TI 車用微型高度整合降壓轉換器兼容機能安全解決方案

April 2019

Auto Camera Module PMIC - Target Auto Camera Applications

Core Applications

Surround View Camera
Satellite View Camera

Smart Rear View Camera
Smart Camera with or without Functional Safety

360 View L5 Autonomous
Camera with Functional Safety

Remote Front Camera
Front Camera over Serializer & Dash Cam DVR

Emerging Applications

Blind Spot Detection
High Performance with Functional Safety

Driver Monitoring
High Performance with or without Functional Safety

eMirror
High Performance with Functional Safety

Cabin Monitor
Scalable Performance

Scalable Platforms from functional safety to non-safety Auto Camera Applications with Future Proof Autonomous Driving Vehicles

Automotive Camera PMIC

Integrated Power Management

April, 2019

Mid Vin Multi-rail Camera PMIC

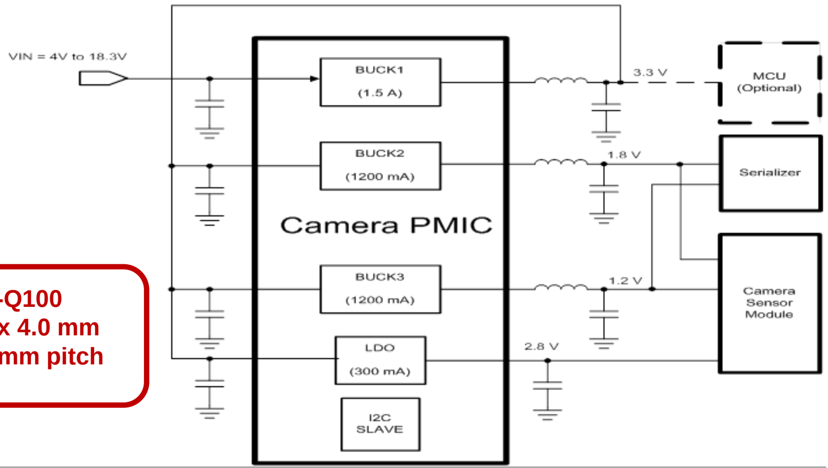
Preliminary
Subject to Change

Features

- Mid Vin Buck Regulator, Vout= 3.0V – 4.0V
  - Operating V_{IN} Range from 4.0V – 18.3V
  - 1.5A, 2.3 MHz switching frequency, spread spectrum
- Two Low Vin Buck Regulators, Vout = 0.9V – 1.9V
  - Operating V_{IN} Range from 2.5V – 5.5V
  - 1.2A, 2.3 MHz switching frequency , spread spectrum
- Low Noise LDO, Vout= 2.7V - 3.3V, 25mV steps
  - Operating V_{IN} Range from 2.2V - 5.5V
  - High PSRR (~75dB @ 1KHz)
  - 300mA; 300mV Dropout
- Up to 3.4MHz High Speed I2C interface
- Programmable up/down sequencing
- Power Good, OV/UV/OC/system fault interrupt
- Forced PWM
- 150°C max Junction Temp

Benefits

- **Cost Optimized** low-cost, low noise solution for camera modules
- **Solution Size Optimized and Fully Integrated** power solution in a 4.0 x 4.0 mm QFN package with wettable flanks
- **Flexibility** and **Efficiency** enabled by triple DCDC/ one LDO design with factory programmed voltage & sequence with 130nm process
- **Ease of Design** with user programmability during project development
- **Better Reliability and Component Logistics** with less components compared to discrete power



Applications

- Automotive Camera Module
  - Surround View, Rear View, Front View, DMS, E-Mir
    DVR and Autonomous Driving Cameras

AEC-Q100
4.0 mm x 4.0 mm
VQFN .5mm pitch

Support Automotive Imagers from the Following Companies Plus Other Imager Vendors

SONY

ON Semiconductor

OmniVision

SAMSUNG

Contact TI for a list of Imagers Supported

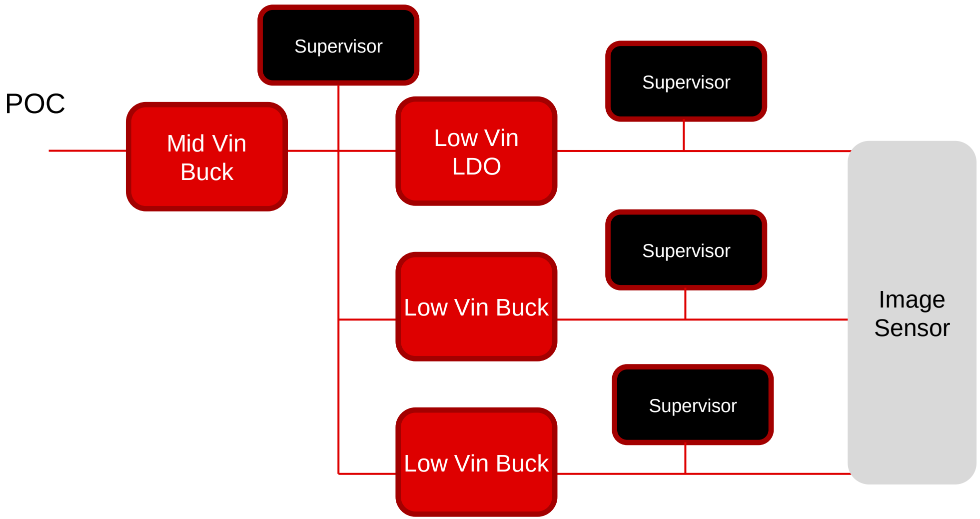
Next Gen PMIC Value Propositions

Key Application Problems		TI Solutions	
Board Space Constraint	→	Integrated Mid Vin Buck and three camera power rails reducing size W/O external resistors/ sequencer	✓
High Efficiency Thermal performance	→	Improved RdsOn and Gate Drive current with LBC9PLV 130nm process	✓
Difficulty of Design and Design Scalability	→	Integrated PMIC enables ease of design for all image sensor types thru customer programmability	✓
EMI (Conducted and Radiated)	→	Patented ARSS (Adaptively Randomized Spread-Spectrum) Clock & Ringing Mitigation for Reduced EMI	✓
High PSRR/Low noise- Imager performance	→	Integrated LDO with LP5907-Q1 class PSRR and low noise performance	✓
Component Logistics	→	Integrated PMIC with less component count	✓
Reliability	→	Better reliability with less device component count	✓
Functional Safety	→	SafeTI ISO26262 ASIL-B Capable	✓

Space Saving and Component Count Reduction

Auto Camera Module Power with Functional Safety – Discrete vs. PMIC

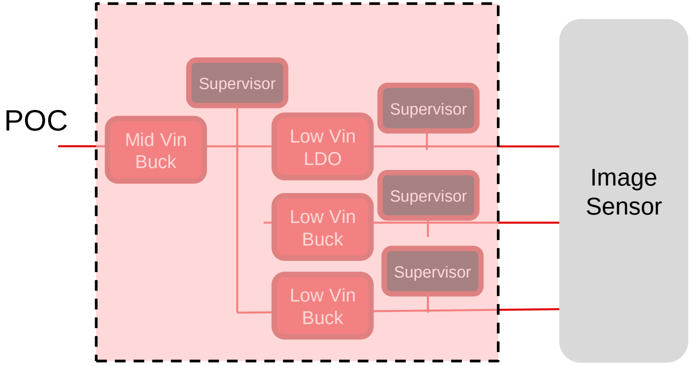
Discrete Power



- Eight power components
- Eight resistors (voltage settings)
- Huge PCB routing/spacing overhead

VS.

