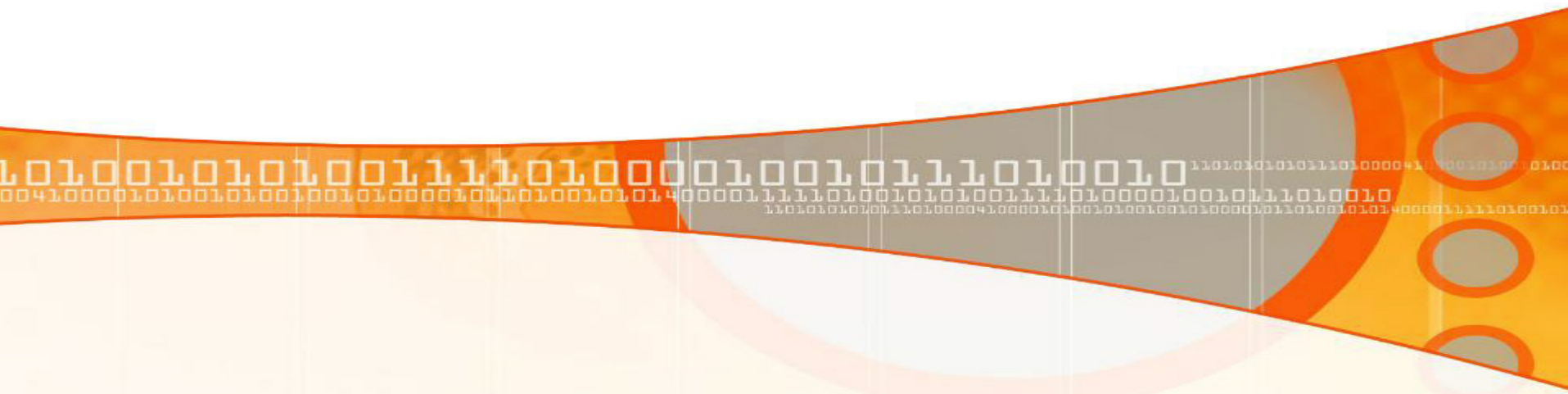
Power Back Off With AFEXT

Bijit Halder

18 February 2005

Email: bijit@platonetworks.com



IEEE 802.3an: 10BASE-T Task Force

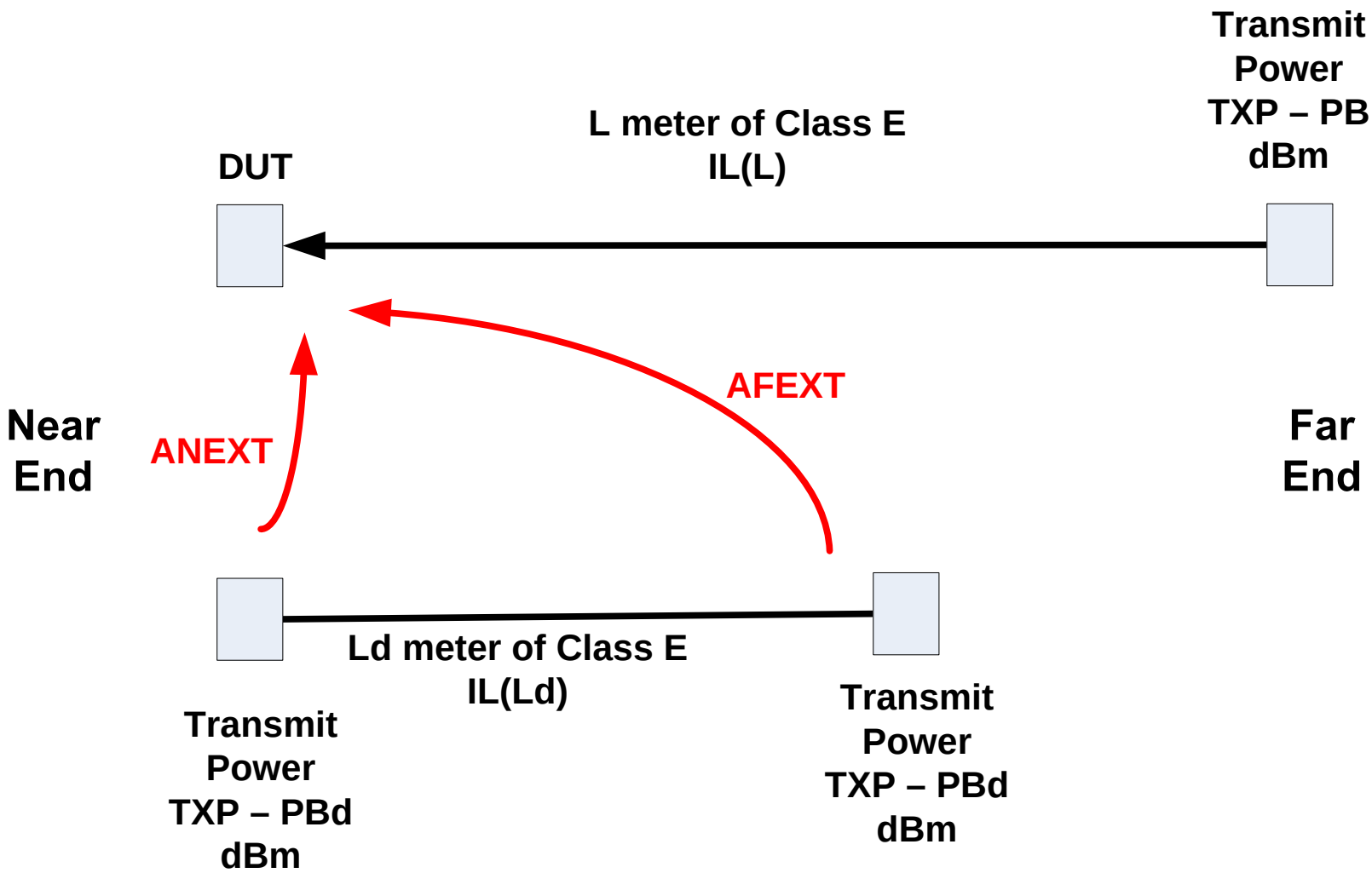
Acknowledgement

- Supporter:
  - Dieter Schicketanz, Corning

Purpose

- ANEXT only analysis is not adequate for deciding the need for power back off
- Must include both AFEXT and ANEXT
- We study the receiver SNR when
  - Different length for the main cable and disturber cables
  - Power back-off is applied
- We consider the following impediments
  - PS ANEXT
  - PS AFEXT
  - No transmit distortion
  - All other impediments are modeled as -140dBm/Hz white noise

