EMI Noise Reduction Techniques

TI Precision Labs – Clocks and Timing

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What is EMI?

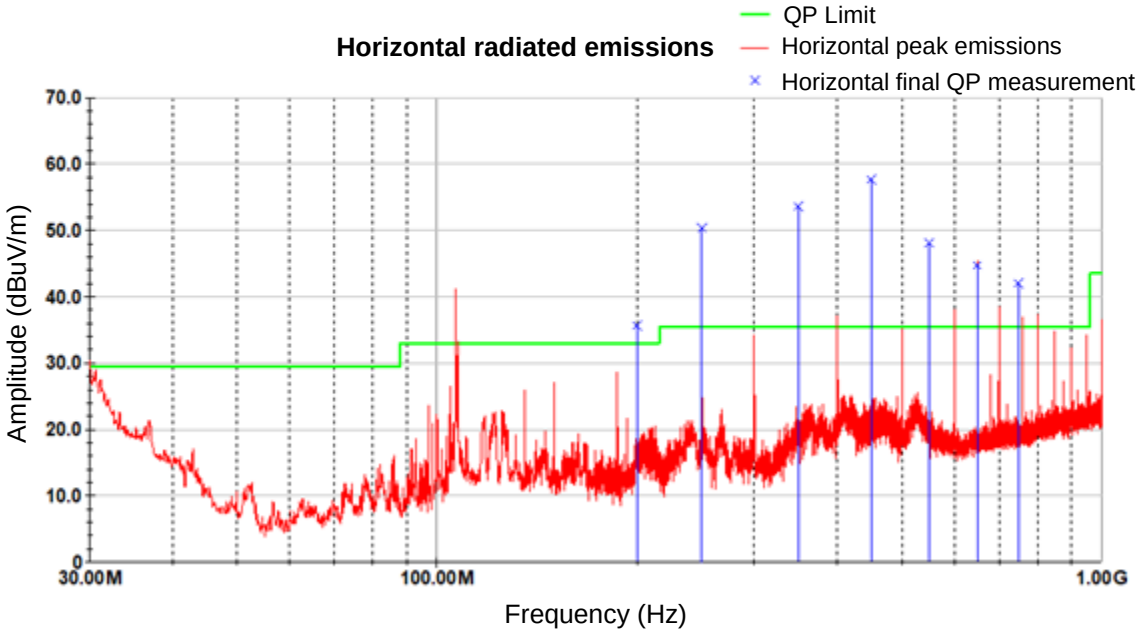
Electromagnetic Interference:

The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.

