Impact of Duplexing Methods on RFI Immunity in Camera Links

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Summary

- Duplexing methods
  - **Asymmetric Concurrent Transmission (ACT) :** based on the design shared in jonsson_3dm_01_09_15_24.pdf
  - **Time Division Duplexing(TDD) :** ASA-MLE as an example

- The impact of these duplexing methods on PHY immunity against Radio Frequency Interference (RFI) noise sources are studied

- Focus will be on the camera side

Camera link
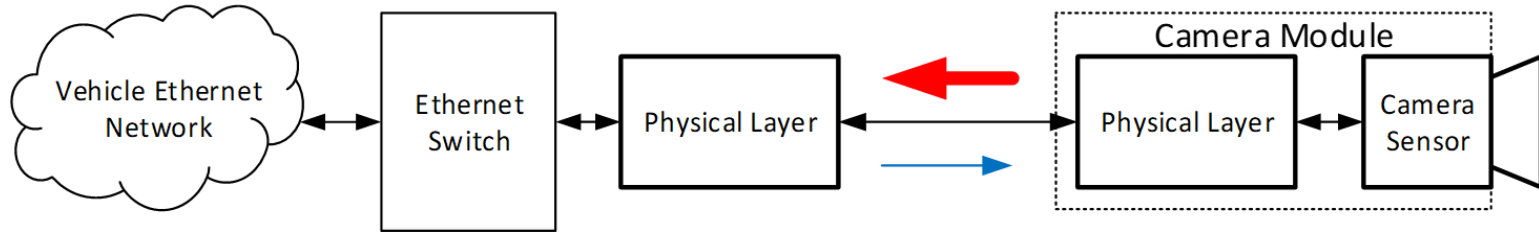
- Size and power of camera PHY is the most critical design consideration
- Focus on **low data rate receiver at the camera side**

Low Data Rate(LDR) direction is the key difference

- ACT
  - Low baud rate signal
  - Independent of other direction rate
- TDD
  - higher baud rate signal
    - Example ASA-MLE

Duplexing Method	Data rate	BW in LDR
ACT	100M	140MHz
ASA-MLE	2.5G/100M	2000MHz
ASA-MLE	5G/100M	4000MHz
ASA-MLE	10G/100M	3000MHz

Narrow-band RFI

- There are many tests in this category

| Tests	standard	Freq range (MHz)	Passing criteria
Bulk current injection (BCI)	ISO 11452-4	1-400	No frame error
Portable Transmit Test	ISO 11452-9	142-6000	No frame error
Radiated Immunity Test	ISO 11452-2	200-18000	No frame error

Narrow-band RFI immunity

Tests	Frequency range (MHz)	ACT-LDR	ASA-MLE
Bulk current injection	1-400	In-band	In-band
Portable Transmit Test	142-6000	Out of band	In-band
Radiated Immunity Test	200-18000	Out of band	In-band

Out of band noise can be eliminated by a simple low pass filter

Radar Pulse

- The radar pulses can be modeled as being in two bands:
  - around1300 MHz
  - around 3000 MHz
- Reference
  - jonsson_3dm_01_07_15_24.pdf

3us   3ms
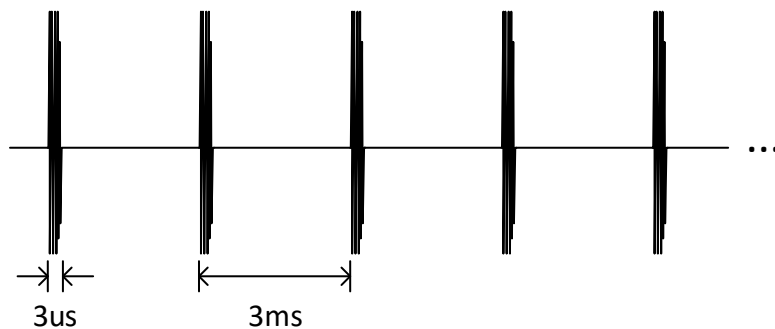
Radar pulse immunity

Bands	ACT-LDR	ASA-MLE
1300MHz band	Out of band	In-band for 2.5/5/10G
3000Mhz band	Out of band	In-band for 5G/10G

Out of band noise can be eliminated by a simple low pass filter

Conclusion

- In the presence of RFI noise, ACT camera receiver is significantly more robust than TDD camera receiver

References

- ACT :
  - https://www.ieee802.org/3/dm/public/0924/jonsson_3dm_01_09_15_24.pdf
- ACT versus TDD
  - https://www.ieee802.org/3/dm/public/0924/jonsson_razavi_3dm_01_09_15_2.pdf
- Other contributions in ISSAC and dm about RFI
  - https://www.ieee802.org/3/dm/public/0724/jonsson_3dm_01_07_15_24.pdf
  - https://ieee802.org/3/dm/public/0524/Chini_Tazebay_3dm_01a_0524.pdf