

Transmit Emissions Considerations for 10BASE-T1S

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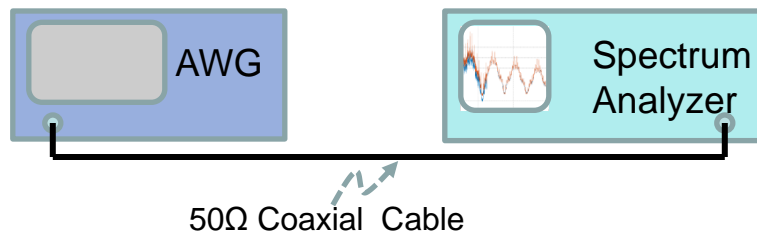
Problem Statement

- Clauses 147 and 148 in 802.3cg D1.0 have 4B5B encoding with no scrambler before DME modulation.
- Peak emissions are of critical importance for automotive applications and have direct correlation with peak transmit PSD.
- Emission can be further reduced with methods described in this presentation, which evaluates the effect of the new proposed scrambler and the preamble on peak PSD.

Measurement Setup

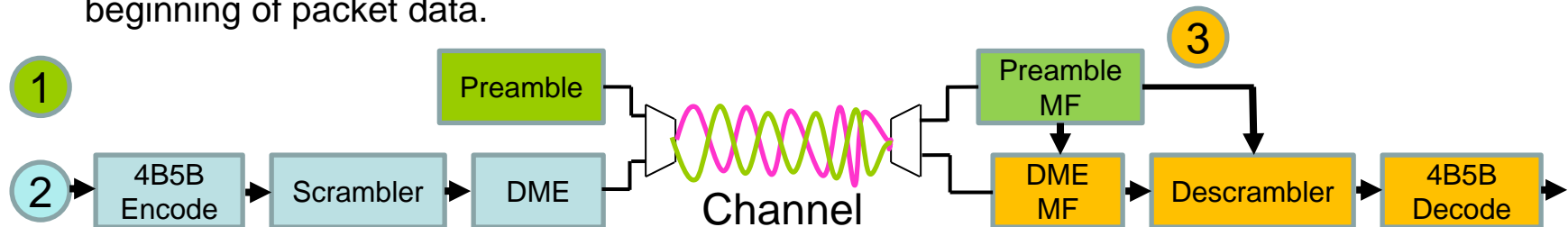
Tektronix AWG7051 Arbitrary Waveform Generator connected directly to R&S FSU Spectrum Analyzer. 50Ω single-ended TX impedance into 50Ω coaxial cable.

- Max hold scan from 0.1 to 125 MHz
 - 0.1-30 MHz RBW set to 10 kHz
 - 30-125 MHz RBW set to 100 kHz
- TX Rate: 12.5 Mbps
- IPG: 12 Octet
- Preamble: Evaluate with current 802.3cg D1.0 preamble and new proposed preamble.
- Payload – 182 octet UDP frame captured from Ethernet network using Wireshark, payload 4B5B encoded and DME modulated per 802.3cg D1.0 Clause 147.1.2.
- Compare:
 - 4B5B encoded packet without scrambler and then DME modulated
 - 4B5B encoded packet scrambled with Clause 97 Master mode scrambler $x^{15}+x^4+1$ and then DME modulated



How to scramble 10BASE-T1S Frames

- 10BASE-T1S does not transmit IDLEs on the line when no data present.
→ No continuously running scrambler.
- How to synchronize the scrambler?
 1. Transmit preamble unscrambled in order to synchronize.
→ Emissions performance of raw preamble is important.
 2. Scramble the 4B5B-encoded payload at the transmitter with $x^{15}+x^4+1$ scrambler with same initial state loaded at beginning of every frame.
$$\text{scr_initial_state} = ([0 0 1 1 1 1 1 0 0 1 1 0 1 0 1])$$
 3. At receiver, detect preamble and then start descrambler with same fixed initial state at beginning of packet data.



