Test Report
For TIDA-00098
Aptina Automotive Camera Module
02/14/2014

Overview

The reference design is an automotive camera module solution with Aptina image sensor and processor, and TI FPD-Link III serializer. The design is a collaboration work from Aptina and Texas Instruments; the hardware design is done by Aptina, and the power supply and serializer design references the TI Design PMP9300.

The module consists of two 32x32mm boards, one power/serializer board and one camera board. The power/serializer board has the buck regulator LM34919C and TPS62231 to supply the required 2.8V and 1.8V voltage rails of the system, and the serializer DS90UB913A-Q1 to provide an FPD-Link III interface. The power/serializer board allows the camera data, I2C control signal and input power to be transmitted over a signal coaxial cable. The camera board has the Aptina AR0132AT 1.2Mp image sensor with the lens assembly, and the AP0101AT image signal processor (ISP).The power/serializer board is mounted on the camera board's back to form a compact module. The system block diagram is shown in Figure 1.

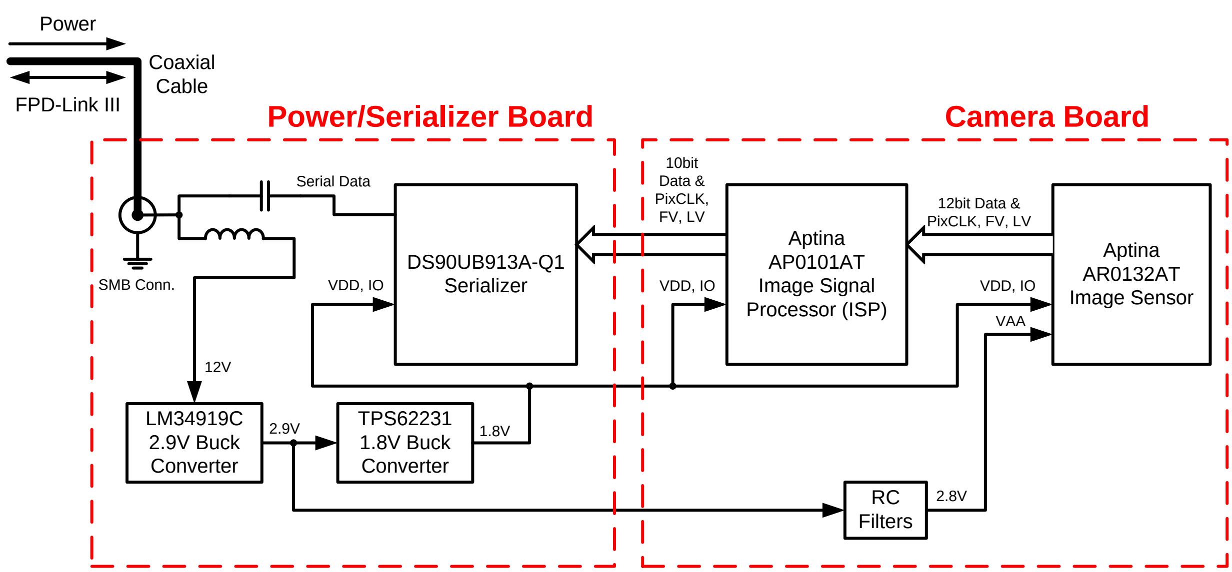

Figure 1

Power Specification

Vin range: 4.7V – 42V

Nominal Vin = 12V

Outputs: 1.8V@155mA, 2.9V@150mA

Board Photos

Figure 2 Camera Module

Power/Serializer Front

Power/Serializer Back

Camera Board Front

Camera Board Back

Figure 3

Board Size: 32x32mm

Test Setup

The test setup consists of the camera module, the deserializer DS90UB914A-CXEVM EVM, the Aptina Demo2x image sensor demo base board, and a modified connector adapter board (see Figure 4).The camera module is connected to the deserializer board through a coaxial cable with SMB/FAKRA connectors. The function of the deserializer board is to convert the serial camera data back to parallel data and to provide power to the camera module. It is connected to the Aptina Demo2x base board via an adapter board. The base board processes the image data and interfaces with a computer via a USB cable.

The Aptina development suite DevWare is used to monitor the captured video and send commands to configure the camera module. The connection of the setup is shown in Figure 5.

