



Design Note – DN05019/D 200V Boost Regulator

ON Semiconductor

Device	Application	Input Voltage	Output Voltage	Output Current	Topology
CS5171	General	12V	200V	20mA	Enhanced Boost

Circuit Description

The following solution is presented to support a low voltage to high voltage DC to DC boost application. The module has an input voltage range from 3.3V to 30V. The module provides 1 regulated output of 200V but can be configured for different outputs.

The CS5171 is a 280 kHz/ switching regulators with a high efficiency, 1.5 A integrated switch. The part operates over a wide input voltage range, from 2.7 V to 30 V. The flexibility of the design allows the chip to operate in most power supply configurations, including boost, flyback, forward, inverting, and SEPIC. The ICs utilize current mode architecture, which allows excellent load and line regulation, as well as a practical means for limiting current. Combining high frequency operation with a highly integrated regulator circuit results in an extremely compact power supply solution. The circuit design includes provisions for features such as frequency synchronization, shutdown, and feedback controls for either positive or negative voltage regulation.

Key Features

- Wide Input Range: 2.7V to 30V
- High Frequency Allows for Small Components
- Minimum External Components
- Easy External Synchronization
- Built-in Overcurrent Protection
- Frequency Foldback
- Thermal Shutdown with Hysteresis
- Integrated Power Switch: 1.5A Guaranteed

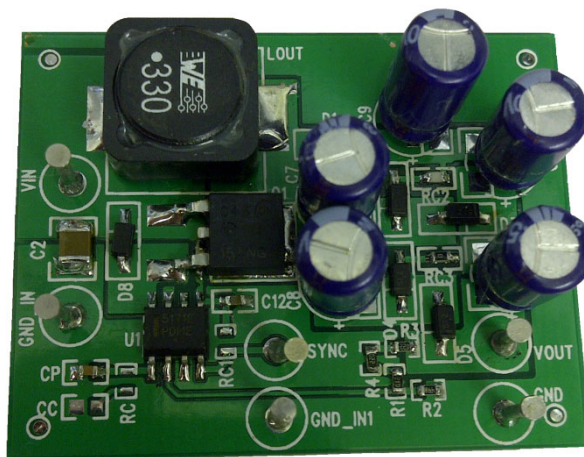


Figure 1: CS5171 Demonstration Board

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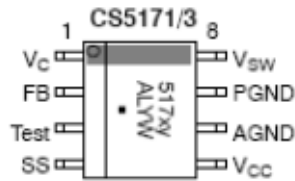


Figure 2: CS5171 Pinout

Table 1: Pin Description

PIN	PIN NAME	DESCRIPTION
1	VC	Loop compensation pin. The VC pin is the output of the error amplifier and is used for loop compensation, current limit and soft start. Loop compensation can be implemented by a simple RC network as shown in the application diagram on page 2 as R1 and C1.
2	FB	Positive regulator feedback pin. This pin senses a positive output voltage and is referenced to 1.276 V. When the voltage at this pin falls below 0.4 V, chip switching frequency reduces to 20% of the nominal frequency.
3	Test	These pins are connected to internal test logic and should either be left floating or tied to ground. Connection to a voltage between 2 V and 6 V shuts down the internal oscillator and leaves the power switch running.
4	SS	Synchronization and shutdown pin. This pin may be used to synchronize the part to nearly twice the base frequency. A TTL low will shut the part down and put it into low current mode. If synchronization is not used, this pin should be either tied high or left floating for normal operation.
5	VCC	Input power supply pin. This pin supplies power to the part and should have a bypass capacitor connected to AGND.
6	AGND	Analog ground. This pin provides a clean ground for the controller circuitry and should not be in the path of large currents. The output voltage sensing resistors should be connected to this ground pin. This pin is connected to the IC substrate.
7	PGND	Power ground. This pin is the ground connection for the emitter of the power switching transistor. Connection to a good ground plane is essential.
8	VSW	High current switch pin. This pin connects internally to the collector of the power switch. The open voltage across the power switch can be as high as 40 V. To minimize radiation, use a trace as short as practical.

