EXHIBIT B

TO

PETITION FOR RECONSIDERATION

OF

ASSOCIATION OF AMERICAN RAILROADS

WT DOCKET NO. 99-87

AUGUST 18, 2003

Investigations performed for the Federal Railroad Administration regarding

WIDEBAND-to-NARROWBAND MIGRATION...

and its effects on VHF land-mobile radio voice communications

ITS Institute for Telecommunication Sciences
Boulder, Colorado

Who is affected:

- **Freight railroads**
  - BNSF
  - CSX
  - Union Pacific
  - Norfolk Southern
  - and others
- **Passenger railroads**
  - Amtrak
- **Commuter rail**
  - BART
  - VRE
  - and others
- **Public transit**
  - subway/light rail
    - WMATA
    - and others

… this is an issue of nationwide scope to the rail industry

Some issues expected during migration:

- Decrease in audio volume experienced by wideband receiver to narrowband signal
  - as locomotive leaves wideband transmitter coverage and enters narrowband transmitter coverage, could emergency call from dispatcher be missed?
- Distortion experienced by narrowband receiver from wideband signal
  - overdriven final audio stage in receiver, resulting in "fuzzy" audio
  - some narrowband receivers, upon sensing wide deviation, may mute signal, resulting in "choppy" speech

Some issues expected during migration:

- **Decreased RF coverage range?**
  - Loss of coverage?
  - "Holes" in coverage?
  - Need to investigate...
- **What are effects of adjacent channel interferers in "near/far" scenario? Need to quantify:**
  - wideband interference into interstitial narrowband channel
  - interstitial channel narrowband interference into wideband channel
- **What are effects of fading due to real-world multipath and shadowing?**
- **Other?**

Initial laboratory-based investigations

Equipment:

IFR-2975 communications service monitor/analyzer

- generates test signals and measures response of radio under test

Kenwood TK-272G commercial-grade VHF handheld radio - - radio is capable of both wideband and narrowband operation

Tests:

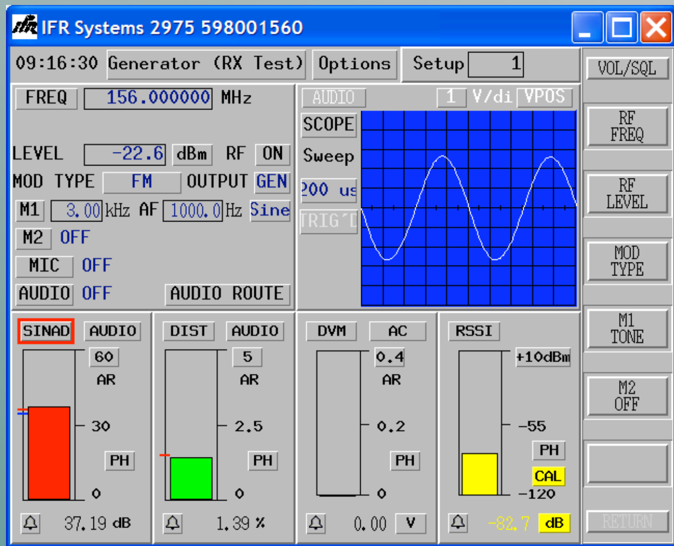
Receiver sensitivity

- wideband deviation/wideband receiver

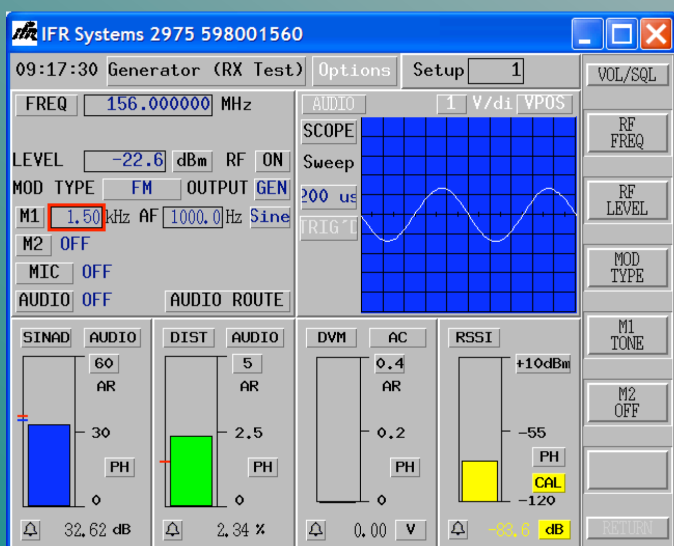
- narrowband deviation/wideband receiver

