Precision Switchable Vout Regulator for OTP Applications

Preliminary Technical Data

FCDC 00159

FEATURES

Output Voltage Switchable between 2.5V 2% and 7.0V 1%
Output Current: 0 to 50 mA
Input voltage: 3.2 V to 5.25V
Ripple 2% ppk of Output Voltage

DESCRIPTION: OTP POWER REFERENCE DESIGN USING ADP1610, ADP1710 AND ADR550

- This OTP Power Reference design is a switchable output voltage regulator. It provides 2.5V during normal operation and 7.0V +/- 1% for One Time Programming.
- The 2.5V is regulated by an adjustable ADP1710 LDO with output through a Schottky series blocking diode.
- The 7.0V output uses an ADP1610 boost regulator with a DC blocking charge pump to allow the output to drop to 0 volts when the boost is not running. It also uses an ADR550 reference in the feedback path to provide superior set point accuracy.
- Input voltage is 3.3V to 5.0V
- Output current is 0 to 40 mA.

Rev. 1

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REVISION HISTORY

10/09/2008—Revision 1: Initial Version

GENERAL DESCRIPTION

ADP1610

The ADP1610 is a dc-to-dc step-up switching converter with an integrated 12V 1.2 A, 0.2 Ω power switch. It operates using current mode pulse-width modulation (PWM).

The ADP1610 has a Soft Start pin. Typical applications use a capacitor from the soft start pin to ground to slow the rate of rise of the error amplifier output at power up. This limits the regulator inrush current. In this application, the ADR550 reference in the feedback path significantly changes the feedback loop dynamics, and we are most concerned with limiting overshoot of the 7V output on power-up. We control this by limiting the voltage rate-of-rise using a series RC bypass in parallel with the ADR550 reference. This technique works best with no capacitor at the soft start pin.

A normal boost regulator has no ability to block current flow from the input through the diode and inductor to the output. In this application, this normal boost "pass-through" is unacceptable. DC blocking is needed so that Vout can be controlled by the LDO when the boost regulator is not working. For that reason, we insert a DC blocking capacitor-diode charge pump ahead of the boost output diode. This causes the Vout to settle to the LDO output voltage when the boost is not running. This modification reduces the output current capability of the boost regulator, however the 40 mA requirement is far below the normal capability of the ADP1610 and the charge pump is appropriate for this application.

ADP1710

The ADP1710 is a low dropout linear regulator that operates from 2.5 V to 5.5 V and provides up to 150 mA of output current. It is available in sixteen fixed output voltage options and an adjustable version, which is the one chosen for this application.

In this application , the ADP1710 output is isolated from the 7V output using a Schottky series output blocking diode. For extra protection of the LDO we have a second diode added antiparallel from LDO output to input. Using the adjustable version ADP1710 with suitable resistor stuffing options allows the LDO to regulate 2.5V at either the anode or the cathode of the series output blocking diode.

ADR550

The ADR520/ADR525/ ADR530/ADR540/ADR550 are high precision shunt voltage references that are set for 2.048 V, 2.5 V, 3.0 V, 4.096 V, and 5.0 V respectively. They are available in either SC70 and SOT-23-3 packages. These references feature low temperature drift of 40 ppm/°C, an initial accuracy of better than ±0.2%, and ultralow output noise of 14 μV peak-peak.

The advanced design of the ADR520/ADR525/ ADR530/ADR540/ADR550 eliminates the need for compensation by an external capacitor, but they are stable with any capacitive load. They are specified over an operating current range of 50 μA up to 15 mA. This low operating current and ease of use make these references ideally suited for handheld, battery-powered applications.

This application uses the 5.0V ADR550 in the feedback loop divider of the ADP1610 in order to provide 1% output voltage accuracy. We operate the ADR550 at 1.23V / 3.01K ohms, which gives us about 400 uA. This allows a wide margin relative to both the minimum and maximum operating current of the ADR550.