Next Gen PMIC Power



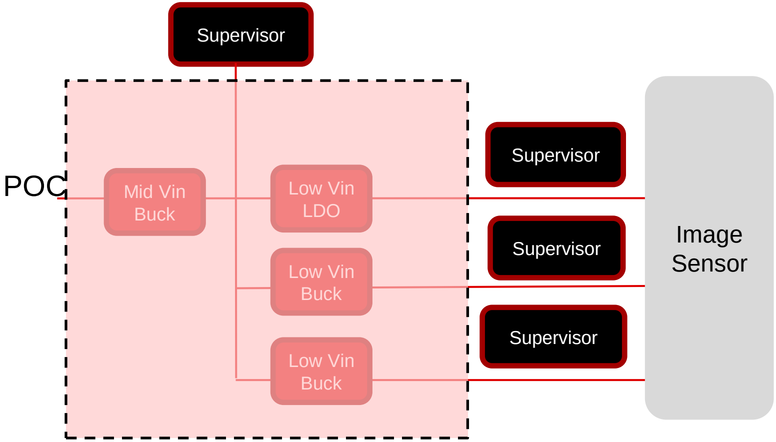
- One power component
- No resistor (Internal settings)
- Minimum PCB routing overhead

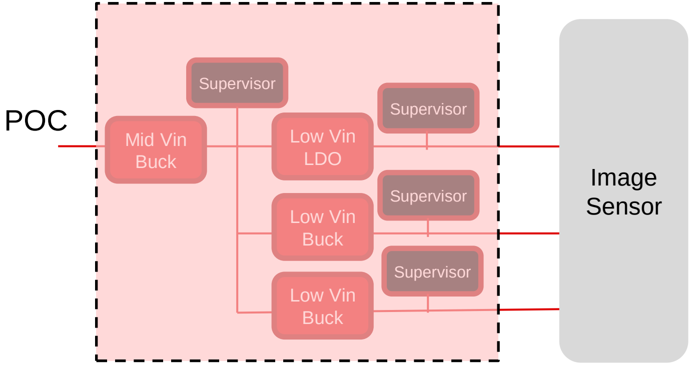
Auto Camera Module Power with Functional Safety
– PMIC with External Safety vs. PMIC with Integrated Safety

PMIC W/ External Safety

VS.

Next Gen PMIC W/ Integrated Safety



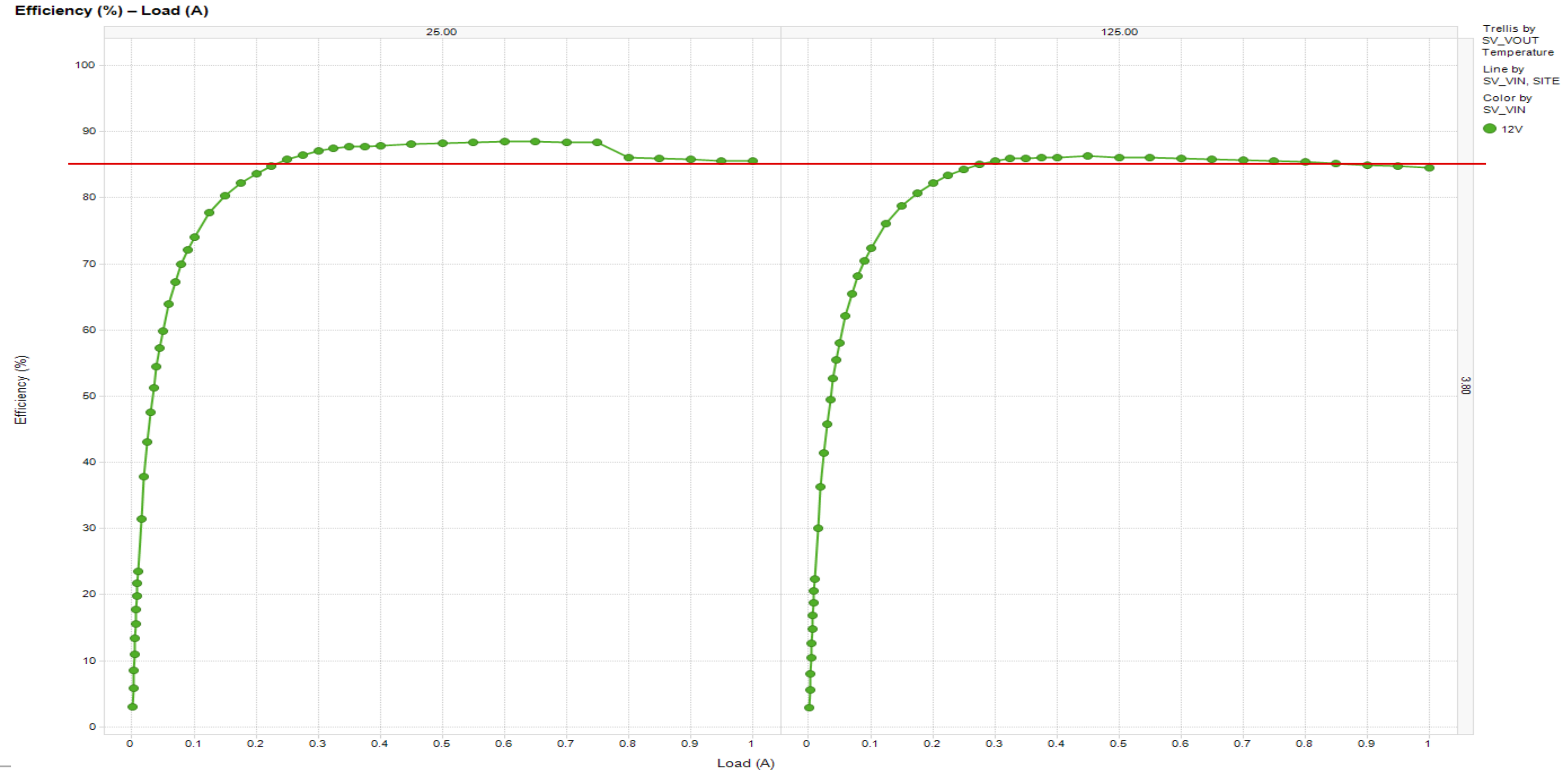


- Five power components
- Eight resistors (voltage settings)
- Large PCB routing/spacing overhead