- narrowband deviation/narrowband receiver

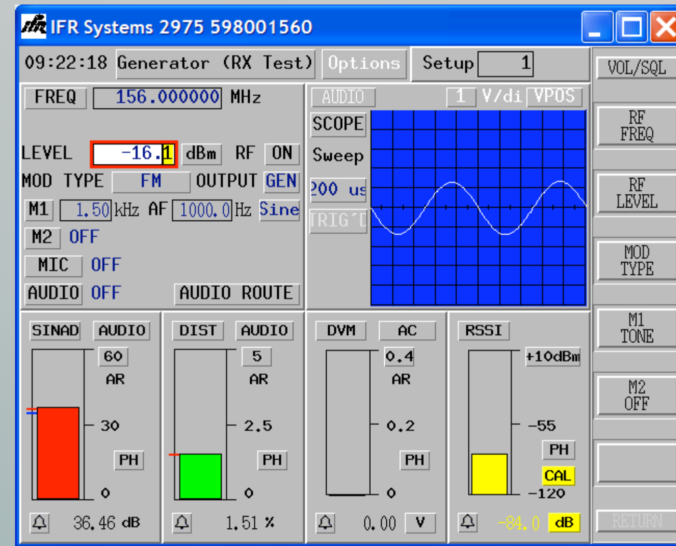
Demonstration - wideband deviation/narrowband receiver



-101 dBm, wide transmitter deviation, wide receiver bandwidth

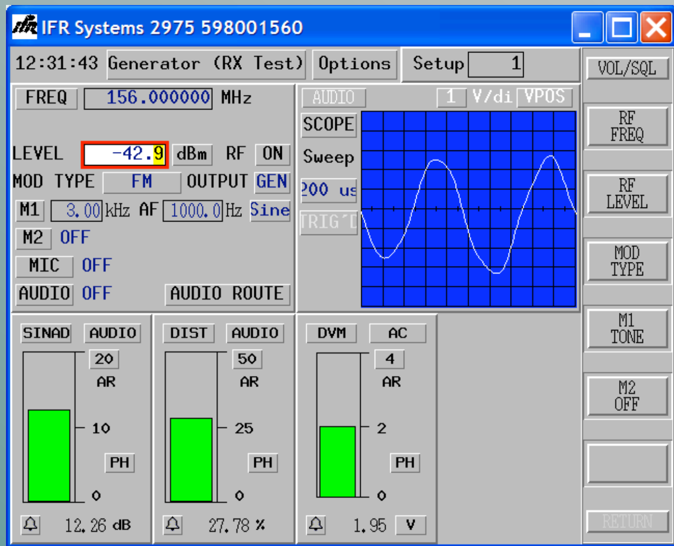


same as above but change Tx deviation 3 --> 1.5 kHz, SINAD decreases ~6 dB, audio output amplitude is halved at same volume control setting as above

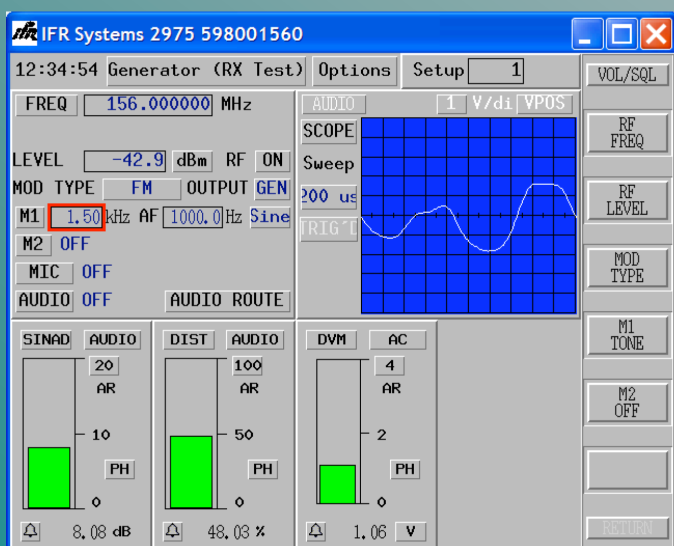


increase transmitter 6.5 dB to -94.5 dBm received signal strength, wideband receiver bandwidth; same SINAD at ~6 dB higher CNR, audio output amplitude still one-half that of wideband

