

# Transmit Emissions Considerations for 10BASE-T1S

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# Contributors

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# Problem Statement

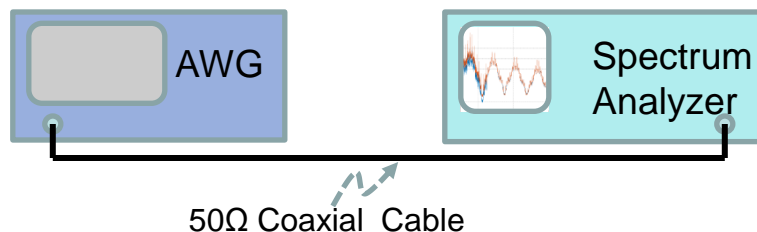
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- Clauses 147 and 148 in 802.3cg D1.0 have 4B5B encoding with no scrambler before DME modulation.
- Peak emissions are of critical importance for automotive applications and have direct correlation with peak transmit PSD.
- Emission can be further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

# Measurement Setup

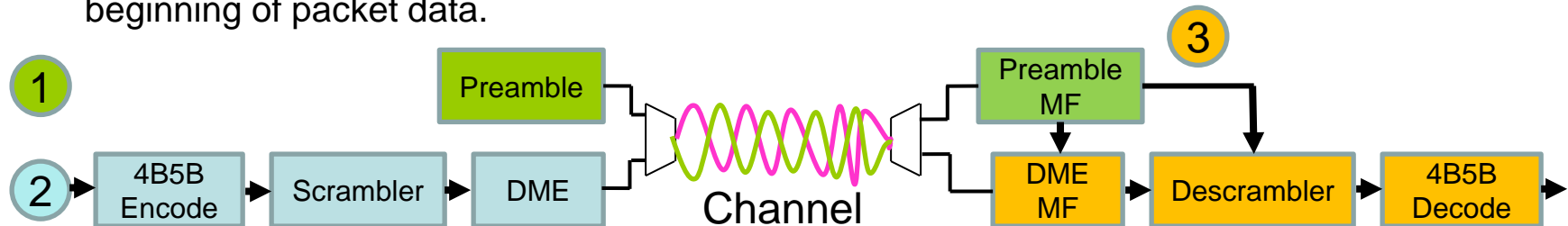
Tektronix AWG7051 Arbitrary Waveform Generator connected directly to R&S FSU Spectrum Analyzer. 50Ω single-ended TX impedance into 50Ω coaxial cable.

- 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.
  1. 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.  
$$\text{scr\_initial\_state} = ([0\ 0\ 1\ 1\ 1\ 1\ 1\ 0\ 0\ 1\ 1\ 0\ 1\ 0\ 1])$$
  2. 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 )

