ADP1829, APD210X and ADP171X Reference Design

Preliminary Technical Data

FCDC 00059

FEATURES

Seven Output Voltages: 3.6 V, 3.3 V,3.3l V 2.5 V, 1.8 V, 1.25 V, 0.9 V
Output Current: 0.002 A to 3.0 A
Input voltage: 10.8-13.2 V
Ripple 2% ppk of Output Voltage
Transient step ±5%, 50% max load

ADP1829, APD210X AND ADP171X REFERENCE DESIGN DESCRIPTION

This ADP1829, APD210X and ADP171X Reference Design uses 10.8 V to 13.2 V for the input voltage. The output voltages and currents are as follows:

- V_{OUT1} = 3.6 V with a maximum output current of 3.0 A for intermediate rail,
- V_{OUT2} = 3.3 V with a maximum output current of 0.6 A for DCD,
- V_{OUT3} = 3.3 V with a maximum output current of 0.02 A for DCD,
- V_{OUT4} = 2.5 V with a maximum output current of 0.4 A for DCD,
- V_{OUT5} = 1.8 V with a maximum output current of 0.9 A for DCD,
- V_{OUT6} = 1.25 V with a maximum output current of 0.002 A for DCD,
- V_{OUT7} = 0.9 V with a maximum output current of +/-0.5 A for FPGA,

Design criteria are for coincidental tracking of V_{OUT4} and V_{OUT5} with V_{OUT2}. V_{OUT7} is a DDR termination and is designed for ratiometric tracking with V_{OUT5}. All outputs discharge to 0.1 V in under 100 ms through external pull down resistors switched on when the rails are disabled. The ripple and transient assumptions are 2% peak to peak voltage ripple (for the switchers) and 5% deviation due to 50% instantaneous load step respectively. The nominal switching frequency is fixed at 300 kHz for V_{OUT1} and V_{OUT7}. V_{OUT2} and V_{OUT5} switch at a fixed nominal frequency of 1.2 MHz. All other outputs are filtered, or linear regulated out of the switching rails.

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REVISION HISTORY

9/19/2007—Revision 0: Initial Version

GENERAL DESCRIPTION

ADP1823

The ADP1829 is a versatile, dual output, interleaved, synchronous PWM buck controller that generates two independent outputs from an input voltage of 2.9 V to 20 V. Each channel can be configured to provide output voltage from 0.6V to 85% of the input voltage. The two channels operate 180° out of phase, which reduces the current stress on the input capacitor and allows the use of a smaller and lower cost input capacitor.

The ADP1829 operates at a pin-selectable fixed switching frequency of either 300 kHz or 600 kHz. For some noise sensitive applications, it can also be synchronized to an external clock to achieve switching frequency between 300 kHz and 1 MHz. The switching frequency chosen is 300 kHz to get good efficiency over a wide range of input and output conditions.

The ADP1829 includes an adjustable soft start to limit input inrush current, voltage tracking for sequencing or DDR termination, independent power-good output, and a power enable pin. It also provides current-limit and short-circuit protection by sensing the voltage on the synchronous MOSFET.

ADP2105, ADP2106, ADP2107

The ADP2105,6,7 are a versatile, single output, synchronous PWM buck controller with integrated synchronous FETs that generates a single output from an input voltage of 2.7 V to 5.5 V. The controller can be configured to provide output voltage from 0.8 V to the input voltage with an output current up to 2 A.

The ADP2105,6,7 operate at a fixed switching frequency of 1.2 MHz to reduce component size.

The ADP2105,6,7 include an adjustable soft start to limit input inrush current. Inherent to their current mode design they provide current-limit and short-circuit protection by sensing the voltage dropped across the internal MOSFET.

ADP171X

The ADP171X is a family of low drop out CMOS linear regulators that provides versatile and inexpensive step-down voltage regulation. The input voltage range is 2.5 V to 5.5 V and the output current capability is up to 500 mA. The various versions provide features such as Enable, Soft Start, Low Noise Bypass and Tracking. They are available is space saving TSOT-5 and MSOP-8 packages and operate over the −40°C to +125°C temperature range.

ADP1581

The ADR1581[1] is a low cost, 2-terminal (shunt), precision band gap reference. It provides an accurate 1.250 V output for input currents between 60 μA and 10 mA.

The ADR1581 is available in two grades, A and B, both of which are provided in the SOT-23 package. Both grades are specified over the industrial temperature range of −40°C to +85°C.