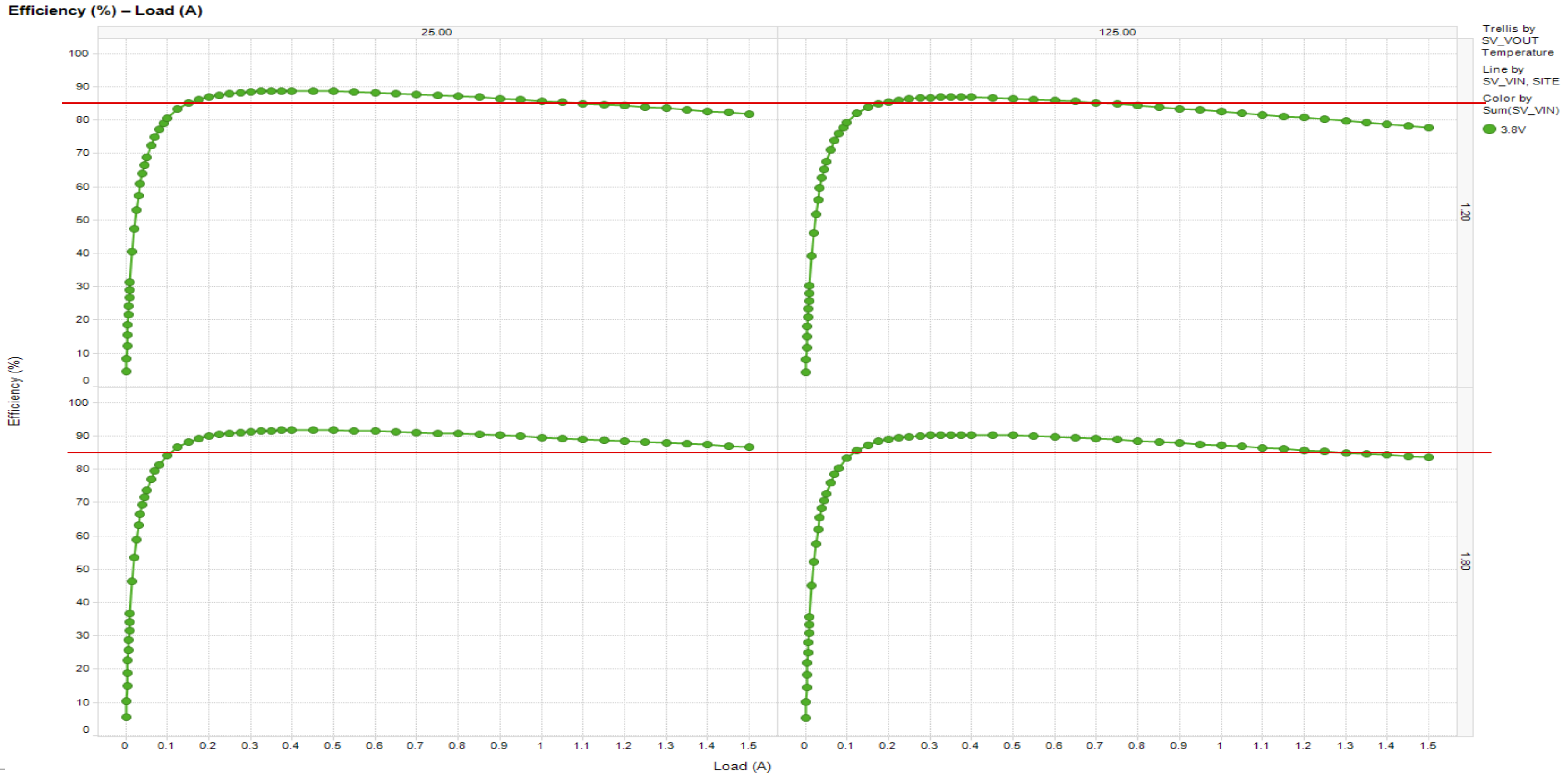
- One power component
- No resistor (Internal settings)
- Minimum PCB routing overhead

Efficiency Measurement

BUCK1 Efficiency (V_{IN} =12V, V_{OUT} = 3.8V) Measured

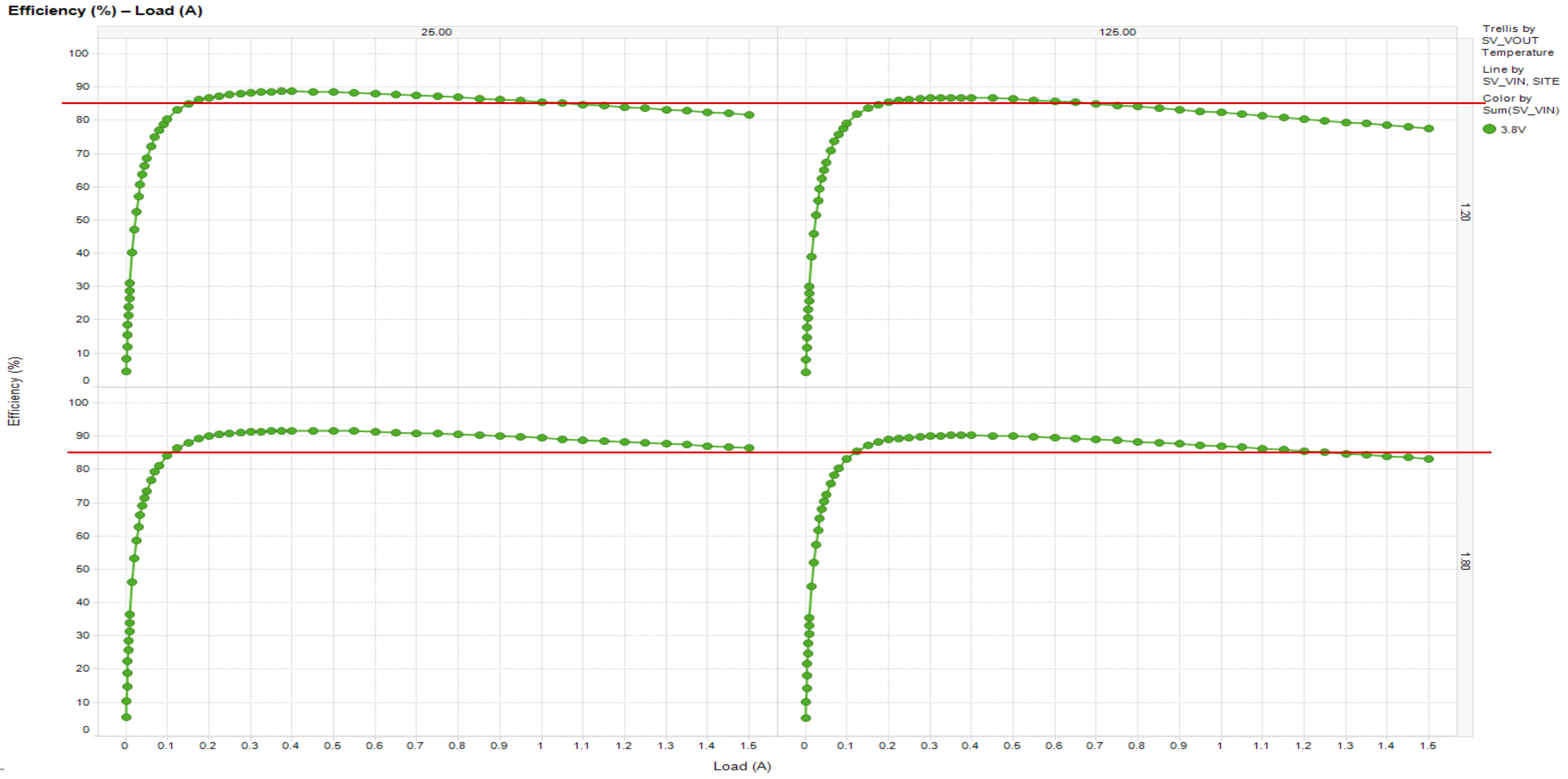


BUCK2 Efficiency (V_{IN} = 3.8V, V_{OUT} = 1.2V/1.8V) Measured



TEXAS INSTRUMENTS

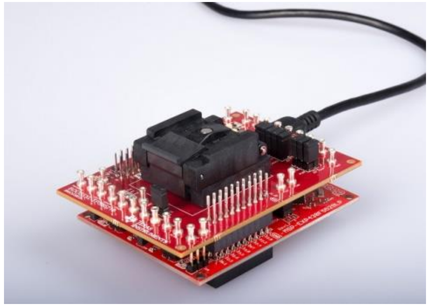
BUCK3 Efficiency (V_{IN} = 3.8V, V_{OUT} = 1.2V/1.8V) Measured



Ease of Use and User Programmability

Customer EEPROM Configurability during Development

1. **Socketed EVM Method**
   - Insert the 1 PMIC device into the socket of the socketed EVM
   - Program the PMIC device with the GUI provided by TI
     - Configure Output voltage settings
     - Configure Power sequencing
     - Configure Other parameters (e.g. Spread Spectrum on/off and etc.)
   - Remove the PMIC device from the socketed EVM and put it on the customer development board
   - Turn on the development board power



