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Powering Multiple Image Sensors with the Same Power Management IC

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1 Introduction

Image sensors in automotive applications have become the mainstream. As more and more sensors are being integrated into automobiles, the need for automotive camera modules has increased significantly. Thermals, size, and performance are all critical in the design of the automotive camera modules and are equally important. Therefore, the camera module designer must take all three items into account. With multiple sensor vendors and each sensor vendor offering multiple sensor options, designing the camera module can be simplified if the same power scheme can be used on all designs.

2 Device Overview

Powering all the various image sensors out in the market today can be simplified by using a fully programmable Power Management IC such as the TPS650330-Q1 Power Management IC. The TPS650330-Q1 Power Management IC has been designed to accept an input voltage range from 4 V to 18.3 V since camera modules are being used in a wide range of applications, such as surround view cameras, smart rear view cameras, remote front cameras, driver monitoring, and cabin monitoring. With each voltage rail having its own independent input and output pins, designing over a wide range of applications is simplified.

3 Device Description

For applications which require functional safety, such as 360° view L5 autonomous driving, blind spot detection, and eMirrors, the TPS650330-Q1 is part of a pin compatible drop in replacement family which integrates functional safety features. Contact Texas Instruments™ for additional information on these devices.

With the TPS650330-Q1 Power Management IC, the required voltages to power any Image Sensor are fully programmable. If power sequencing is needed, the TPS650330-Q1 can be programmed to meet the power sequencing requirements. All this is done internal to the device eliminating the need to use external resistors for voltage settings or connections to meet the power sequencing requirements. By integrating these features, the overall solution size is reduced.

The examples shown in Figure 1, Figure 2, and Figure 3 highlight how one Power Management IC can be used to power multiple sensors from different sensor vendors in a Power over Coax (PoC) application. At least one of the output voltage settings is different in each example, and the same device is being used since the TPS650330-Q1 is fully programmable.

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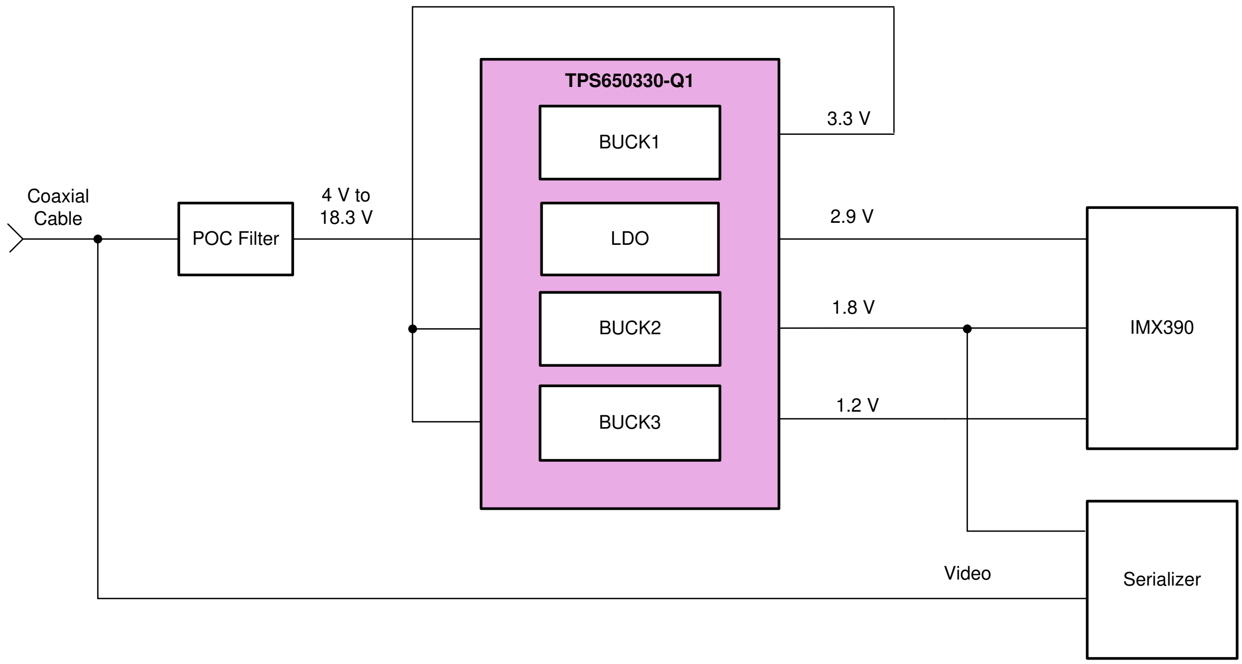