BLOCK DIAGRAM

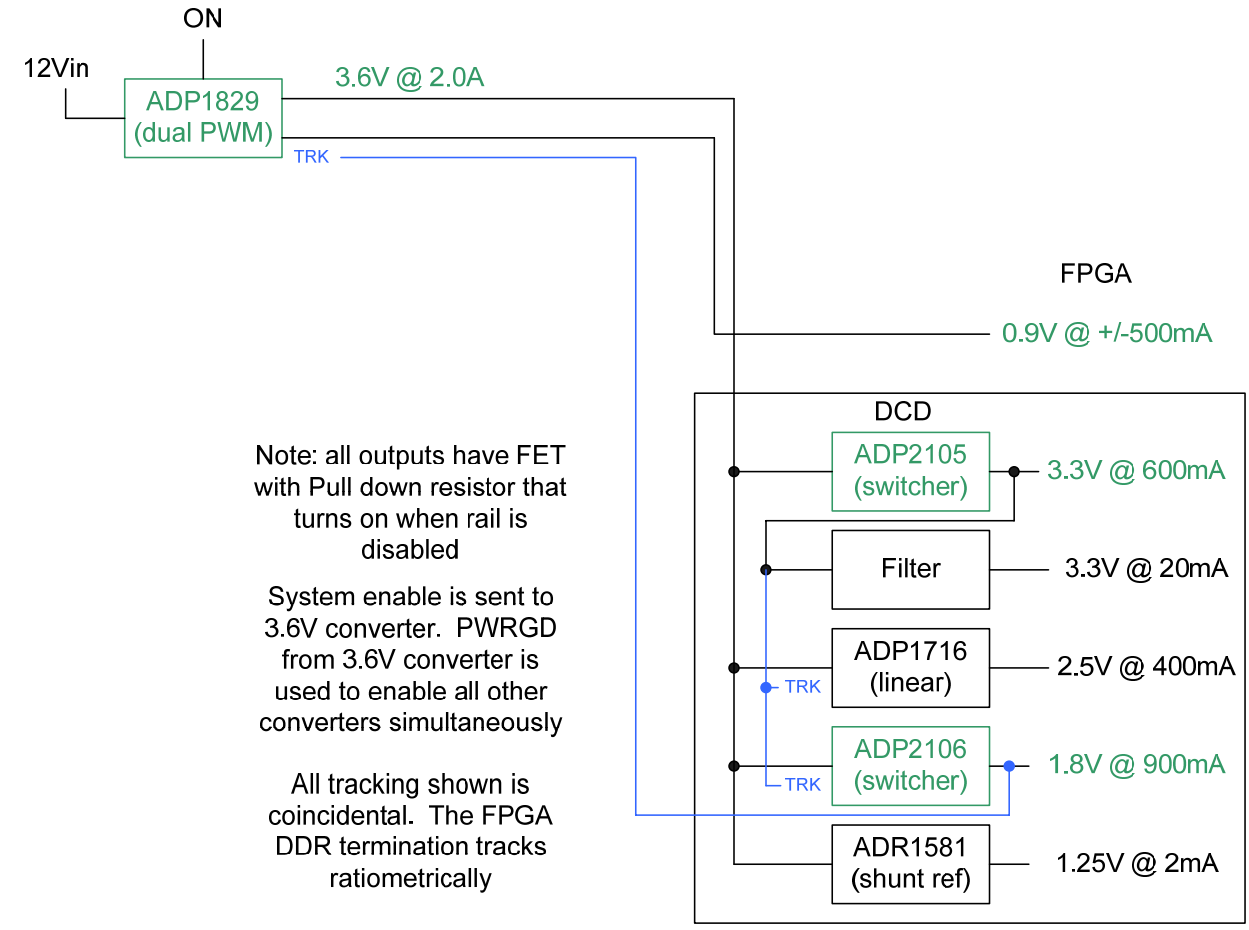


Figure 1. Block Diagram of the System

SCHEMATIC

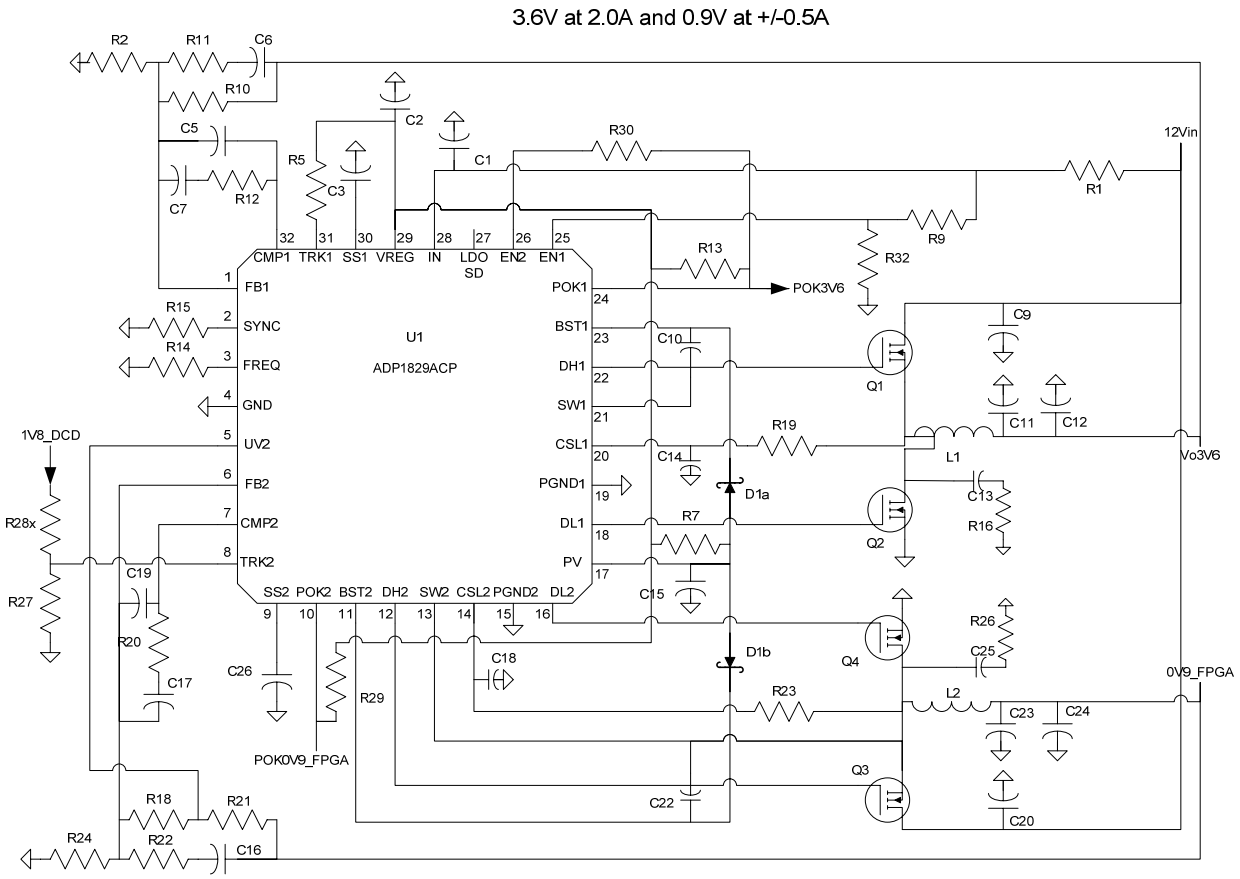
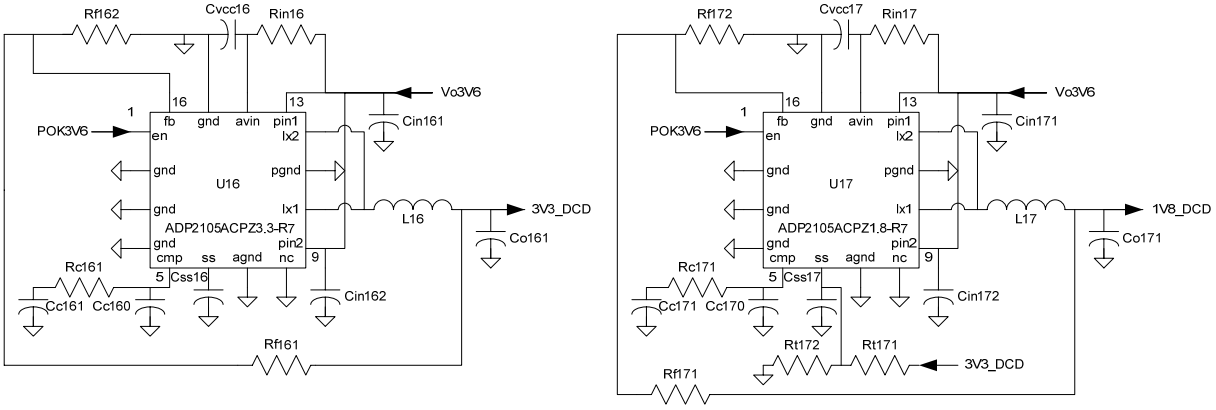
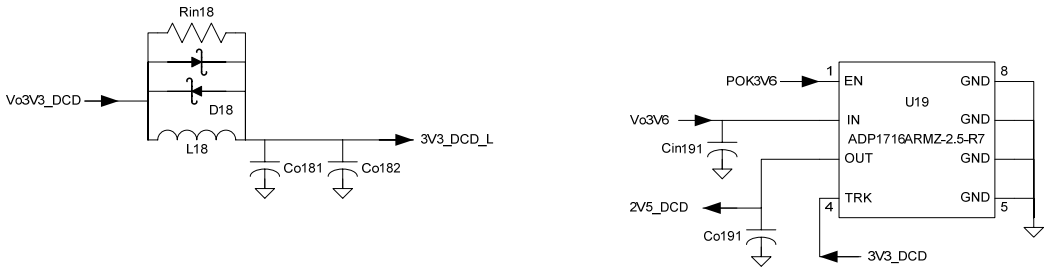