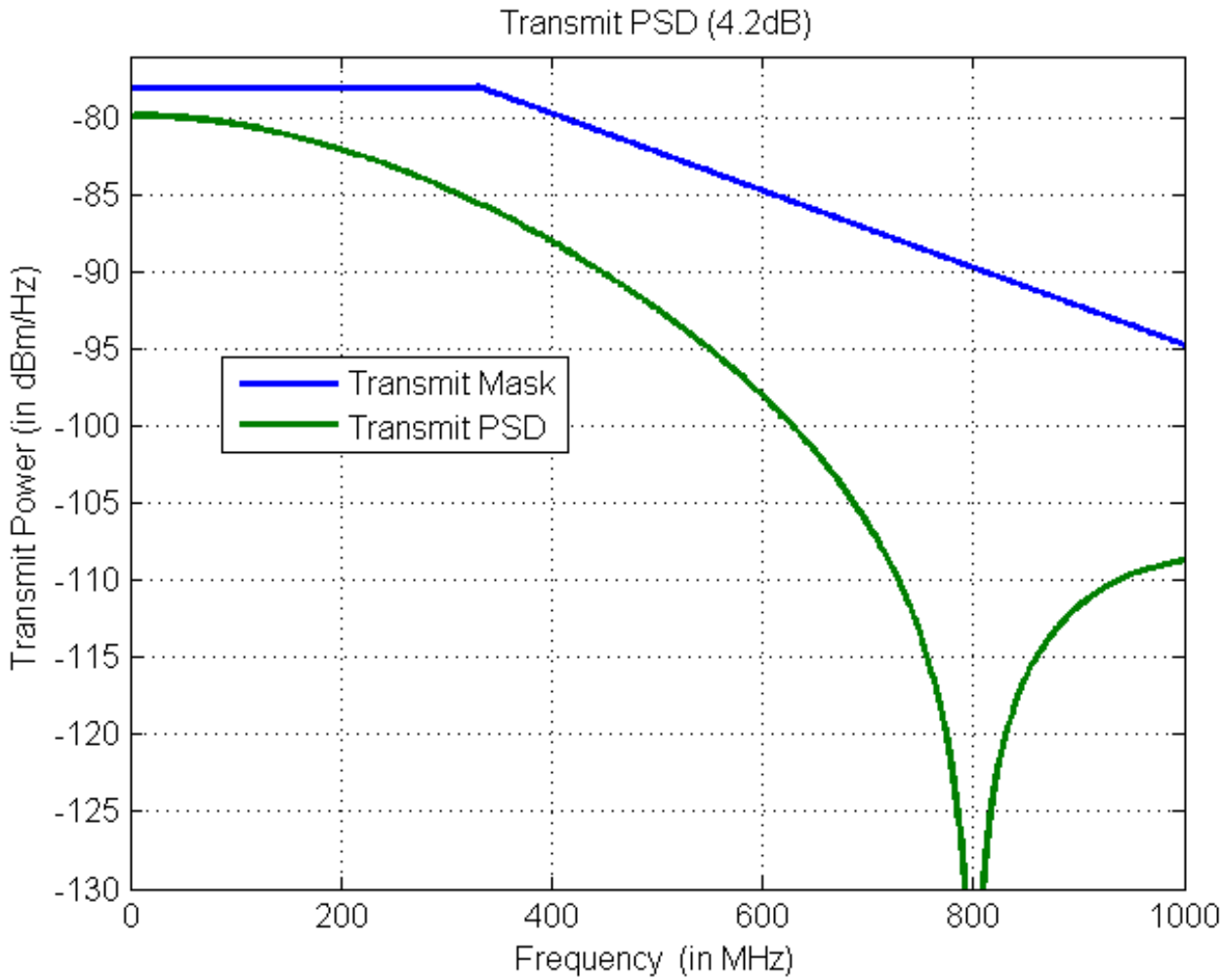
Cable Configuration



Models For Simulation

- All models are based on D1.3
- Channel model: Class E (model 3)
- Transmit PSD
  - Total power without power back-off: TXP = 4.2 dBm
  - Transmit Filter: Second order with fc at 500MHz
  - Transformer: first order lower cutoff at 200KHz
- With Power back off the PSD is scaled down
  - The shape of the transmit PSD is the same

Transmit PSD With 0dB Power Back Off



PSANEXT: Worst Case Model

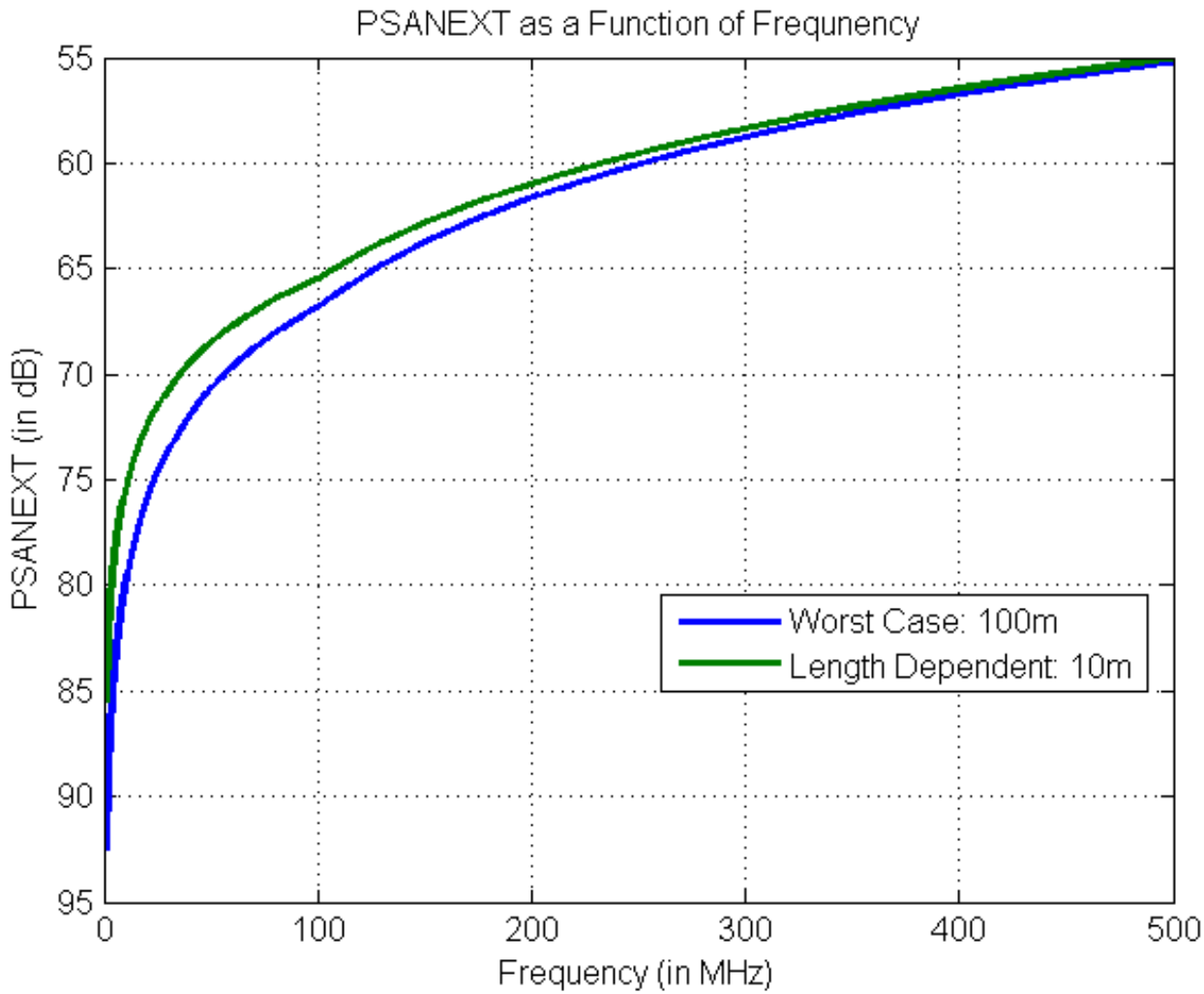
- PSANEXT coupling does not change after a short length, say after 15m
- Worst case PSANEXT model
  - D1.3 does not specify any length dependent ANEXT
  - Does specify the worst case ANEXT for 100m coupling
  - PSANEXT = X1-10log10(f/100), f<=100
    = X1-15log10(f/100), f > 100
    - f in MHz
  - For Class E: X1=65.5
    - 62+ 3.5 dB adjustment

PSANEXT: Length Dependent Model

- Length Dependent PSANEXT model
  - Add length dependent factor for coupling length Lc
  - Lc for our model is min(L, Ld)
  - Length depended factor
    - -10log10[(1-10^(-IL(Lc)/5))/(1-10^(-IL(100)/5))]
    - IL(Lc) is the insertion loss for Lc meter; IL(100) for 100m
  - Provided by Henri from Fluke Networks (Thanks!)