BLOCK DIAGRAM

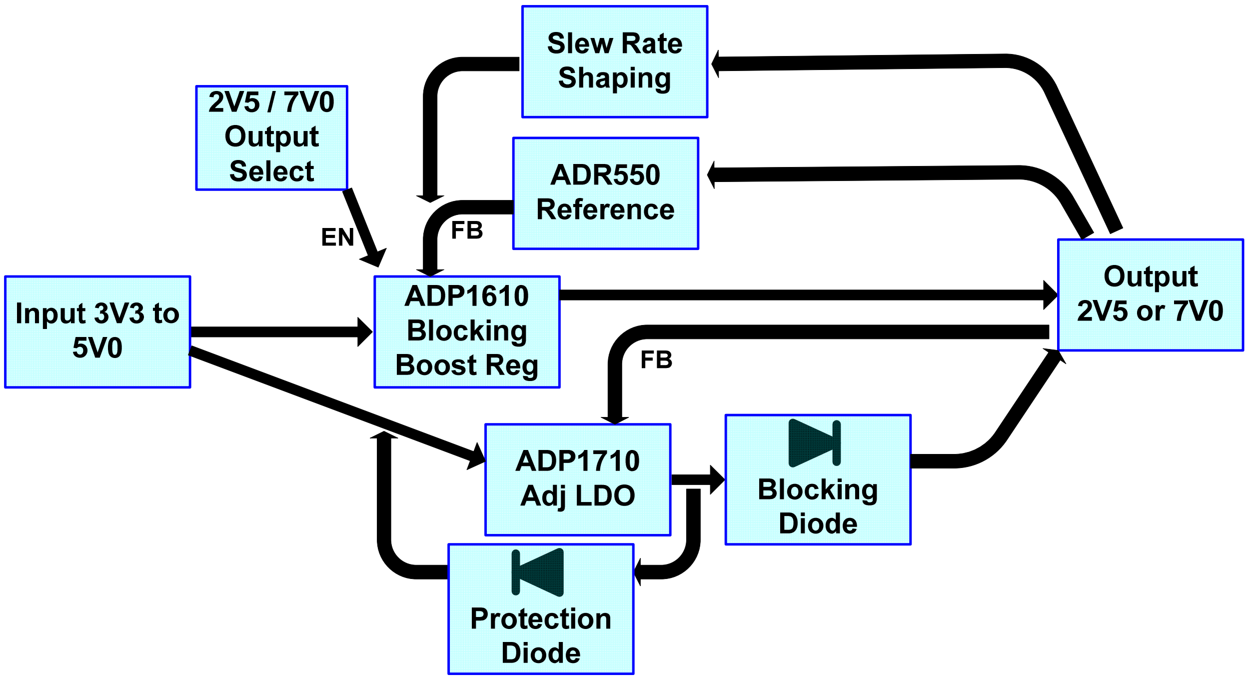

Figure 1. Block Diagram of the Switchable Vout Regulator

SCHEMATIC

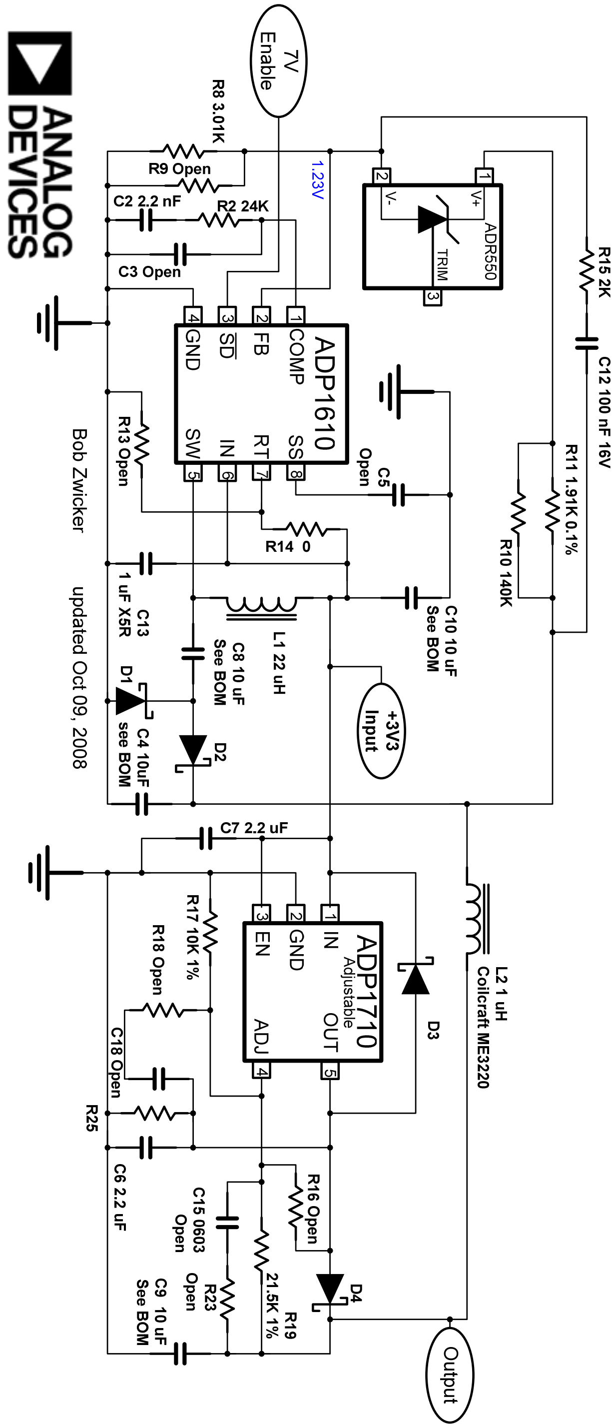

Figure 2. Schematic Diagram of the Switchable Vout Regulator

BILL OF MATERIALS

Table 1. Bill of Materials for the Switchable Vout Regulator design.

Description	Designator	Manufacturer	MFR#
IC Boost Regulator ADP1611	U1	Analog Devices, Inc.	ADP1611
IC Reference ADR550ARTZ	U3	Analog Devices, Inc.	ADR550ARTZ
IC Adjustable LDO ADP1710AUJZ	U4	Analog Devices, Inc.	ADP1710AUJZ
2.2 nF X7R 0603 25V	C2	Generic	Generic
Open	C3		
Capacitor 10 uF X5R 1210 Ceramic	C4	Murata	GRM31CR61A106KA01L
Open	C5		
2.2 uF 6.3V 0603 X5R	C6	Generic	Generic
2.2 uF 6.3V 0603 X5R	C7	Generic	Generic
Capacitor 10 uF X5R 1210 Ceramic	C8	Murata	GRM31CR61A106KA01L
Capacitor 10 uF X5R 1210 Ceramic	C9	Murata	GRM31CR61A106KA01L