Figure 2. Schematic: V_{OUT1} and V_{OUT7}

3.3V at 0.6A (DCD) and 1.8V at 0.9 (DCD)



3.3V at 0.02A (DCD) Low Noise and 2.5V at 0.4 A (DCD)



1.25V at 2mA (DCD) Low Noise

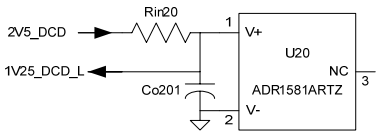


Figure 3. Schematic: V_{OUT2}, V_{OUT3}, V_{OUT4}, V_{OUT5} and V_{OUT6}

Pull Down Circuitry Ensures all rails <0.1V in under 100ms from ON deassertion

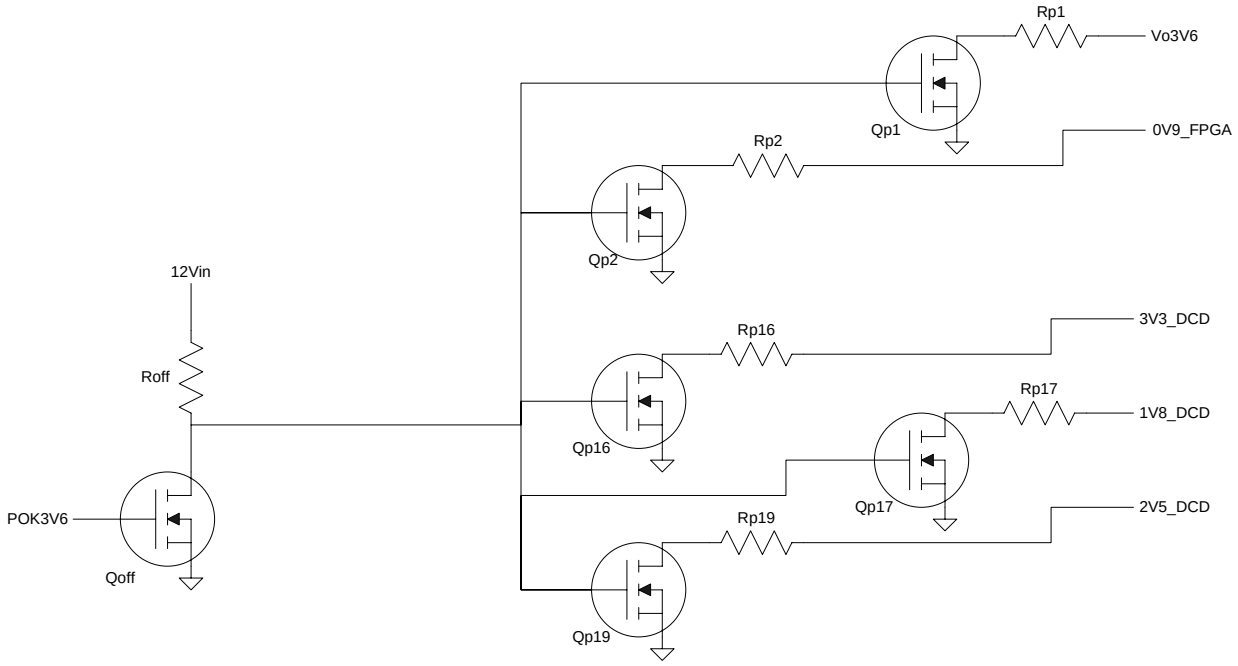


Figure 4. Schematic: Power Down Circuitry

BILL OF MATERIALS

Table 1. Vout1, and Vout7 Bill of Materials (Vo3V6 and 0V9_FPGA)