Preamble and Packet Formats

Current Preamble (802.3cg D1.0 147.3.3)

182 Byte

4



New Proposed Preamble *

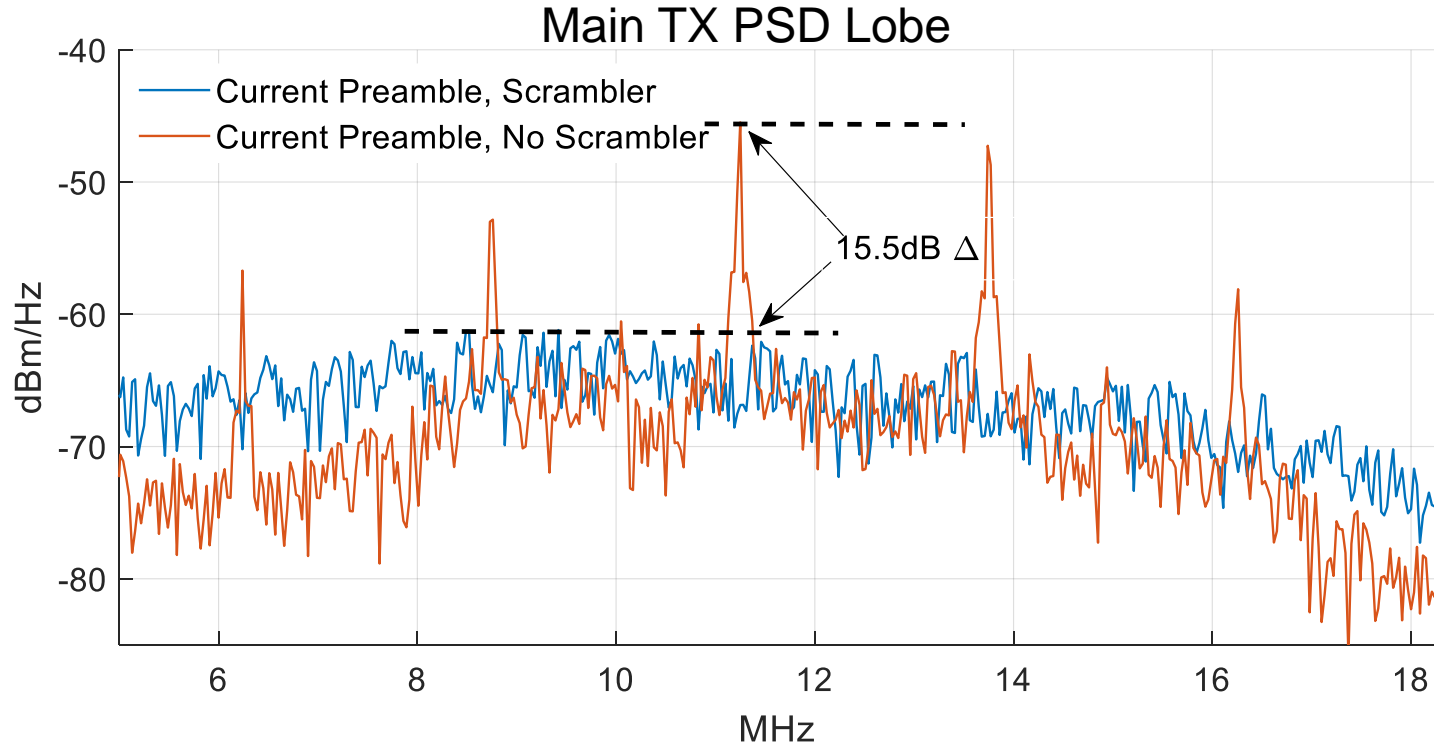