Figure 1. Sony® IMX390™ Powered by the TPS650330-Q1 Power Management IC (Texas Instruments Reference Design TIDA-020003)

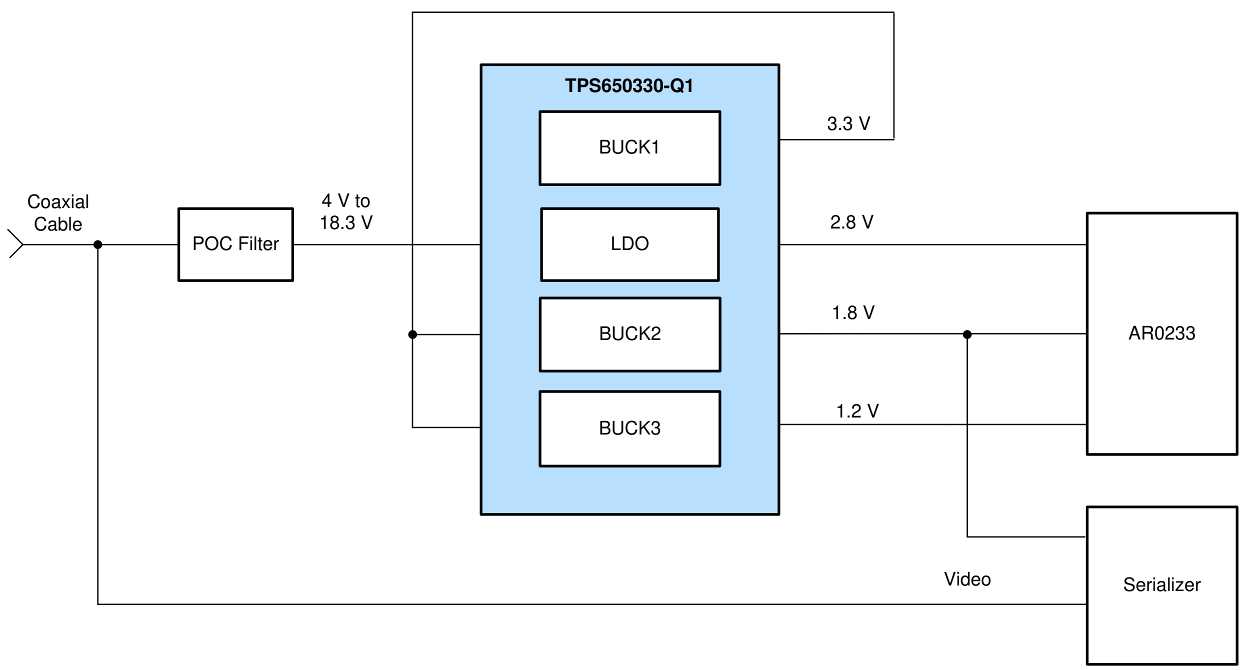

Figure 2. Aptina® AR02333™ Powered by the TPS650330-Q1 Power Management IC (Texas Instruments Reference Design TIDA-050035)