–ITU Radio Regulations, Section IV., Article 1.166

Clocking relative to EMI and EMC

Radiated emissions plot



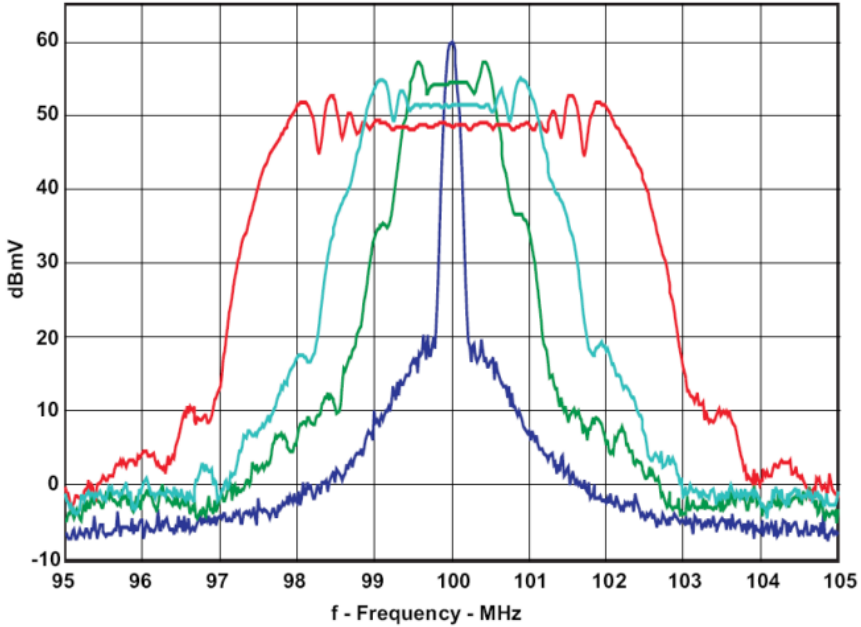
EMC compliance test results

Peak radiated emissions list

Frequency (MHz)	Raw QP (dBµV)	Polarity (V/H)	Azimuth (°)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	QP value (dBµV/m)	Limit	Margin
200	56.3	H	148.0	268.0	12.1	2.1	34.8	35.7	33.0	2.7
250	71.3	H	147.0	256.0	11.7	2.3	35.0	50.4	35.5	14.9
350	71.1	H	13.0	181.0	14.7	2.8	35.0	53.5	35.5	18.0
450	72.6	H	16.0	133.0	17.0	3.2	35.0	57.7	35.5	22.2
550.02	61.3	H	149.0	355.0	18.2	3.5	35.0	48.0	35.5	12.5
649.96	56.0	H	326.0	364.0	19.8	3.8	35.0	44.6	35.5	9.1
749.97	56.2	H	340.0	312.0	20.8	4.1	35.0	42.1	35.5	6.6

- Quasi-Peak value = Raw QP + Antenna Factor + Loss – Amp
- Margin = QP Value - Limit

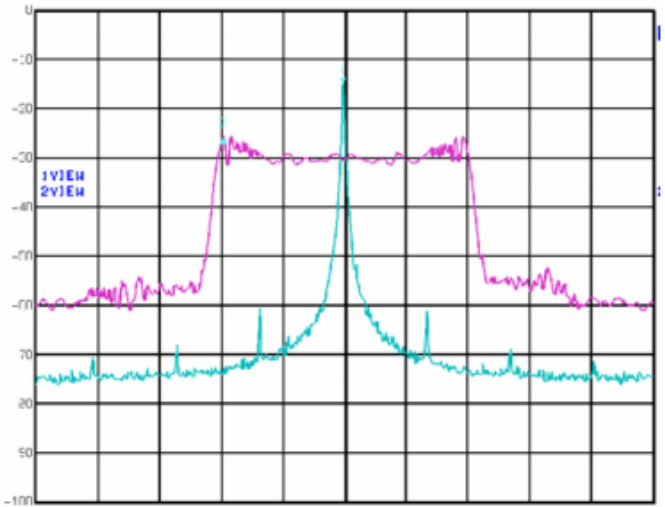
Spread spectrum clocking (SSC)



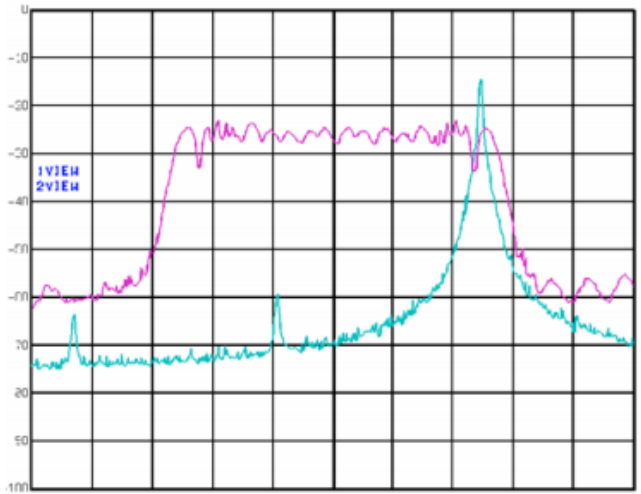
CDCS502 With a 25-MHz Crystal, FS = 1, Fout = 100 MHz, and 0%, ±0.5, ±1%, and ±2% SSC