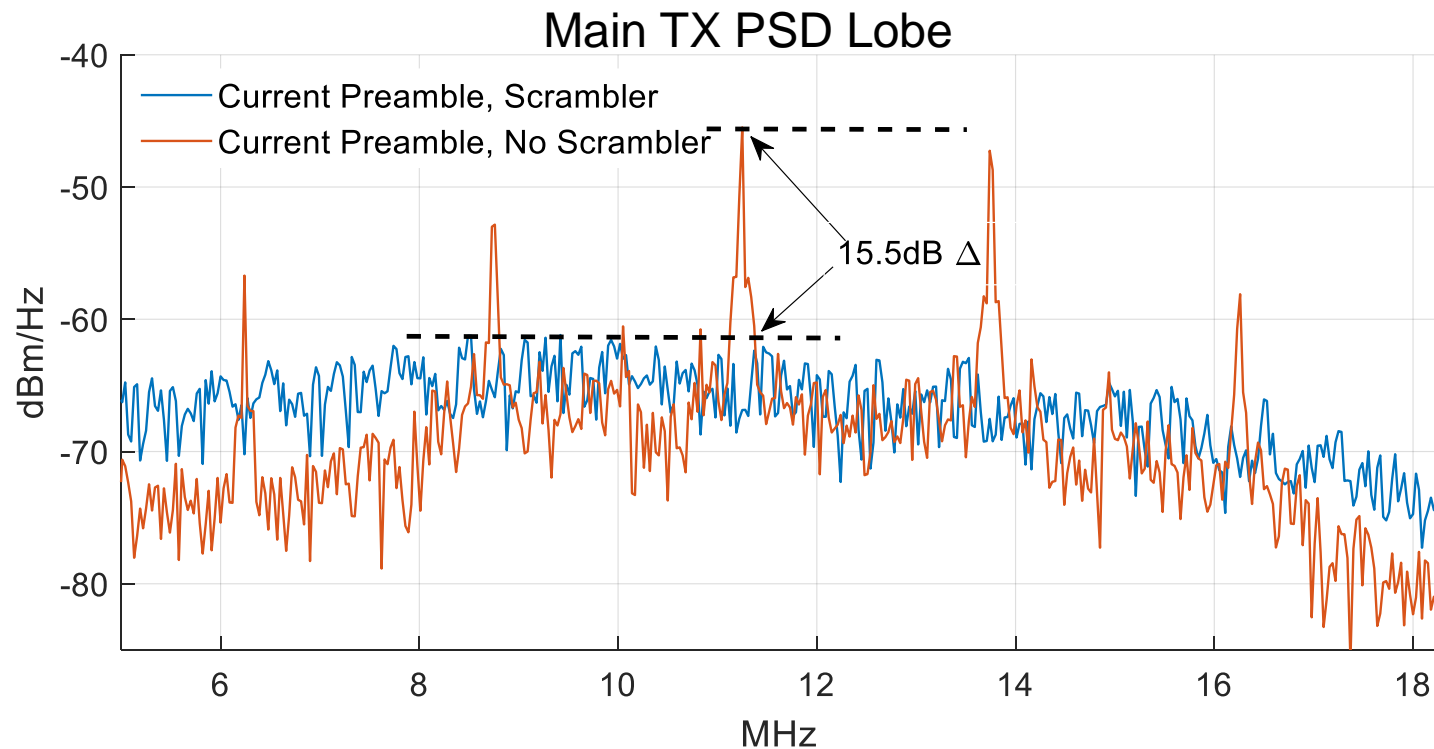


## New Proposed Preamble \*



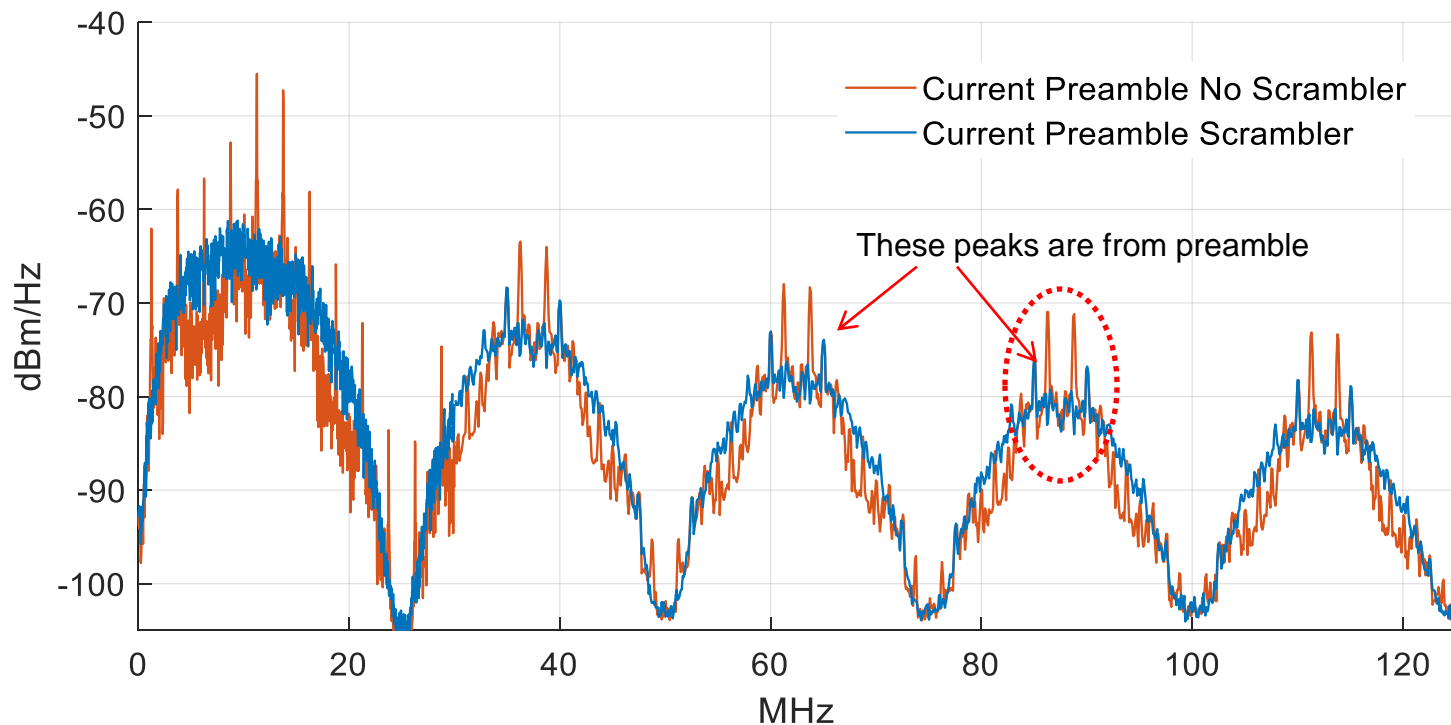
\*[http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_8023cg\\_01\\_0118\\_v2.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_8023cg_01_0118_v2.pdf)