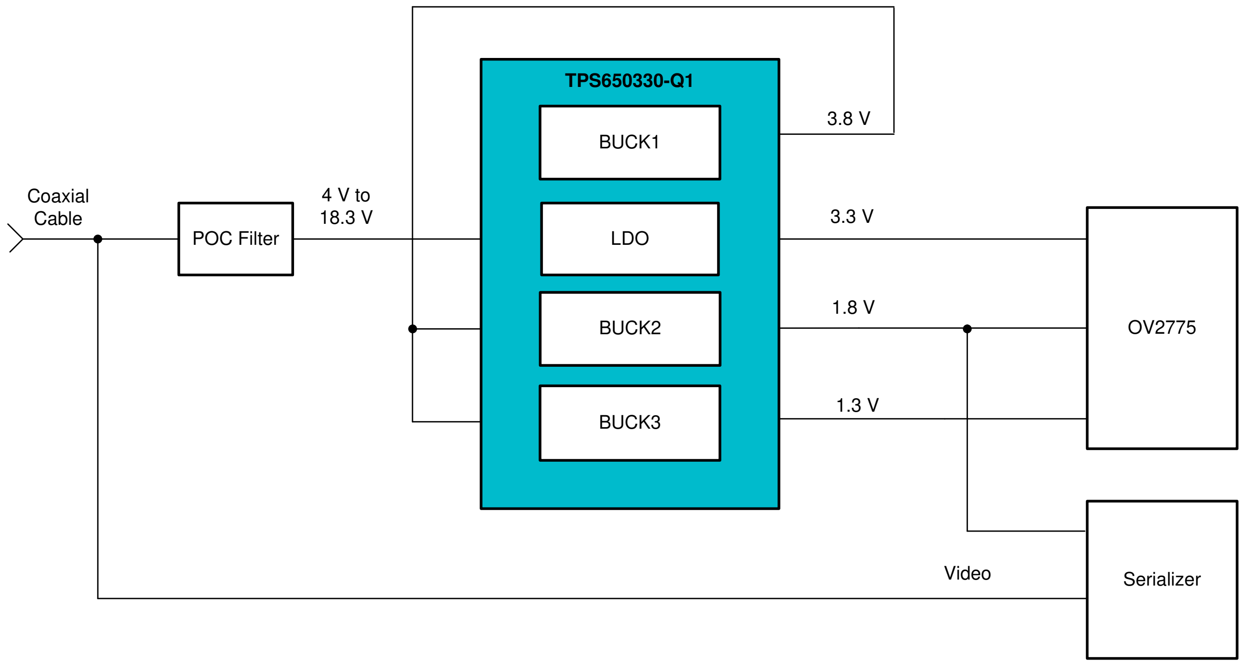

Figure 3. Omnivision® OV2775™ Powered by the TPS650330-Q1 Power Management IC

The TPS650330-Q1 device integrates highly efficient regulators to meet the strict system-level thermal requirements. The configuration of the TPS650330-Q1 device also plays a key role in making sure the overall system-level efficiency minimizes the power dissipation. The following graph compares three different configurations for a power over coaxial application.