182 Byte

4



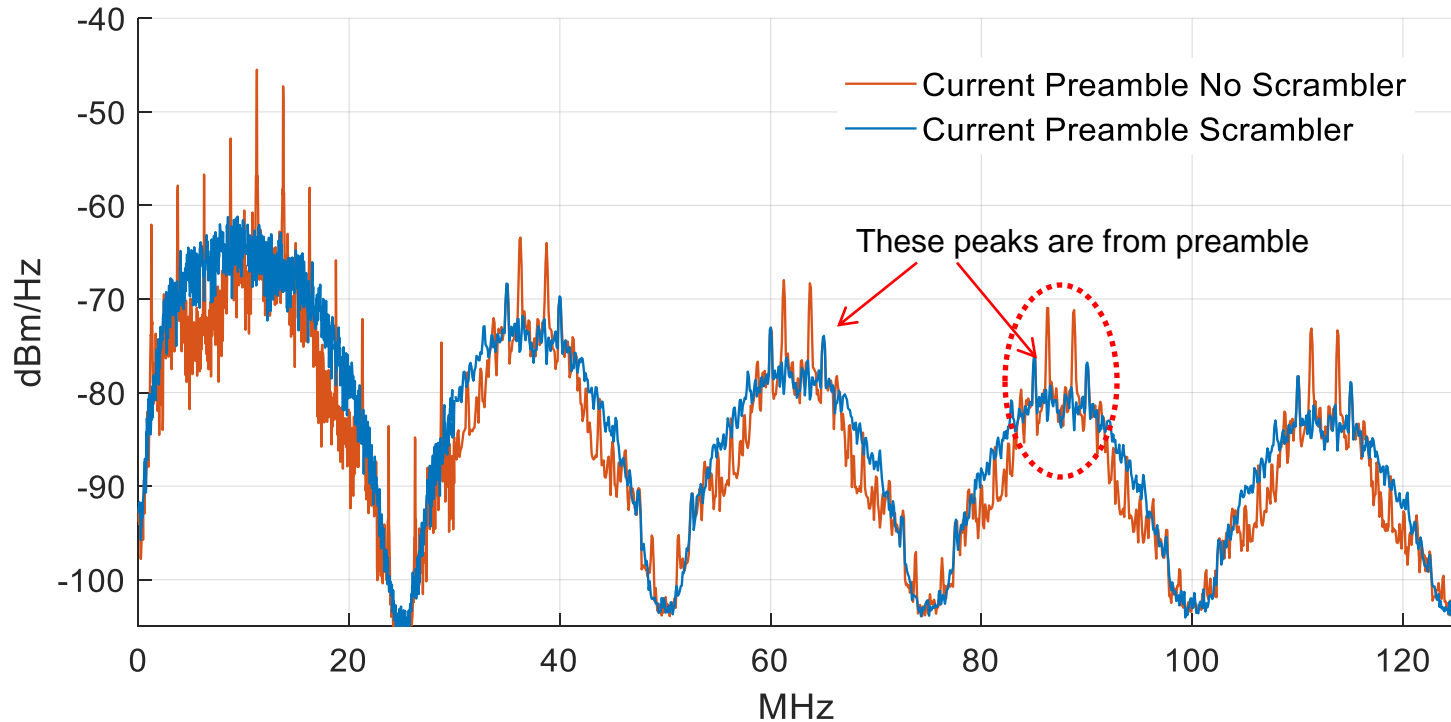
*http://www.ieee802.org/3/cg/public/adhoc/cordaro_8023cg_01_0118_v2.pdf