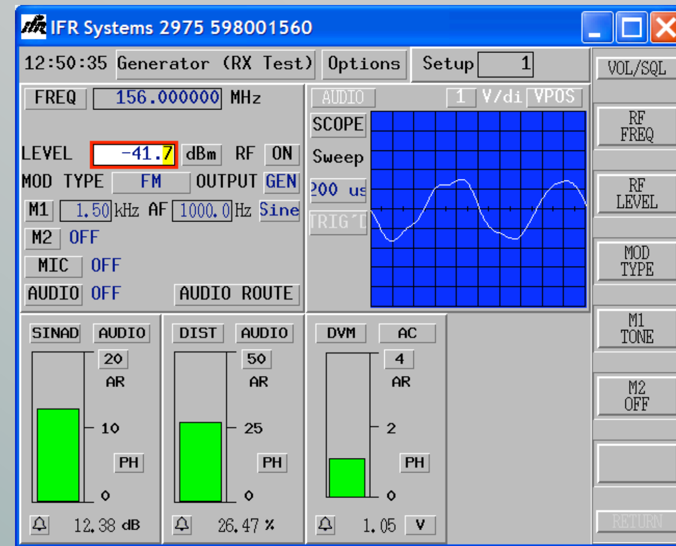
- **The effect of reducing deviation on the transmitter is to reduce the output volume on a wideband receiver, whether the transmitter power is increased or not**



12 dBS ref sens, -121.3 dBm rcvd sig strength, Tx dev 3 kHz, wide rcvr bandwidth

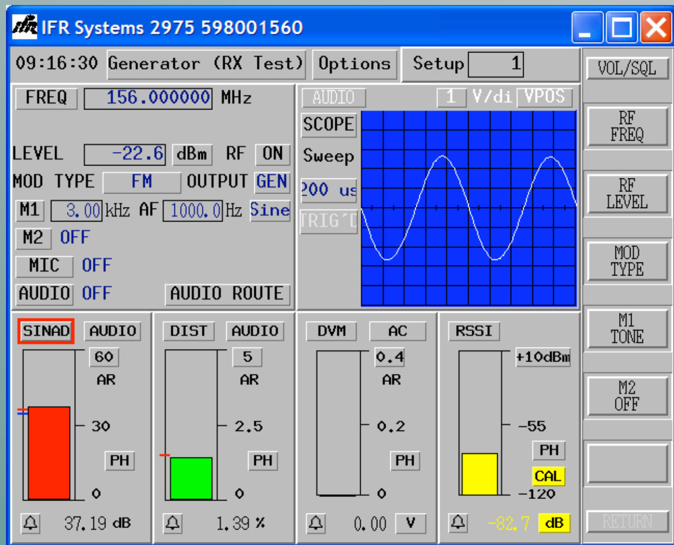


same as above but change Tx deviation 3 --> 1.5 kHz, SINAD decreases ~ 4.2 dB, audio output amplitude is halved at same volume control setting as above

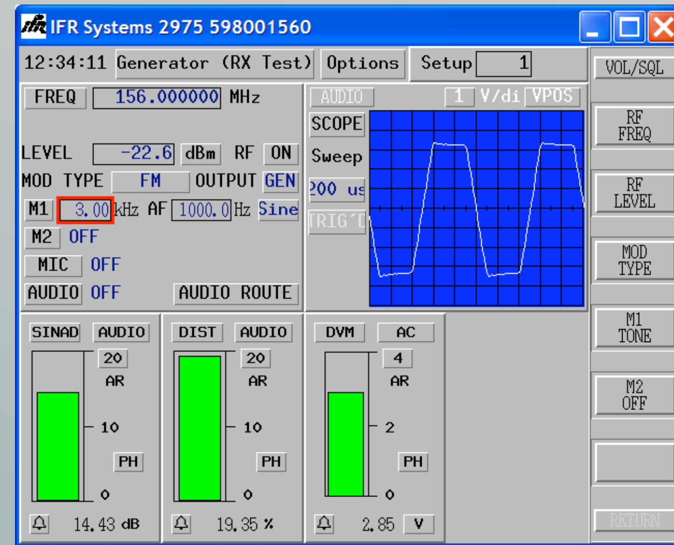


same as lower left but increase carrier power ~ 1.2 dB in order to re-establish 12 dBS reference sensitivity at -120.1 dBm (specification 0.28 μV = -118 dBm), audio output volume unchanged (still one-half that of wideband)

