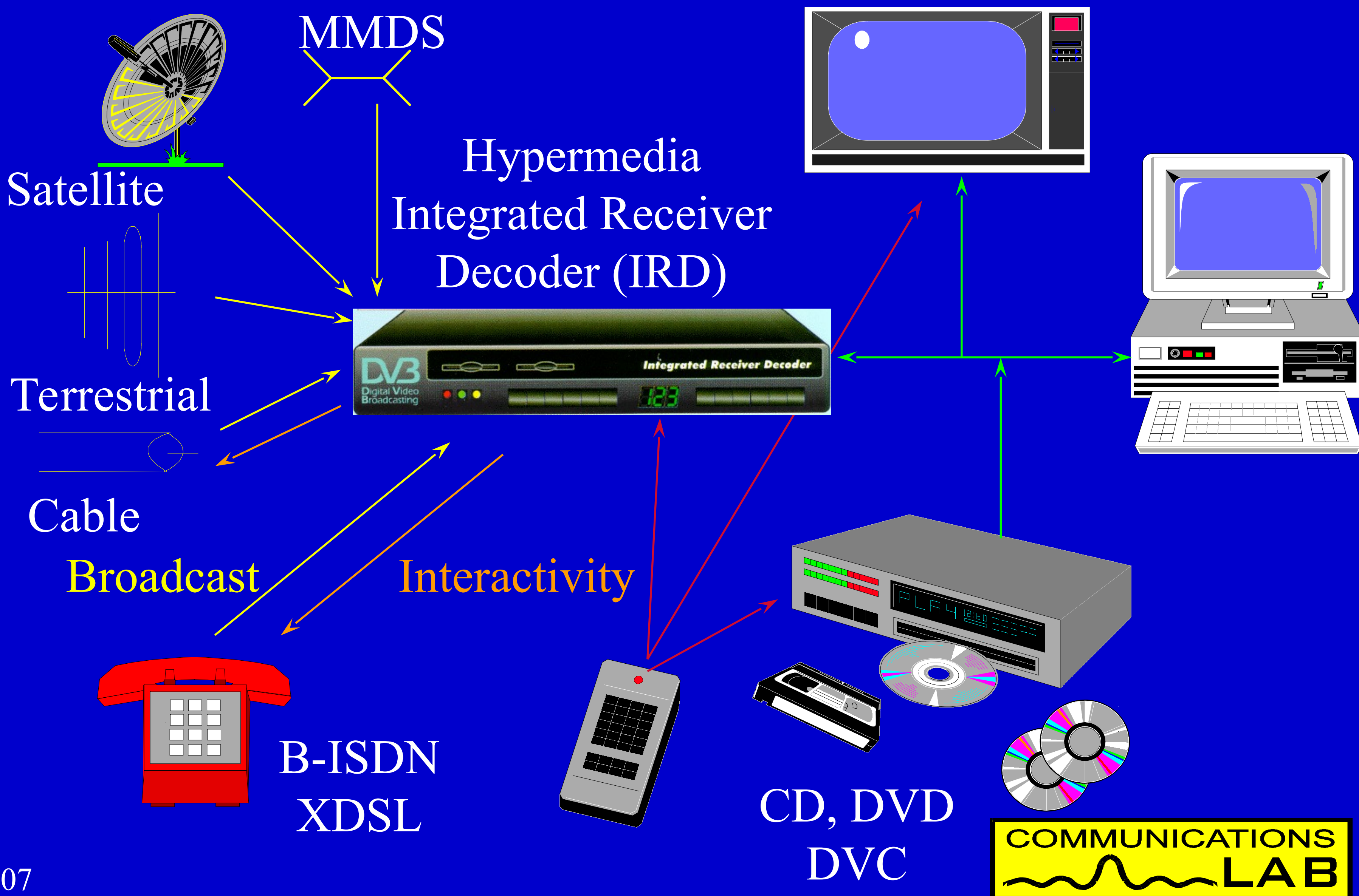
DTTB Implementation Notes:

- Although SFNs are of interest in Australia they will be of little use during the simulcast period.
- Use may be made of Dual Frequency Networks during this period to increase spectrum efficiency
- The channel frequency matrix will be adjusted when Analog services cease. Digital provides the capacity to repack the television spectrum.

A Future Digital System Concept



The End

Thank you for your attention

Any questions?

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