- Difference between the two models is not significant

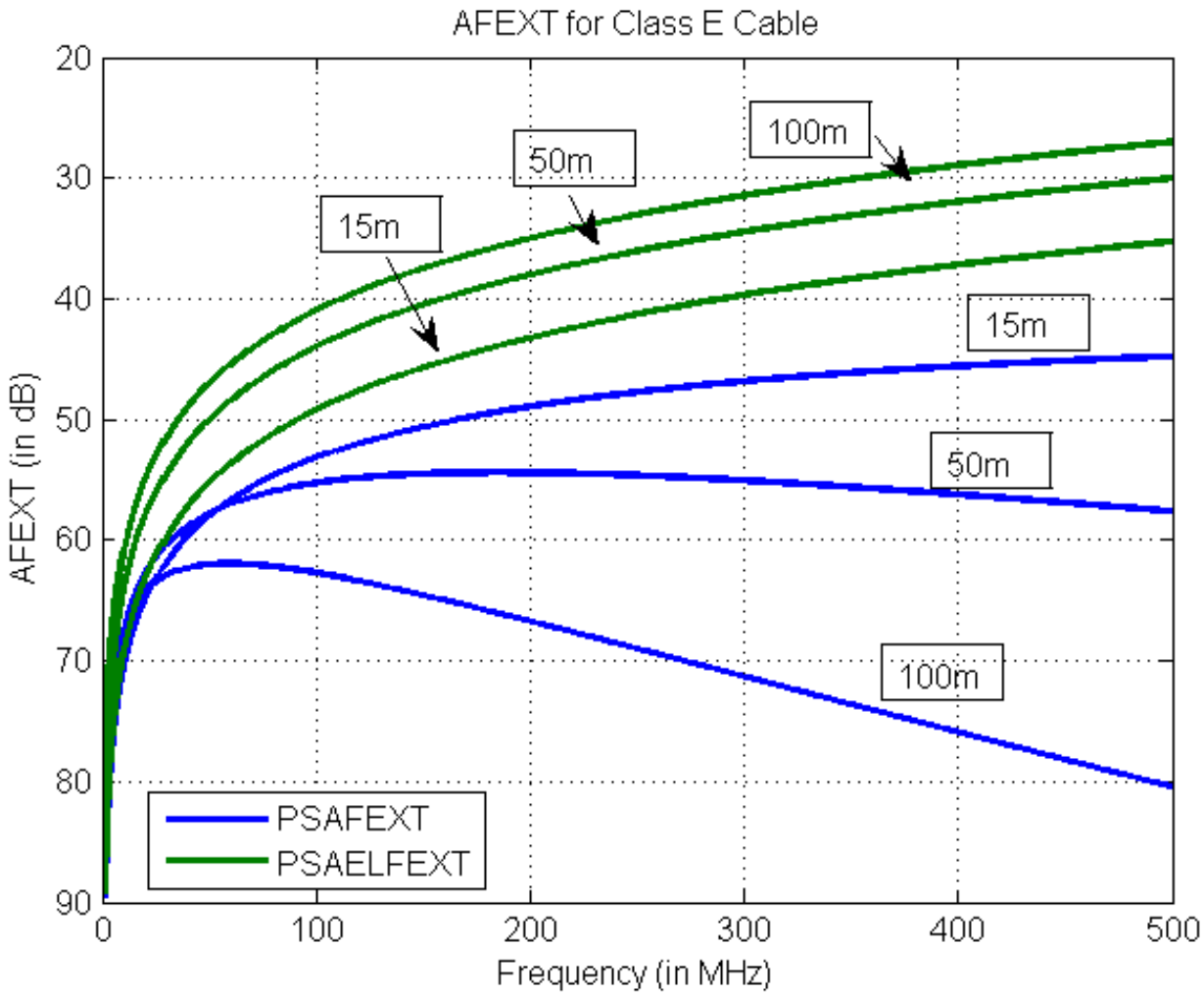
PSANEXT Model Comparison



PSAFEXT Model

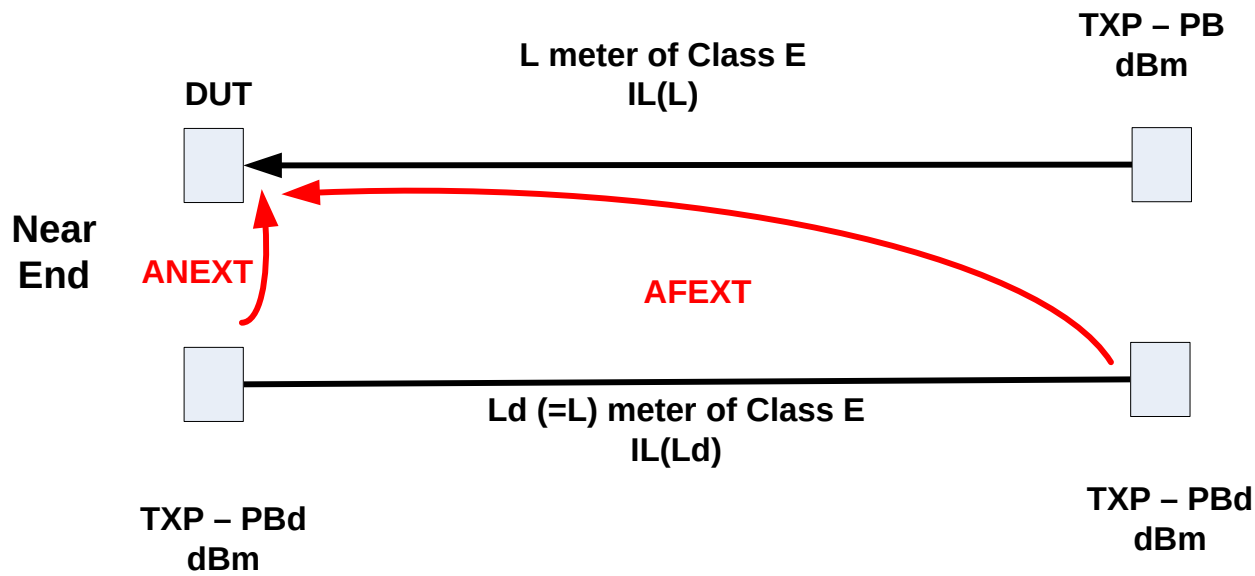
- AFEXT model
  - Coupling length Lc =min(L, Ld)
  - PSAELFEXT = X2-20log10(f/100)-10log10(Lc/100)
  - PSAFEXT = PSAELFEXT + IL(Ld)
  - For Class E: X2 = 41
    - 37 + 4 dB adjustment

PSAFEXT Model For Class E Cable

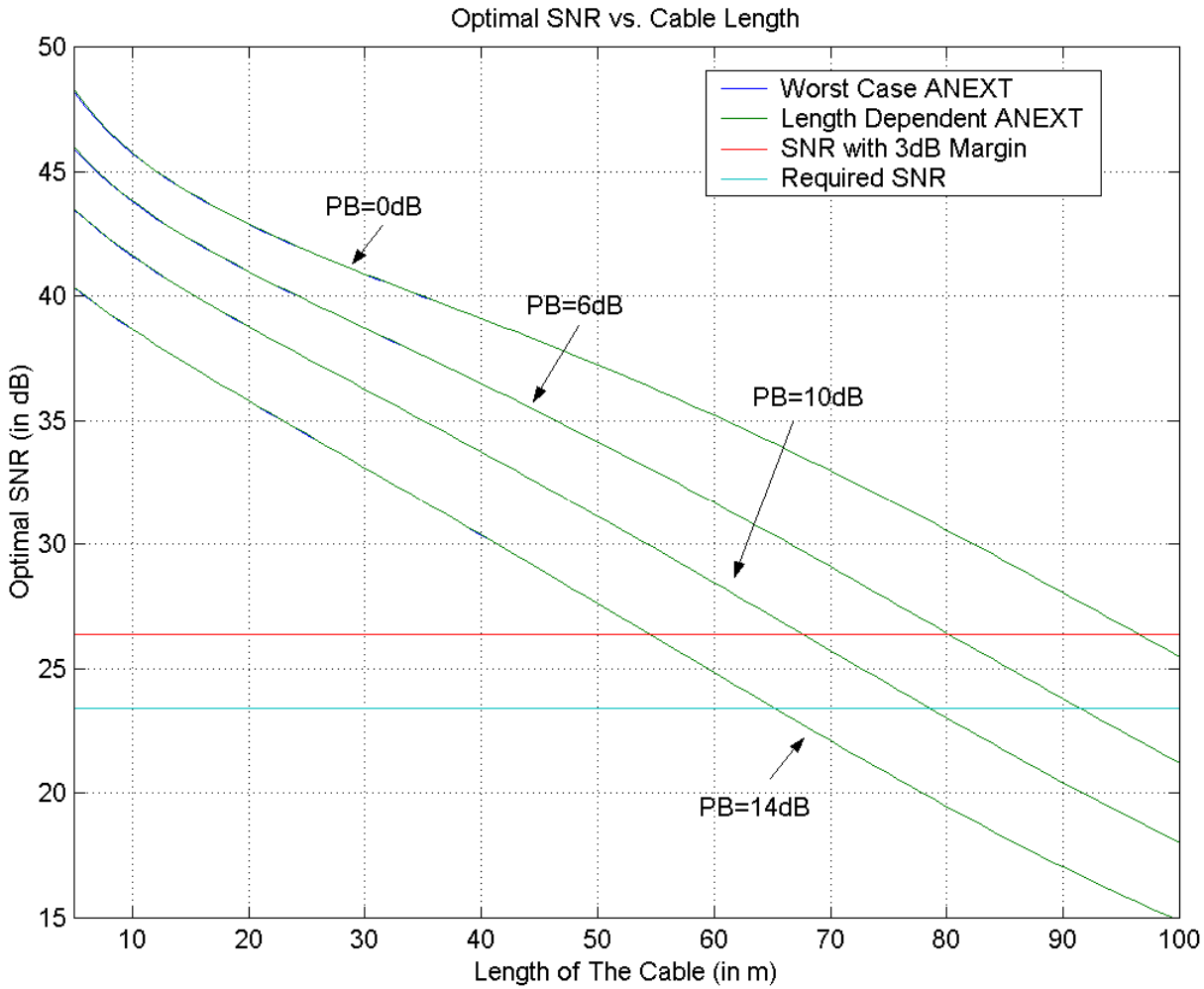


Same Length Cables (L=Ld)