PSD Peak Comparison Current Preamble Scrambler vs. No Scrambler



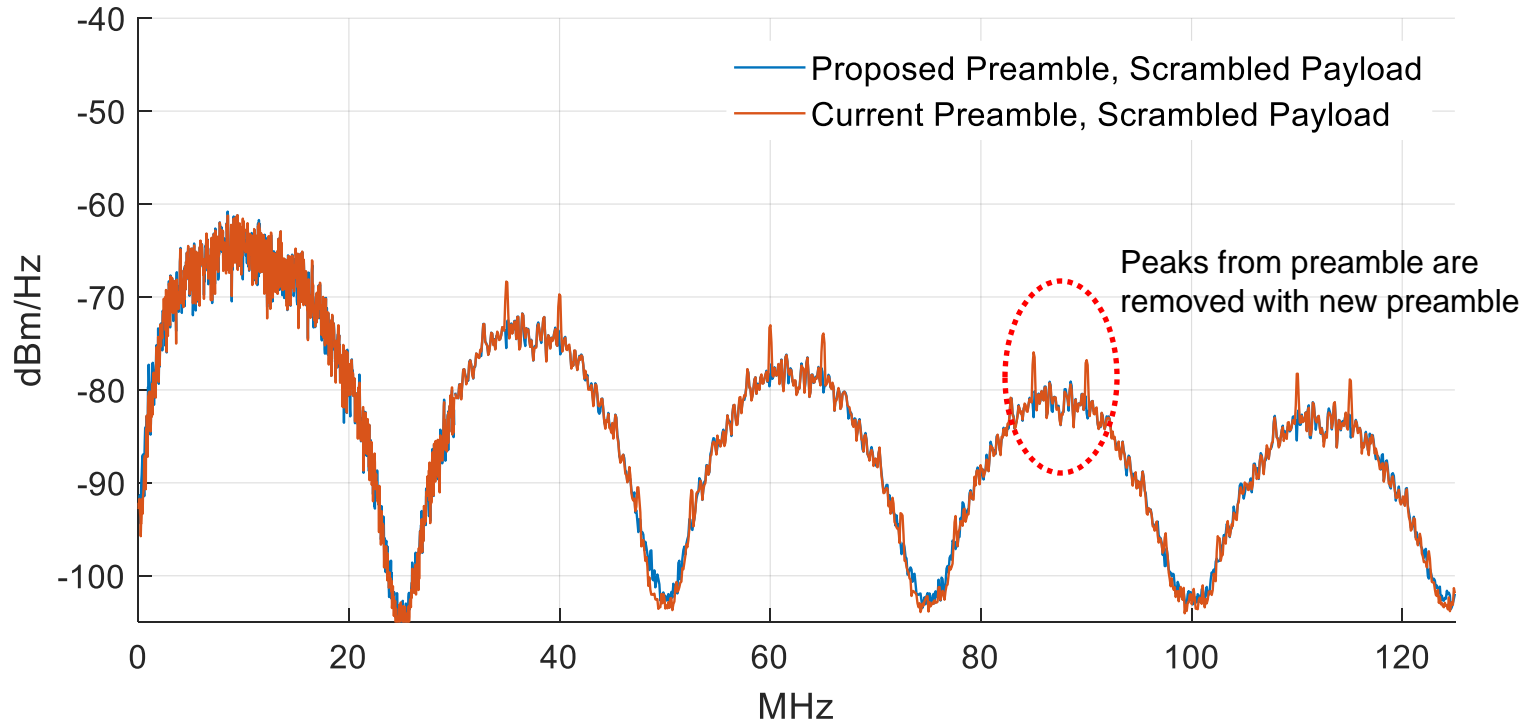
Scrambling reduces peak PSD and peak emission in the main lobe and should be used.