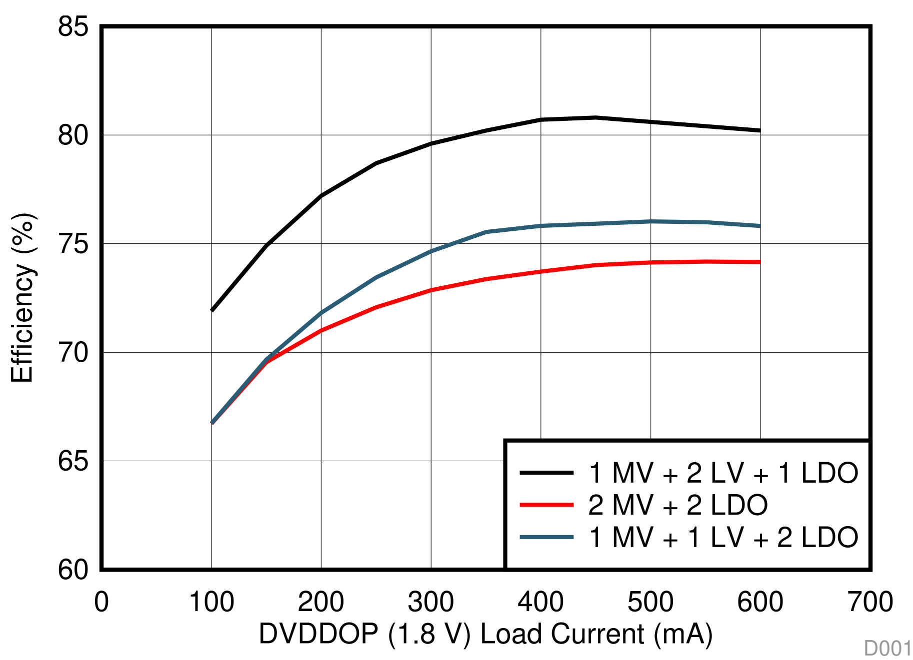

Figure 4. Overall System Level Efficiency Comparison Graph [9]

[9] Legend:
- MV—Refers to a Mid Voltage Buck
- LV—Refers to a Low Voltage Buck
- LDO—Refers to a Low Dropout Regulator

The *1 MV + 2 LV + 1 LDO* configuration is for the TPS650330-Q1. Comparing Figure 5 and Figure 6 shows the impact the *2 MV + 2 LDO* and *1 MV + 1 LV + 2 LDO* configurations have on the overall system level efficiency.

