Tx Noise Self-Desensitization of LMDS CPE Receivers

Erik Boch,
CTO, DragonWave Inc
Eboch@dragonwaveinc.com

DragonWave

Overview

- LMDS systems operating in the 24 – 43.5 GHz range require low cost CPE transceivers in order to meet business case constraints
- LMDS networks are typically engineered so that cell structures are defined by noise limited link budgets. Interference is typically dealt with either through selective frequency re-use programs, through loss in % rooftops-hit performance of a given base station or through C/(N+I) allocations within the link budgets (needed to allow for some degradation in link budgets as a result of self interference)

DragonWave

Overview

- Hidden within many system implementations is a self-degradation of the CPE receiver caused by broadband AM noise leaking from the CPE transmitter (assuming 1 antenna is used for both transmit and receive functions at the CPE site)

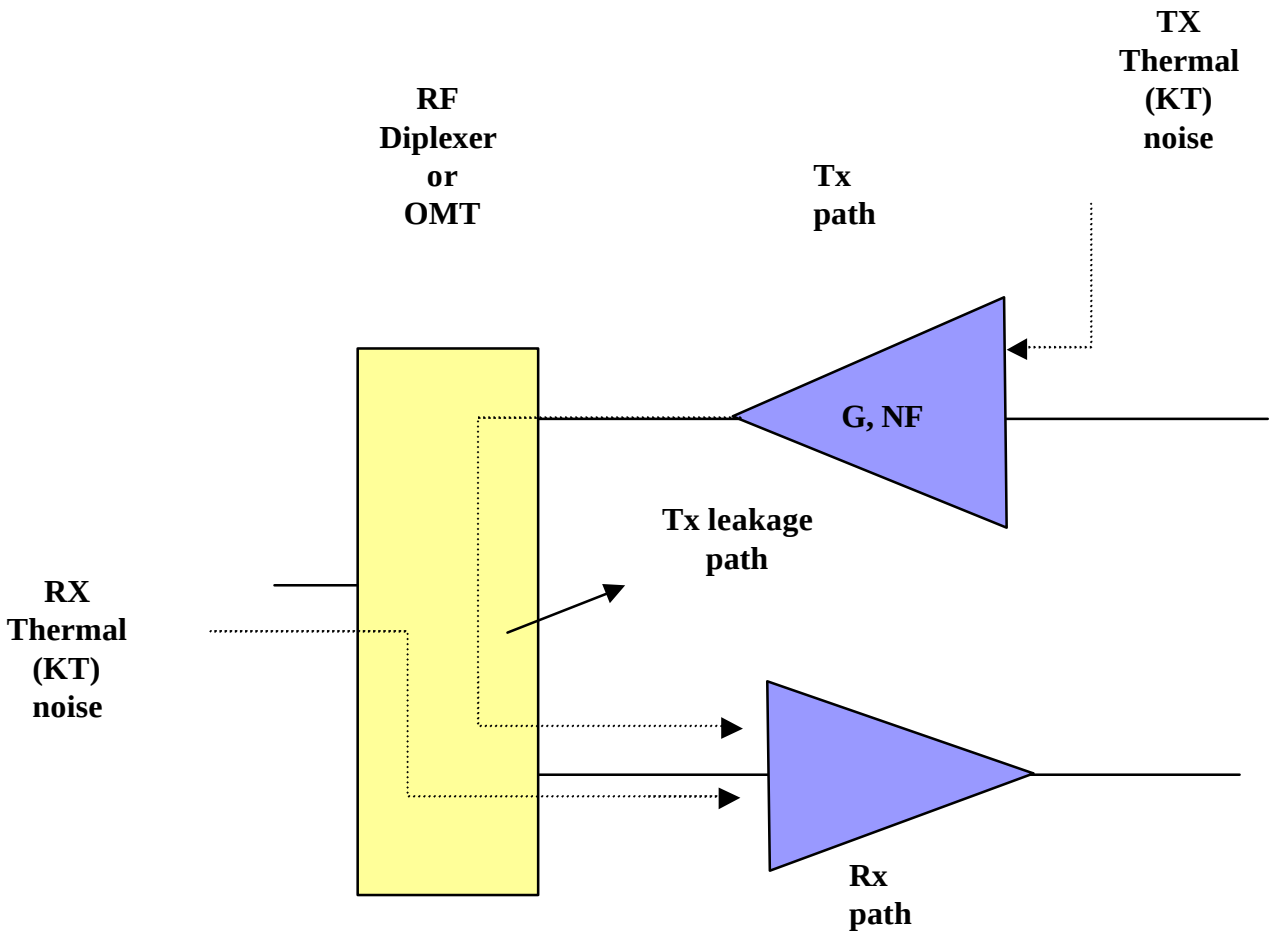
System Architectures

- FDD using co-polarized up-down links
  - At the CPE, achieved through the use of RF diplexing
- FDD using cross-polarized up-down links
  - At the CPE, achieved through the use of Ortho-Mode Transducer (OMT)
- TDD using co-polarized up-down links
  - At the CPE, achieved through the use of T-R switching*or bias-switching final TX stages

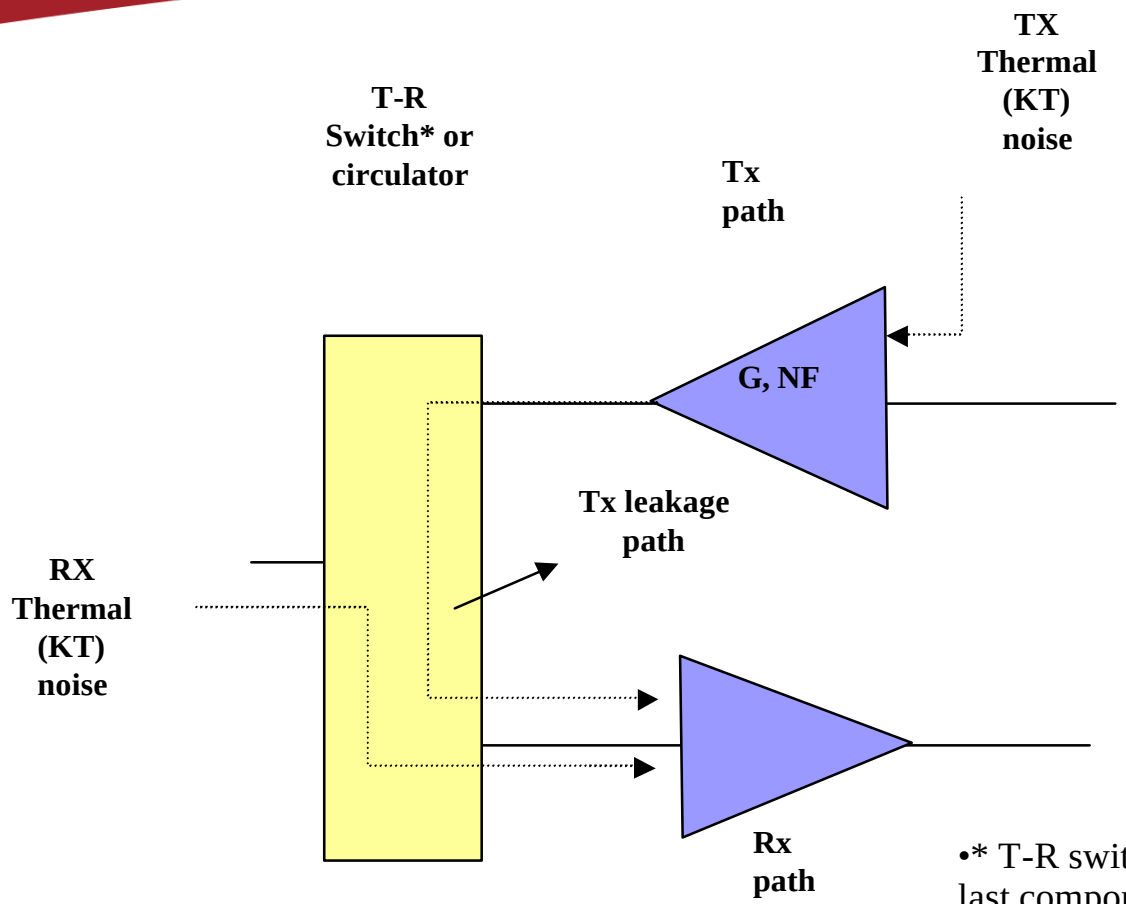
*This may also be combined with RF circulators in order to increase T-R isolation

