TPMS RF Transmissions

Signal Modulation

September 2015

1. Signal Modulation

How to create discrete states ?

Three techniques exist:

- Modulating the frequency of the carrier signal: FSK modulation (Frequency Shift Keying)
- Modulating the amplitude of the carrier signal: ASK modulation (Amplitude Shift Keying)

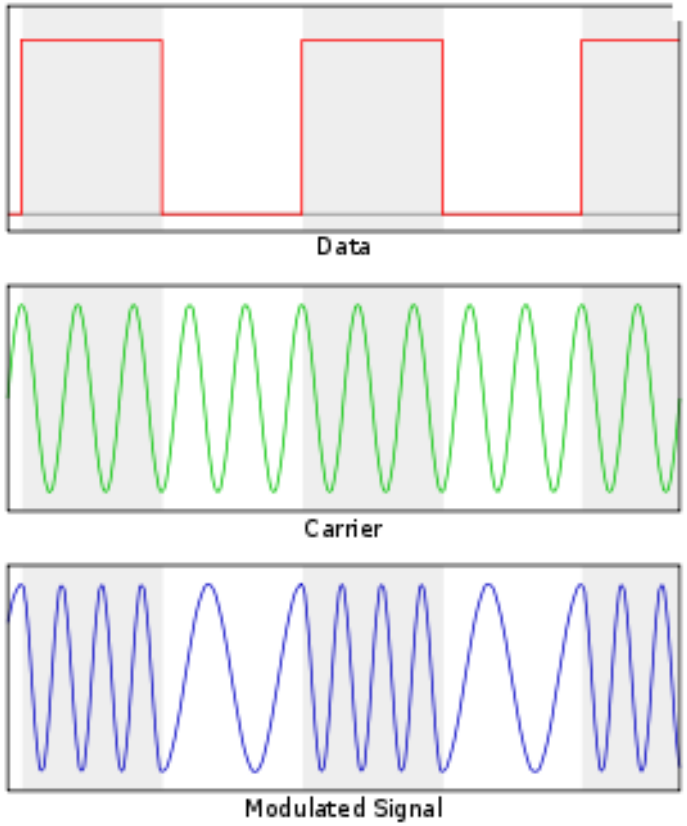
  With ASK, the amplitude of the signal can take any value: 1 for max amplitude, 0.5 for 50% of max amplitude....

  A special case of ASK is OOK (On Off Keying). With OOK, the amplitude is either 100% of max amplitude or 0, there is no value in-between.
- Modulating the phase of the carrier signal: PSK modulation (Phase Shift Keying)

Modulation methods **available with TPMS** for RF transmission at 315 or 434MHz:

- FSK
- OOK

Frequency Shift Keying Modulation - FSK



Fc = 315 or 434MHz

Fdata0 = Fc - Δf
Fdata1 = Fc + Δf

From the TPMS manual:

$$f_{DATA0} = f_{XTAL} \times \left((12 + 4 \times CF) + \frac{AFREQ}{8192}\right)$$

Config in PLLCR0 and PLLCR1

$$f_{DATA1} = f_{XTAL} \times \left((12 + 4 \times CF) + \frac{BFREQ}{8192}\right)$$

Config in PLLCR2 and PLLCR3

Use-case examples

Case 315MHz

AFREQ = 0x39A = 922
fXTAL = 26MHz
CF = 0 (315MHz)

⇩

fDATA0 = 314.926 MHz

BFREQ = 0x3B6 = 950
fXTAL = 26MHz
CF = 0 (315MHz)

⇩

fDATA1 = 315.015 MHz

Case 434MHz

AFREQ = 0x160C = 5644
fXTAL = 26MHz
CF = 1 (434MHz)

⇩

fDATA0 = 433.913 MHz

BFREQ = 0x162A = 5674
fXTAL = 26MHz
CF = 1 (434MHz)