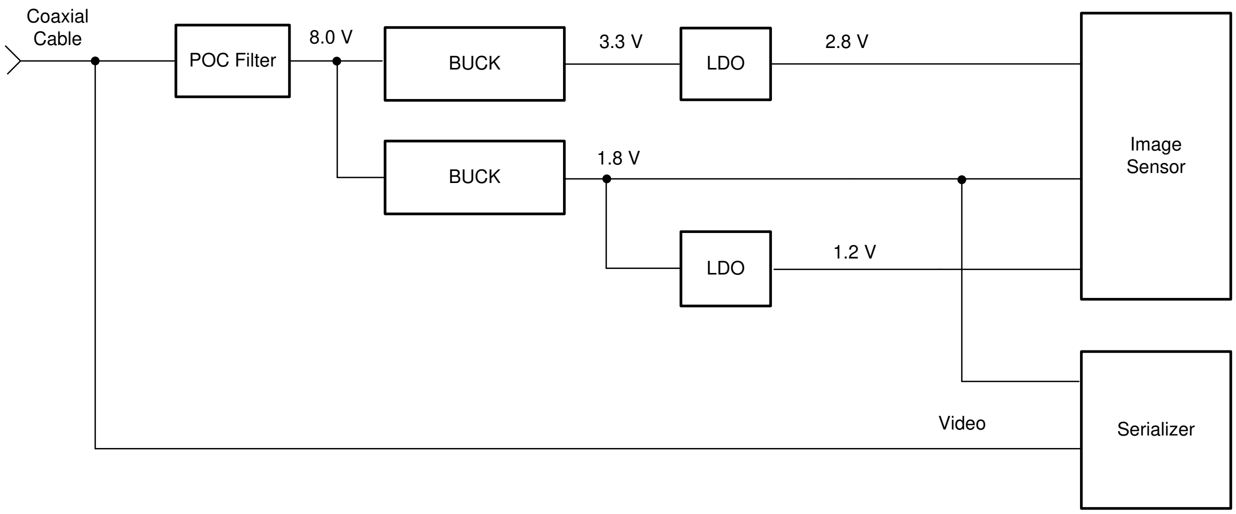

Figure 5. 2 MV + 2 LDO Configuration

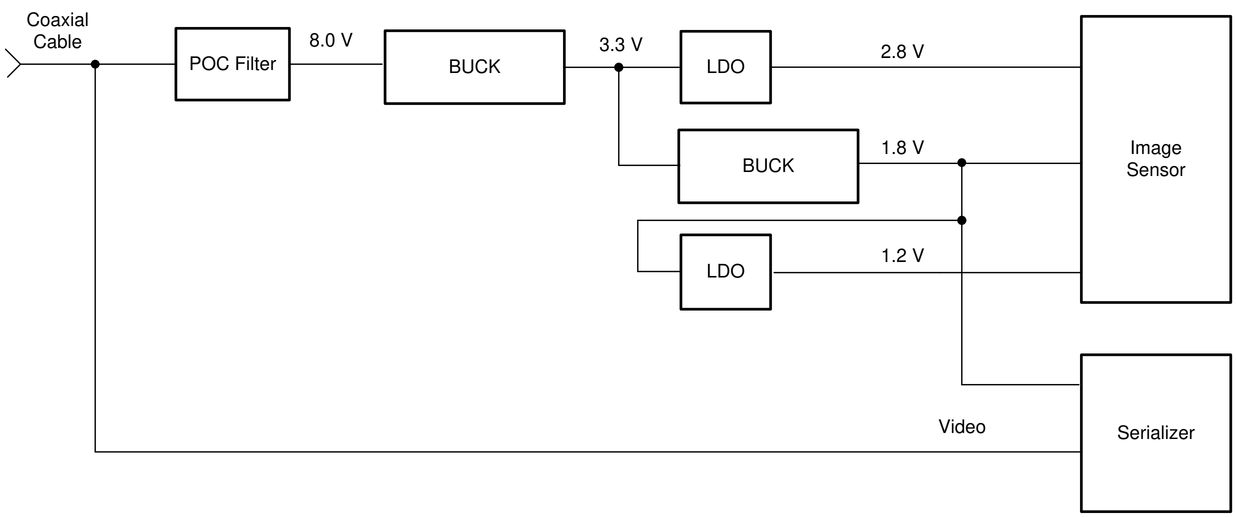

Figure 6. 1 MV + 1 LV + 2 LDO Configuration

The overall solution size challenge is accomplished with the design of the internal regulators. The regulators have been designed to take advantage of the smallest external components available in the market today which meet the overall system load requirements.

Figure 7 and Figure 8 provide examples of small, single board solution sizes that can be achieved. The layouts include the TPS650330-Q1 PMIC, the DS90UB953-Q1 serializer, and their required passive components including the Power Over Coax (POC) filter. A typical image sensor is shown on the opposite side for size reference.

