BitWave SEMICONDUCTOR ™
Wireless Made Simple

An SDR RFFE Reference Design for Femtocells

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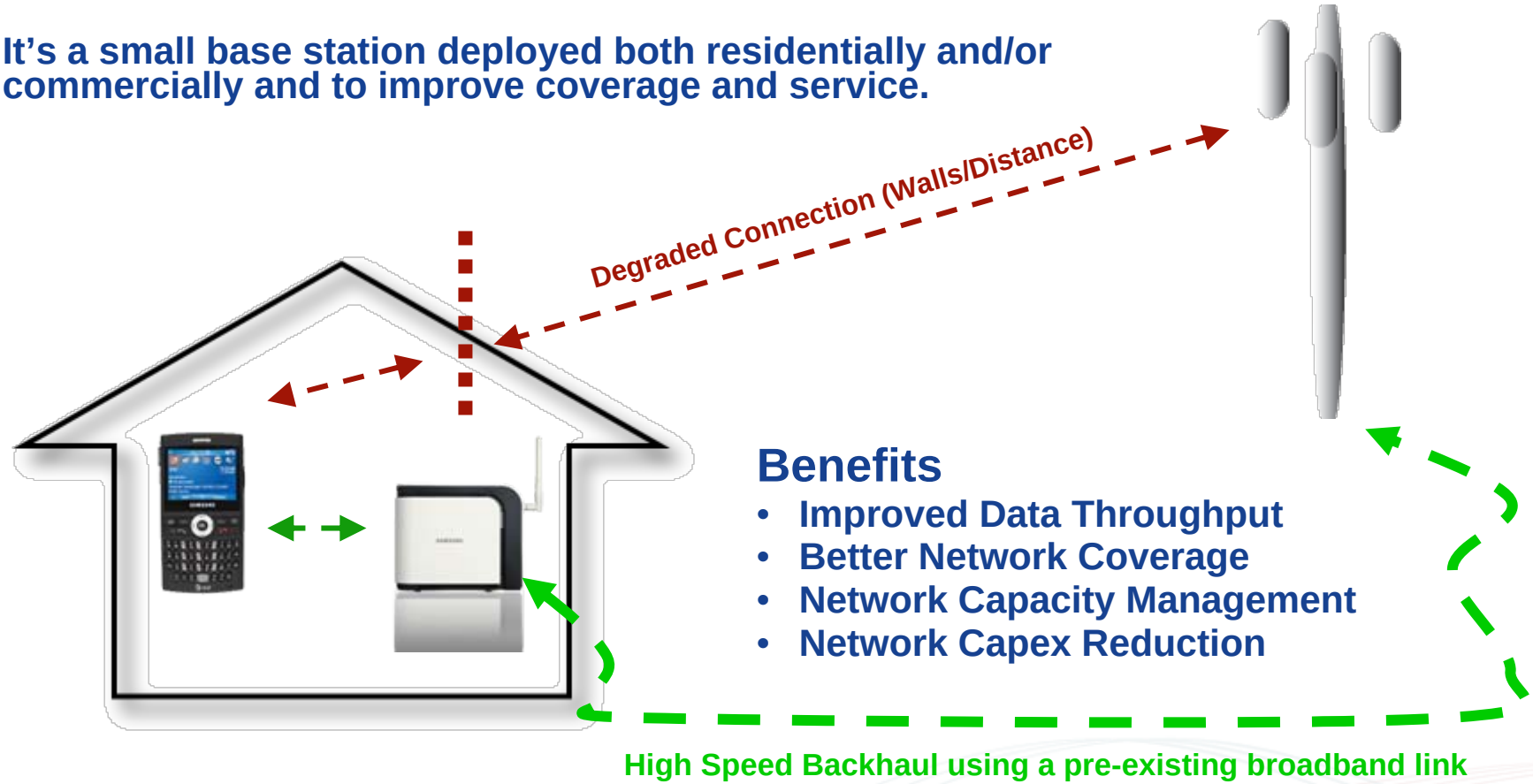
A SDR Femtocell RFFE Reference Design

- Femtocells – what are they?
- Femtocell RFFE Performance Challenges vis a vis the Handset or “UE” (User Equipment)
- BitWave’s Reference Design
- Selected Performance Data
- Conclusions

Femtocells Overview

What is a femtocell?