In order to test the camera module under different input voltage condition and measure the consumed power, the deserializer EVM board is modified to have a separate input power supply dedicated for the camera module. On the deserializer board, the L3 is removed, and the separate input (+) line is soldered to the VFEED pad of the capacitor C3. (For the schematic and user guide of the deserializer EVM, visit http://www.ti.com/tool/ds90ub914a-cxevm)

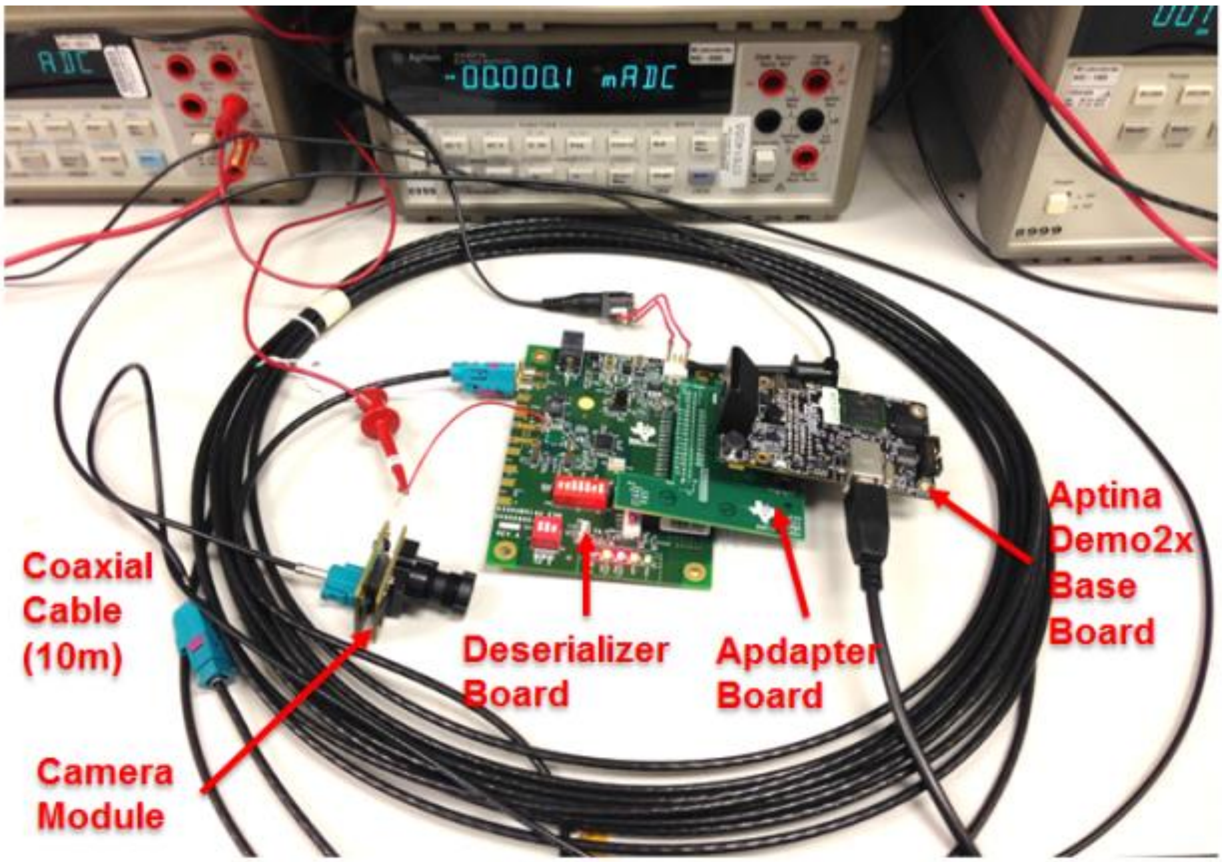

Figure 4 Camera Module Test Setup with 10m Coaxial Cable

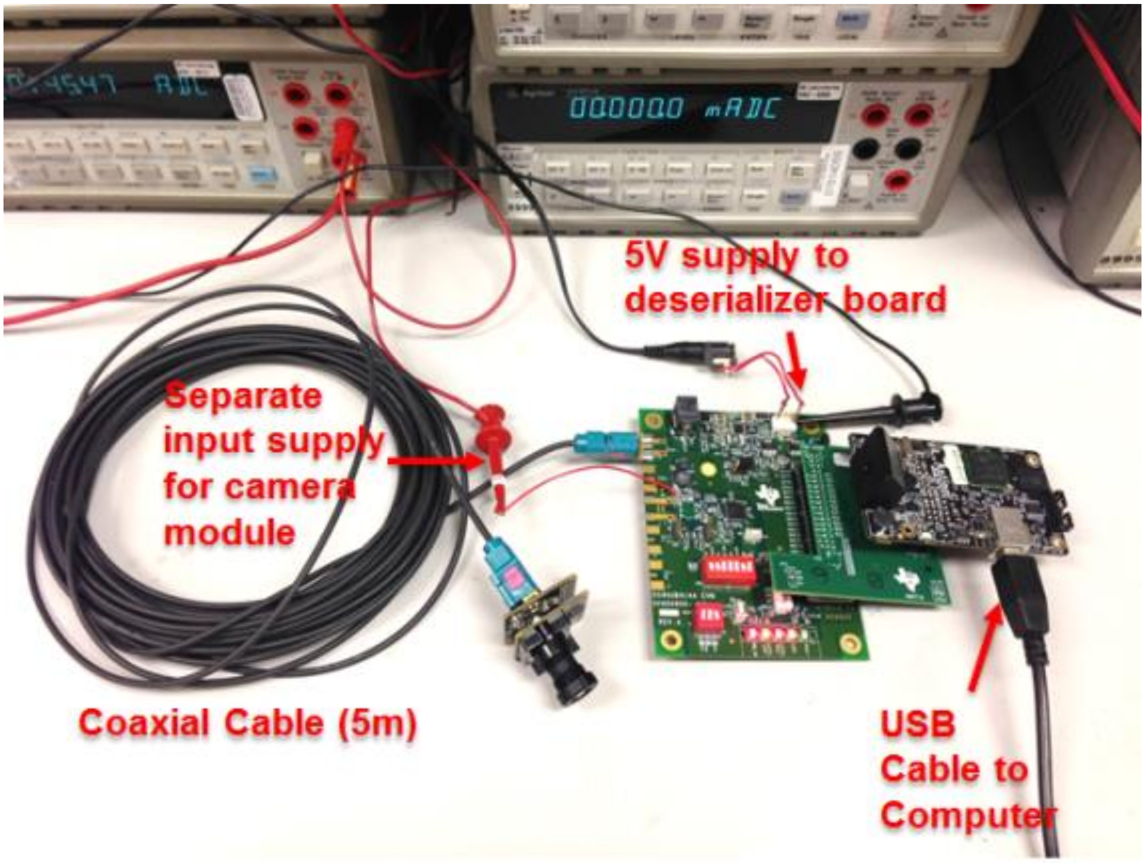

Figure 5 Camera Module Test Setup with 5m Coaxial Cable

Power Consumption and Image Quality

The camera module has an operating input voltage range of 4.7V to 42V. However, the voltage droop across the coaxial cable varies depending on the cable resistance, and the input voltage range observed at the deserializer end will vary accordingly. In the test, two coaxial cables, 10m LEONI Dacar 461 cable (Figure 4) and 5m FAKRA RTK031 cable (Figure 5), were used, and the voltage/current was measured when the camera was active.

As seen in Table 1, at normal Vin=12V, the camera module itself consumes about 0.8W power. Note that the 10m cable is a high quality cable with lower resistance than the 5m cable, and the voltage drop is actually lower even though its length doubles.