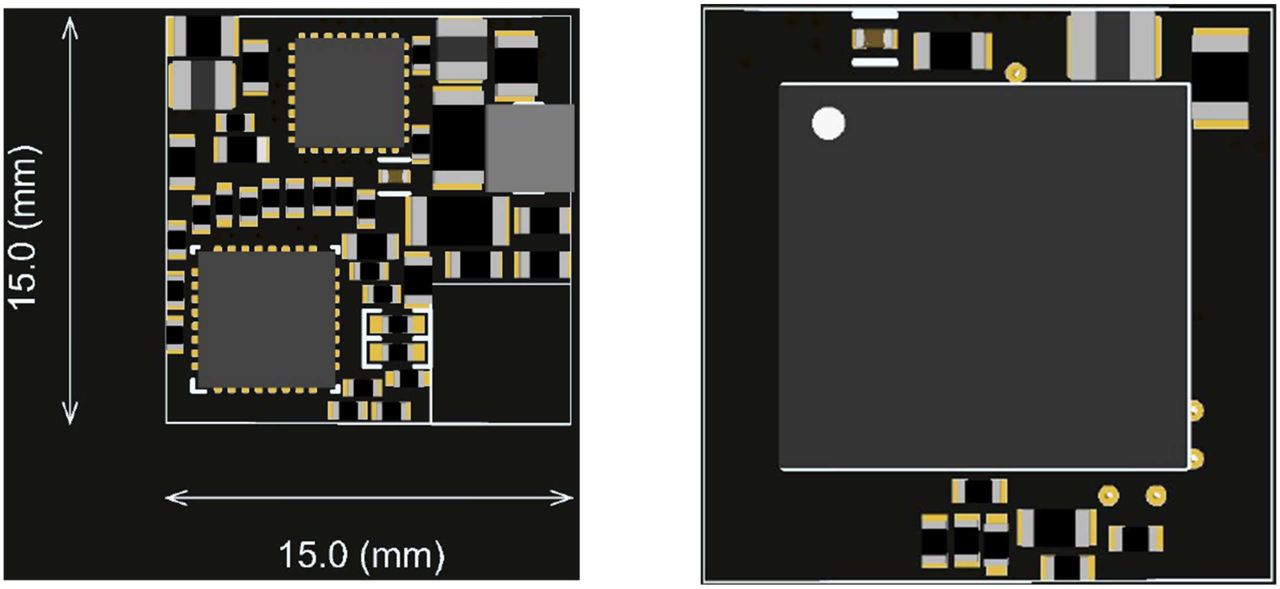

Figure 7. Layout Example – Double Sided

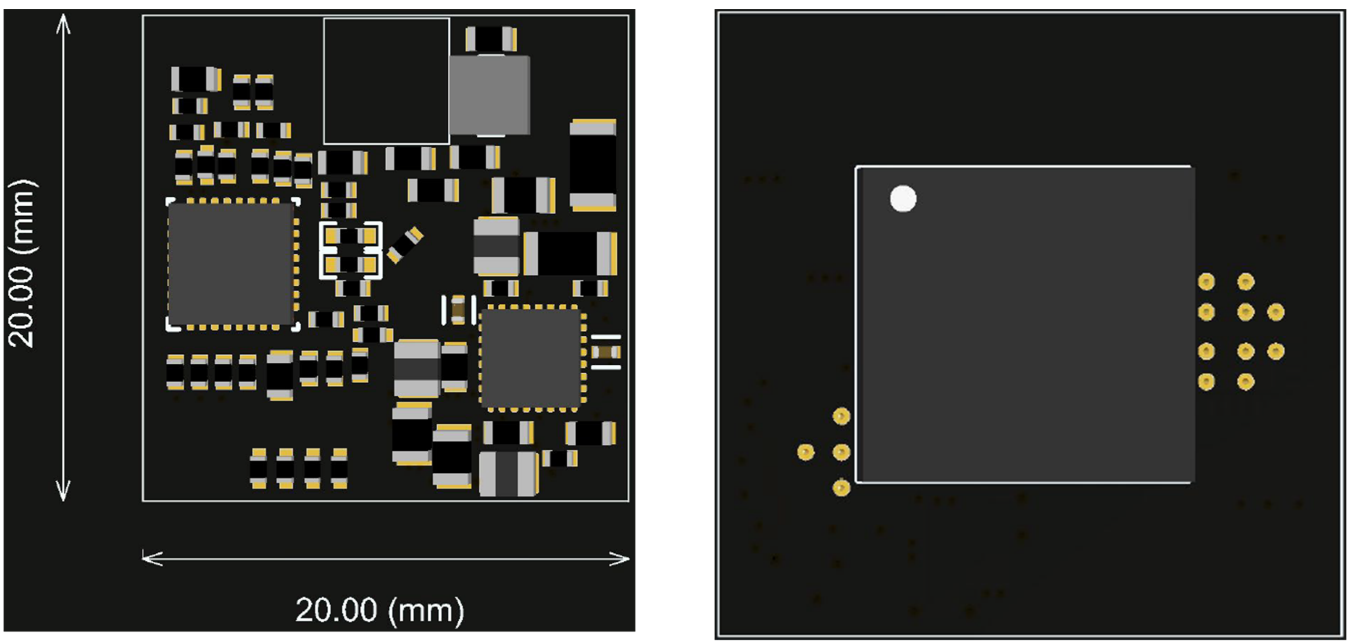

Figure 8. Layout Example – Single Sided

From a performance point of view, noise and EMI are two items which impact the system-level performance. The TPS650330-Q1 device integrates a low noise LDO that can be used to power sensitive analog rails of the Image Sensors. EMI reduction techniques have been implemented in the integrated DCDC converters of the TPS650330-Q1. One such technique is the implementation of an Adaptive Randomized Spread Spectrum (ARSS), which is a technique patented by Texas Instruments. See the Passing CISPR-25 Radiated and Conduction Emissions Using the TPS65033x-Q1 application report for more information regarding TPS650330-Q1 EMI performance. Collectively, these items help the camera module designer meet some of the performance challenges being dealt with today.