- Length of all the cables are same: L=Ld
- Transmit Power: TXP=4.2 dBm
- Power back off same for all: PB=PBd
- Power back off levels: 0, 6, 10 and 14 dB

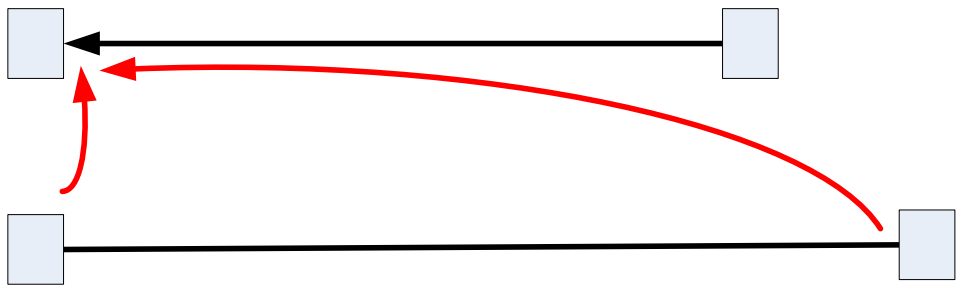


Same Length: (L=Ld, PB=PBd)

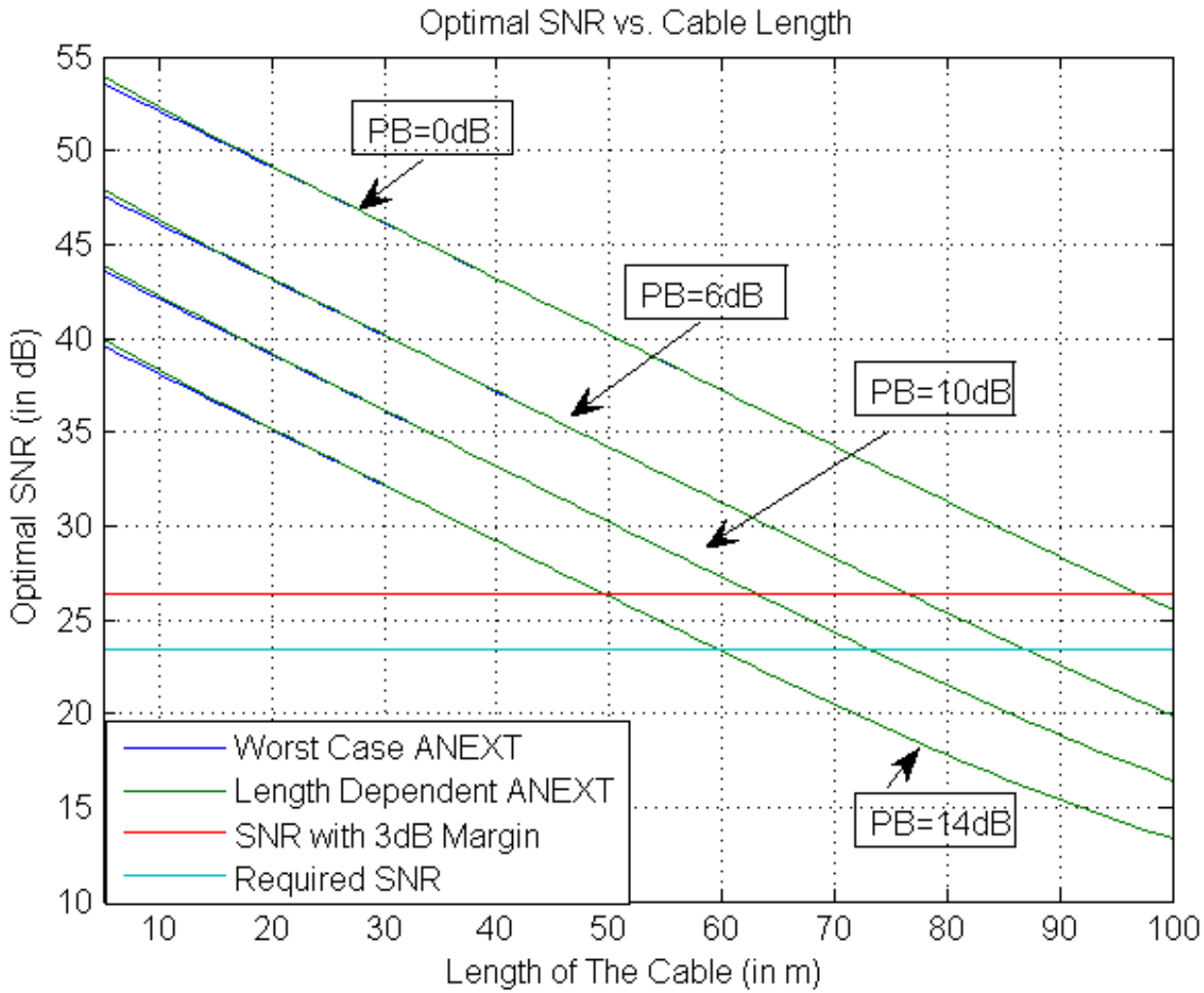


Long Disturber (Ld=100m)

- Length of the disturber cable: Ld =100m
- Power back off for disturber: PBd = 0 dB
- Length of the cable with DUT: L variable
- Power back off for main channel: PB variable
- Power back off levels PB: 0, 6, 10 and 14 dB

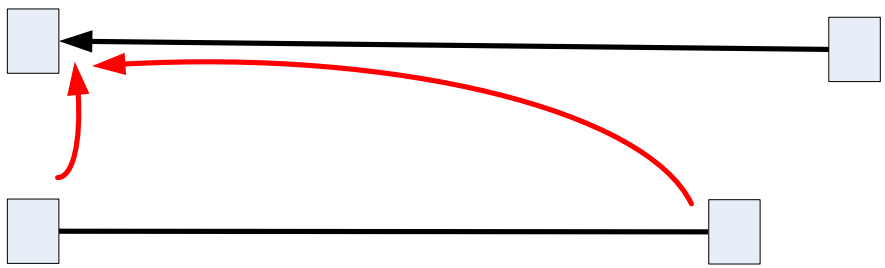


Long Disturber (Ld=100m, PBd=0dB)