If the Vin at the camera module drops below 4.7V, the buck regulator will not be able to maintain stable output at the required level, and the image quality will be degraded as a result.

Table 1

Vin at the Deserializer	Vin at the Module	Input Current	Power w/o. Cable	Power w. Cable
With 10m Cable (center core resistance=1.17Ω, outer shield resistance=0.50Ω)				
5.610V	4.718V	147.4mA	695mW	827 mW
11.91V	11.49V	68.7mA	789 mW	818 mW
19.78V	19.51V	45.8mA	894 mW	906 mW
41.86V	41.69V	28.8mA	1201 mW	1206 mW
With 5m Cable (center core resistance=3.18Ω, outer shield resistance=0.57Ω)				
5.799V	4.683V	150.8mA	706 mW	874 mW
12.02V	11.53V	69.0mA	796 mW	829 mW
19.95V	19.62V	45.6mA	895 mW	910 mW
41.98V	41.77V	28.8mA	1203 mW	1209 mW

The image quality was checked visually using the DevWare, and the video captured was clear and stable without any artifact or distortion at the full input voltage range using the two cables. Some screenshot samples are shown in Figure 6 and Figure 7. Also, the parity error registers in the DS90UB914Q (0x1A~0x1B) was checked, and the reading was zero indicating no bit error in the data transmission.