PSD Peak Comparison Current Preamble, Scrambled vs. Unscrambled



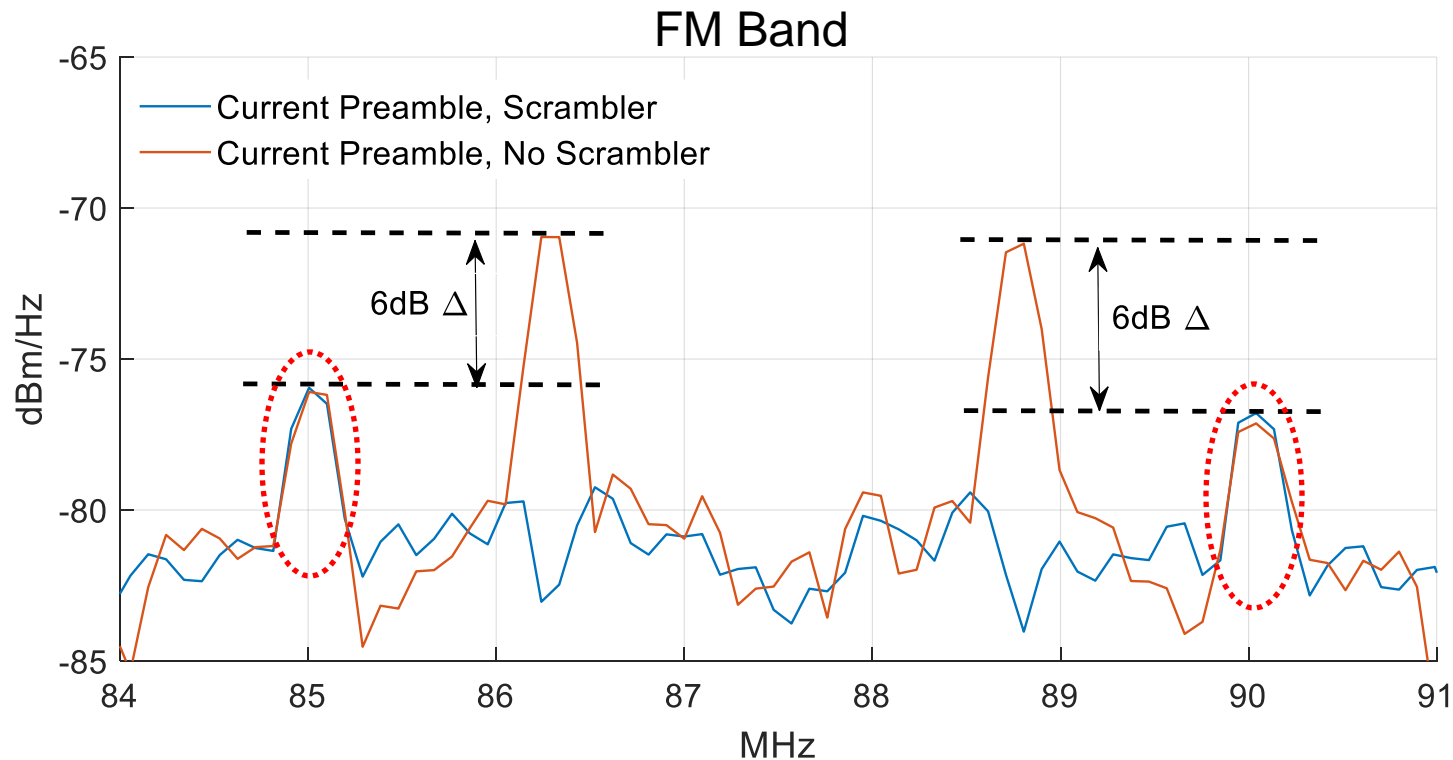
Scrambling reduces peaks due to repetitive pattern in payload but peaks due to preamble remain.