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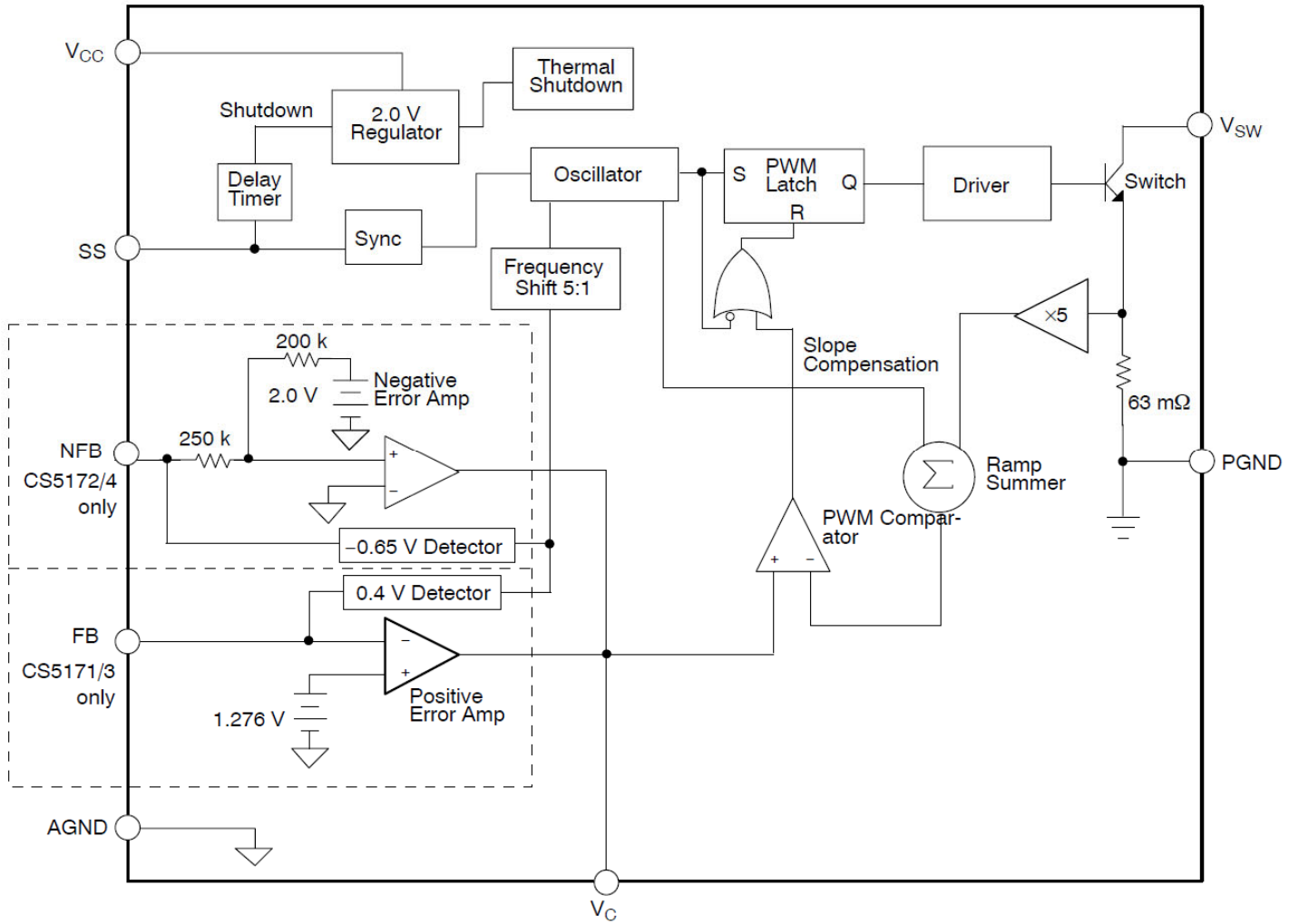


Figure 3: CS5171 Block Diagram

Performance Information

The following figures show typical performance of the evaluation board.