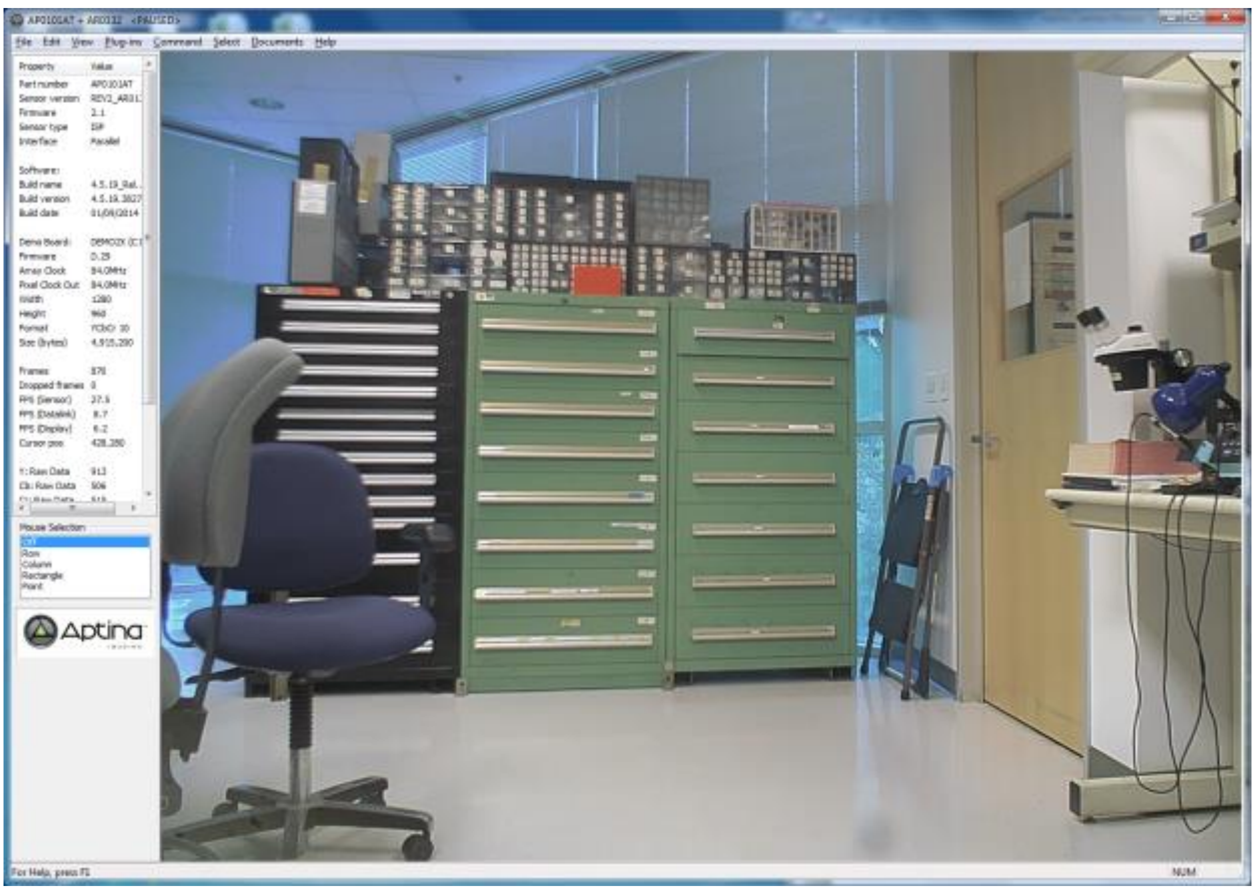

Figure 6 Screenshot at 5.7Vin with 5m cable

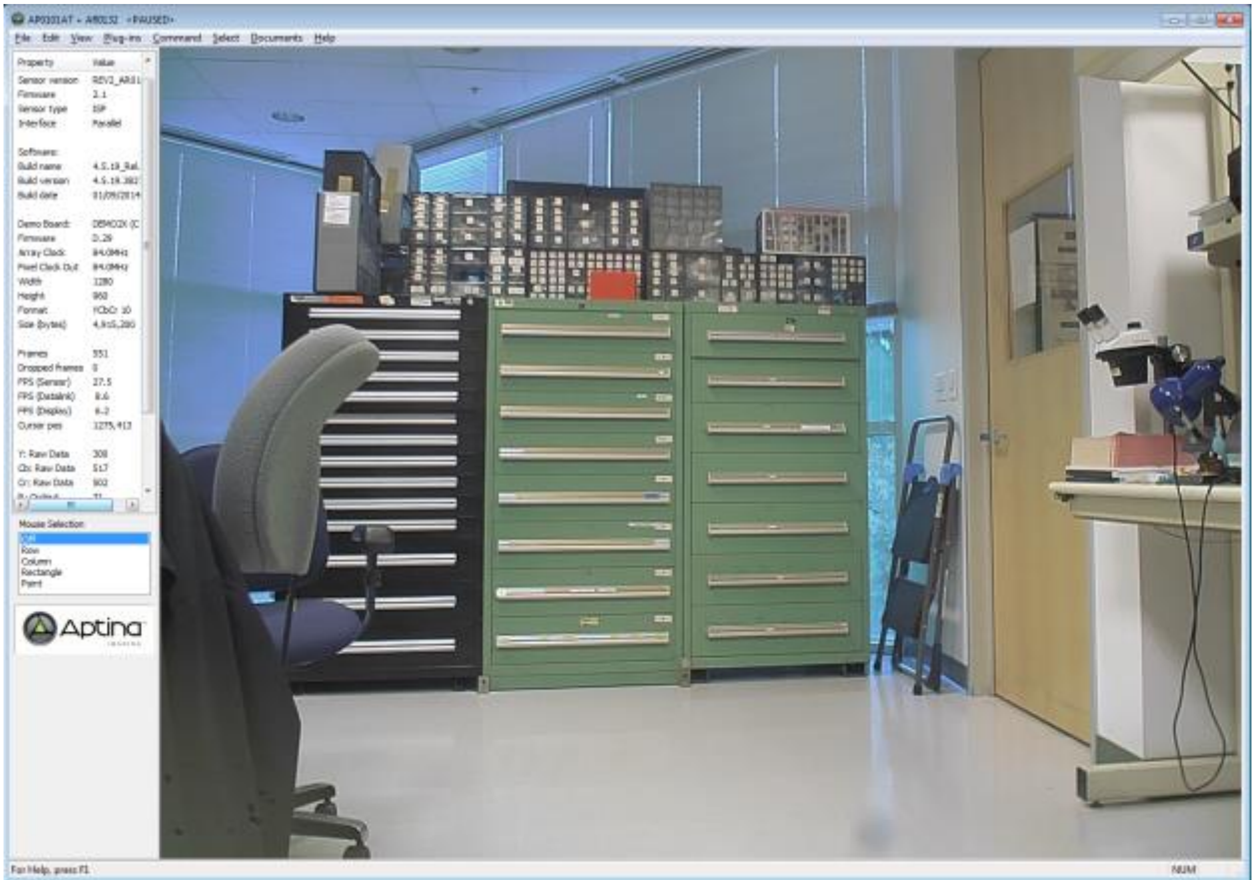

Figure 7 Screenshot at 42Vin with 10m cable

Buck Regulator Switching Waveform

When connected with the camera board the buck regulators on the power/serializer board are sandwiched in the middle making them inaccessible for probing. Therefore, the test is carried out on the power/serializer board with resistor loads used to emulate the max output current condition.

The switching waveform of the 2.9V output buck LM34919C at different Vin is shown in Figure 8, Figure 9 and Figure 10. For the 1.8V output buck TPS62231, its input is from the 2.9V output of the LM34919C. Its switching waveform is shown in Figure 11.