2. **Development Board Method**
   - Solder the PMIC device onto the customer development board
     - By pulling up the SEQ pin, Buck1 and Buck2 power rails are enabled for 3.3V and 1.8V to support Serializer backchannel programming. Buck3 and LDO are default off if the GPIO pin is pulled down or no connect.
   - Program the PMIC device thru Serializer’s I2C backchannel
     - Configure Output voltage settings
     - Configure Power sequencing
     - Configure Other parameters (e.g. Spread Spectrum on/off and etc.)
   - Restart the development board power and PMIC will output desired output voltages and power sequencing and etc

Next Gen PMIC Customer EEPROM Configurability In Development

- **Benefits**
  - **Ease of Use**
    - GUI and Socketed EVM ease of use as well as easy on board programming
  - **Massively Reduce Cycle Time of Parameter Tuning Iterations During Project Development**
    - Faster time to market and development time saving
  - **Scalable to Support Various image Sensor Types, Serializers and ISPs/SoCs**
    - One PMIC scalable for multiple camera module platforms
  - **Eliminate the Need of External Voltage Divider Resistors for Voltage Settings**
    - Space saving
    - Less components in material logistics
  - **Eliminate the Need of External Power Sequencer or Sequencing Logic**
    - Space saving
    - Cost Saving
    - Less components in material logistics and less components for better reliability

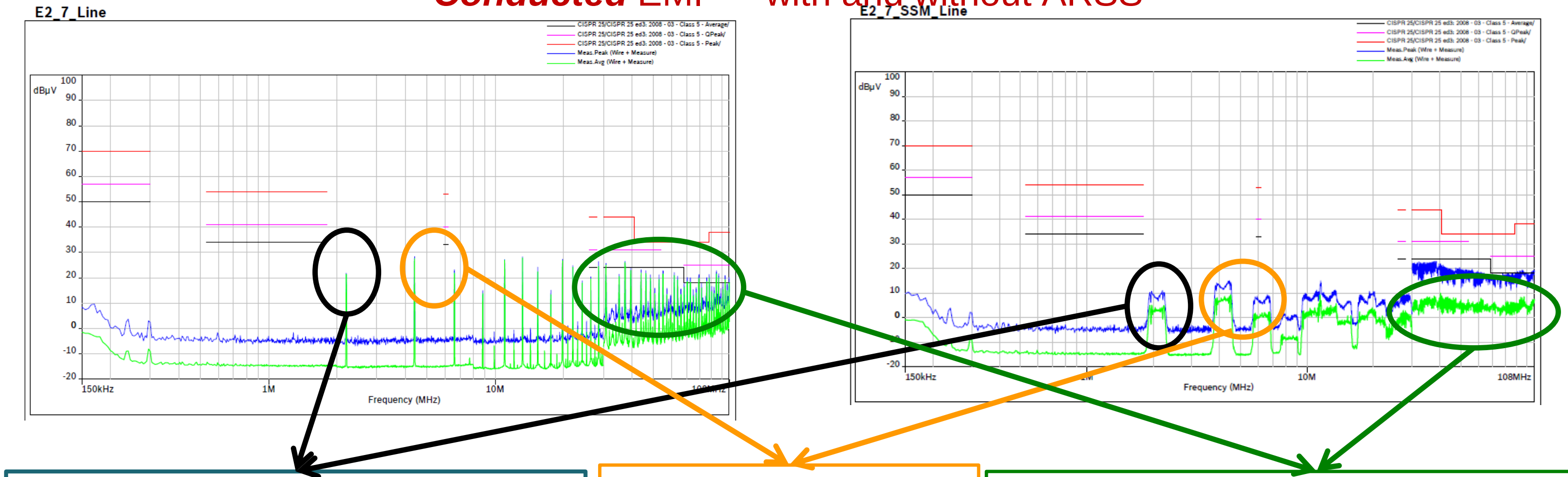
EMI Reduction

ARSS: Adaptively Randomized Spread Spectrum

EMI Mitigation IP

Value Proposition	Algorithm & circuit design **that reduces conducted and radiated EMI spurs** by >**10dB** without affecting the voltage ripple or efficiency, through advanced, randomized spreading of switching frequency.
Differentiation	Ability to achieve >10dB reduction in fundamental spur with only 10% frequency spreading. The approach also avoids low frequency spurs caused by triangular modulation spread spectrum techniques.

Conducted EMI – with and without ARSS



~15 dB reduction in fundamental

~20 dB reduction in 2nd and 3rd harmonic

~15 dB reduction in higher harmonics

ARSS: Adaptively Randomized Spread Spectrum

EMI Mitigation IP

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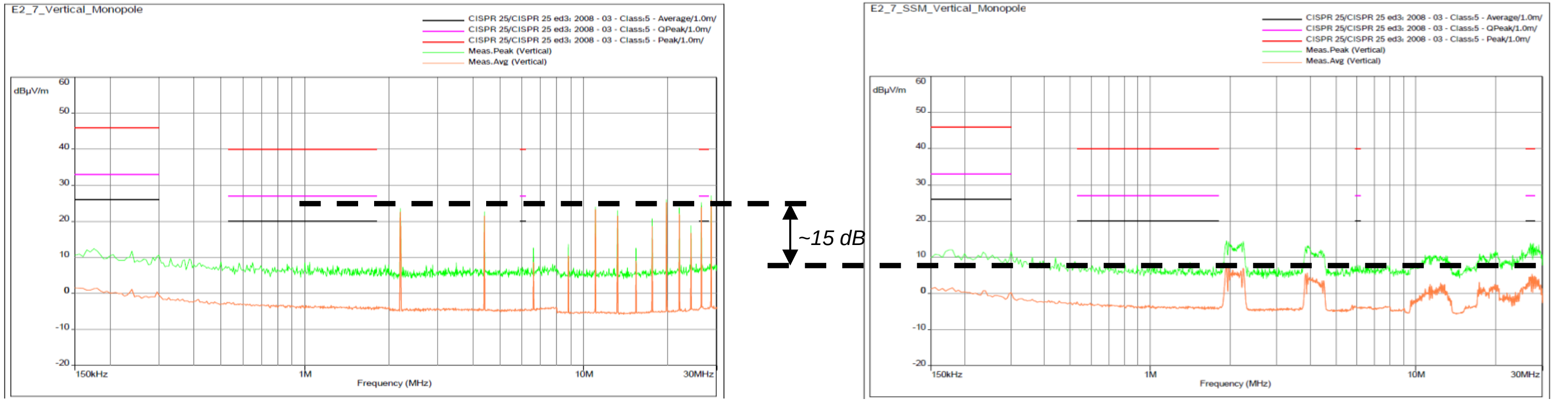
Radiatied EMI – with and without ARSS



~15 dB average reduction across radiated 150 kHz to 30 MHz range

Ringing Mitigation IP, Dead-Time Control IP

Implementation for EMC

- **Ringing mitigation IP and dead-time control IP**
- Focus on EMI mitigation in the pre-regulator MVBK
- Ringing mitigation scheme includes “passive” and “active” elements
- LVBK power stage techniques
  - Slew rate controlled gate driver design
  - Patented adaptive dead-time control to minimize reverse recovery
- Silicon-proven ARSS Spread Spectrum Modulation IP to be used in both MVBK and LVBK and will add additional robustness