Description	Designator	Quantity	Manufacturer	MFR#	Original Designator
Capacitor Ceramic X7R 3.3n 0603 50V	C6	1	Vishay	Generic	Cc12
Capacitor Ceramic COG 22p 0603 50V	C5, C19	2	Vishay	Generic	Cc10, Cc20
Capacitor Ceramic X7R 2.2n 0603 50V	C7	1	Vishay	Generic	Cc11
Capacitor Ceramic X7R 1u 0603 16V	C2, C15, C1	3	Murata	GRM188R71C105KA12D	Cbias1, Cpv1, Cvcc1
Capacitor Ceramic X7R 47n 0603 16V	C3	1	Vishay	Generic	Css1
Capacitor Ceramic X7R 4.7n 0603 50V	C26	1	Vishay	Generic	Css2
Capacitor Ceramic X5R 22u 1210 16V	C9, C20	2	Murata	grm32er61c226k	Cin11, Cin21
Capacitor Al Poly 105C 120u 8mm x 7.6mm 16V	--	1	Nippon Chemi-con	APXE160ARA121MH70G	Cin12
Capacitor Ceramic X7R 100n 0603 16V	C10, C22	2	Vishay	Generic	Cb1, Cb2
Capacitor Ceramic COG 33p 0603 50V	C14, C18	2	Vishay	Generic	Clim1, Clim2
Capacitor Ceramic X7R 1.5n 0603 50V	C17	1	Vishay	Generic	Cc21
Capacitor Ceramic COG 820p 0603 50V	C16	1	Vishay	Generic	Cc22
Capacitor Ceramic X5R 22u 1206 6.3V	C11, C23	2	Murata	grm31cr60j226k	Co11, Co21
Capacitor Al Poly 105C 470u 8mm x 7.7mm 6.3V	C12	1	Nippon Chemi-con	APXE6R3ARA471MH80G	Co12
Diode Schottky 200mA SOD-323 30V	D1	1	Diodes inc	BAT54AW	Db1, Db2
Inductor Ferrite 15uH 7.6mm x 7.6mm	L1	1	Cooper	DR74-150-R	L1
Inductor Ferrite 10uH 8mm x 8mm	L2	1	Coilcraft	MSS7341-103MLD	L2
Single N-Channel MOSFET PG-TSDSON-8 30V	Q1, Q2	2	Infineon	BSZ130N03LS	QH1, QL1
Single N-Channel MOSFET SOT23-6 20V	Q3, Q4	2	Vishay	Si3460DV	QH2, QL2
1A Thick Film 0 Ohm jumper 0603	R14, R15, R30	3	Vishay	Generic	--
5% Thick Film 10 Ohms 0603	R7, R1	2	Vishay	Generic	Rpv1, Rin1
1% Thick Film 3.92k 0603	R2	1	Vishay	Generic	Rf12
1% Thick Film 10.0k 0603	R13, R29, R22	3	Vishay	Generic	Rpg1, Rpg2, Rc21
0.1% Thin Film 4.99k 0603	R18	1	Vishay	Generic	Rf23
1% Thick Film 20.0k 0603	R10	1	Vishay	Generic	Rf11
0.1% Thin Film 20.0k 0603	R26x	1	Vishay	Generic	Rt21
0.1% Thin Film 24.9k 0603	R24	1	Vishay	Generic	Rf22
0.1% Thin Film 15.0k 0603	R21	1	Vishay	Generic	Rf21
0.1% Thin Film 7.68k 0603	R27	1	Vishay	Generic	Rt22
1% Thick Film 60.4 Ohms 0603	R22	1	Vishay	Generic	Rc22
1% Thick Film 1.18k 0603	R19	1	Vishay	Generic	Rlim1
1% Thick Film 1.05k 0603	R23	1	Vishay	Generic	Rlim2
1% Thick Film 2.87k 0603	R11	1	Vishay	Generic	Rc12
1% Thick Film 49.9k 0603	R12	1	Vishay	Generic	Rc11
2 chan 300k to 600k PWM LFCSP-32	U1	1	Analog Devices	ADP1829ACPZ	U1

Table 2. Vout2, Vout3, Vout4, Vout5 and Vout6 Bill of Materials (3V3_DCD, 3V3_DCD_L, 2V5_DCD, 1V8_DCD and 1V25_DCD_L)

Description	Designator	Quantity	Manufacturer	MFR#
Capacitor Ceramic X7R 1u 0603 16V	Cin161, Co162	2	Murata	GRM188R71C105KA12D
Capacitor Ceramic X5R 2.2u 0805 16V	Cin171, Cin172, Cin191, Co191	4	Murata	GRM21BR61C225KA88L
Capacitor Ceramic X7R 1n 0603 50V	Css16, Co201	2	Vishay	Generic
Capacitor Ceramic COG 100p 0603 50V	Cc171, Css17	2	Vishay	Generic
Capacitor Ceramic X7R 100n 0603 16V	Cvcc16, Cvcc17, Co181	3	Vishay	Generic
Capacitor Ceramic COG 47p 0603 50V	Cc161	1	Vishay	Generic
Capacitor Ceramic X5R 22u 1206 6.3V	Co161	1	Murata	grm31cr60j226k
Capacitor Ceramic X5R 10u 1206 10V	Co171	1	Murata	grm31mr61a106k
Capacitor Al Poly 105C 150u 5mm x 5.8mm 4V	Co182	1	Nippon Chemi-con	APXE4R0ARA151ME61G
Inductor Ferrite 4.7uH 1210 1A	L16	1	Taiyo Yuden	CB C3225T4R7MR
Inductor Ferrite 2.2uH 1210 1.1A	L17	1	Taiyo Yuden	CB C3225T2R2MR
Inductor Ferrite 100uH 1210 0.27A	L18	1	Taiyo Yuden	CB C3225T101MR
5% Thick Film 10 Ohms 0603	Rin16, Rin17, Rin18	3	Vishay	Generic
1% Thick Film 402 Ohms 0603	Rin20	1	Vishay	Generic
1A Thick Film 0 Ohm jumper 0603	Rf171	1	Vishay	Generic
1% Thick Film 249k 0603	Rf161	1	Vishay	Generic
1% Thick Film 80.6k 0603	Rf162	1	Vishay	Generic
1% Thick Film 100k 0603	Rt171	1	Vishay	Generic
1% Thick Film 80.6k 0603	Rt172	1	Vishay	Generic
1% Thick Film 200k 0603	Rc161	1	Vishay	Generic
1% Thick Film 76.8k 0603	Rc171	1	Vishay	Generic
Diode Dual Schottky 200mA SOT-323 30V	D18	1	Diodes inc	BAT54SW
Integrated 1.2MHz PWM LFCSP-16	U16	1	Analog Devices	ADP2105ACPZ-3.3-R7
Integrated 1.2MHz PWM LFCSP-16	U17	1	Analog Devices	ADP2105ACPZ-1.8-R7
500mA 2.5V Linear Reg MSOP-8 w/track	U19	1	Analog Devices	ADP1716ARMZ-2.5-R7
10mA 1.25V Shunt Ref SOT23	U20	1	Analog Devices	ADR1581ARTZ