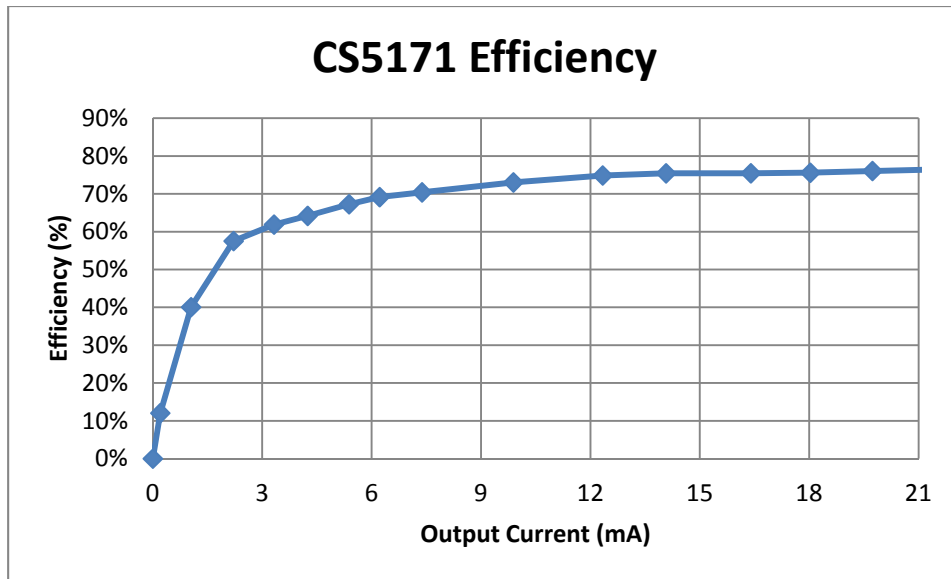


Figure 4: CS5171 12V to 200V Efficiency

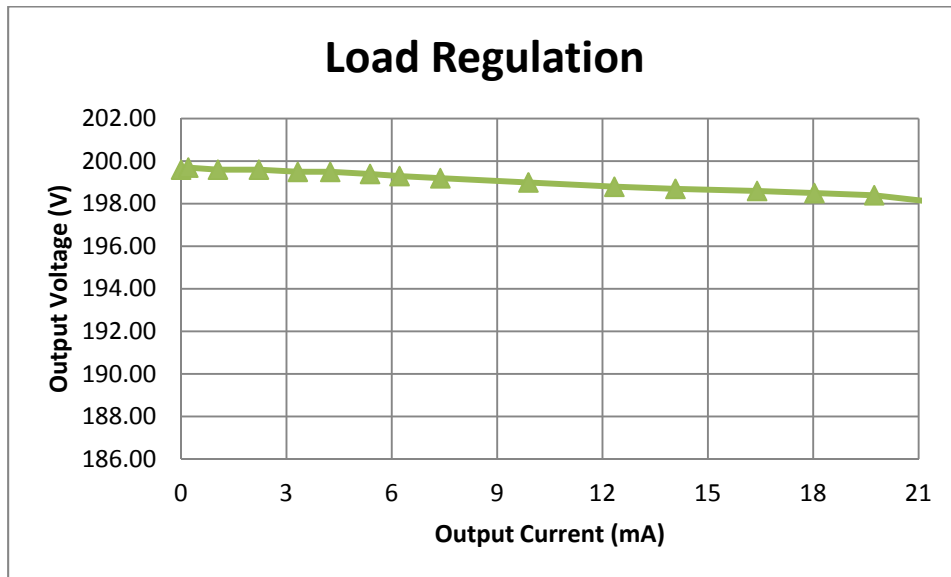
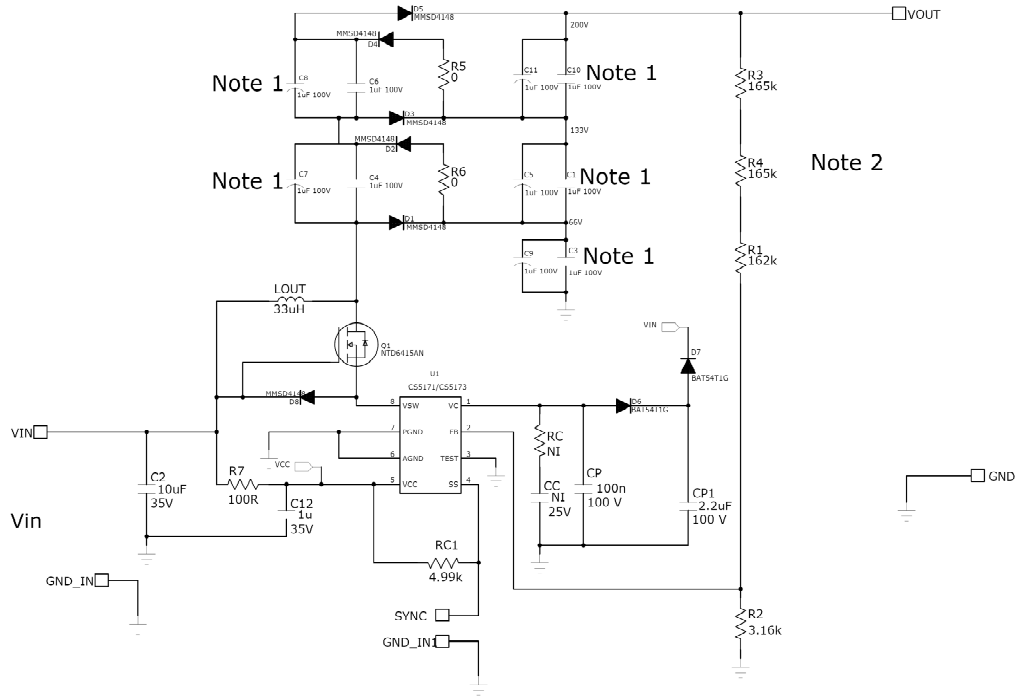


