# Automotive cameras and size

IEEE 802.3dm

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# Motivation

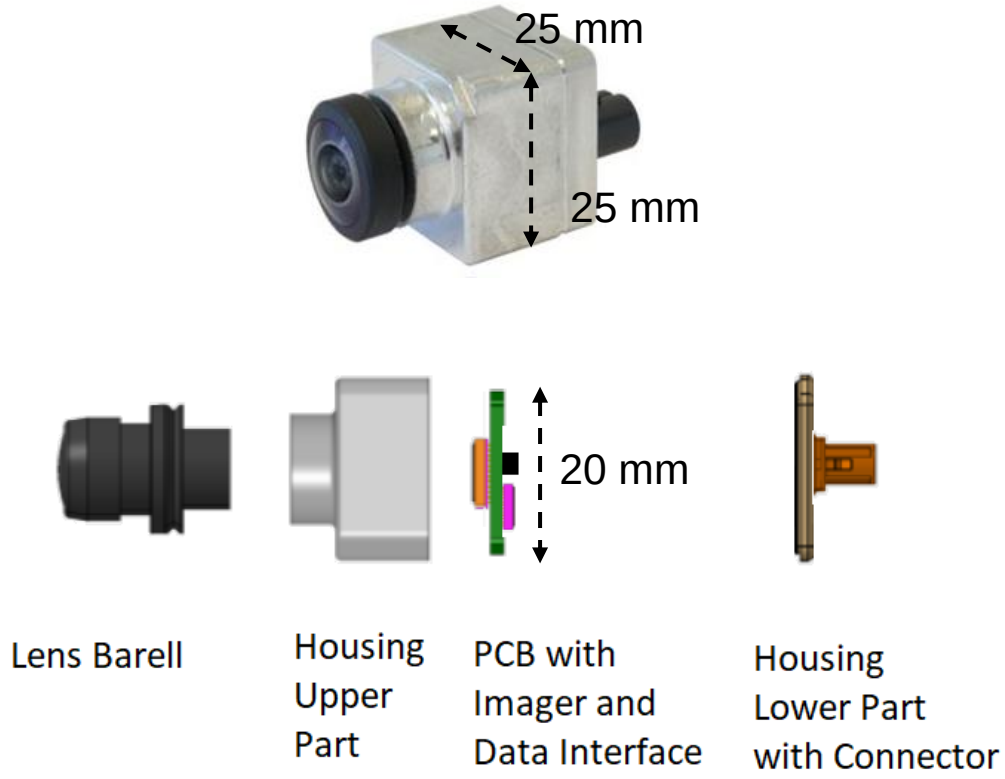
- Size is important for automotive camera use cases.
- This presentation thus investigates the impact of the transceiver chip size in the camera distinguishing between two scenarios
  - Reducing the size of the transceiver chip
  - Integrating the transceiver into the imager

# Typical camera PCB elements

**Components**
5 x 5 mm² QFN package Serializer (32 pins common)
PMIC
Imager (40 to 200 pins common)
Power over components
Oscillator (placeholder)
EEPROM (for imager calibration)
Connector
Passives, peripherals

**Signaling between imager and Serializer**
2 MIPI C/D-PHY interfaces (10 lanes + 20 pins)
I2C (1, between imager, Serializer, and EEPROM)
GPIOs (e.g. reset synch, error, imager clock)

**Signaling to connector**
Asymmetric high-speed communication




See https://www.ieee802.org/3/cfi/0723_1/CFI_01_0723.pdf

*) Hypothetical, not available today

# Reducing the size of the serializer

| Typical today | Reduced serializer size |
|---|---|
| 5 x 5 mm² QFN package Serializer (32 pins common) | 3 x 3 mm² QFN package*) Serializer (20 pins possible?) |
| PMIC | PMIC |
| Imager (40 to 200 pins common) | Imager (40 to 200 pins common) |
| Power over filter components | Power over filter components |
| Oscillator (placeholder) | Oscillator (placeholder) |
| EEPROM (for imager calibration) | EEPROM (for imager calibration) |
| Connector | Connector |
| Passives, peripherals | Passives, peripherals |
| 2 MIPI C/D-PHY interfaces (10 lanes + 20 pins) | 2 MIPI C/D-PHY interfaces (10 lanes + 20 pins) |
| I2C (1, between imager, Serializer, and EEPROM) | I2C (1, between imager, Serializer, and EEPROM) |
| GPIOs (e.g. reset, frame synch, error, imager clock) | GPIOs (e.g. reset, frame synch, error, imager clock) |
| Asymmetric high-speed communication | Asymmetric high-speed communication |