Table 3. Power Down Bill of Materials

Description	Designator	Quantity	Manufacturer	MFR#
Single N-Channel MOSFET SOT23 60V	Qoff, Qp1, Qp2, Qp16, Qp17, Qp19	6	Diodes inc	2N7002-F
1% Thick Film 10.0k 0603	Roff	1	Vishay	Generic
1% Thick Film 28.7 Ohms 1206	Rp1	1	Vishay	Generic
1% Thick Film 1.43k 0603	Rp2	1	Vishay	Generic
1% Thick Film 9.76k 0603	Rp19	1	Vishay	Generic
1% Thick Film 154 Ohms 0603	Rp16	1	Vishay	Generic
1% Thick Film 2.37k 0603	Rp17	1	Vishay	Generic

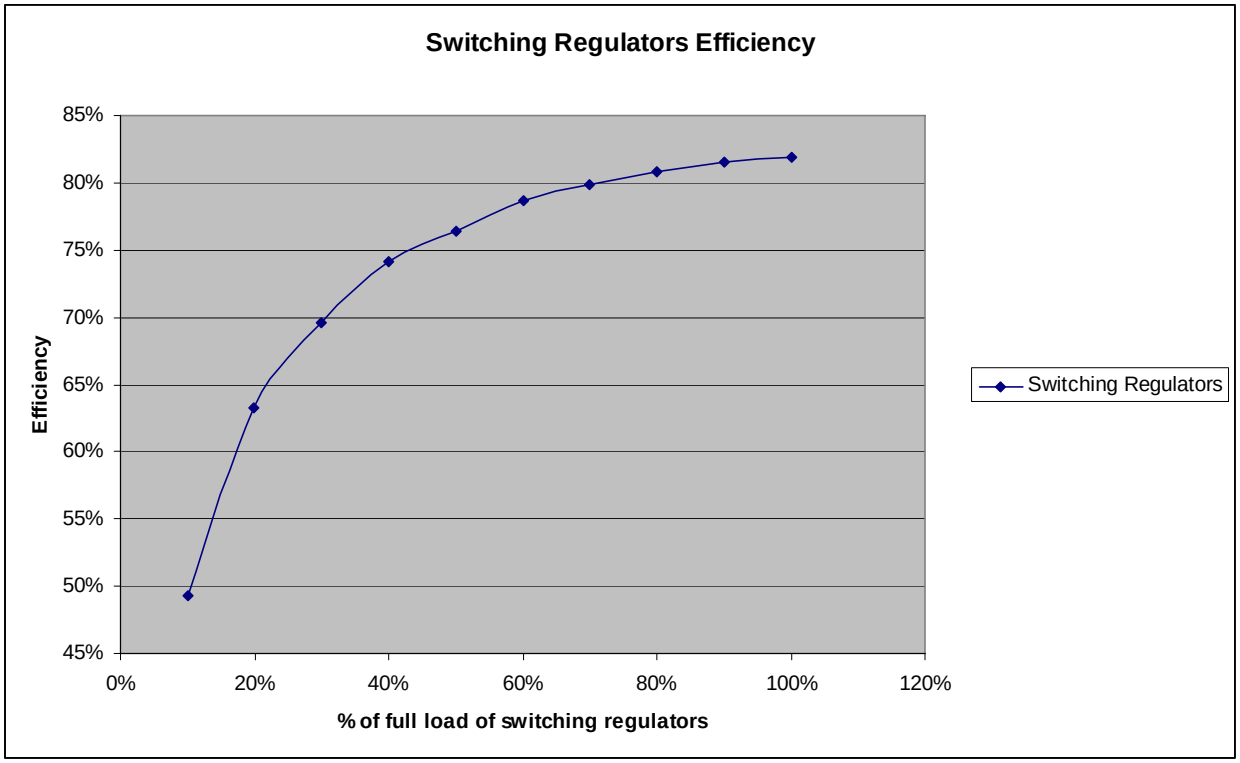


Figure 5. 12 V Efficiency (linear regulators enabled at no load)

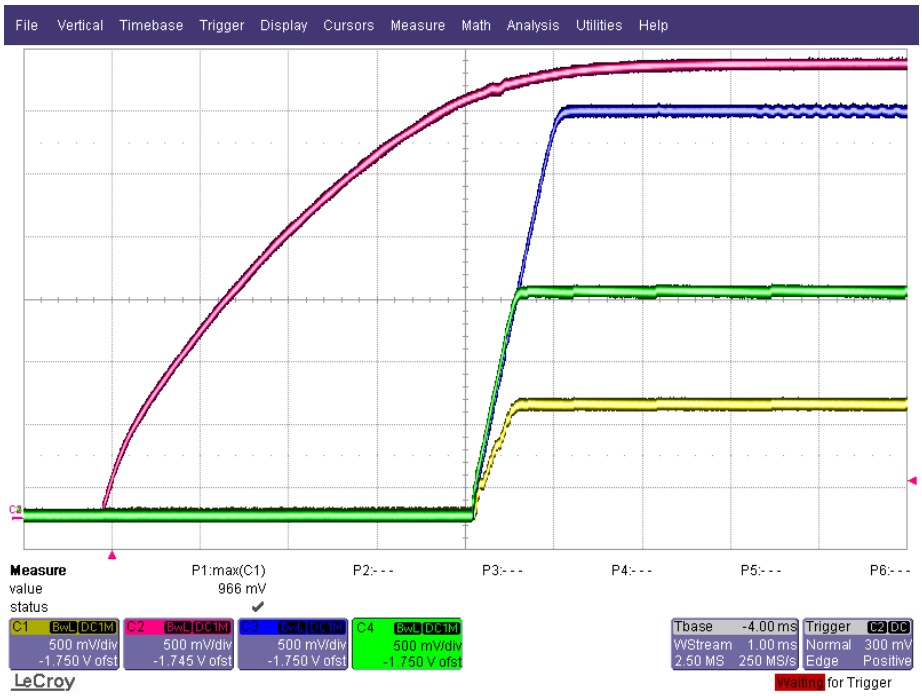


Figure 6. Switching regulator turn on at no load: Ch1 = 0V9_FPGA, Ch2 = Vo3V6, Ch3 = 3V3_DCD, Ch4 = 1V8_DCD