Capacitor 10 uF X5R 1210 Ceramic	C10	Murata	GRM31CR61A106KA01L
100 nF 16V 0603 X7R	C12	Generic	Generic
1 uF 6.3V 0603 X5R	C13	Generic	Generic
Open	C15		
Open	C18		
Diode Schottky 1A 30V	D1	On Semi	MBRS130LSFT1
Diode Schottky 1A 30V	D2	On Semi	MBRS130LSFT1
Diode Schottky 1A 30V	D3	On Semi	MBRS130LSFT1
Diode Schottky 1A 30V	D4	On Semi	MBRS130LSFT1
Inductor shielded 22 uH	L1	Coilcraft	LPS4012-223
Inductor unshielded 1 uH	L2	Coilcraft	ME3220 1 uH
Resistor 24K 5% 0603	R2	Generic	Generic
Resistor 3.01K 0.1% 0603	R8	Generic	Generic
Open	R9		
Resistor 140K 1% 0603	R10	Generic	Generic
Resistor 1.91K 0.1% 0603	R11	Generic	Generic
Open	R13		
Resistor 0 Ohms 0603	R14	Generic	Generic
Resistor 2K 5% 0603	R15	Generic	Generic
Open	R16		
Resistor 10.0K 1% 0603	R17	Generic	Generic
Open	R18		
Resistor 21.5K 1% 0603	R19	Generic	Generic
Open	R23		
Open	R25		