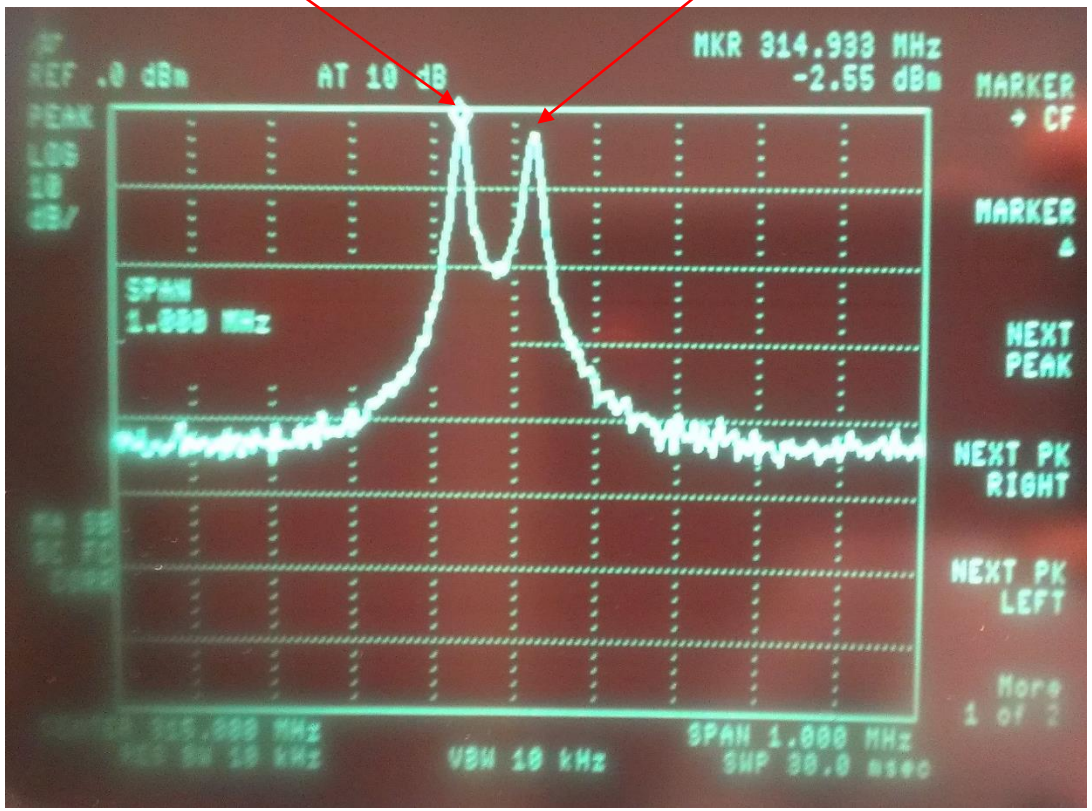
⇩

fDATA1 = 434.008 MHz

Case 315MHz

314.933 MHz

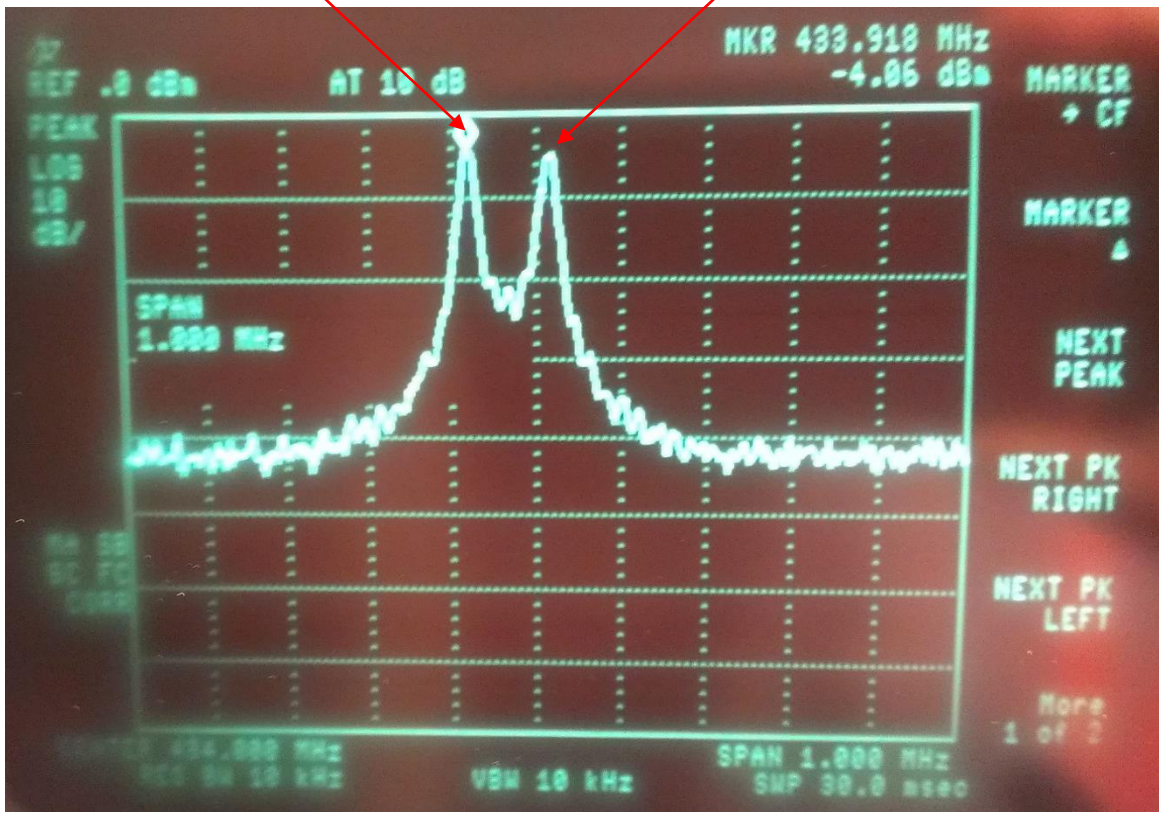
315.018 MHz



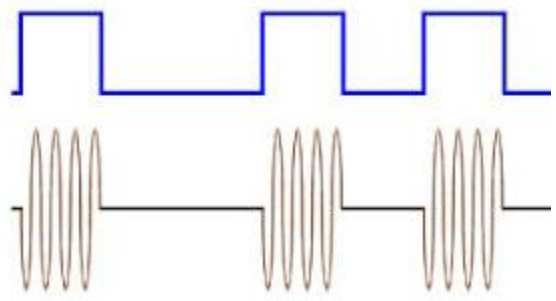
Case 434MHz

433.918 MHz

434.018 MHz



On Off Keying Modulation - OOK



Fc = 315 or 434MHz

Fdata0 => no amplitude
Fdata1 = Fc

From the TPMS manual:

$$f_{DATA1} = f_{XTAL} \times \left((12 + 4 \times CF) + \frac{BFREQ}{8192} \right)$$

Config in PLLCR2 and PLLCR3

Use-case examples

Case 315MHz

BFREQ = 0x3B6 = 950
fXTAL = 26MHz
CF = 0 (315MHz)

⇩

fDATA1 = 315.015 MHz

Case 434MHz

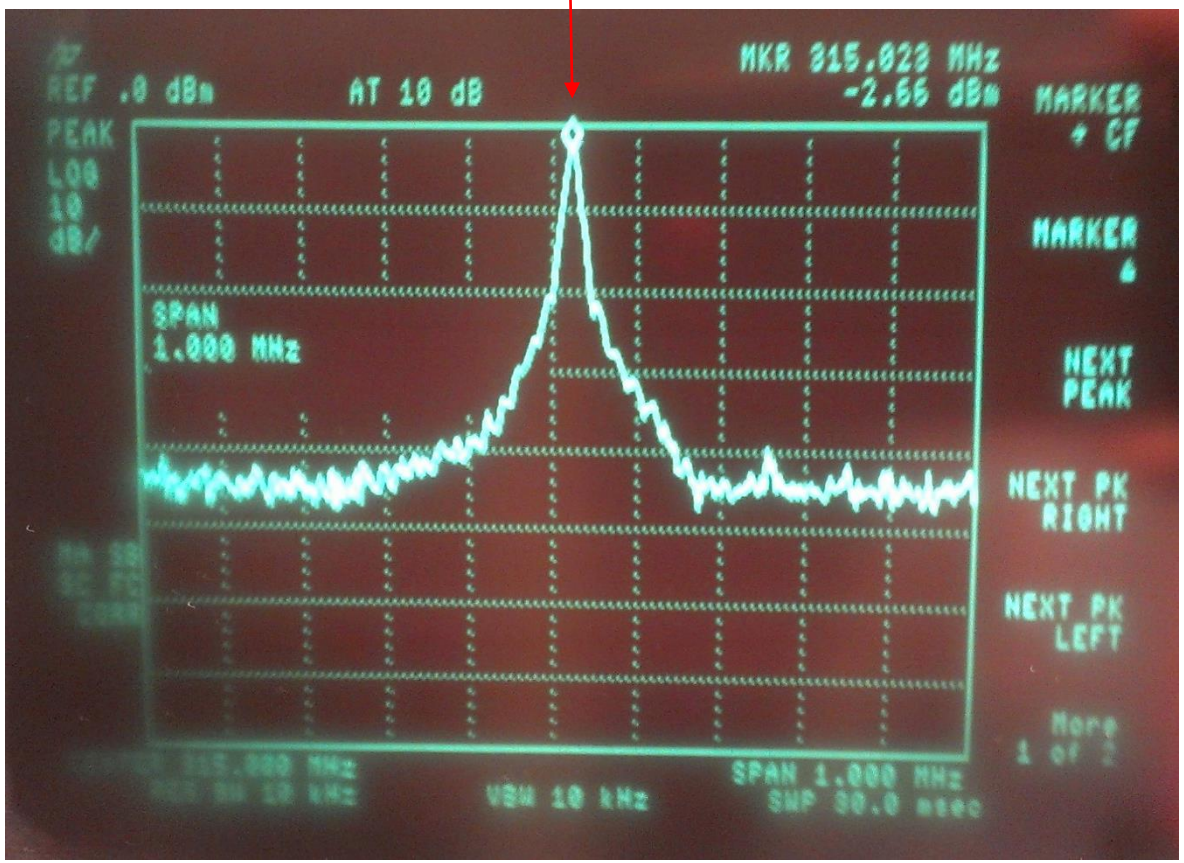
BFREQ = 0x162A = 5674
fXTAL = 26MHz
CF = 1 (434MHz)

⇩

fDATA1 = 434.008 MHz

Case 315MHz

315.023 MHz



Case 434MHz

434.013 MHz