*) Hypothetical, not available today

# Integrating serializer with imager

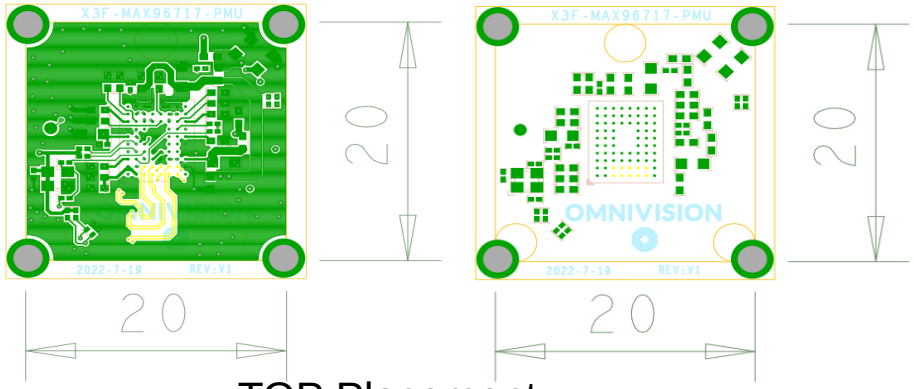
| Typical today | Reduced serializer size | Integrated |
|---|---|---|
| 5 x 5 mm² QFN package Serializer (32 pins common) | 3 x 3 mm² QFN package*) Serializer (20 pins possible?) | ~~5 x 5 mm² QFN package Serializer (32 pins common)~~ |
| PMIC | PMIC | PMIC |
| Imager (40 to 200 pins common) | Imager (40 to 200 pins common) | Imager (same size) |
| Power over filter components | Power over filter components | Power over filter components |
| Oscillator (placeholder) | Oscillator (placeholder) | Oscillator (placeholder) |
| EEPROM (for imager calibration) | EEPROM (for imager calibration) | EEPROM (for imager calibration) |
| Connector | Connector | Connector |
| Passives, peripherals | Passives, peripherals | Passives, peripherals (somewhat less) |
| 2 MIPI C/D-PHY interfaces (10 lanes + 20 pins) | 2 MIPI C/D-PHY interfaces (10 lanes + 20 pins) | ~~2 MIPI C/D-PHY interfaces (10 lanes + 20 pins)~~ |
| I2C (1, between imager, Serializer, and EEPROM) | I2C (1, between imager, Serializer, and EEPROM) | I2C (1, between imager and EEPROM) |
| GPIOs (e.g. reset, frame synch, error, imager clock) | GPIOs (e.g. reset, frame synch, error, imager clock) | ~~GPIOs (e.g. reset, frame synch, error, imager clock)~~ |
| Asymmetric high-speed communication | Asymmetric high-speed communication | Asymmetric high-speed communication |

# Example for PCB size reduction

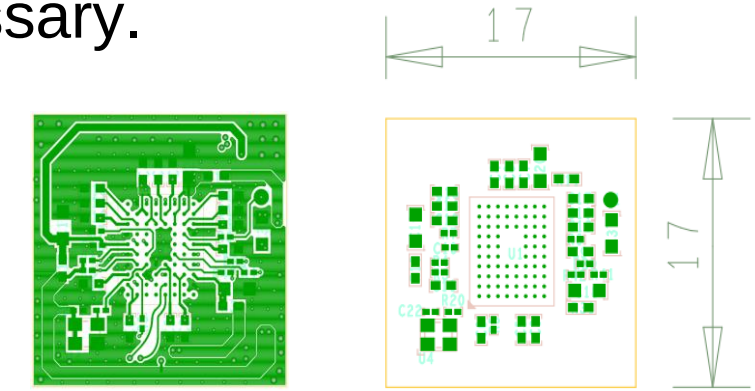
Simulated for a 3MPx imager:

- (20x20-17x17) mm² = 111 mm² = 1.11 cm²
- (20x20-17x17) mm²/20x20 mm² = 27.75%

- Expected that 2 PCB layers can be removed.
- Potentially HDI-technology no longer necessary.




TOP Placement




HDI = High Density Interconnect

# Overall reduction of power consumption

- Power distribution PMIC (~30-40%), imager (~40-50%), Serializer (~20%).
- In case of integration, the power for the serializer adds to the power for the imager. As, however, two MIPI D/C-PHYs can be saved (one in imager, one in serializer), it is expected that the overall power consumption is somewhat reduced.

Note:

- Reducing the size of the camera also impacts the heat dissipation of the camera.
- The smaller the camera the more difficult the heat dissipation, especially in case of plastic housing or plastic mounting brackets.
- It needs to be evaluated carefully, how the increased heat (because of the smaller size) and the reduced power (because of integration) balance. It might be advisable to keep the housing the same size.
- 8MPx imagers are already close to size and power limits. Integration scenarios are thus significantly more challenging.

# Summary and conclusion

- The size of the camera is determined by the components needed on the PCB and the signal lanes on the PCB.
- Reducing the chip size of the transceiver chip does not have much impact, because the same number of components and lanes need to be supported on the PCB.
- In case of integration, one chip, two implementations of the MIPI C-PHY/D-PHY interface and various signaling lanes on the PCB can be removed. It is expected that the PCB can be smaller and requires fewer layers (two less).
- For 8Mpx imagers integration is more challenging, because of inherently higher power dissipation.
- For max. supported added power inside the imager, see e.g. https://www.ieee802.org/3/ISAAC/public/091423/2023-09-06_Automotive%20camera%20PHY%20requirements%20study_V2.1.pdf.

# Thank You!