# PSD Peak Comparison Current Preamble Scrambler vs. No Scrambler



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

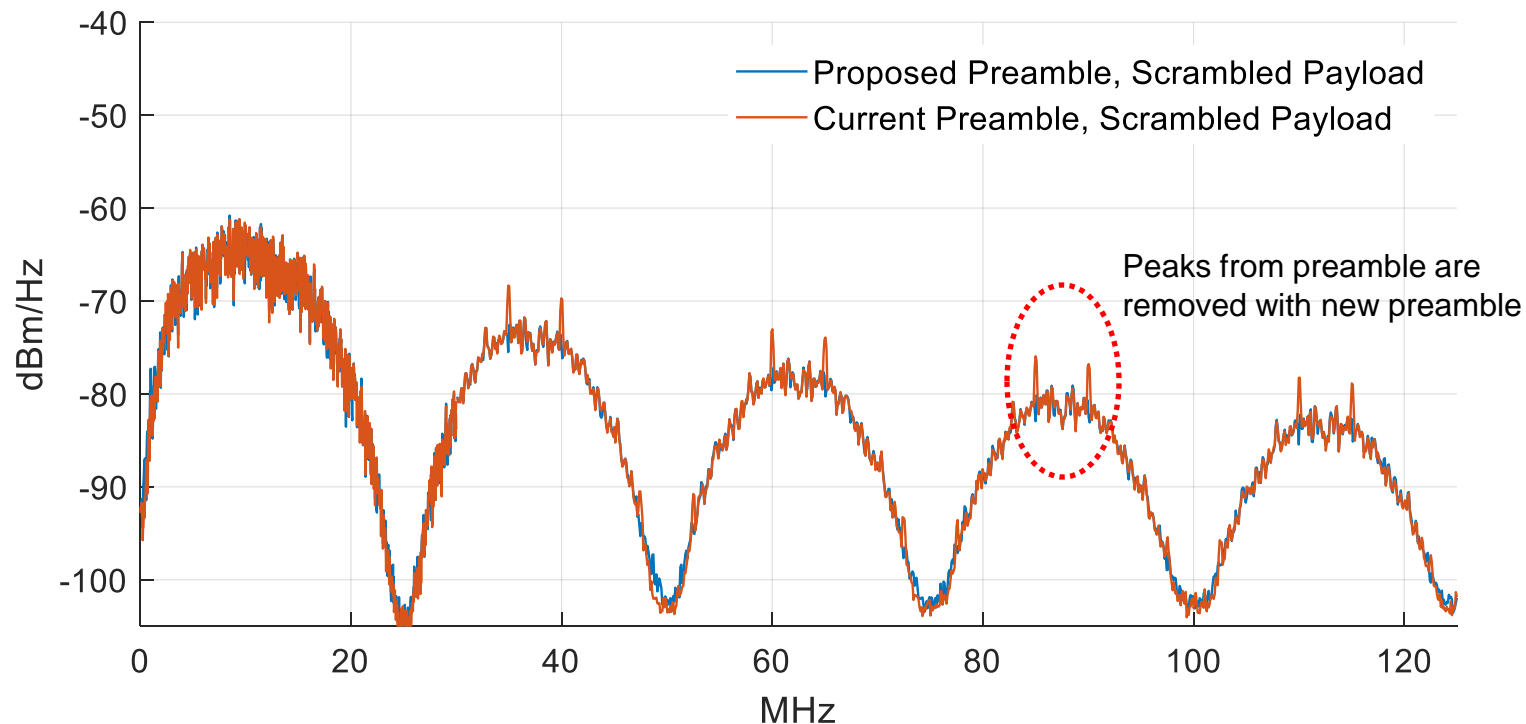
# PSD Peak Comparison Current Preamble, Scrambled vs. Unscrambled