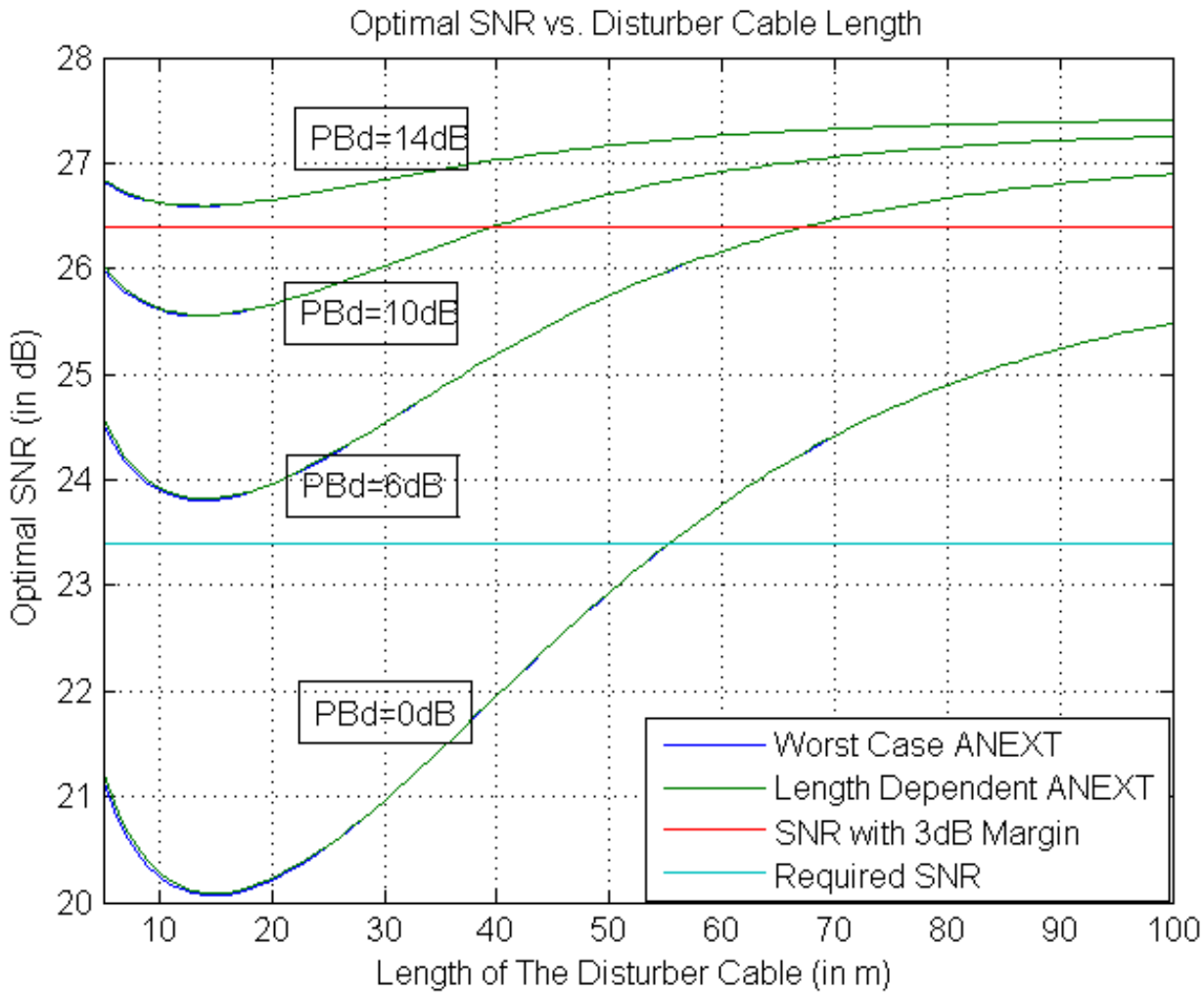


Short Disturber (Ld<=100m)

- Length of the cable with DUT: L=100m
- Power back off for main channel: PB=0 dB
- Length of the disturber cable: Ld variable
- Power back off for disturber: PBd variabe
- Power back off levels PBd: 0, 6, 10 and 14 dB



Short Disturber (L=100, PB=0dB)



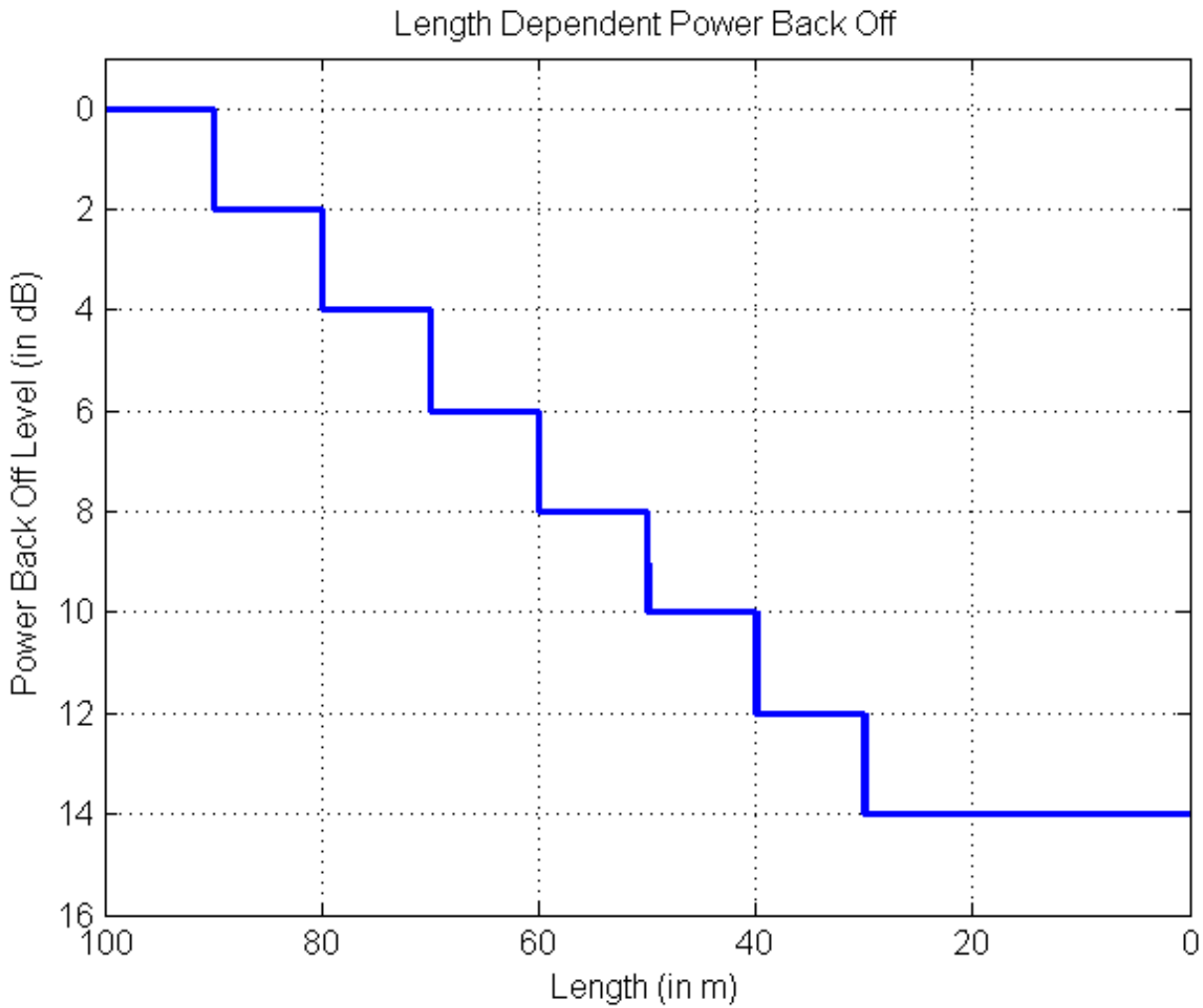
Observations

- Power back off calculations
  - Should not be based on only same cable length case
  - Must consider all possible cable length configurations
- The effect of short disturber cable is significant
- More than 10dB power back off needed for shorter cable
- The difference between worst case ANEXT and length dependent ANEXT is not significant