Down spread and center spread

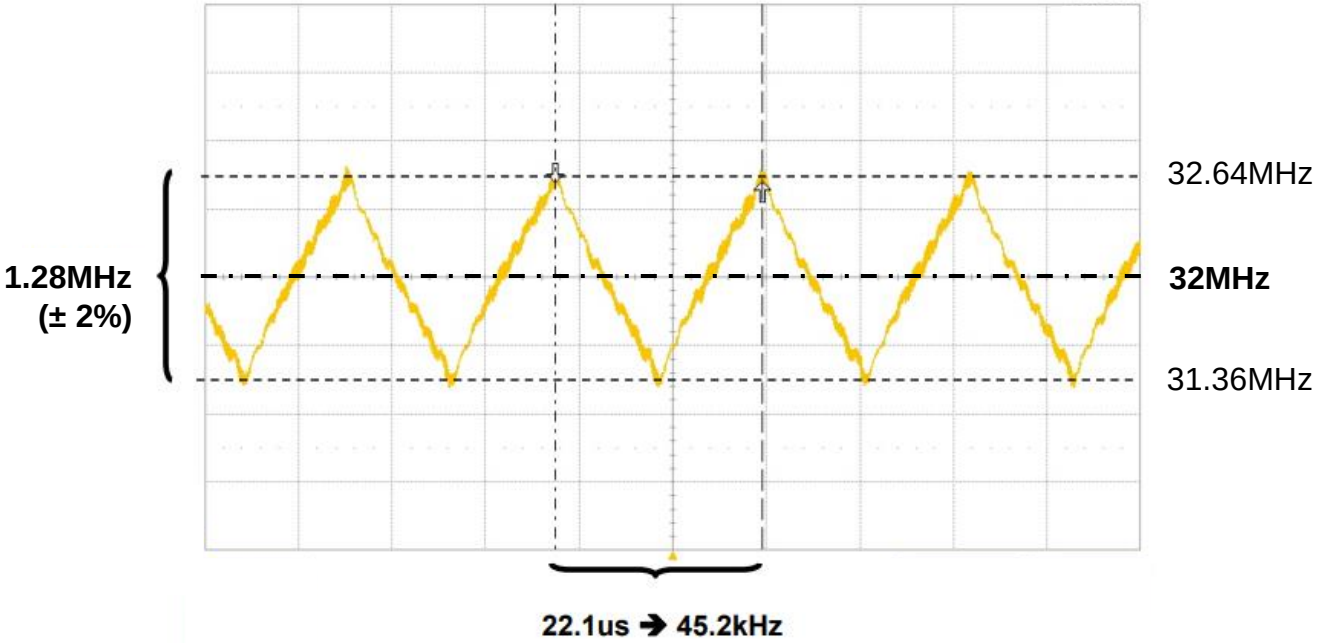
Center spread:
Frequencies are distributed around the desired clock frequency



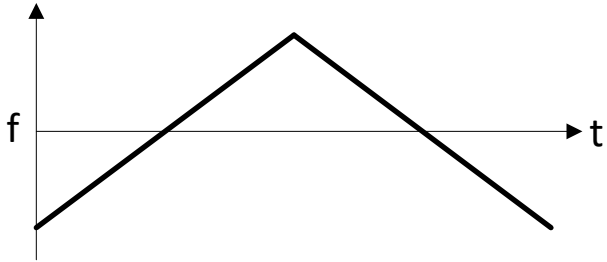
Down spread:
Highest frequency is the one that is programmed into the device