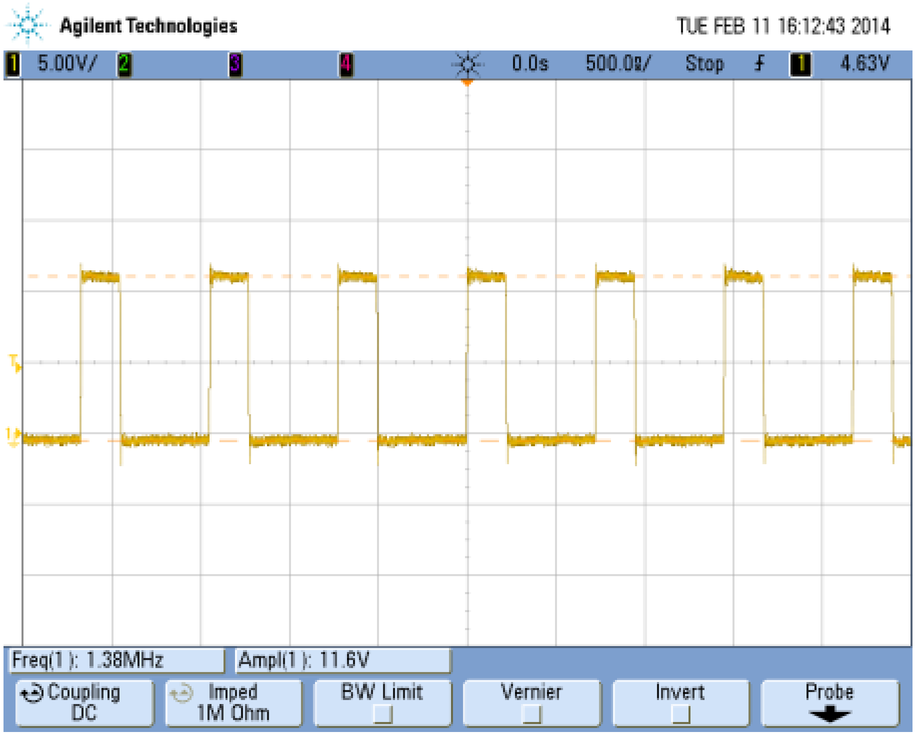

Figure 8 2.9V Buck Switching at 5Vin

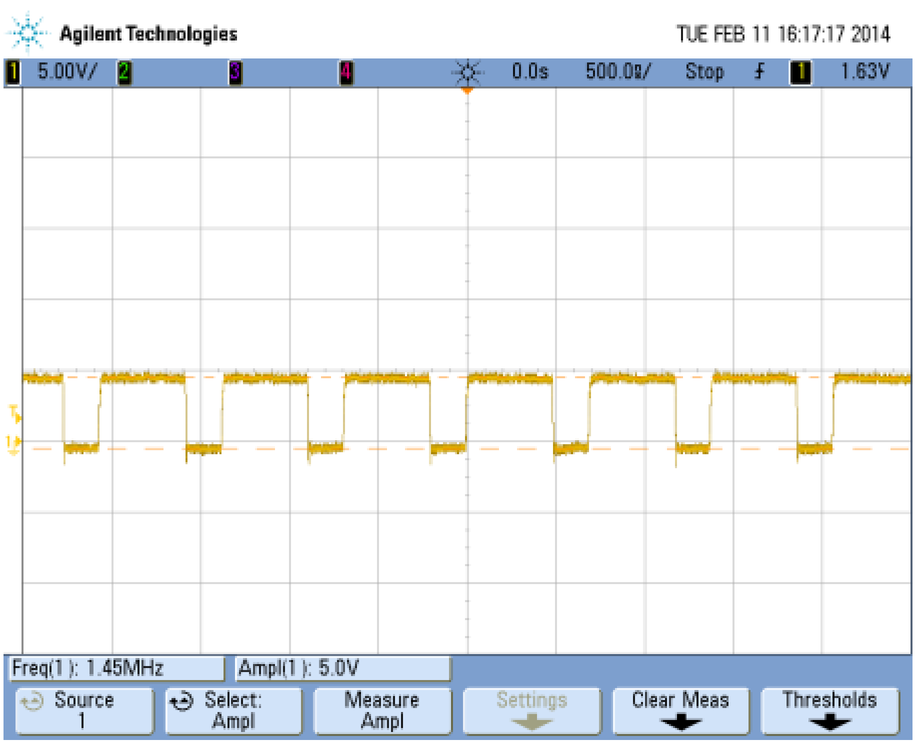

Figure 9 2.9V Buck Switching at 4.7Vin

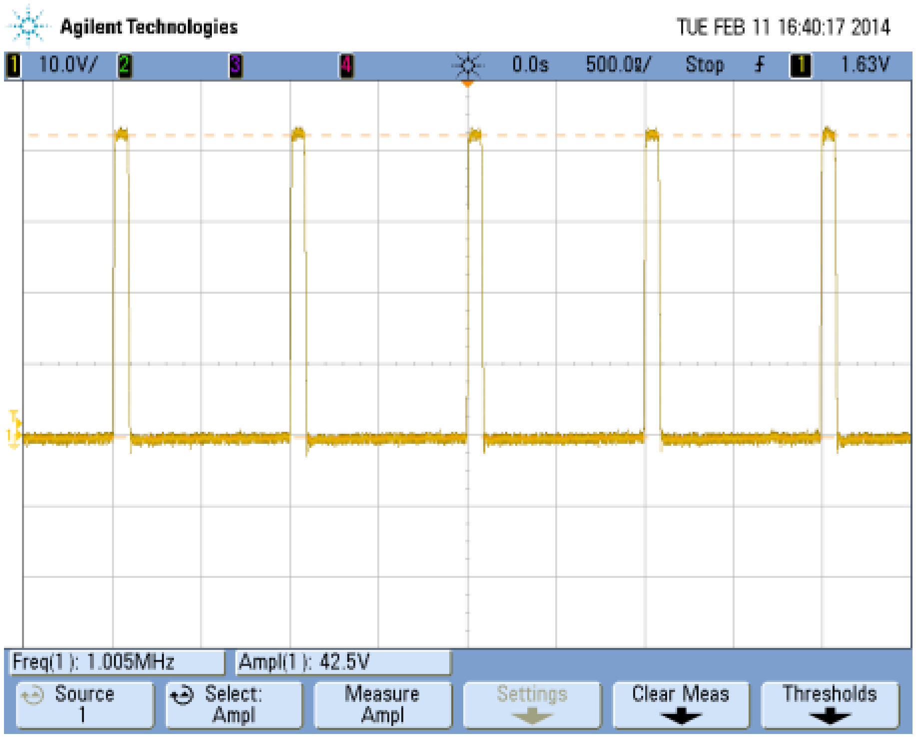

Figure 10 2.9V Buck Switching at 42Vin

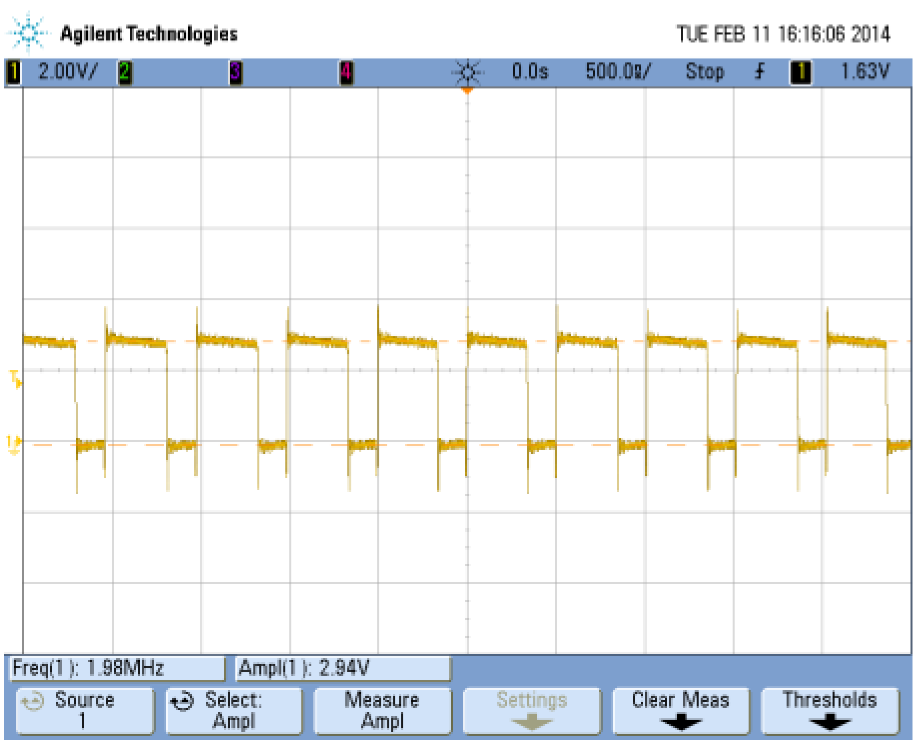

Figure 11 1.8V Buck Switching

Power Up

The power up sequence of the 2.9V and 1.8V at Vin=12V and full load condition is shown in Figure 12. Ch1 (yellow) – Vin, Ch2 (green) – 2.9V output, Ch3 (purple) – 1.8V output.

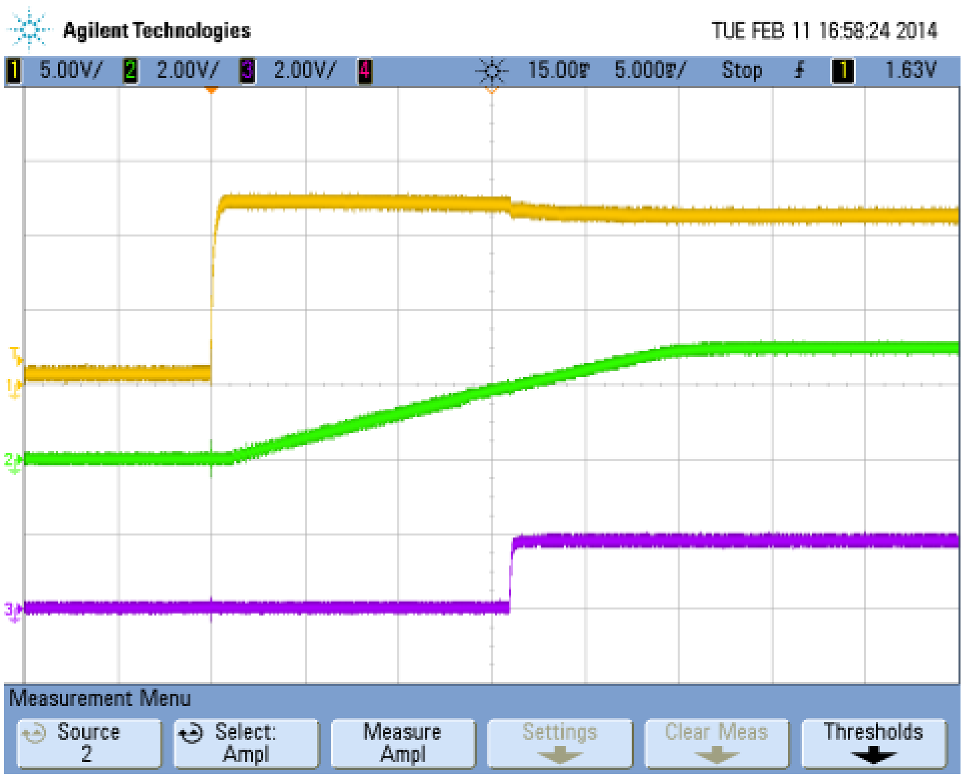

Figure 12

Output Voltage Ripples

Output ripples are measured on the Power/Serializer board along with resistive load on the 1.8V and 2.9V output rails to emulate the full load condition. As there are additional RC filter stages on the camera board, the actual ripple to the image sensor will be further dampened.