SAMPLE OUTPUT WAVEFORMS

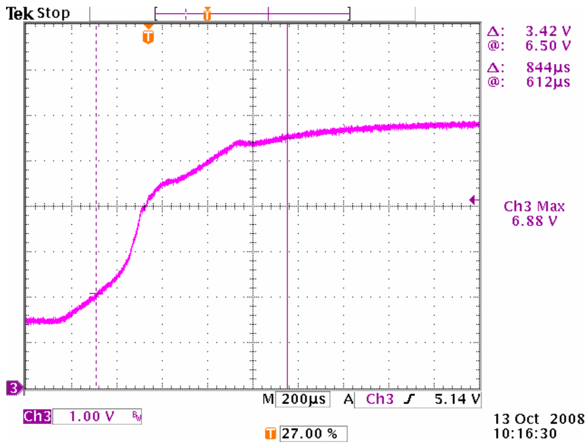

Figure 3. Transition from 2.5V to 7.0V Output with No Load and 5.0 VDC input

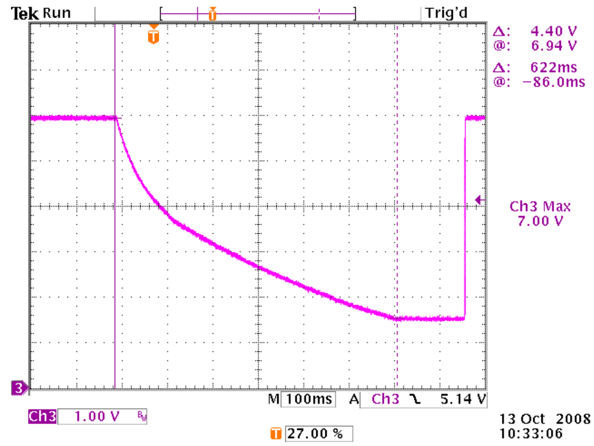

Figure 4. Transition from 7.0V to 2.5V Output with No Load and 5.0 VDC input

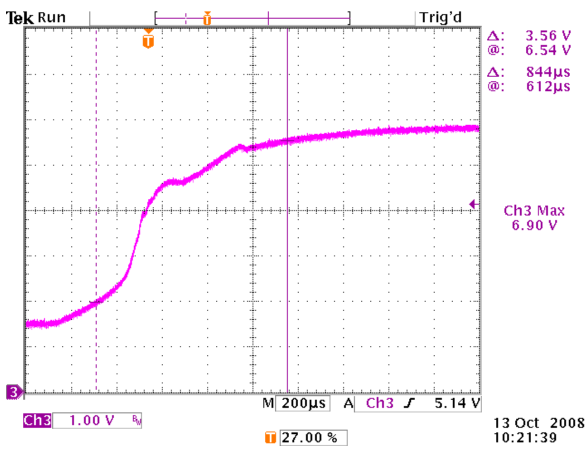

Figure 5. Transition from 2.5V to 7.0V Output with 40 mA Load and 5.0 VDC input

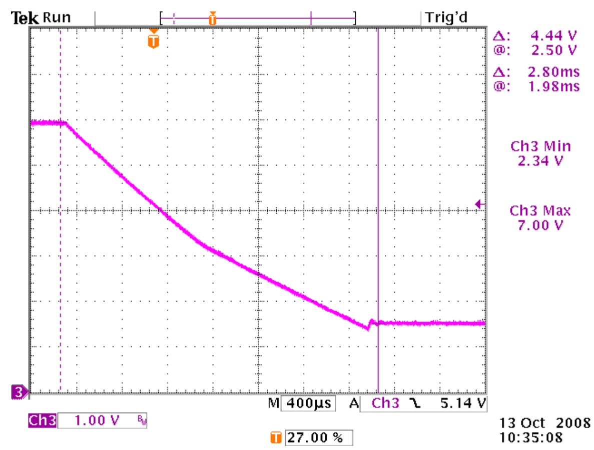

Figure 6. Transition from 7.0V to 2.5V Output with 40 mA Load and 5.0 VDC input