- **Weak signal - output already distorted for wide deviation; with narrow deviation into wideband receiver, now have reduced output volume as well - may affect intelligibility or even detection by user in noisy environment**

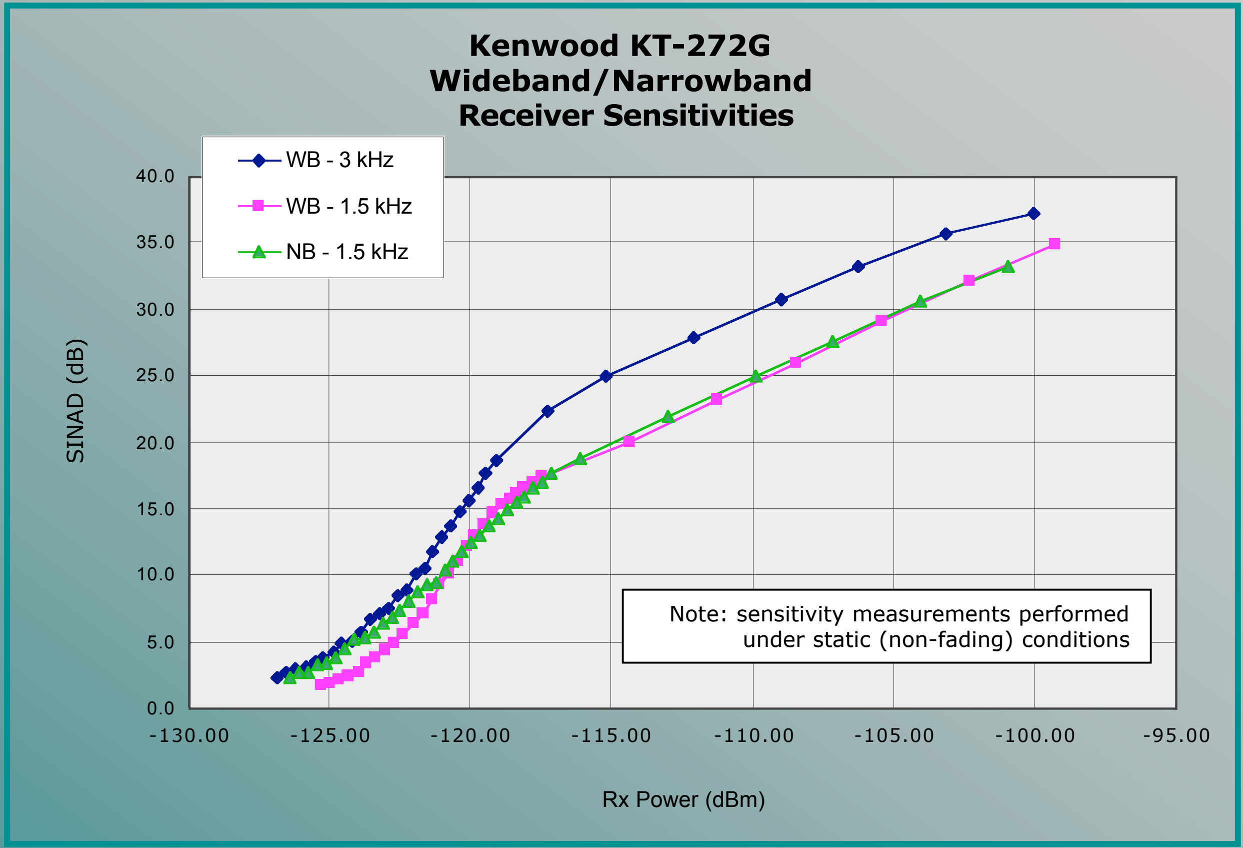


original signal -101 dBm received signal strength, wide Tx dev, wide rcvr bandwidth



original signal (wide Tx deviation) into narrow rcvr bandwidth; output audio signal clips (lowering volume eliminates clipping/distortion, but then normal narrow deviation signals will be at low volume)

- **wide deviation into narrow bandwidth causes significant distortion**



Strong/moderately strong signals:

-Degradation in audio output signal-to-noise ratio at same received power

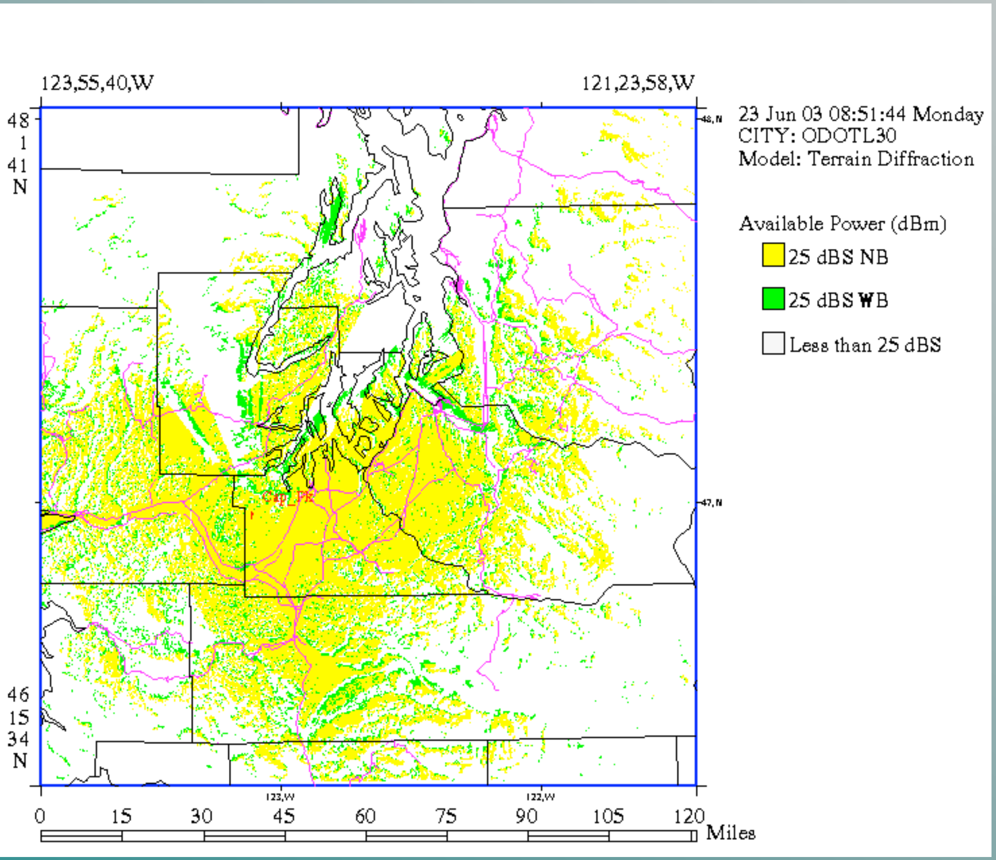
-For same system design performance (i.e., for "X" dB SINAD), transmitter must be stronger

-Narrowband transmitter into wideband receiver results in diminished audio output volume

Weak signals:

-At extreme fringes of coverage, signal quality is, essentially, equally bad

Example RF coverage prediction



For purposes of example, use received power levels for static 20 dBS:

- -115 dBm NB --> WB
- + -119 dBm WB --> WB

- May introduce "holes" in coverage at critical locations, individual site coverages should be evaluated
- Bigger issue: reduced audio volume of NB Tx and WB Rx