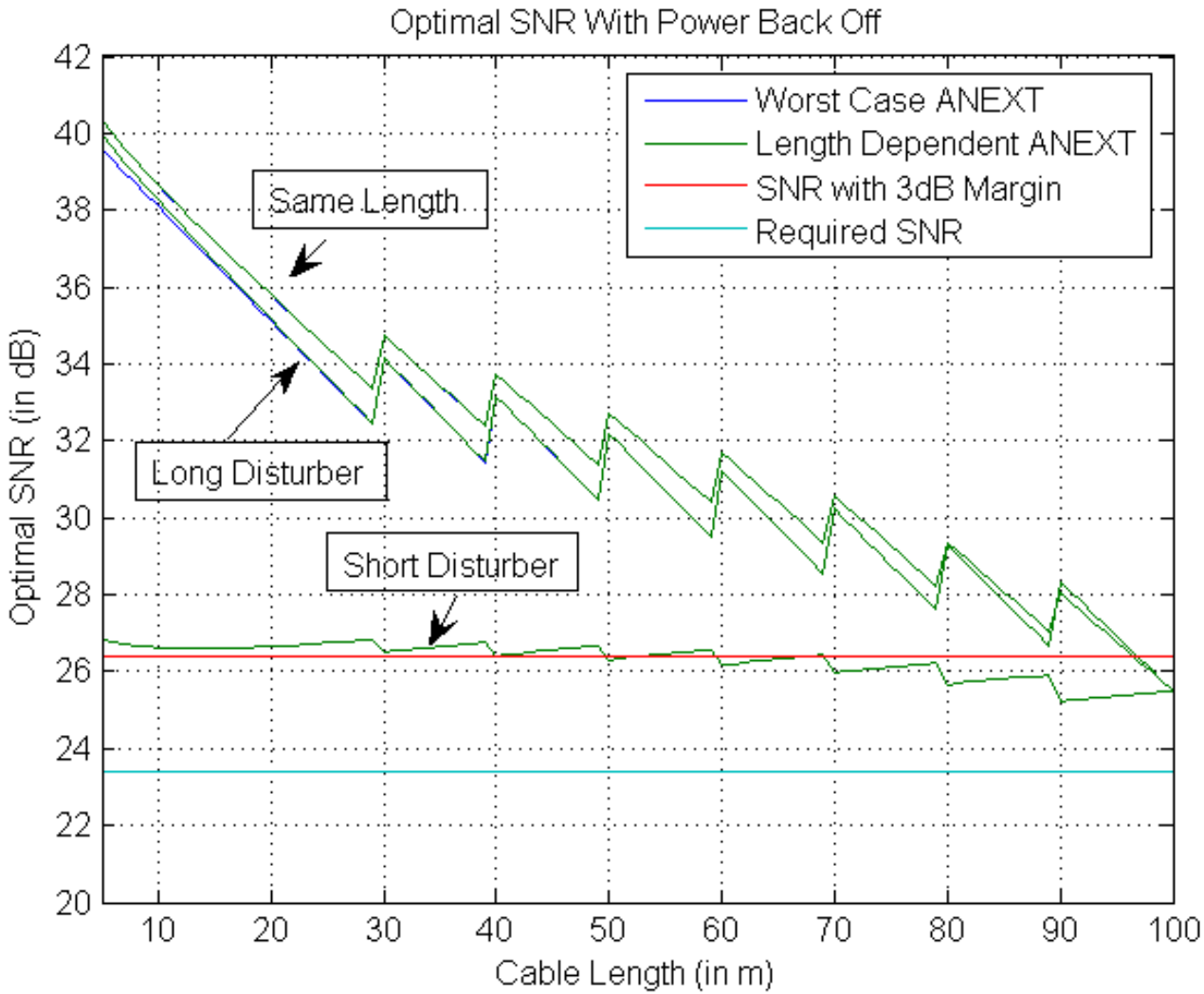
Power Back Off Policy

- SNR Based: Receiver sends desired the power back off level based on SNR
  - SNR can change over time due to external change
  - Only dynamic power back off can solve the problem
  - Vendor dependent SNR calculation may result in different power back off levels for same condition
  - Interoperability issues
- Length Based: Power back off level is based on length of the cable, that is insertion loss
  - Still vendor dependent calculation may need to interoperability issues

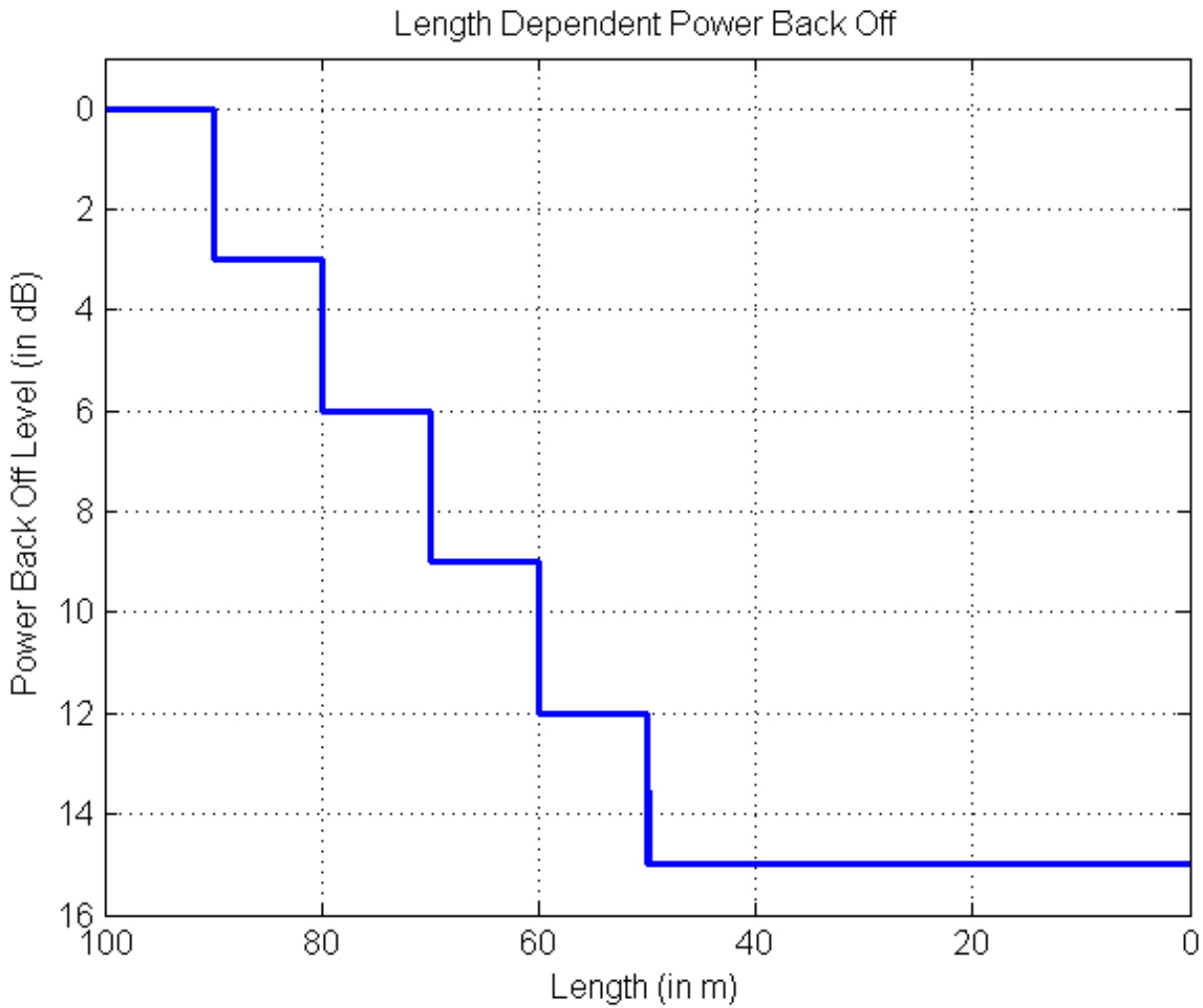
Length Dependent PBO: Example 1



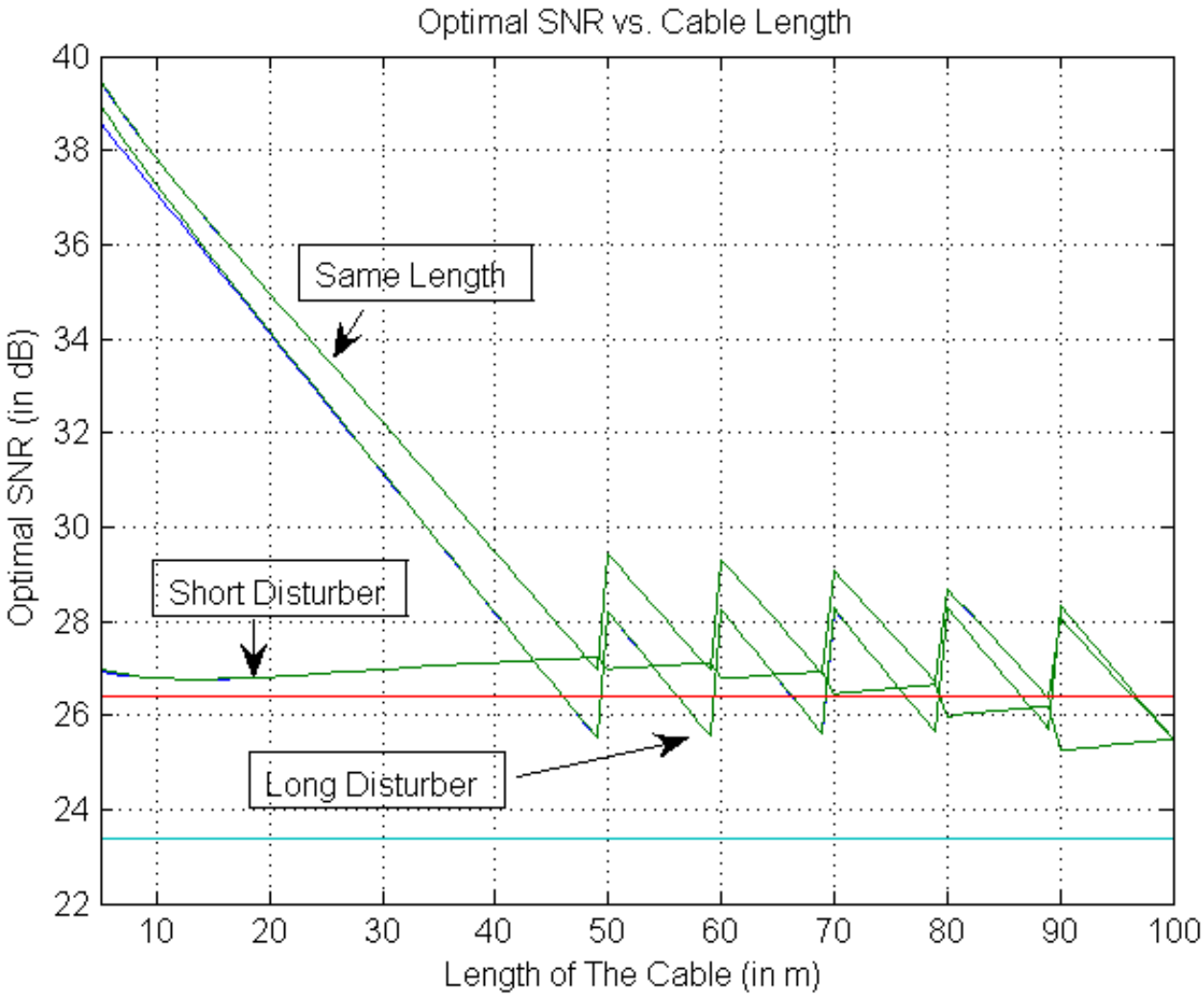
Receiver SNR With Power Back Off (1)