Figure 5: CS5171 12V to 200V Load Regulation

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Note 1: The designer should choose either an electrolytic capacitor or a ceramic capacitor both are not required

Note 2: The three resistors are used to set the proper output voltlage $1.276 * (1 + ((165 + 165 + 162) / 3.16)) = 199.94V$

Figure 6: CS5171 12V to 200V Schematic

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Table 2: BOM for the CS5171 200V Design

Reference	Qty	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number
C1 C3-4 C6 C10	5	SMT Ceramic Capacitor	NI	20%			
C12	1	SMT Ceramic Capacitor	1u	±10%	603	Taiyo Yuden	GMK107BJ105KA-T
CC	1	SMT Ceramic Capacitor COG	NI	±5%	603	AVX	C1608C0G1E682J
CP	1	SMT Ceramic Capacitor	100n	±5%	603	Murata	GRM188R71C104JA01J
CP1	1	SMT Ceramic Capacitor	2.2uF	±10%	603	TDK Corporation	C1608X5R1A225M
C2	1	SMT Ceramic Capacitor	10uF	±20%	1210	Taiyo Yuden	GMK325F106ZH-T
U1	1	500 kHz Synchronous Switching Regulator	500 kHz	NA	SOIC8	ON Semiconductor	CS5171/CS5173
D1-5 D8	6	Standard Rectifier	100V 1A	NA	SOD-123-2	ON Semiconductor	MMSD4148
D7 D6	2	Standard Rectifier	30V 10mA	NA	SOD-123-2	ON Semiconductor	BAT54T1G
LOUT	1	SMT Inductor	33uH	20%	(12.3 x 12.3 x 8.1)mm	Würth	744771133
Q1	1	N-Channel Power Mosfet	100V 55mOhm	NA	DPAK-4	ON Semiconductor	NTD6415AN
R1	1	SMT Resistor	162k	±1.0%	603	Vishay / Dale	CRCW0603162KFKEA
R2	1	SMT Resistor	3.16k	±1.0%	603	Vishay / Dale	CRCW06037K87FKEA
R3-4	2	SMT Resistor	165k	±1.0%	603	Vishay / Dale	CRCW0603165KFKEA
R5-6	2	SMT Resistor	0	±5.0%	603	Vishay / Dale	CRCW06030000Z0EA
R7	1	SMT Resistor	100R	±5.0%	603	Vishay / Dale	CRCW0603100RJNEAHP
RC	1	SMT Resistor	NI	±1.0%	603		
RC1	1	SMT Resistor	4.99k	±1.0%	603	Vishay / Dale	CRCW06034K99FKEA
C5 C7-9 C11	5	Aluminum Electrolytic Capacitor	1uF 100V	±20%	TH	Panasonic - ECG	ECA-2AM010B