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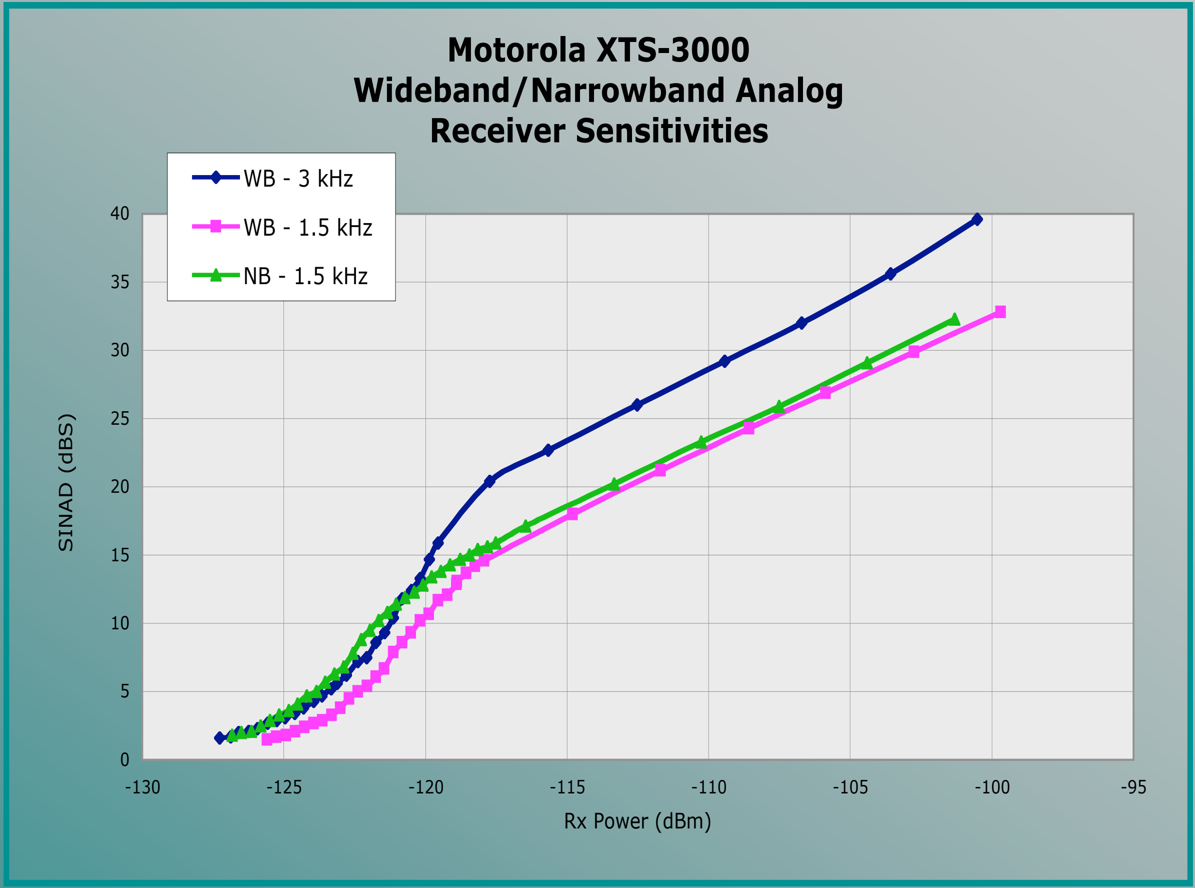
Summary of recent testing:

- Choose "typical" radio
  - selected Motorola XTS-3000
- Measure receiver 25, 20, 17, 12 dBS sensitivities
  - Configurations:
    - … 3 kHz dev --> WB Rx
    - … 1.5 kHz dev --> NB Rx
- PESQ/MOS score
  - Configurations:
    - … 3 kHz dev --> WB Rx (legacy)
    - … 1.5 kHz dev --> WB Rx (NB --> WB transition period)
    - … 3 kHz dev --> NB Rx (WB --> NB transition period)
  - use ITU-recognized objective scoring techniques to create PESQ/MOS scores at the specified sensitivities
  - Harvard phonetically balanced sentences, 2 male, 2 female, 10 sentences each
  - XTS-3000 received audio (lab bench environment)
  - compare to software simulation
- aural samples

Motorola XTS-3000 receiver sensitivity:



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PESQ scores:

(1) Rx power level measured on Motorola radio for WB-->WB
25, 20, 17, & 12 dBS
(2) At each WB-->WB configuration, Rx power level kept unchanged and Tx-->Rx configuration varied
(3) At each configuration, SINAD measured, demodulated audio sample captured and PESQ-scored
(4) Several Matlab audio simulations created, PESQ-scored for comparison to "real-world" lab measurements

Tx --> Rx config		SINAD (dBS)	PESQ	SINAD (dBS)	PESQ	SINAD (dBS)	PESQ	SINAD (dBS)	PESQ
WB --> WB	measured	25	2.2	20	1.9	17	1.7	12	1.5
	simulated		2.1		1.8		1.6		1.3
WB --> NB	measured	25	2.1	21	1.9	19	1.8	15	1.3
NB --> WB	measured	19	1.9	14	1.5	12	1.4	9	1.3
	simulated		1.7		1.4		1.3		1.2

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