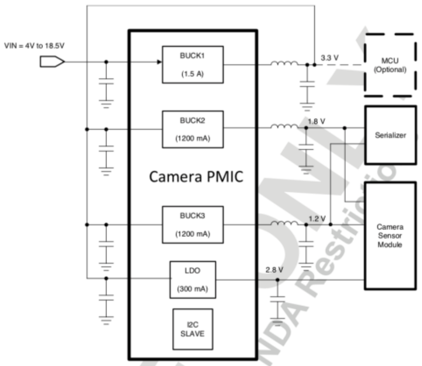
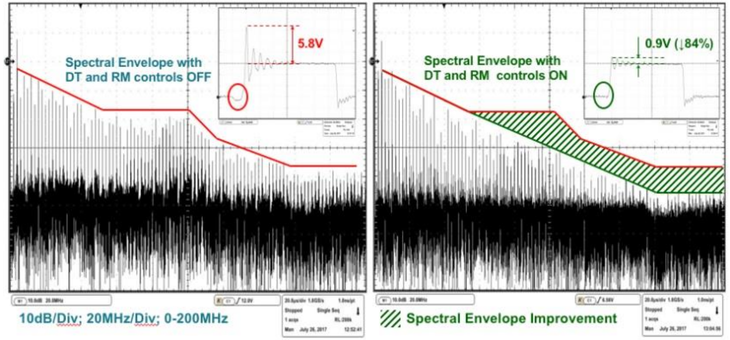


Figure 1-1. TPS65033x-Q1 Application Circuit

Transient/Frequency Performance (Measured)



+10dB ringing reduction on the switch-node, **without Spread-Spectrum Modulation**, enabling hot-rod level transient performance in a wire-bonded package (QFN)

High PSRR and Low Noise LDO

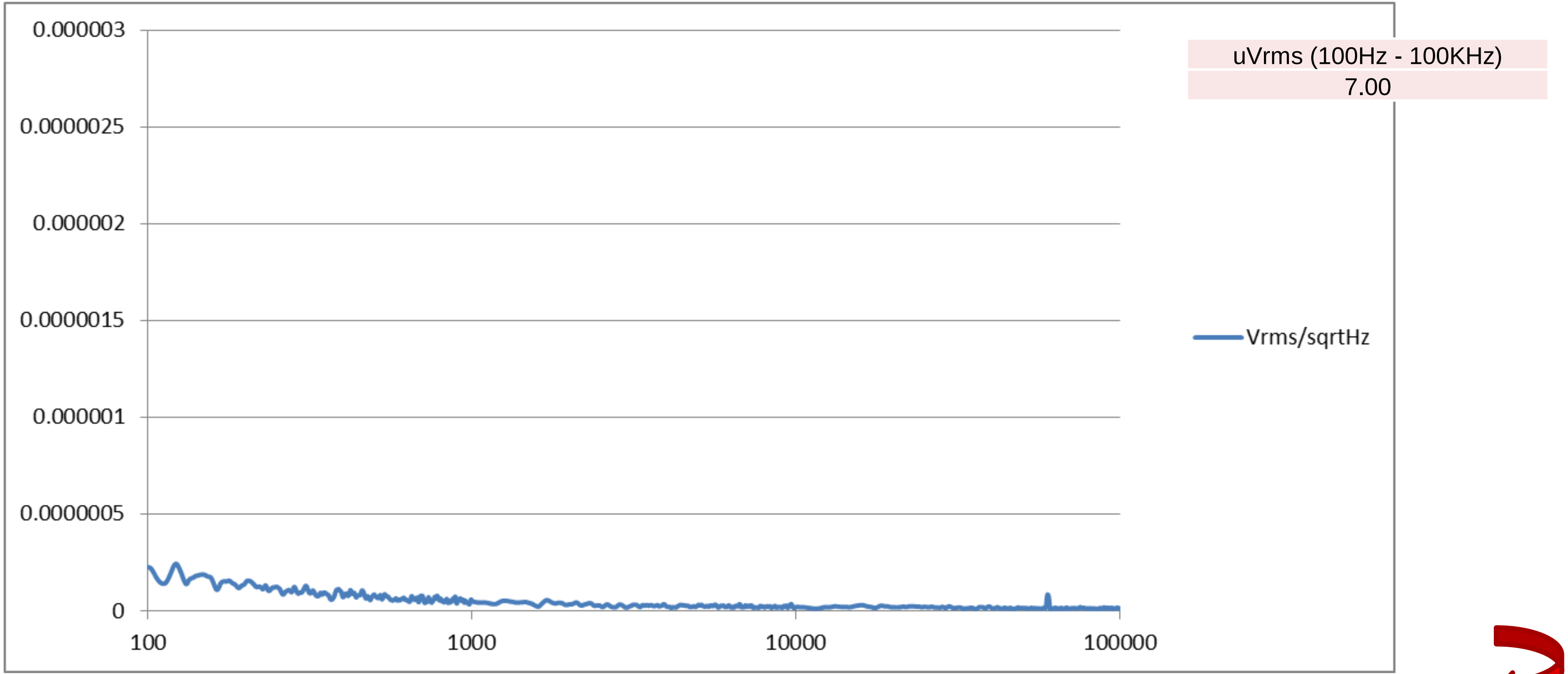
LDO PSRR

Frequency	Measured Value	Target Spec
1KHz	74 dB	75
10KHz	71 dB	65
100KHz	53 dB	40
1MHz	35 dB	20

T_A = 25°C
V_{IN} = 3.3V
V_{OUT} = 2.8V
I_{OUT} = 300mA

PSRR performance will be higher than the numbers shown if Vin and Vout delta is increased

LDO Noise, 3.3Vin, 2.8Vout, 300mA



Functional Safety

Next Gen PMIC Functional Safety

- TI SafeTI™ devices are catalog devices developed as Safety Elements out of Context (SEooC)
  - Safety Element out of Context (SEooC) - A safety-related element which is not developed for a specific item (specific system, application, safety goal).. This means it is not developed in the context of a particular vehicle.
  - A SEooC developed in accordance to ISO 26262: Is intended to be reusable under given assumptions. SafeTI™ documentation is provided to help customers put the SEooC into the context of their system

- The PMIC device is ASIL-B capable metrics with SPFm ≥90% and LFm ≥60% for permanent random hardware and transient failures