Camera Module designers may conclude that a high current load on the LDO output will result in a higher power loss and that using a DCDC converter may make sense even though the integrated LDO can support a sizeable current load. In this case, see Figure 9 for an example of how one of the integrated DCDC converters can be used to power the analog rail in order to minimize the power loss.

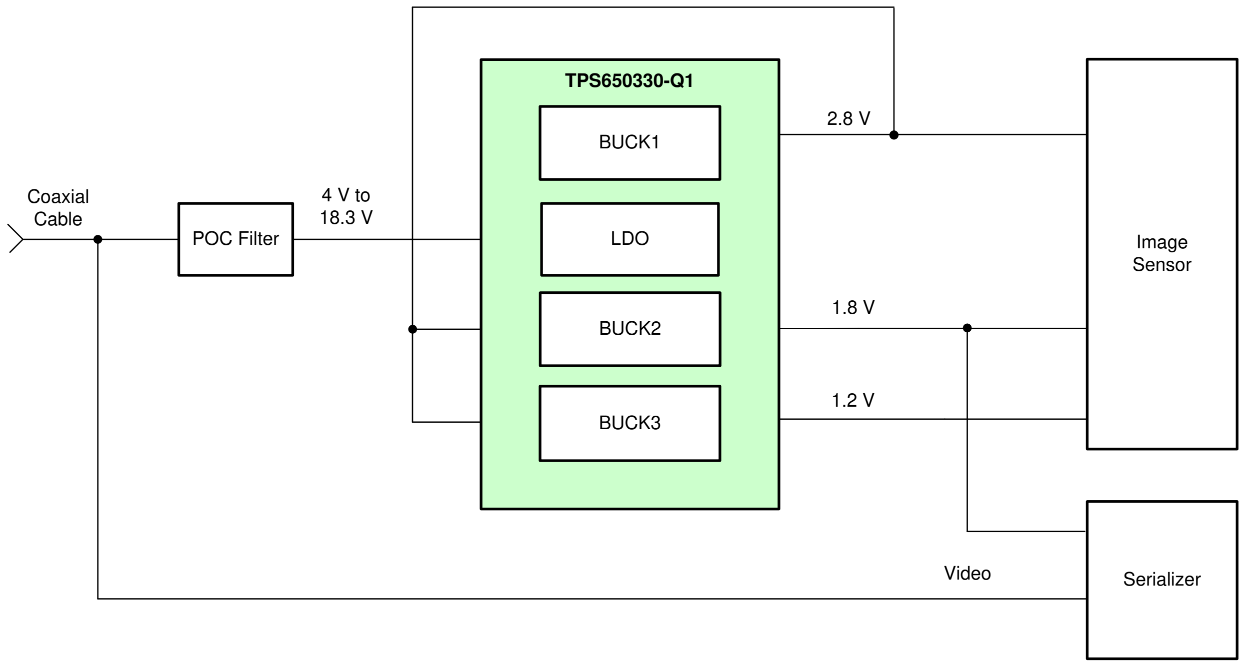

Figure 9. Using a DCDC Converter to Power the Analog Rail.

4 Summary

The flexibility of the TPS650330-Q1 device makes it the ideal power solution for any camera module design. Using the TPS650330-Q1 Power Management IC reduces time to market and adds the peace of mind that a proven power solution on one camera module design will easily port over to any camera module design. By minimizing external components and integrating functional safety features into pin compatible PMICs, layout and component changes become a thing of the past with the TPS650330-Q1.

5 References

1. Automotive 2-MP Camera Module Reference Design with MIPI CSI-2 Interface, PMIC, FPD-Link III and POC (TIDA-020003).
2. Scalable Automotive 2-MP Camera Module Reference Design with Camera PMIC (TIDA-050035).
3. Passing CISPR-25 Radiated and Conduction Emissions Using the TPS65033x-Q1 (SLVAEN0).