DragonWave

Co & Cross Polarized FDD Model



Co Polarized TDD Model



•* T-R switch is not necessarily the last component in the chain, functionality may also be executed through bias switching TX driver stages

DragonWave

Isolation Requirements

- Leaked TX AM noise is a function of Tx gain, Tx NF and T-R isolation across the diplexer or OMT (within the Rx passband)
- Leaked Tx AM noise must be > 6 dB down from RX AM noise for sensitivity impact to be < 1 dB (∴ N/I > ~ 6 dB)
- ∴ T-R isolation must be > (Tx Gain + Tx NF + N/I)
- Example T-R isolation requirement: (40 dB gain + 20 dB NF + 6 dB) > 66 dB

DragonWave

Design Performance Issues

- If the Transmitter gain has uncertainty, this must also be considered
  - For example: if the broadband transmitters' gain uncertainty is +/- 4 dB, then isolation requirement increases to;
    - ∴ T-R isolation must be > (Tx Gain + uncertainty + Tx NF +N/I)
    - Example T-R isolation requirement: (40 dB gain + 4dB uncert + 20 dB NF + 6 dB) > 70 dB

DragonWave

Typical Isolation Performances

- In order to attempt achieve the required isolations, several techniques can be applied;
  - Copol FDD
    - Low Diplexers with 250 MHz T-R split can achieve ~ 50 dB isolation
    - More isolation is possible with larger T-R splits, but many global license structures don't accommodate this
  - Xpol FDD
    - Broadband low cost OMTs can achieve ~ 50 dB isolation
  - Copol TDD
    - Combinations of T-R switches and circulators can typically achieve ~ 50 dB

DragonWave

Link Budgeting to Accommodate Leakage - Induced CPE RX Sensitivity Losses

- Link Budgets can be augmented to include these desensitization effects
- For a 6 dB N/I, a 1 dB degradation can be allocated.
  - This is a loss of ~ 100m cell radius/range at 28 GHz @ 99.995% availability, ITU-R region K
- Generally, in cellular [LMDS] systems, network designers must also allocate desensitization factors associated with;
  - base station TX IM levels (when operating multicarrier)
  - Intra cell interference
  - Inter cell interference

DragonWave

Link Budgeting to Accommodate Leakage-Induced CPE RX Sensitivity Losses

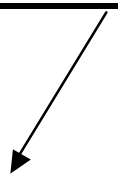
- If these factors are all designed/set to 6 dB N/I, then the overall link budgets can degrade by 3 – 5 dB…..a serious cell size reduction therefore can occur

- A loss of 3 dB in the link budget can result in ~ 300 m radius reduction. For a 3 km nominal radius, this results in a requirement for ~ 20% more cells in order to provide the same coverage within an overall, continuous coverage network topology

DragonWave

DragonWave Design Remedies

- Designing the CPE to exceed the “nominal” values discussed earlier allows significant mitigation of the desensitization effects;
- For example:
  - Tx gain: 35 dB, adjustable
  - Tx NF: ~ 12 dB
  - Tx gain flatness: < +/- 2 dB
- Example T-R isolation req’ment: (35 dB gain + 2dB uncert + 12 dB NF + 6 dB N/I) > 55 dB isolation requirement



This requirement is addressable using DragonWave, low cost transceiver implementations

DragonWave

Summary

DragonWaves' CPE RF architectural approach, combined with high performance, low cost implementation technologies allow LMDS CPEs to avoid this desensitization effect