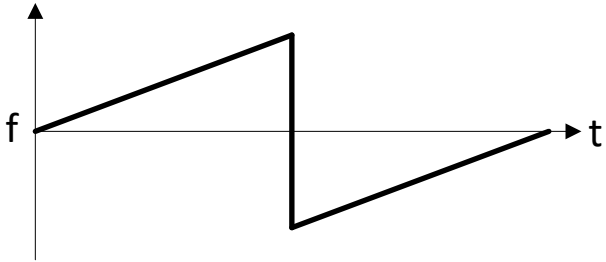
SSC in the time domain



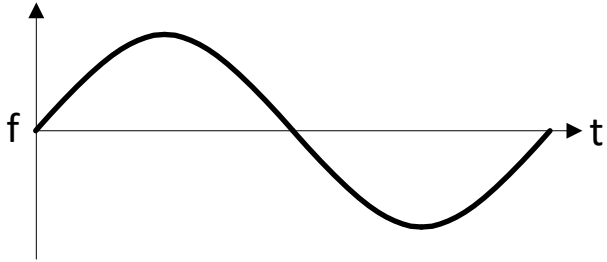
SSC spread function



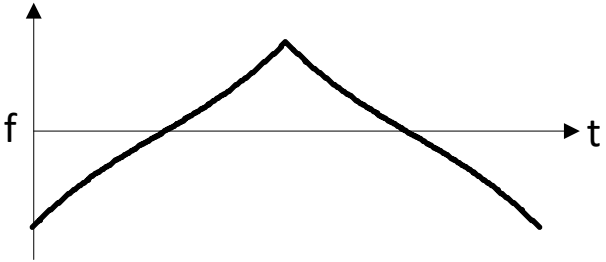
triangular shape



sawtooth shape



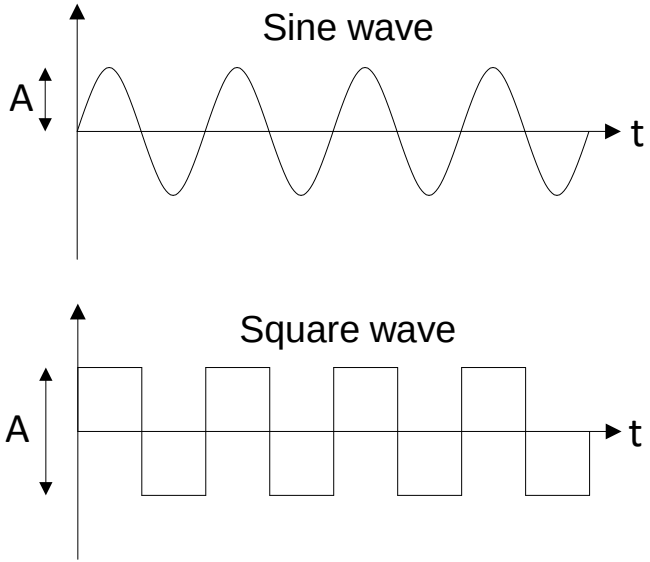
sinusoidal shape



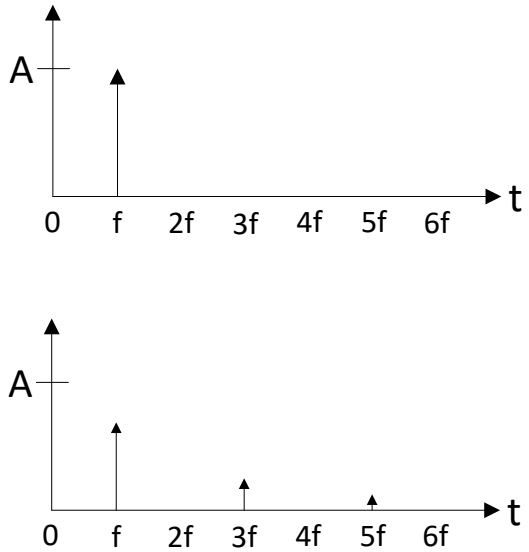
hershey shape

Sine and square waves in time and frequency domains

Time Domain



Frequency Domain



$$a_1 = A$$

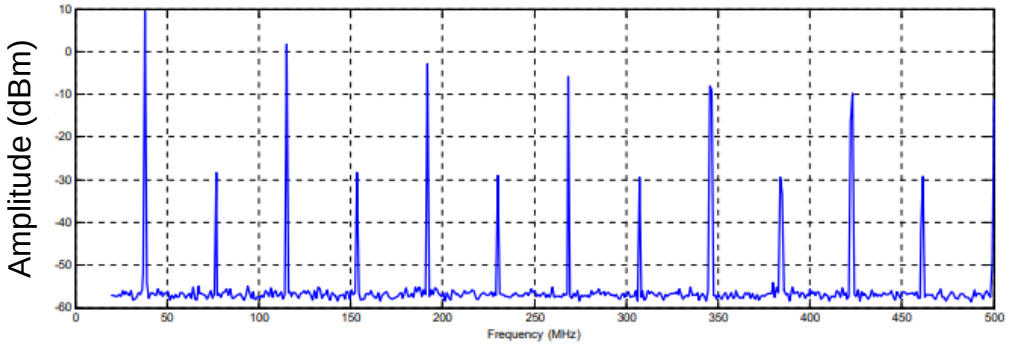
$$a_0 = 0$$

$$a_n = \frac{2A}{n\pi}\sin\left(\frac{n\pi}{2}\right)$$

$$b_n = 0$$

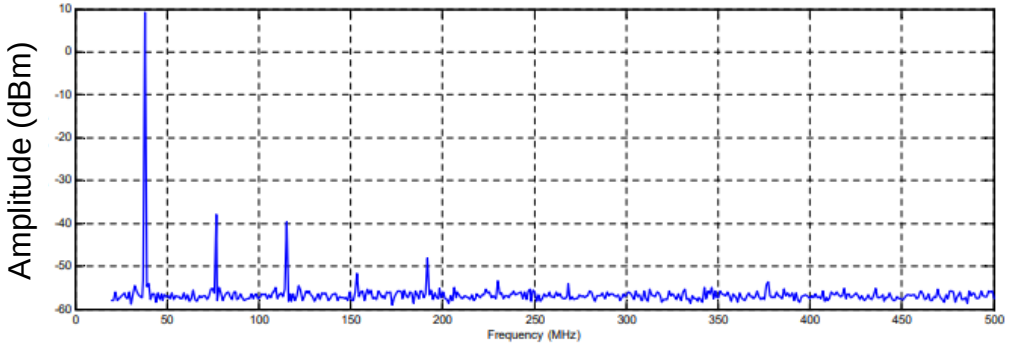
Clocking relative to EMI and EMC

38.4MHz square wave, 0.3ns rise/fall time



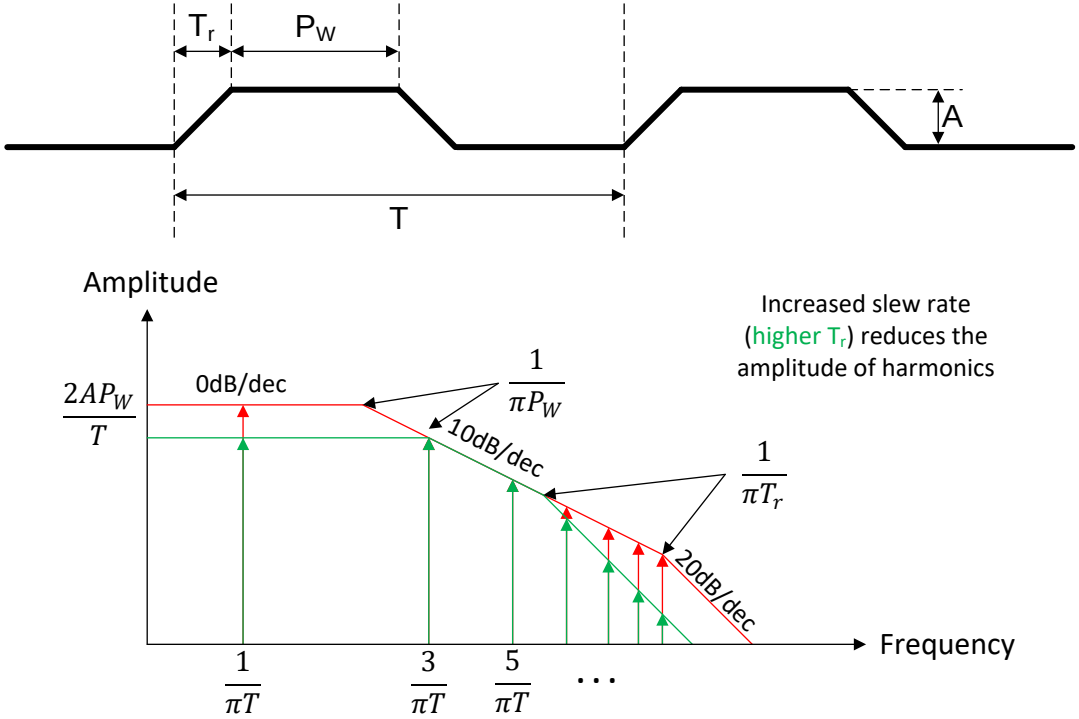