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

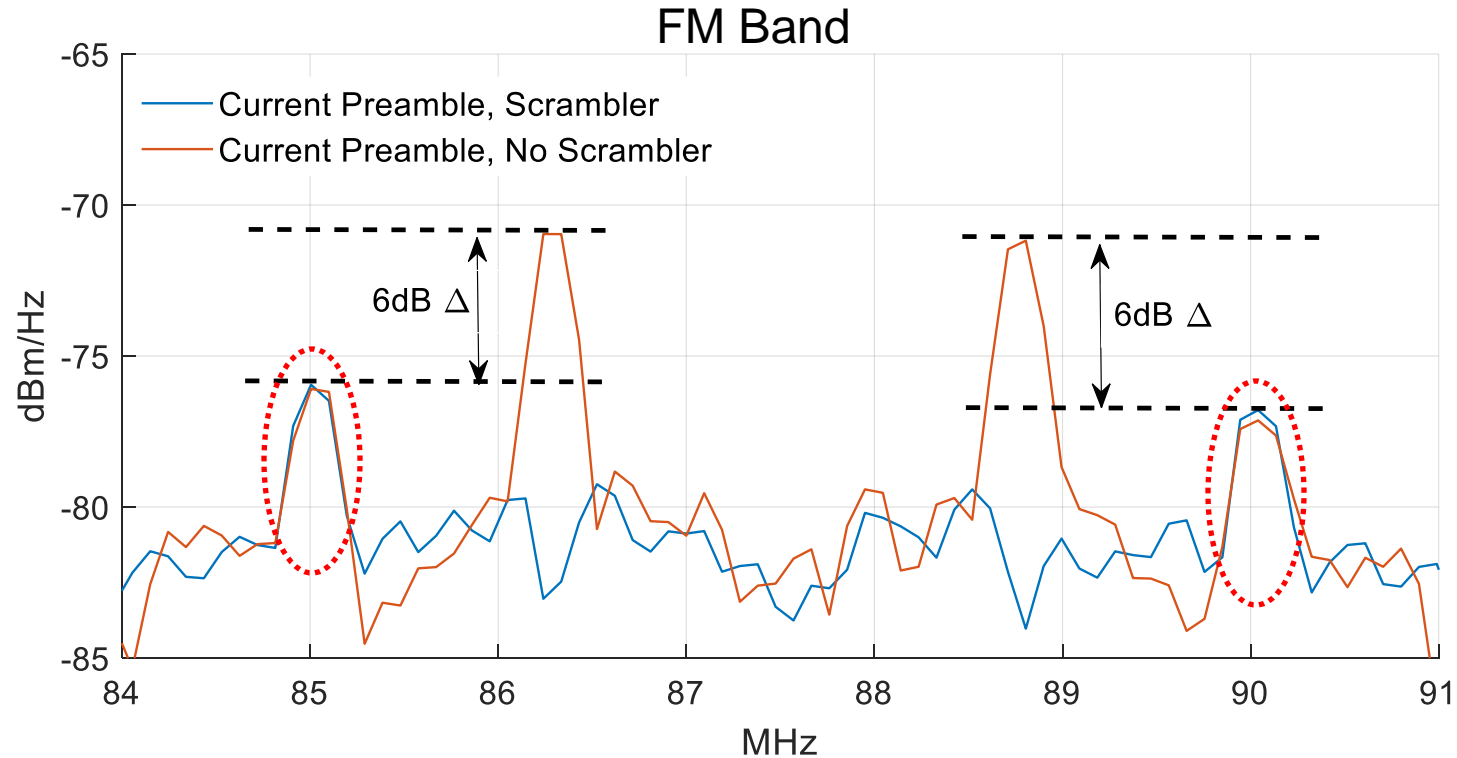


# PSD Peak Comparison, Scrambled, Current vs. New Proposed Preamble



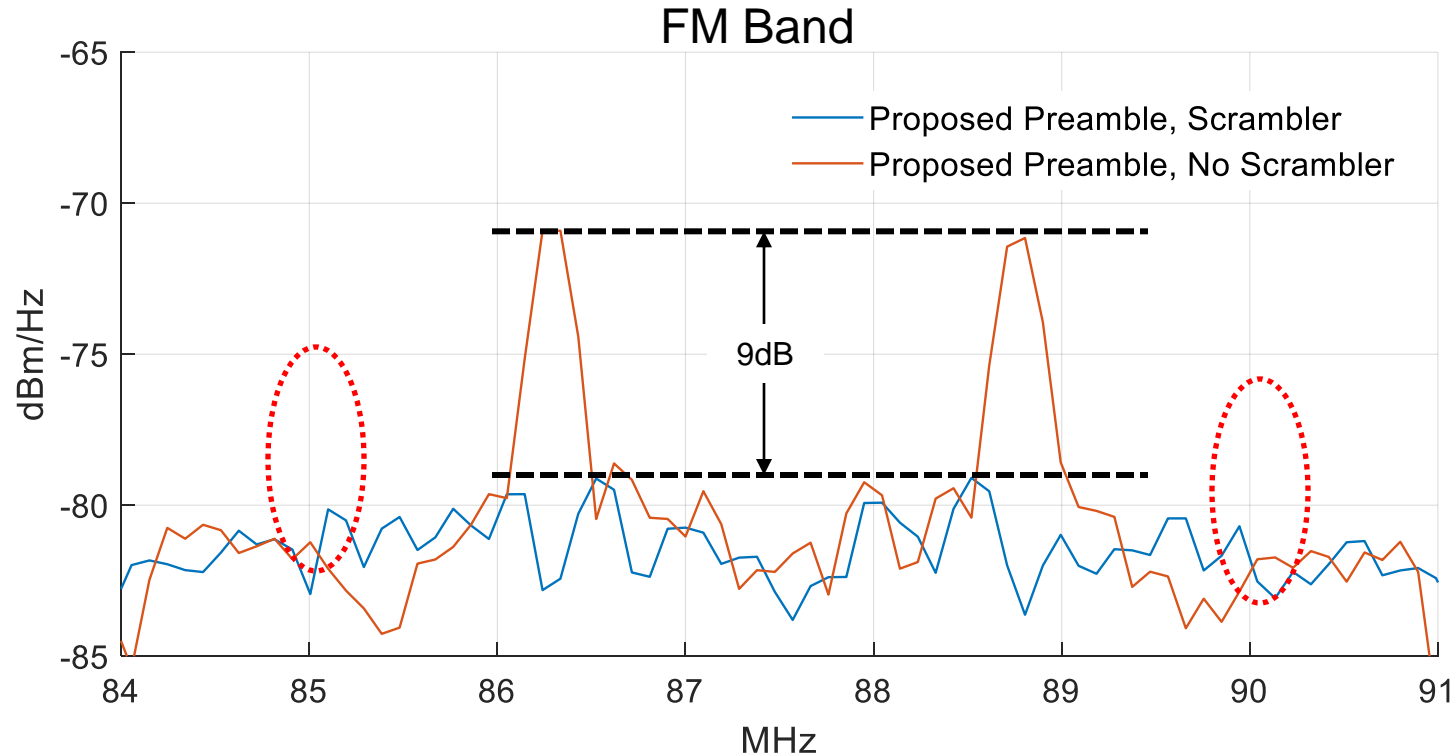
Improvement from scrambler is fully utilized with new preamble.

# 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

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- 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.