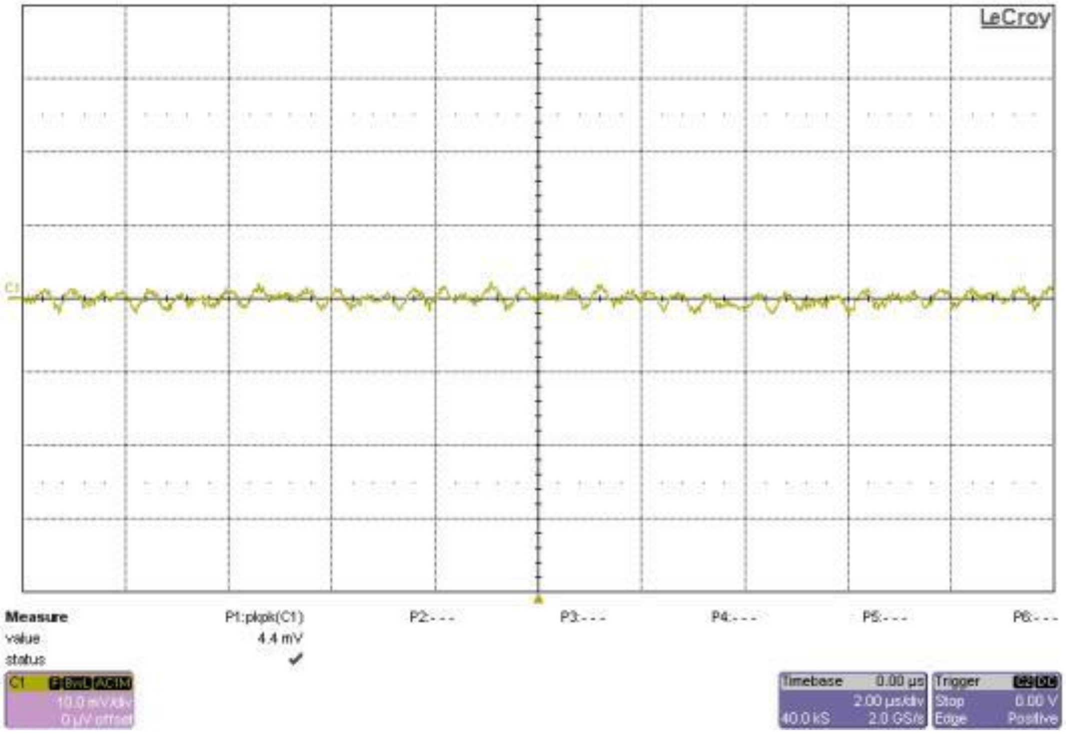

Figure 13 2.9V Output Ripple at 150mA

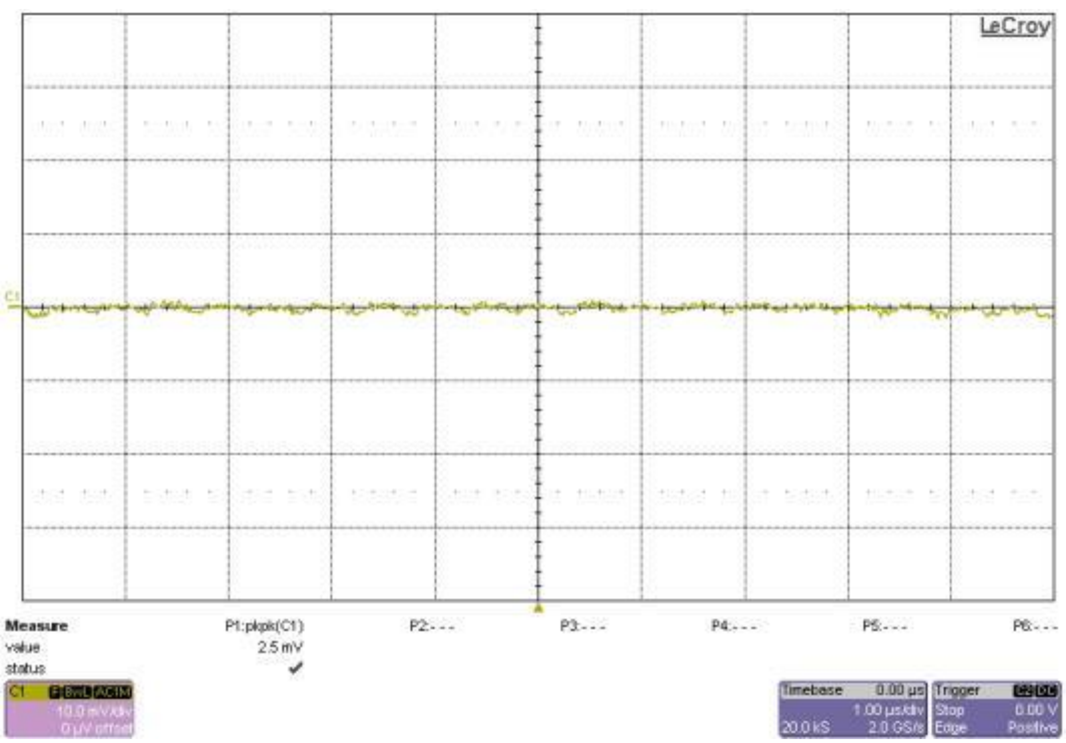

Figure 14 1.8V Output Ripple at 155mA

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