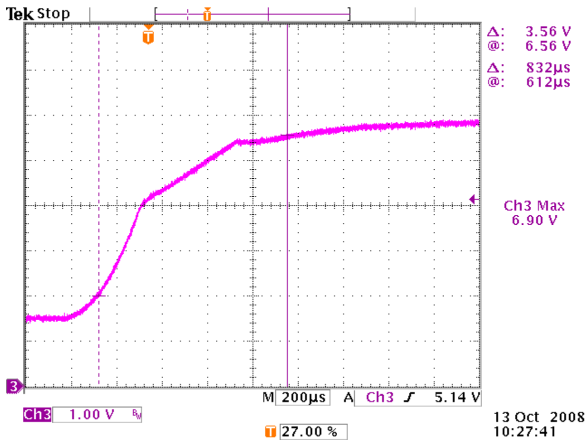

Figure 7. Transition from 2.5V to 7.0V Output with No Load and 3.3 VDC input

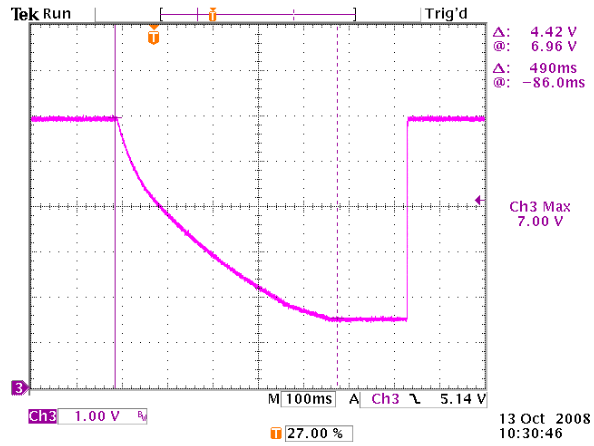

Figure 8. Transition from 7.0V to 2.5V Output with No Load and 3.3 VDC input

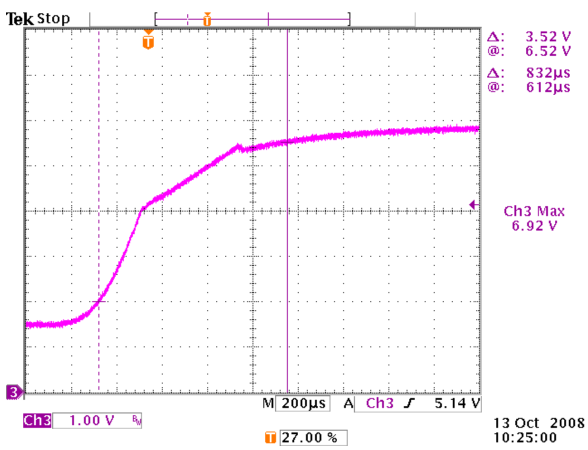

Figure 9. Transition from 2.5V to 7.0V Output with 40 mA Load and 3.3 VDC input

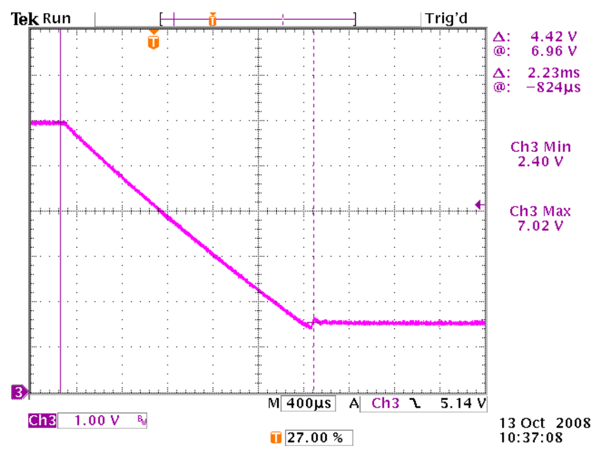

Figure 10. Transition from 7.0V to 2.5V Output with 40 mA and 3.3 VDC input

NOTES