Frequency (MHz)

38.4MHz sinewave



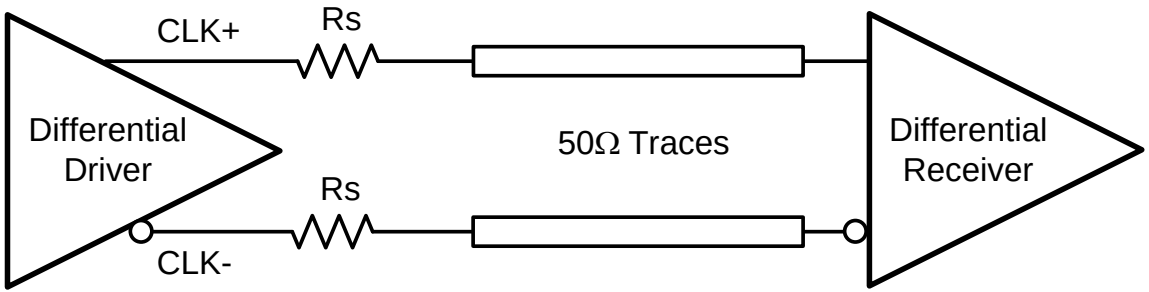
Frequency (MHz)

Slew rate control



Envelope of a square wave spectrum with rising/falling edges

Small series resistance



To find more clocks and timing technical resources and search products, visit ti.com/clocks

Short Quiz

1. True or False:

EMI issues observed at high frequencies can be caused by lower frequency signals.

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Ideal square wave spectra consist only of even harmonics.

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Increasing the slew rate of a square wave's edges will decrease the amplitude of harmonics.

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