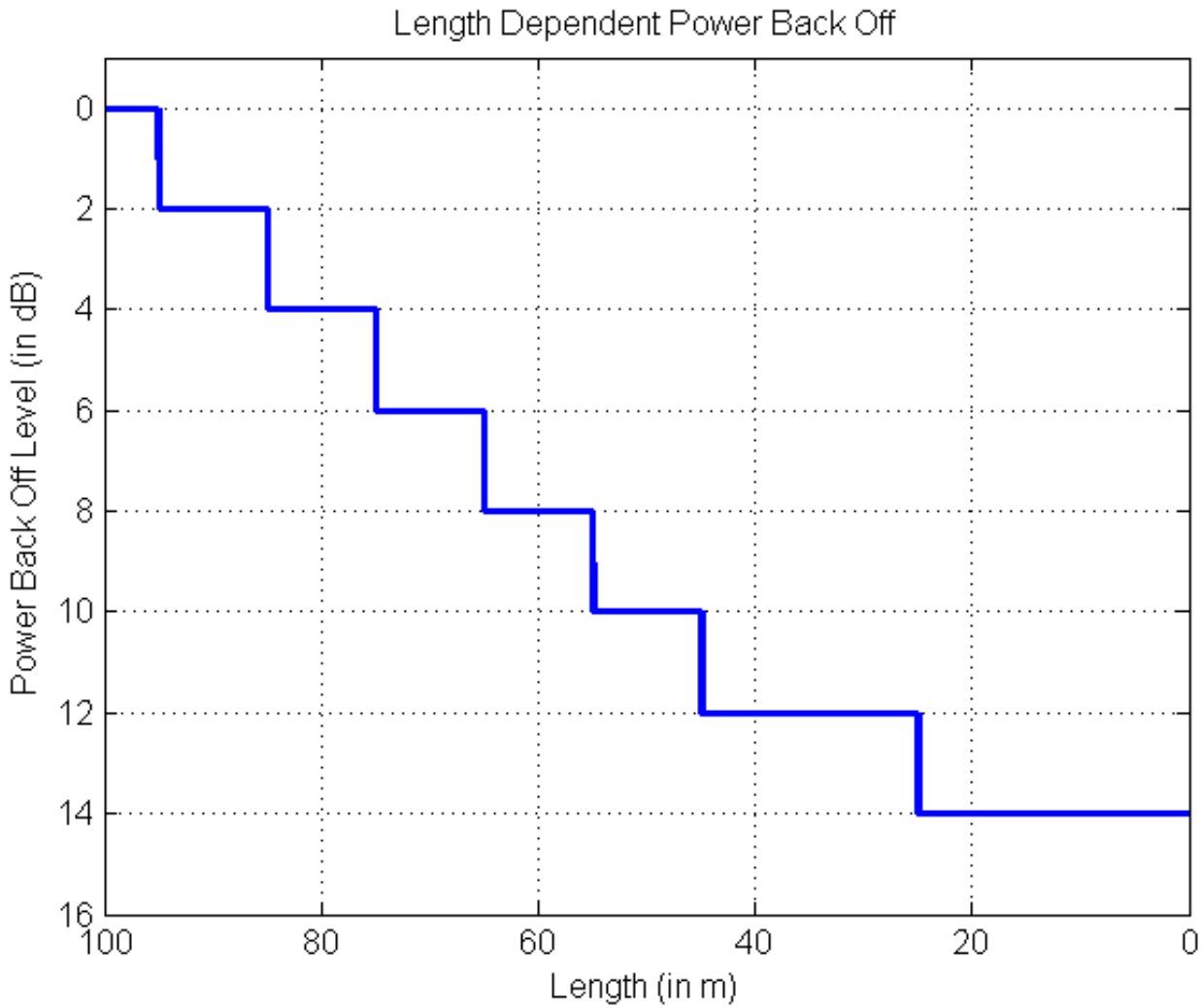
Length Dependent PBO: Example 2



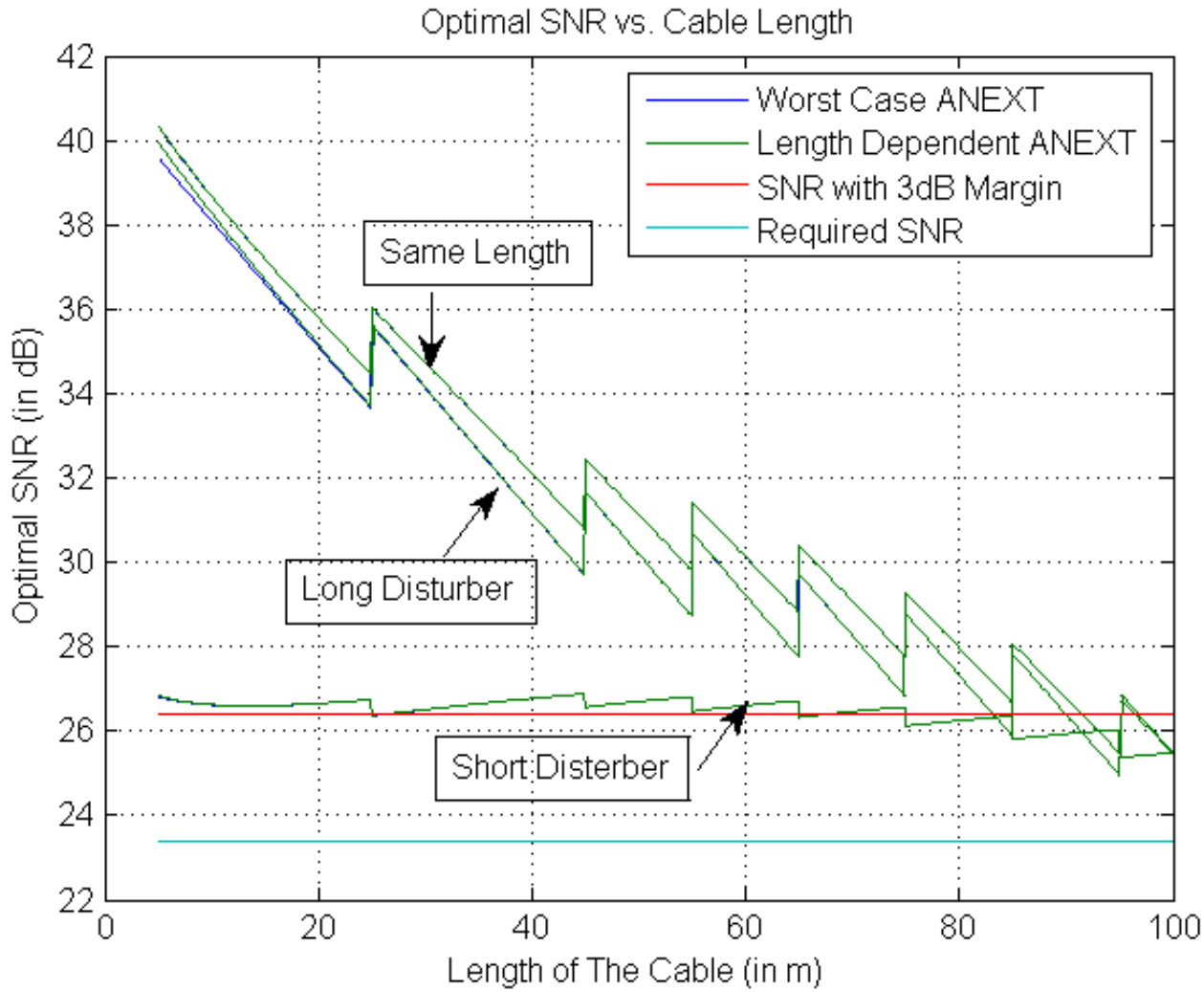
Receiver SNR With Power Back Off (2)



Length Dependent PBO: Example 3



Receiver SNR With Power Back Off (3)