It's a small base station deployed both residentially and/or commercially and to improve coverage and service.



Femtocell Challenges

- **Cost - Carriers today often license multiple spectrum bands. A Femtocell optimized for a particular carrier should therefore be designed to provide support across all of the carriers licensed spectrum. This is expensive (if you don't have reconfigurable radios)**
  - Multiple Bands
  - Lower Volumes (of infrastructure in contrast to UEs) means higher prices
  - But wide scale adoption could lead to higher volume / lower prices
- **Operational Requirements and Device Complexity – Network planning can be complicated by the addition of Femtocells. Frequency planning must now adapt for the addition of low power femtocells. Network planning tools need to identify the femtocells location once a customer deploys it. Generally, femtocells require GPS and/or downlink scanning to locate their position.**
  - Must function both as BTS as well as a UE
  - Higher Overall Performance (dynamic range and transmit mask) than that required of a mobile terminal or UE (see Femto Forum Specs)

Femtocell / UE Performance Comparison

	Handset specs (dBm)	Femtocell spec (dBm)
Test Case	Signal	Signal
Ref Sensitivity	-106.7	-107
DPCH_Ec/Ior	-10.3 dB	-1.87 dB
Maximum Input	-25	NA
Dynamic Range	NA	-77
	NA	-57 *
Spurious Emissions	-57 dBm / 100 kHz	-57 dBm / 100 kHz
Max Power	+24 dBm (+1/-3 dB)	<+20
Frequency Error	+/-0.1 ppm	+/-0.25 ppm
OL Power Control Tolerance	+/-9 dB	+/-2 dB
CL Power Control Tolerance	+/-0.5 dB	NA
Min Power	<-50 dBm	<+6 dBm
Off Power	<-56 dBm	NA
Occupied BW (99%)	<5 MHz	<5 MHz
ACLR (adjacent channel)	>33	>45
ACLR (alternate channel)	>43	>50
EVM	<17.5%	<17.5% (QPSK) <12.5% (16QAM) (over the dynamic range of -3 to -28 dB CDP)
Peak Code Domain Power	<-15 dB (SF=4)	<-33 dB (SF=256)
Spurious Emissions into Rx band		
Low band	-79 dBm in 100 kHz	-82 dBm in 100 kHz
High band	-60 dBm in 3.84 MHz	-82 dBm in 100 kHz

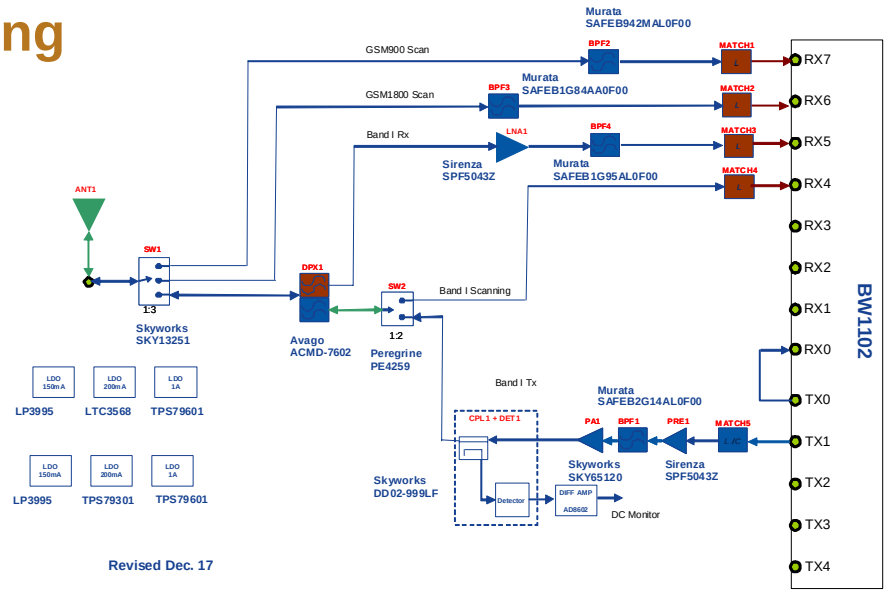
Key metrics:

- Dynamic Range
- FD vs HD
- ACLR
- Spurious

BitWave's WCDMA RFFE Reference Design

WCDMA Band 1

GSM Dual Band Downlink Scanning



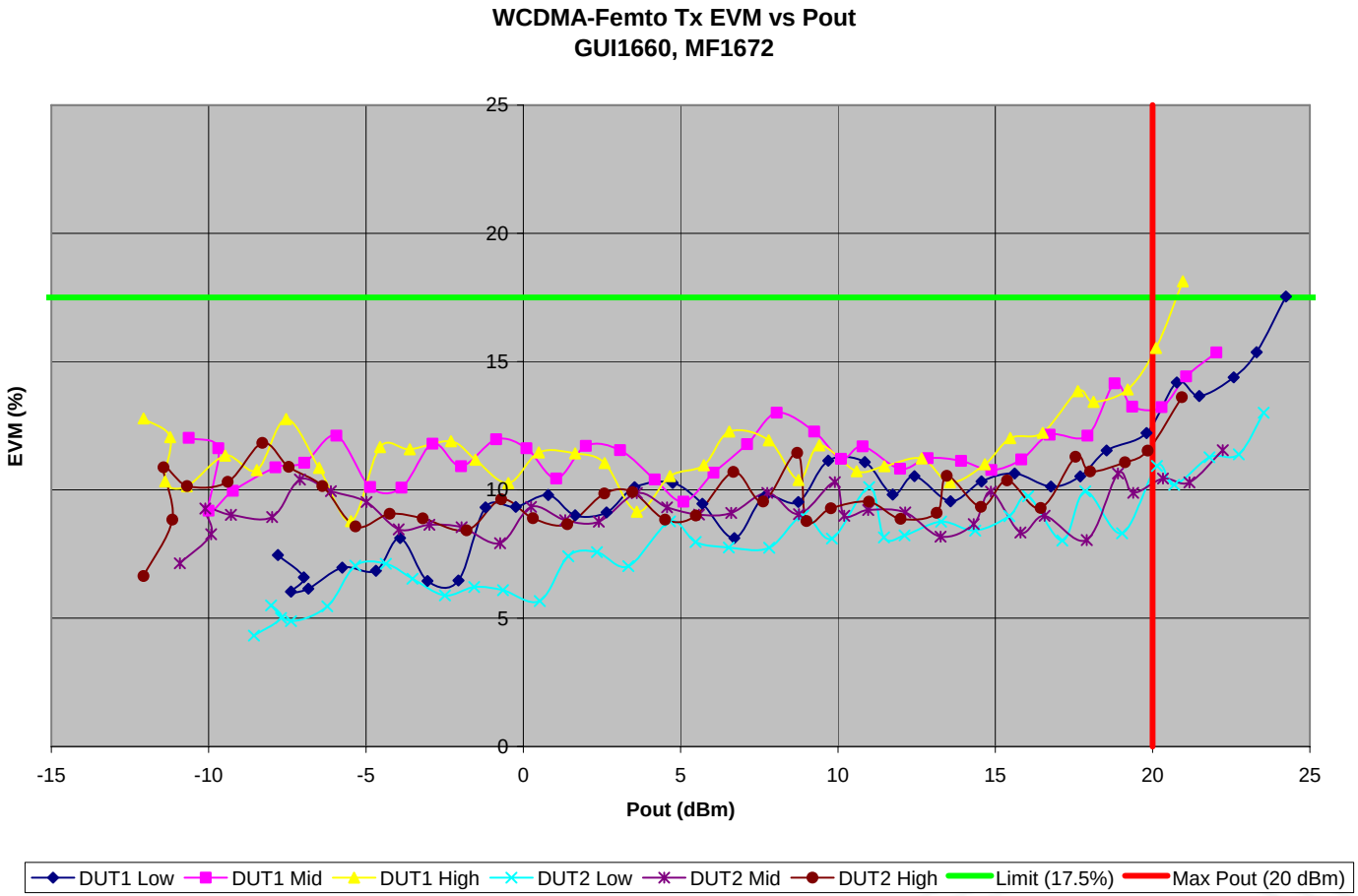
Revised Dec. 17

- **Leverages BitWave's reconfigurable Softransceiver RFIC as foundation of Radio**
  - RFFE built with reconfigurable transceiver is substantially similar to RFFE based on multiple custom ASICs
- **Multiple RFICs required to implement today**
- **Supply Chain would benefit from a reconfigurable radio platform which supported multiple configurations and SKUs**
- **RFFE BOM approximately $10 (not including Softransceiver RFIC)**