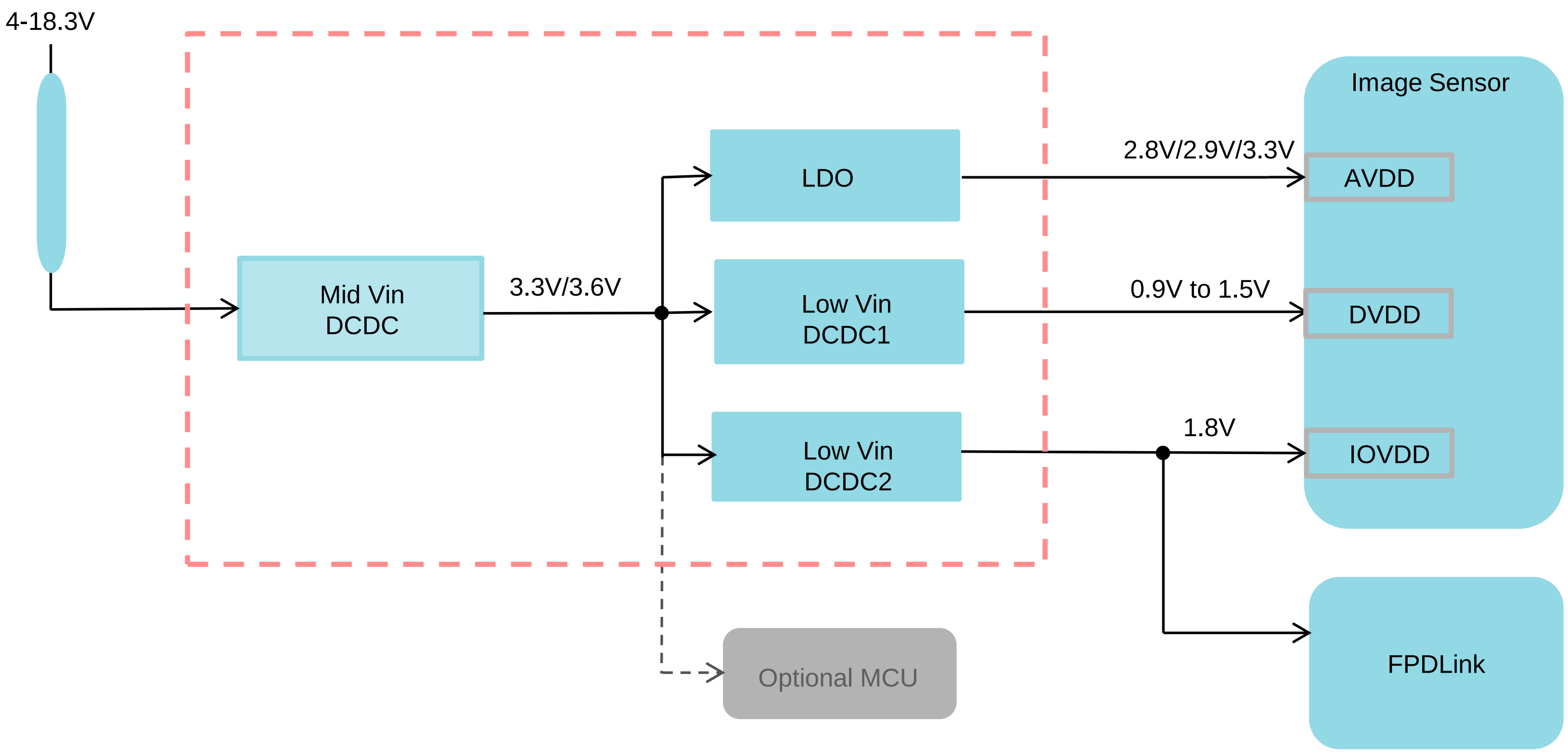
- The development process of the PMIC device complies with SafeTI™ ISO26262 ASIL-D requirements

SafeTI™ Functional Safety PMIC Benefits

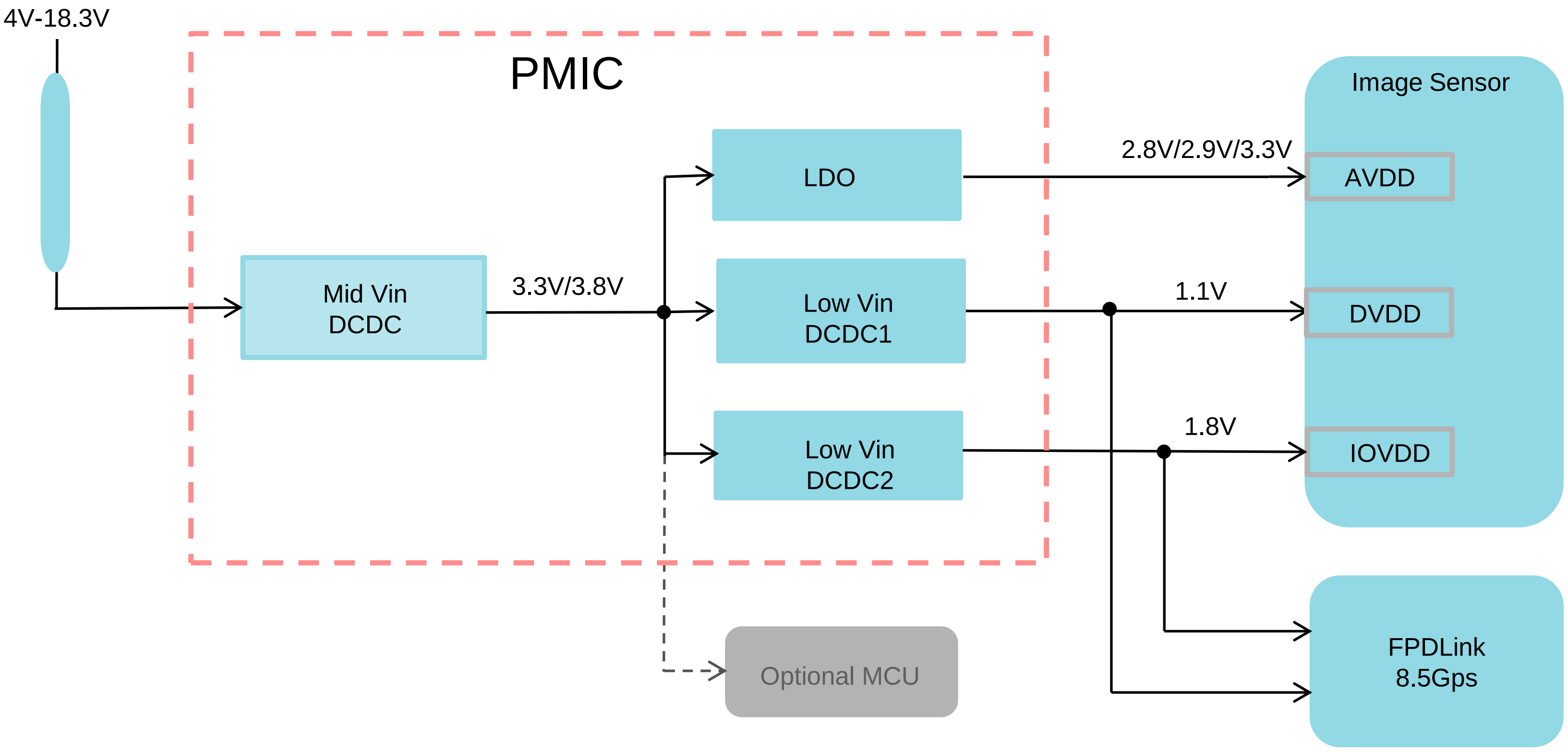
Benefits	TI Solutions
Reduced Development Time and Cost	• Best in Class SafeTI Safety Documentation - Safety Manual (Safety Mechanism, SEOOC and etc.) - Safety Analysis Report (FMEDA and etc) • Enable reuse of sub elements of functional safety system designs • Power and functional safety analysis is re-usable across platforms
SEOOC Device Tailorable for Specific Use Cases	• Safety Analysis Report including FMEDA's tailorable for customer device use case with re-calculated ISO26262 metrics summary
Better Functional Safety Integration with SafeTI Combo	• Motor Control Example: TPS653xx-Q1 + DRV32xx + C2000 or TMS570/Hercules • BMS Example: TPS6538xx-Q1 + TMS570/Hercules + BQxxxx • ADAS (Camera or Radar): TPS65917/9-Q1 + TDA2Ex, • ADAS (Camera): Next Gen camera PMIC + TI FPD-Link