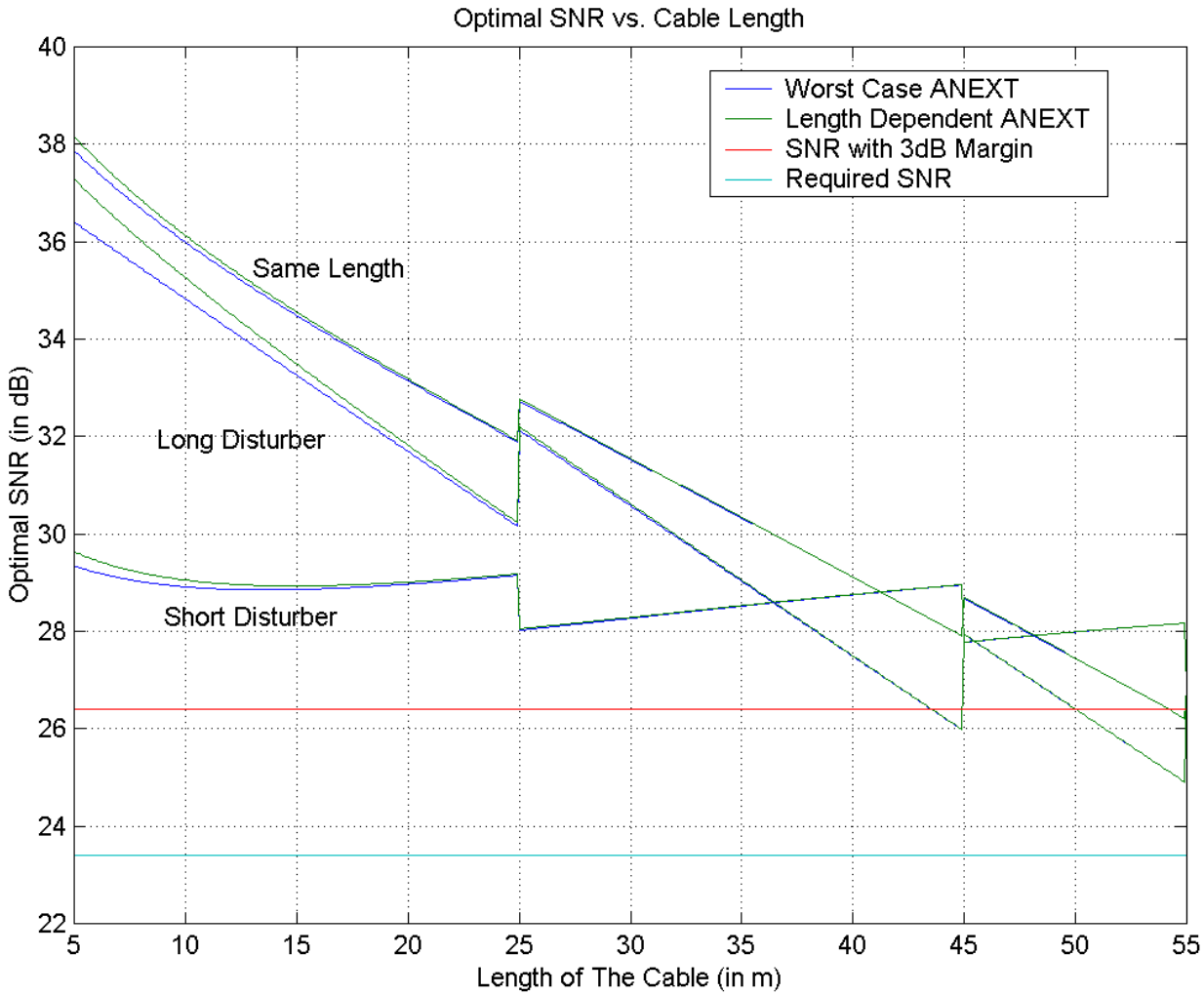
Conclusions

- Even with power back off we cannot get 3dB system margin
  - Worst case SNR is < 25.5dB, < 2dB margin
- In practice the situation is even worse
  - Transmit distortion
  - Variation in transmit power (2dB)
  - Variation on IL for same length
  - Finite length equalizer
- Full Power Start up problem
  - Even a single short cable (say 15m) may disrupt a 100m cable operation

Q&A

Thanks!

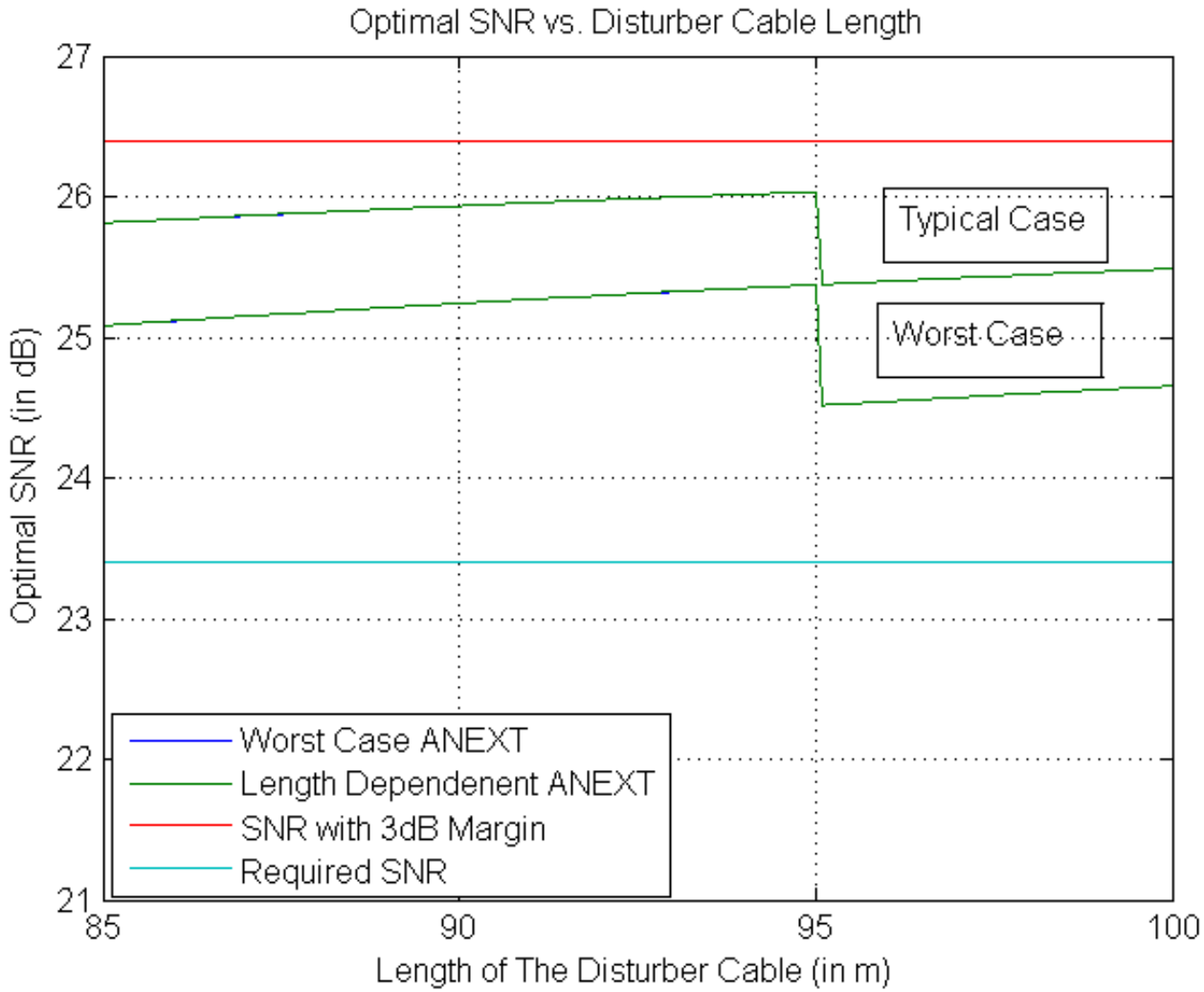
CAT6 55m Cable Results (PBO 3)



Effects of Variation on Transmit Power

- We now consider the effect of transmit power variation
  - Allowed transmit power with 0dB back off: 3.2-5.2dBm
- Effect of Noise floor: Optimistic model
  - noise power changes linearly with transmit power
  - Example: 4.2dB -> -140dBm; 3.2 -> -141dBm
  - Applies to power back off as well
  - Real improvement less than assumed here
- Typical Case: all have nominal power 4.2dBm
- Worst Case: DUT has 3.2 dBm power, Others have 5.2 dBm power

Class E, Short Disturber (PBO 3)



Class E, Long Disturber (PBO 3)