PSD Peak Comparison, Scrambled, Current vs. New Proposed Preamble



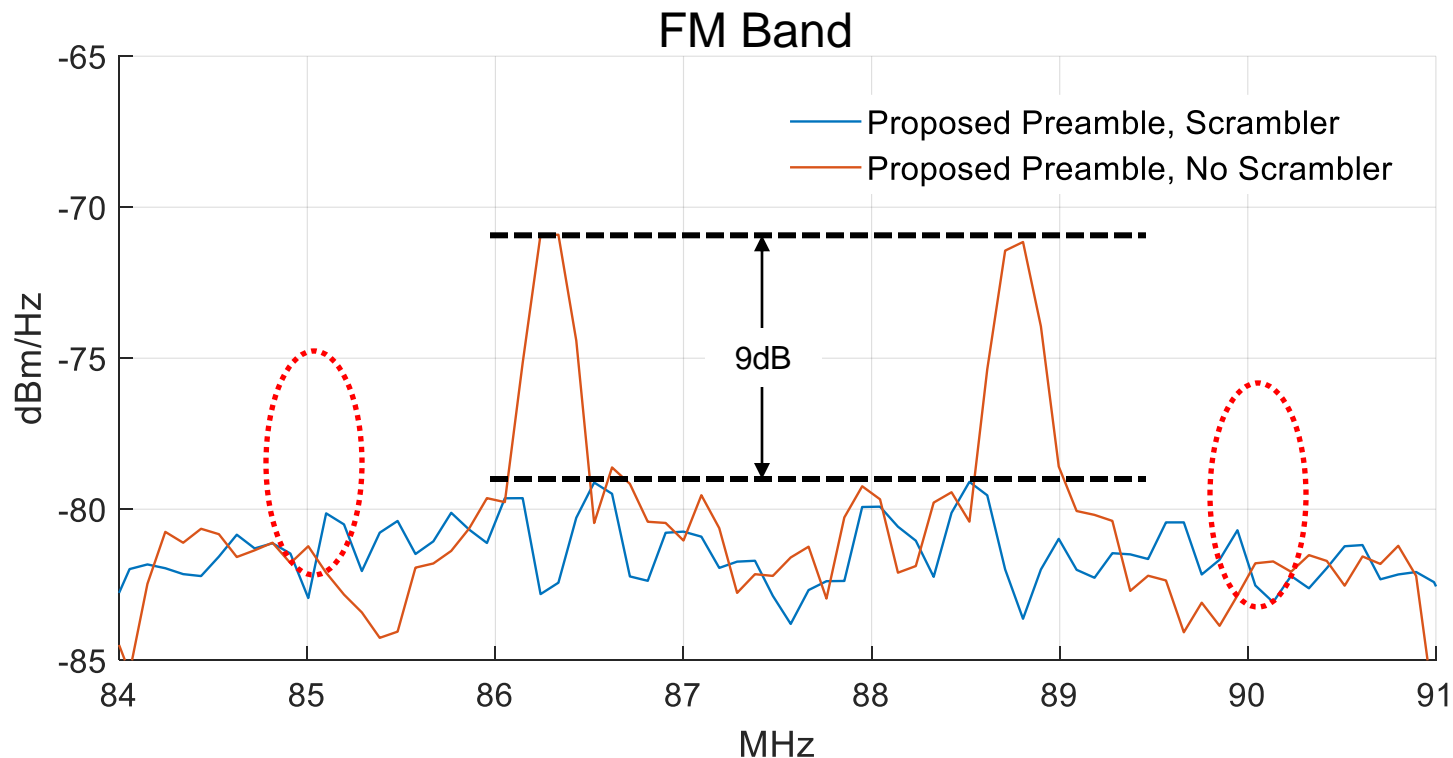
Improvement from scrambler is fully utilized with new preamble.

PSD Current Preamble Scrambler vs. No Scrambler



Scrambling does improve peak PSD in FM Band, but limited by repeated 55 in preamble.

Effect of Proposed Preamble in Addition to Scrambler



Frame with scrambled payload and proposed preamble has less peak PSD in FM band.

Conclusions

- The scrambler shown improves peak emissions especially below 30 MHz. However, the full benefit of the scrambler is not utilized due to peaks associated with the current preamble.
- The proposed preamble further improves peak emission by an additional 3 dB in the FM Band.
- TX spectral shaping may be required to control peak PSD to meet emissions masks especially in the FM Band.
- Precise detection of packet is required for proper descrambling.
- Proposed preamble and scrambling improves peak emissions and this improvement allows design with improved SNR.