Next Gen PMIC Application Block Diagrams

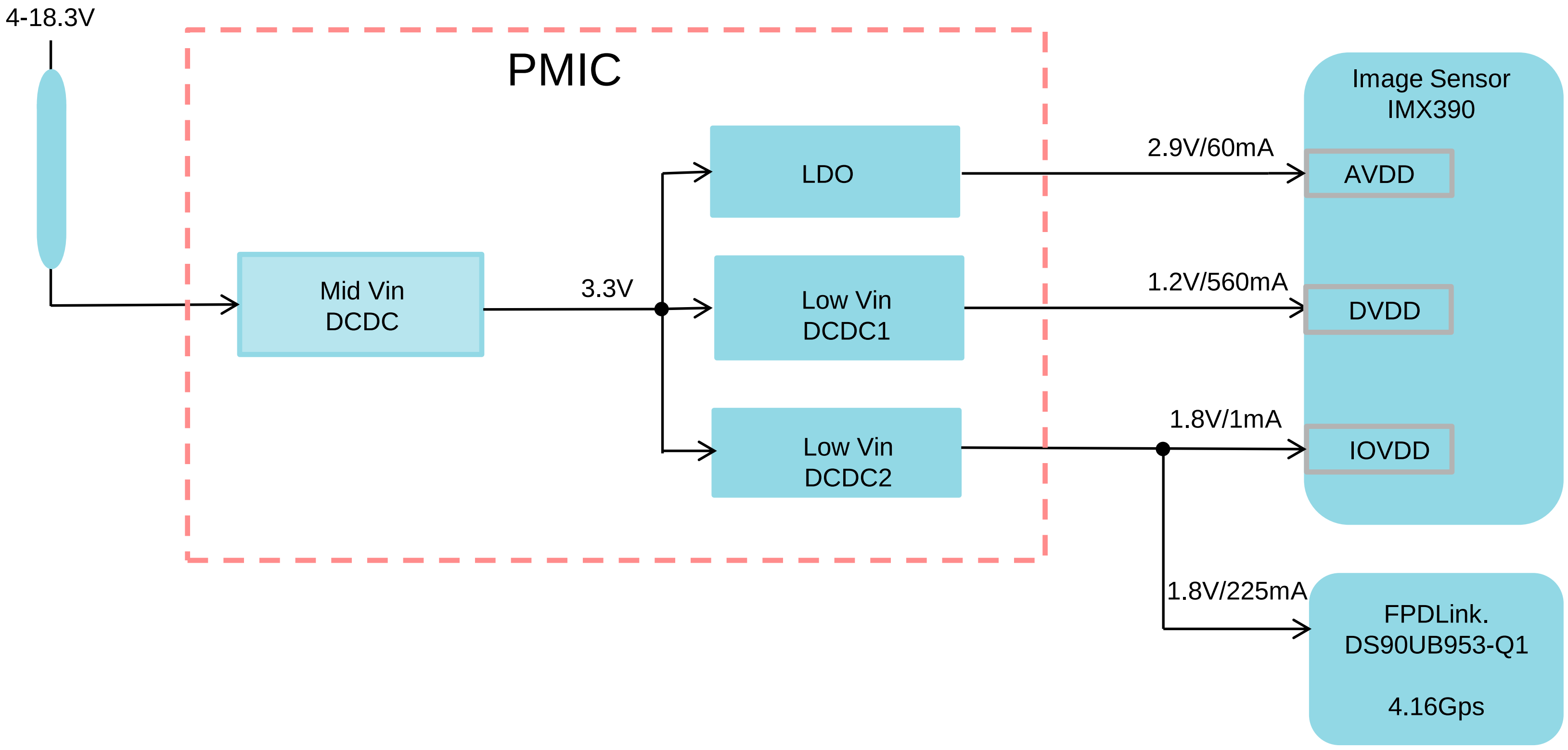
PMIC in Automotive Camera Module
With Single 1.8V Vin FPD-link



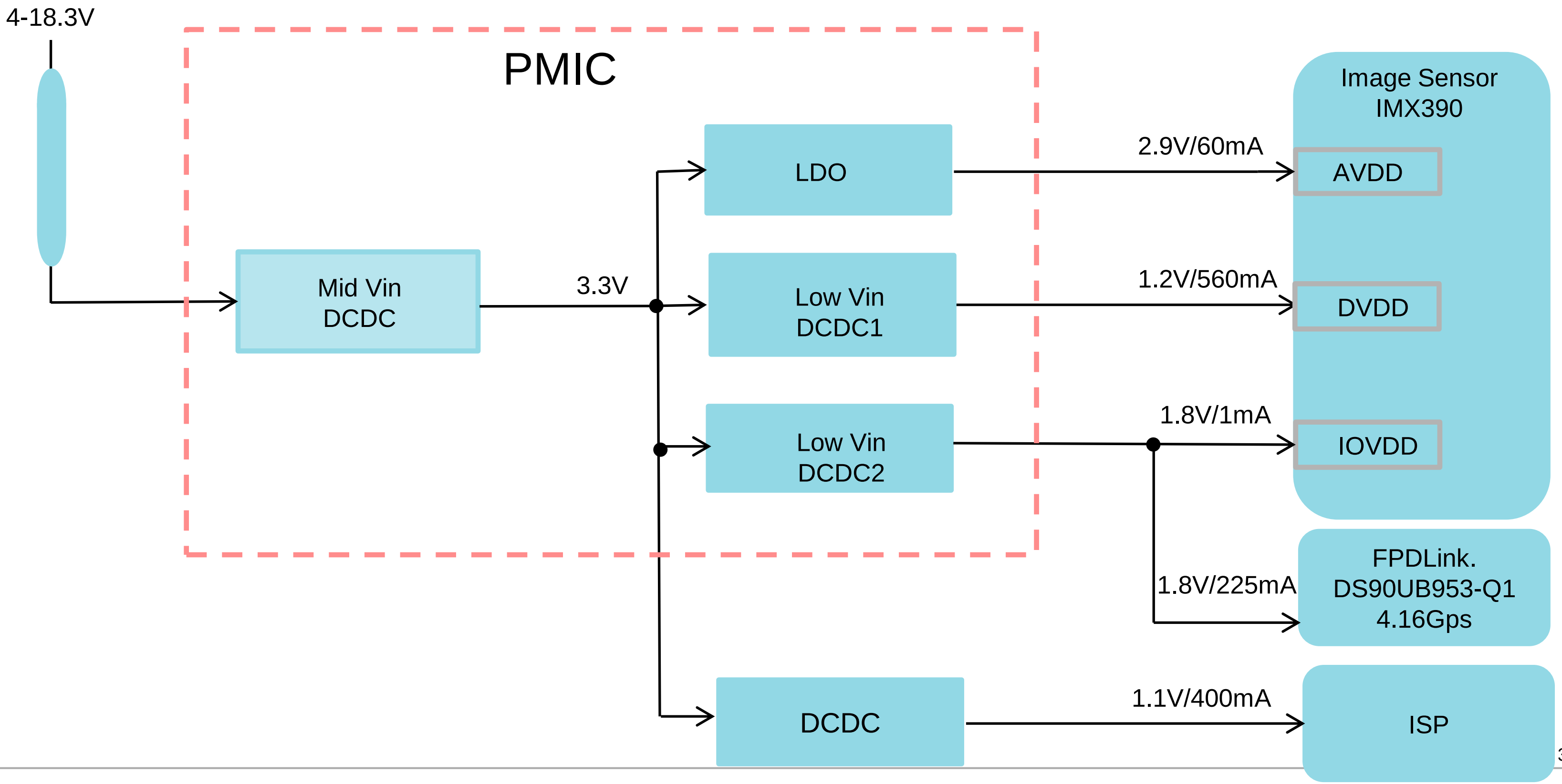
PMIC in Automotive Camera Module
With Dual Voltage FPD-link - Voltage of imager DVDD is same as FPD-link's