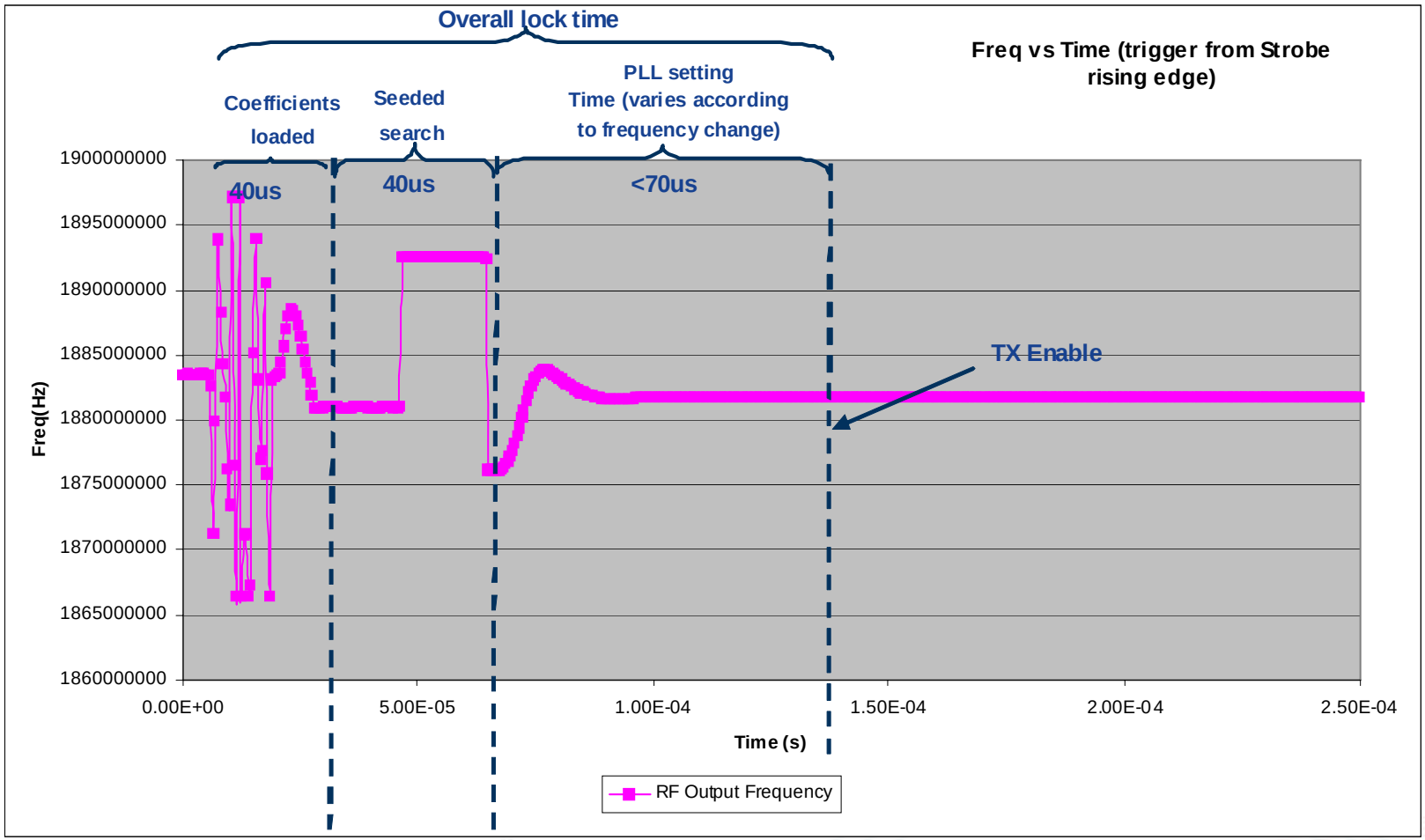
WCDMA Data Package

- TX EVM vs P_{out}
- Frequency vs. Settling Time
- SNR vs P_{in}
- In Band Blocker Performance
- Transmit ACLR (@ 18 dBm P_{out}