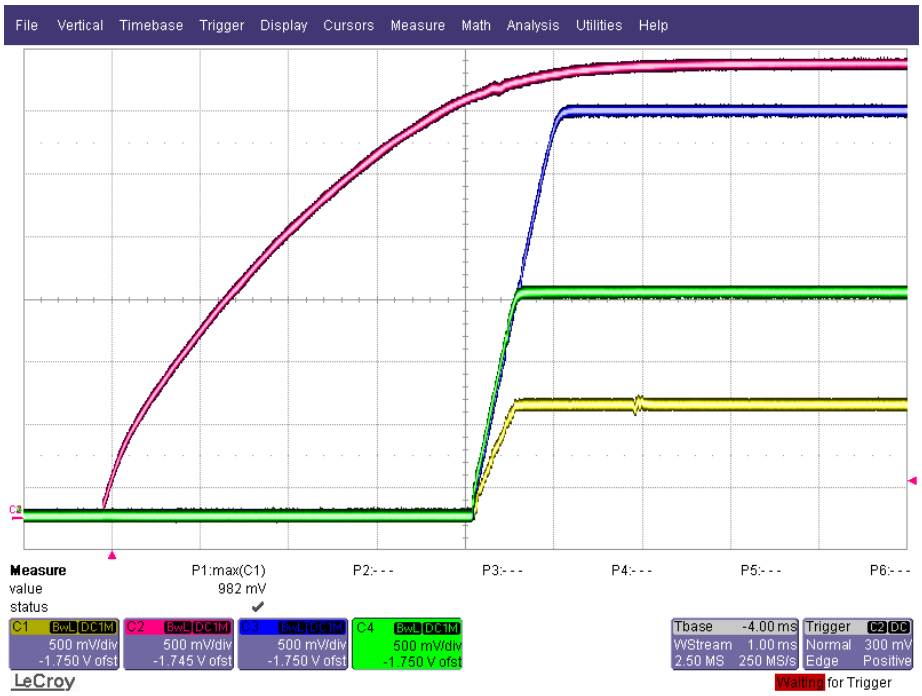


Figure 7. Switching regulator turn on at full load: Ch1 = 0V9_FPGA, Ch2 = Vo3V6, Ch3 = 3V3_DCD, Ch4 = 1V8_DCD

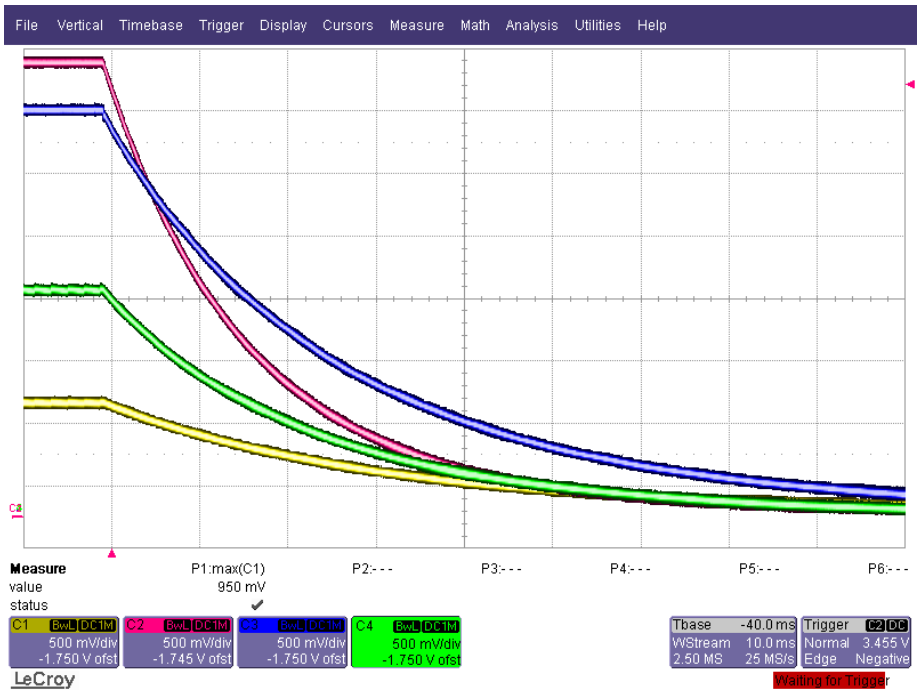


Figure 8. Switching regulator turn off at no load: Ch1 = 0V9_FPGA, Ch2 = Vo3V6, Ch3 = 3V3_DCD, Ch4 = 1V8_DCD

Figure 9. Switching regulator turn off at full load: Ch1 = 0V9_FPGA, Ch2 = Vo3V6, Ch3 = 3V3_DCD, Ch4 = 1V8_DCD

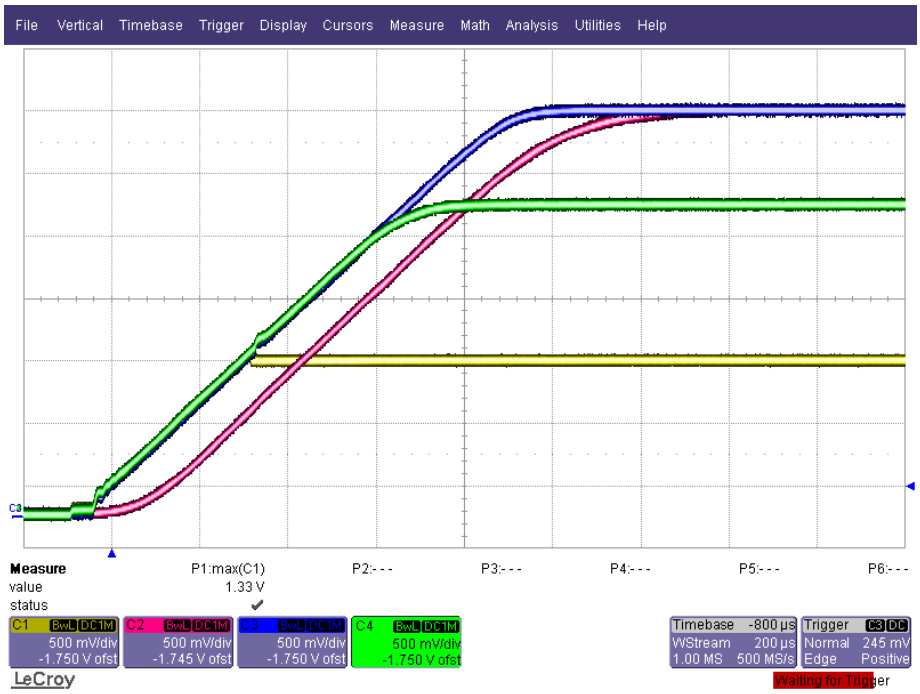


Figure 10. Linear/filtered regulator turn on at no load: Ch1 = 1V25_DCD_L, Ch2 = 3V3_DCD_L, Ch3 = 3V3_DCD, Ch4 = 2V5_DCD