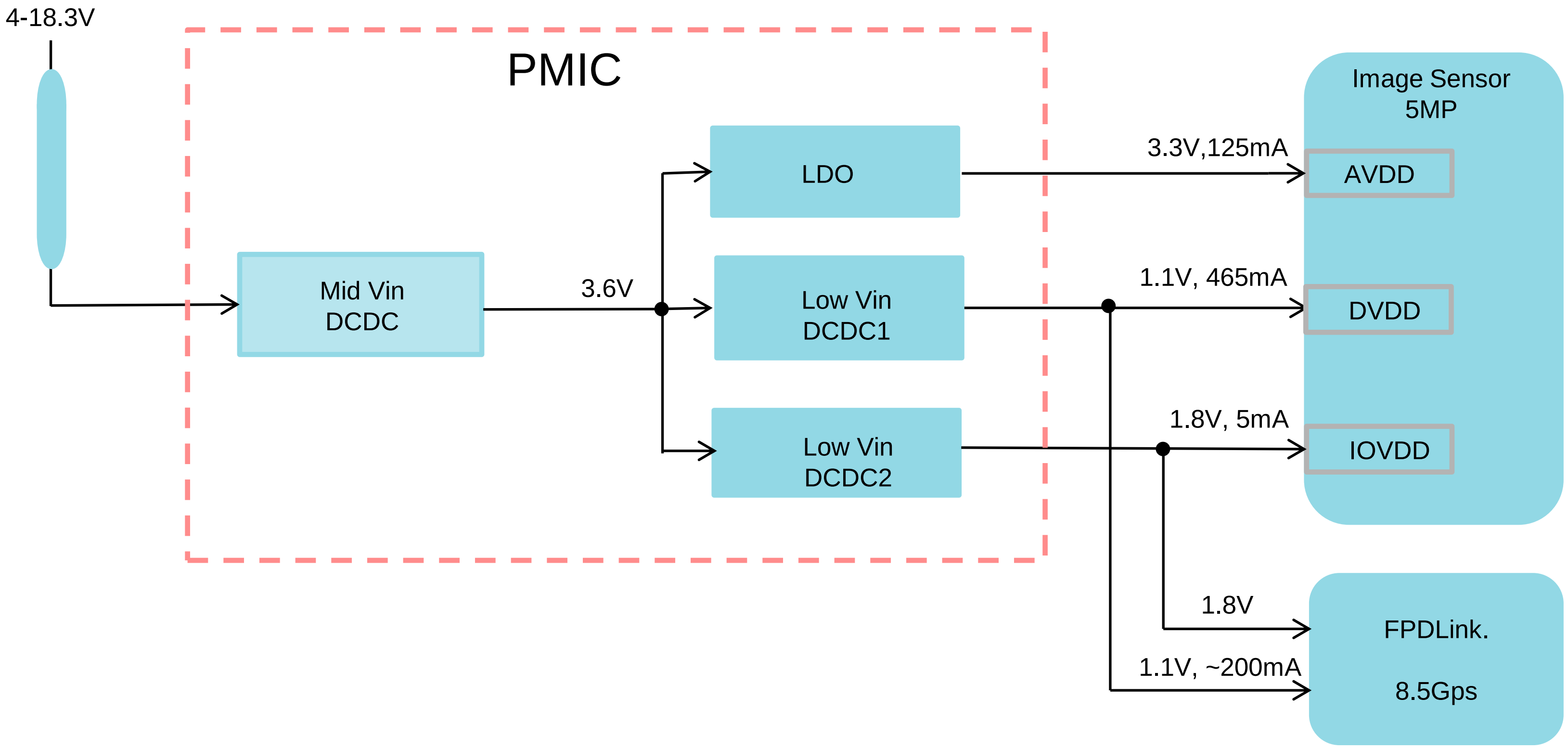
PMIC in Automotive Camera Module – Sony IMX390
With Single Voltage FPD-link



PMIC in Automotive Camera Module – Sony IMX390
With Single Voltage FPD-link



PMIC in Automotive Camera Module – Example
With Dual Voltage FPD-link - Voltage of imager DVDD is same as FPD-link's



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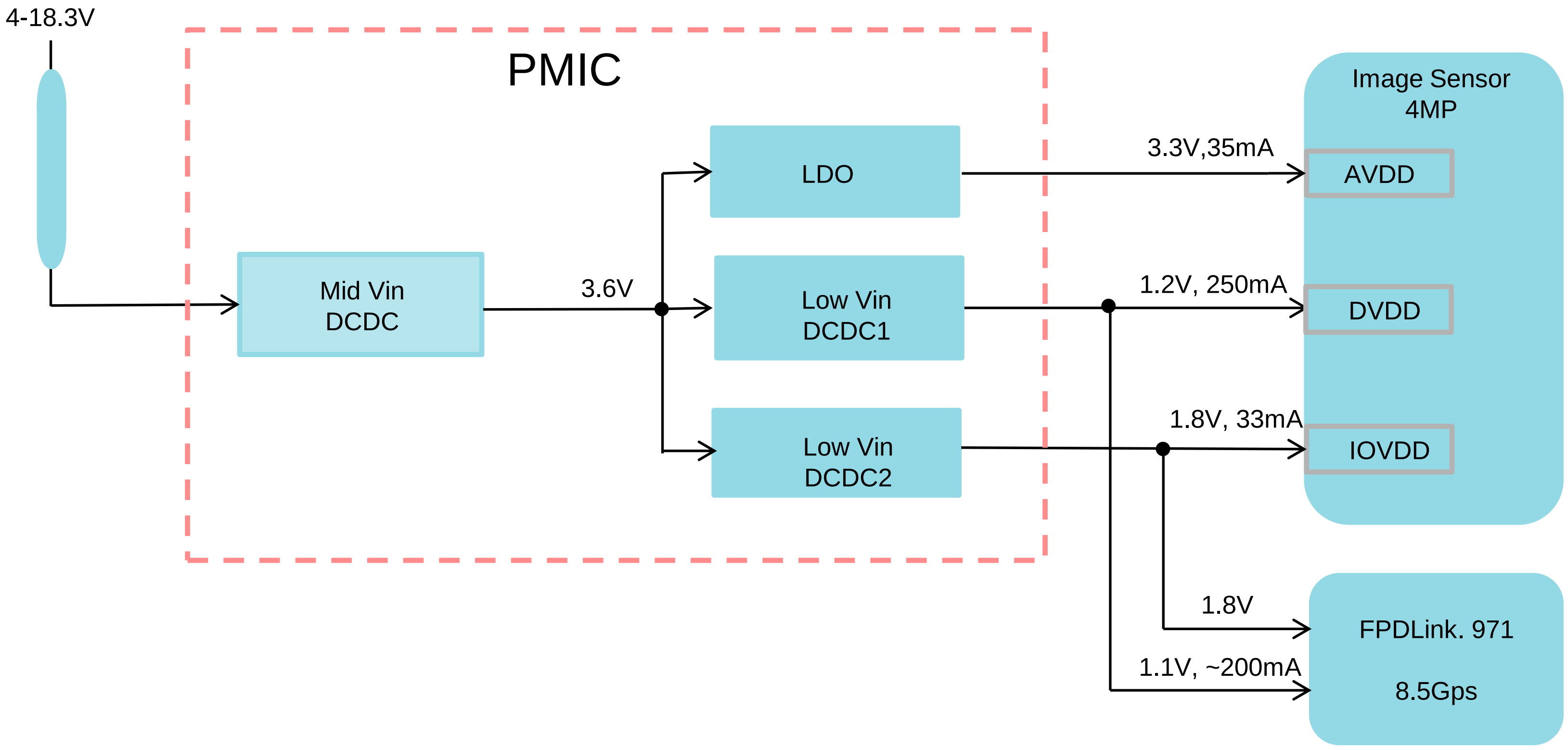

PMIC in Automotive Camera Module
With Dual Voltage FPD-link - Voltage of imager DVDD is different from FPD-link’s