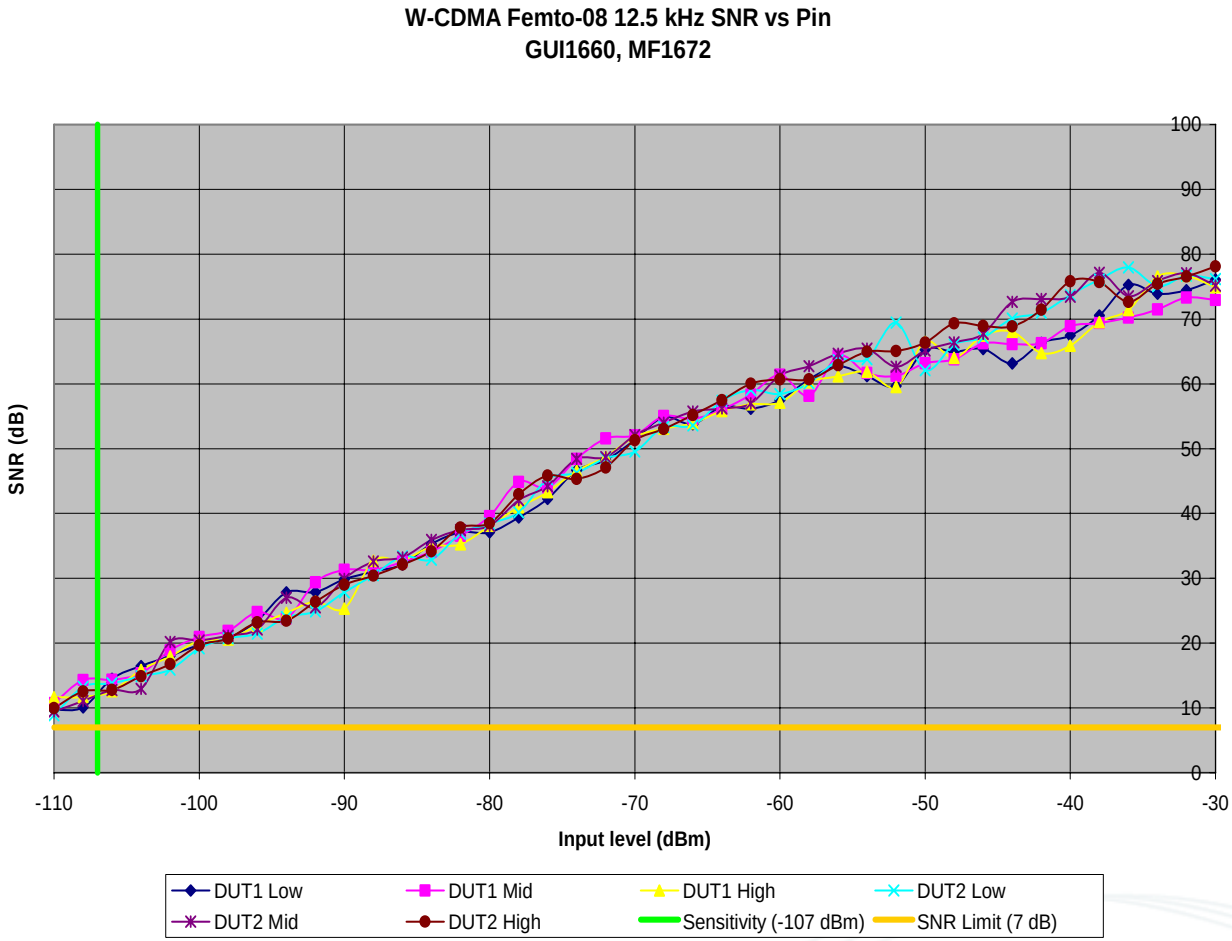
TX EVM vs P_{out}



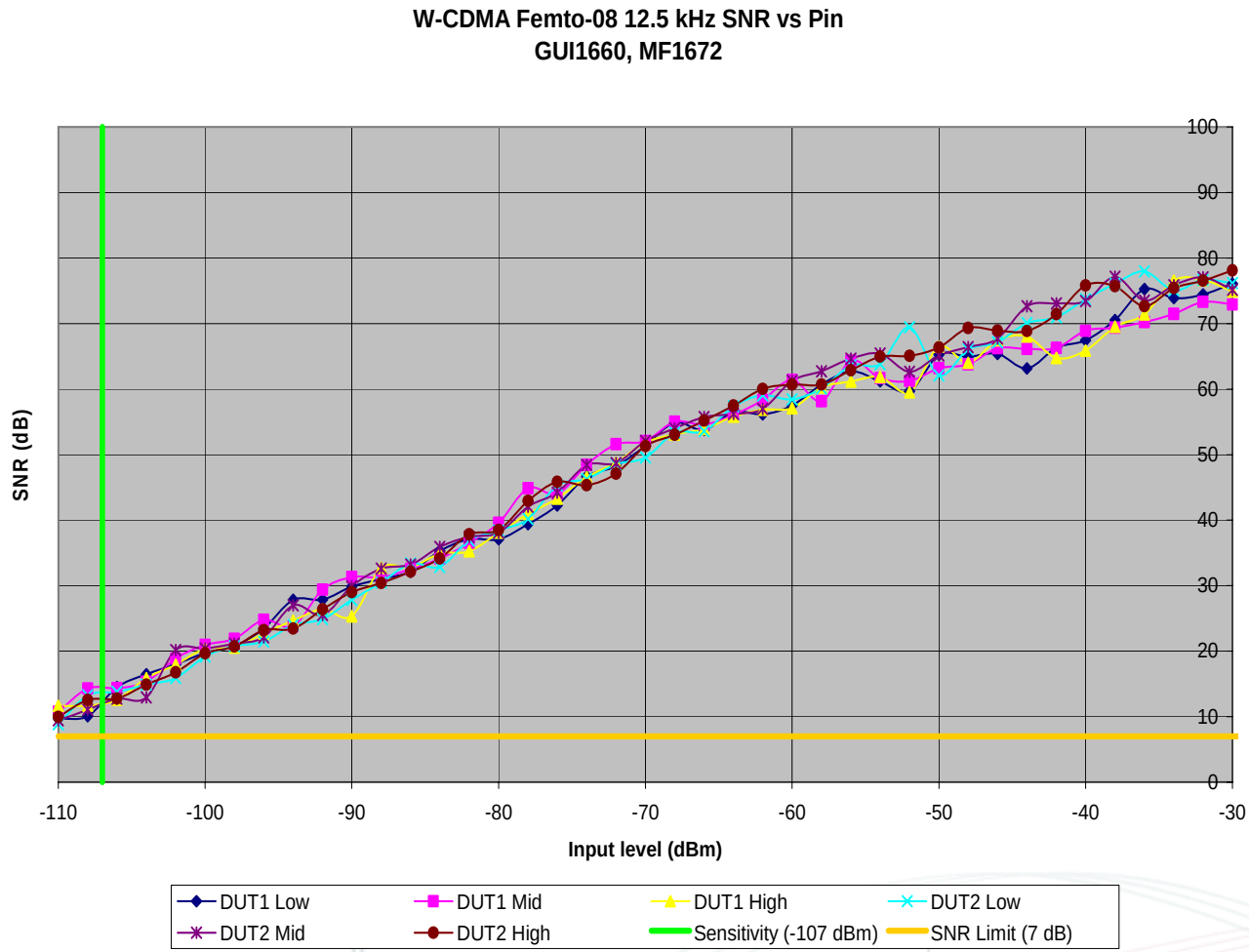
Frequency vs. Settling Time



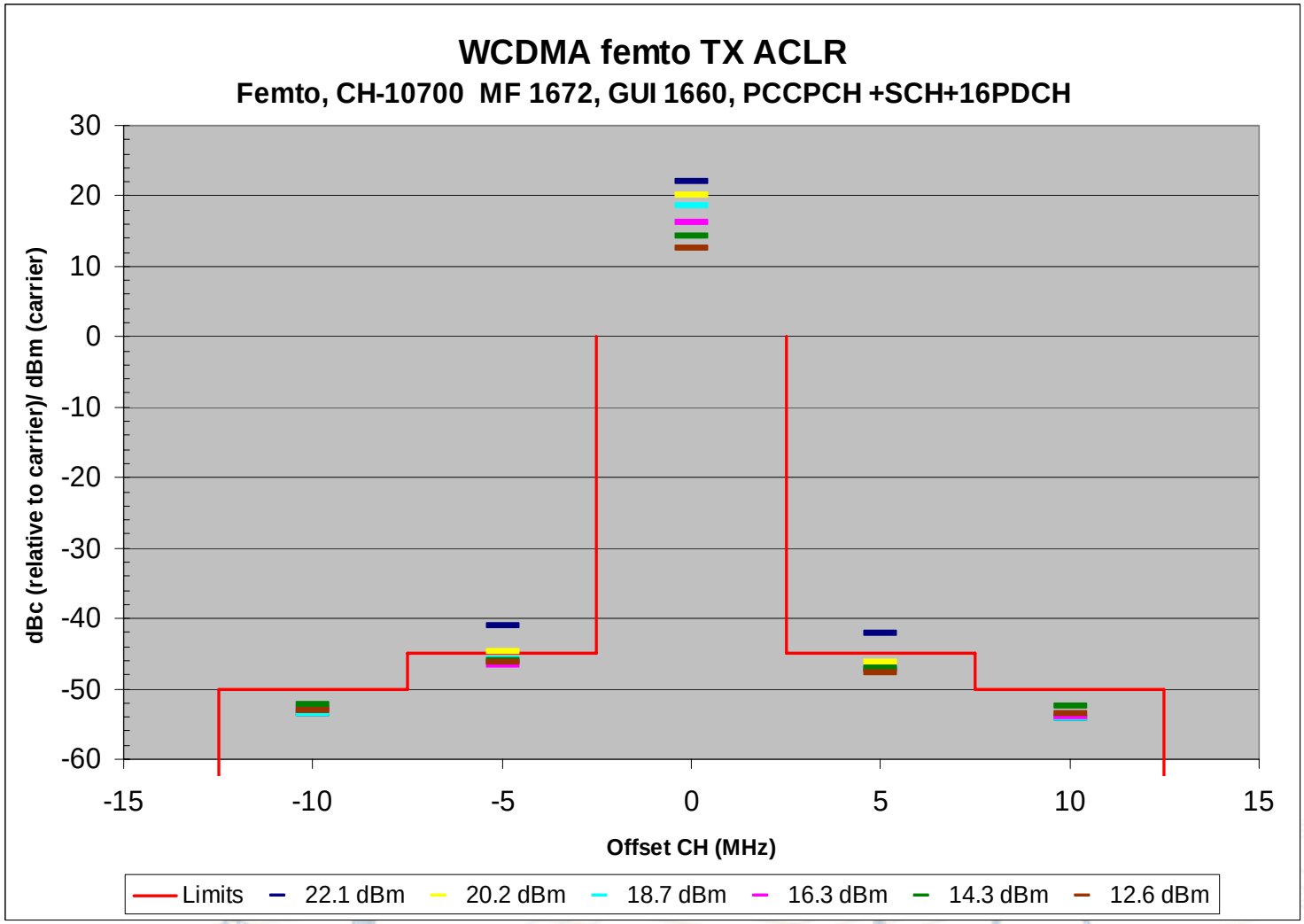
SNR vs. Pin



In Band Blocker



TX ACLR



Summary

- **Multi-band functionality, as implemented in BitWave's RFFE reference design, is and continue to be, extremely important to commercial radio design.**
- **BitWave offers a platform**
  - Economies of scale to lower cost
  - Easily upgradable
  - Software self destruct if not used in proper location
- **Many consumer devices will need to do more than just be a femtocell.**
  - How to integrate WiFi BT WiMAX cheaply is a concern
- **Time to market shorter with SW than with HW**