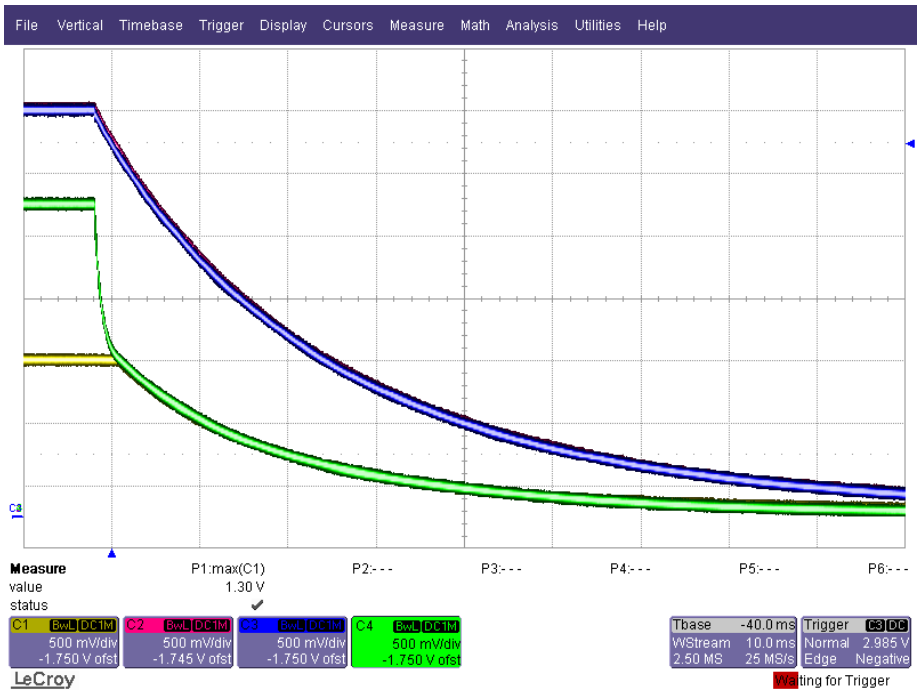


Figure 11. Linear/filtered regulator turn off at no load: Ch1 = 1V25_DCD_L, Ch2 = 3V3_DCD_L, Ch3 = 3V3_DCD, Ch4 = 2V5_DCD

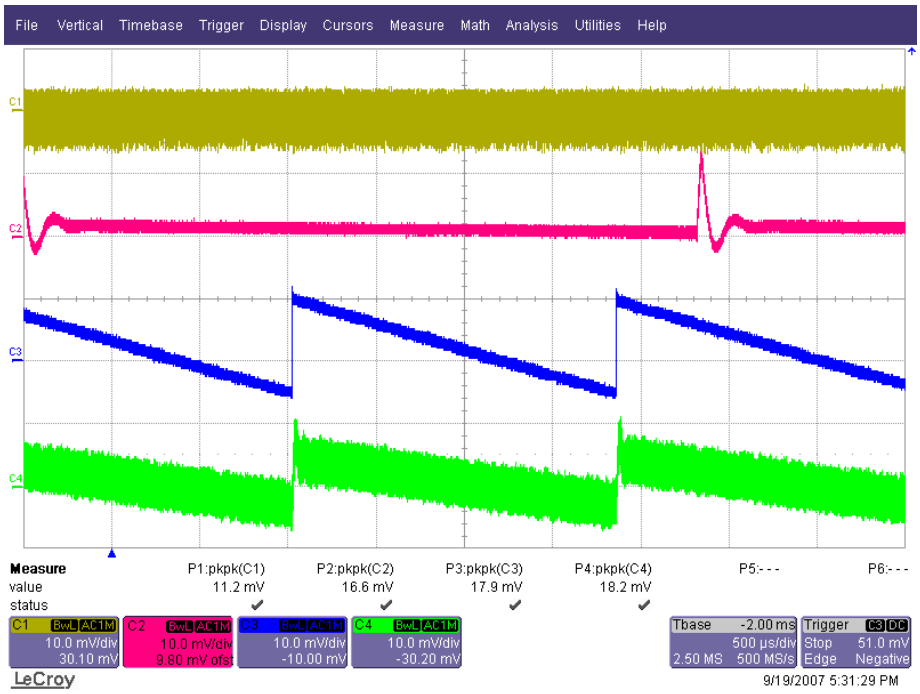


Figure 12. Switching regulator ripple and noise at no load: Ch1 = Vo3V6, Ch2 = 3V3_DCD, Ch3 = 1V8_DCD, Ch4 = 0V9_FPGA

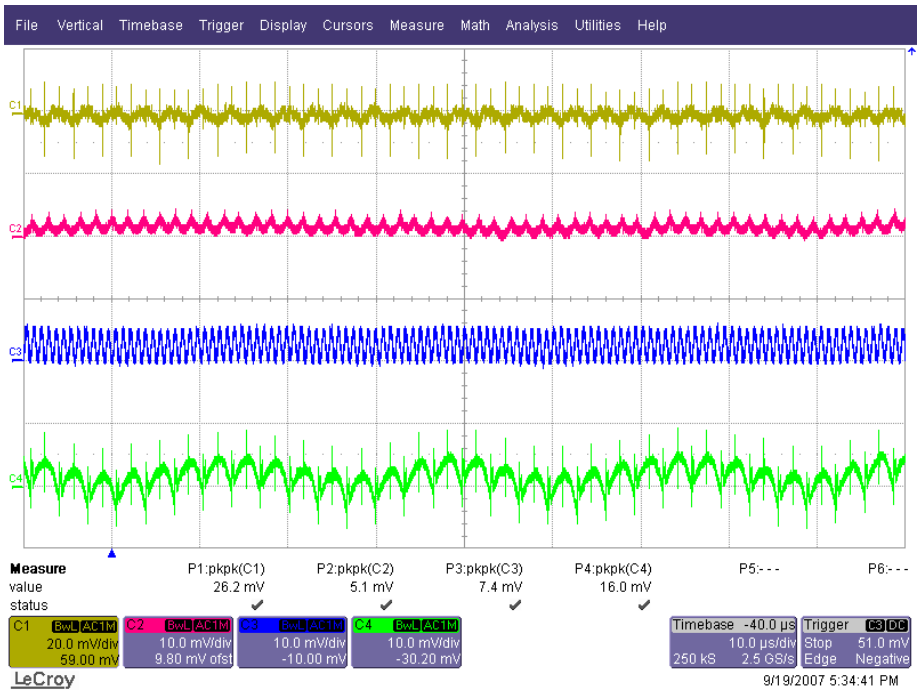


Figure 13. Switching regulator ripple and noise at full load: Ch1 = Vo3V6, Ch2 = 3V3_DCD, Ch3 = 1V8_DCD, Ch4 = 0V9_FPGA

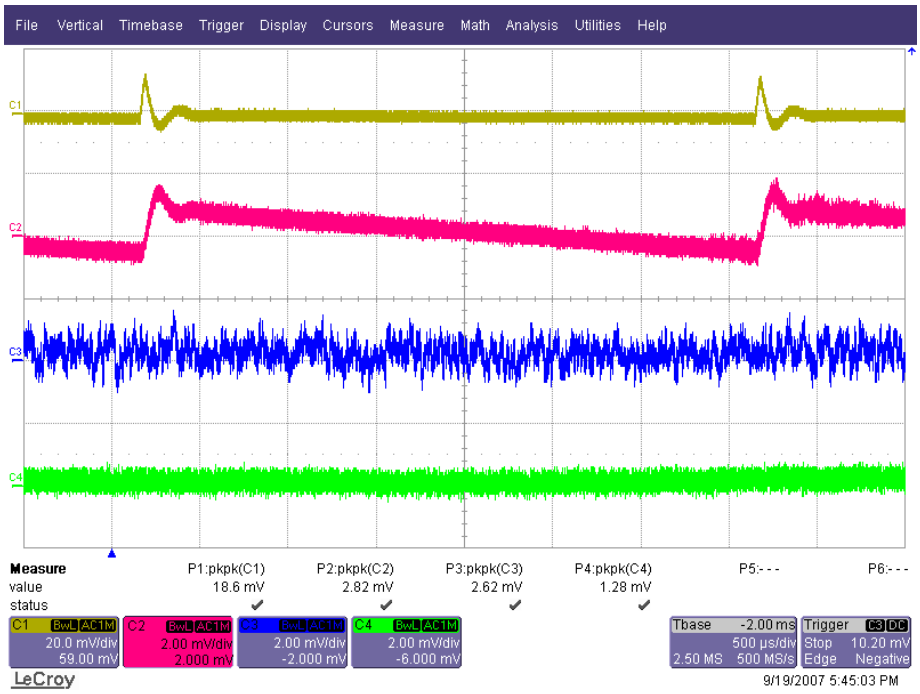


Figure 14. Linear/filtered regulator ripple and noise at no load: Ch1 = 3V3_DCD, Ch2 = 3V3_DCD_L, Ch3 = 2V5_DCD, Ch4 = 1V25_DCD_L

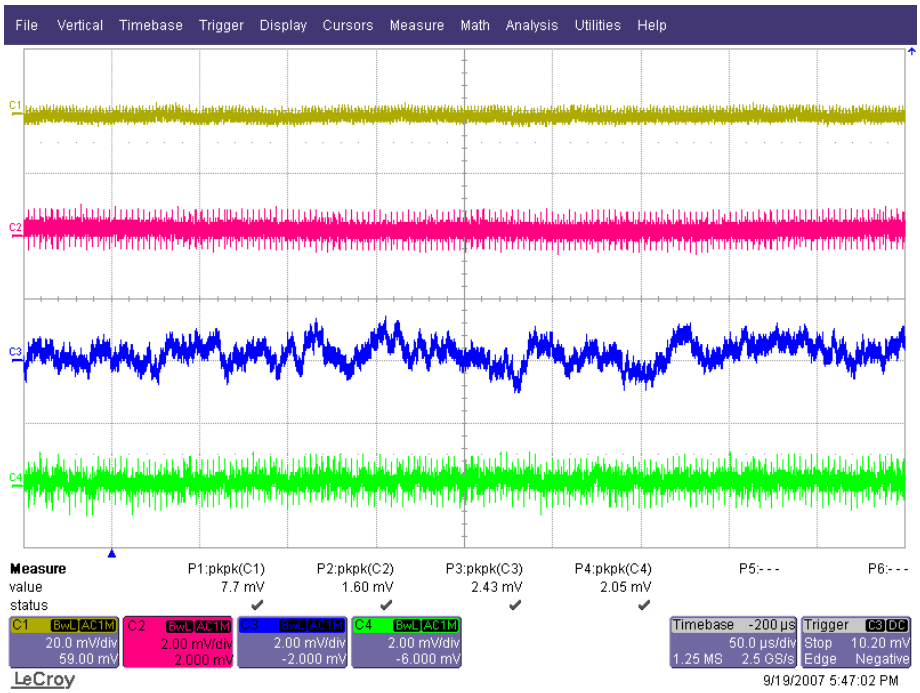


Figure 15. Linear/filtered regulator ripple and noise at full load: Ch1 = 3V3_DCD, Ch2 = 3V3_DCD_L, Ch3 = 2V5_DCD, Ch4 = 1V25_DCD_L

NOTES

Efficiency measurements include loss due to linear and shunt regulators being active at no load. Lower than average efficiency is to be expected due to the two stage conversion (creation of intermediate 3.6 V bus). Additionally, the 3.6 V converter is sized to provide over double the required current for this demo board, therefore its no load loss will be high.

Ripple voltage measurements especially on the low noise linear outputs show high frequency spikes that are likely probe noise pickup from attempting to probe the non-ideal two layer copper board. Noise levels are expected to be much lower on a multilayer FR4 board with proper decoupling techniques.