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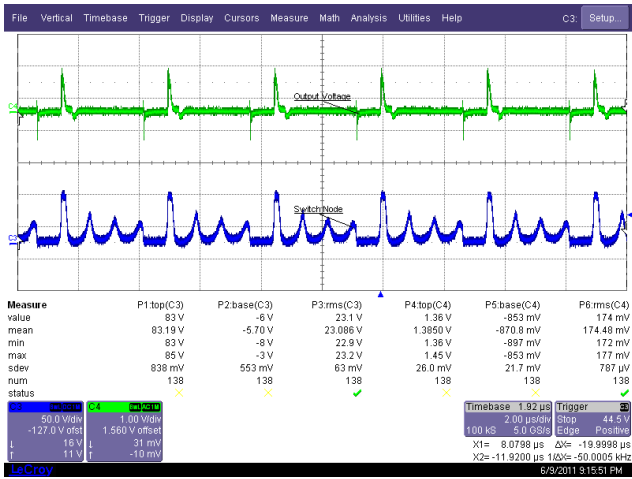


Figure9: Ripple Voltage 12 V to 200 V with no Load

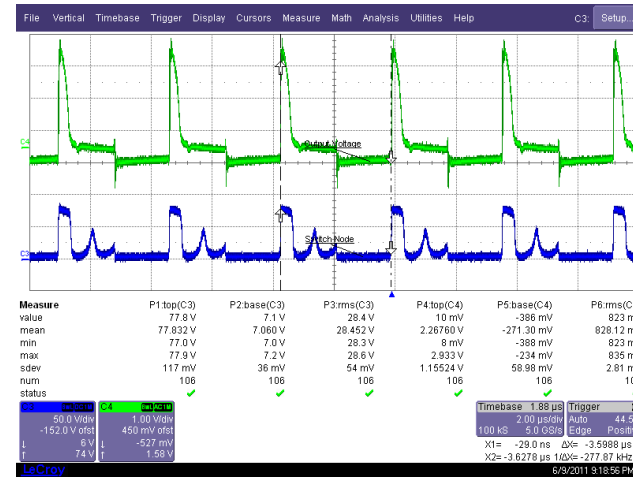


Figure10: Output Ripple 12 V to 200 V with 10 mA Load

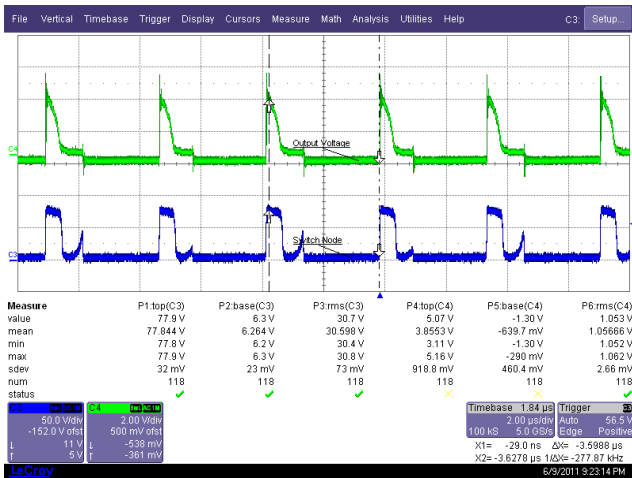


Figure10: Ripple Voltage 12 V to 200 V with 20 mA Load

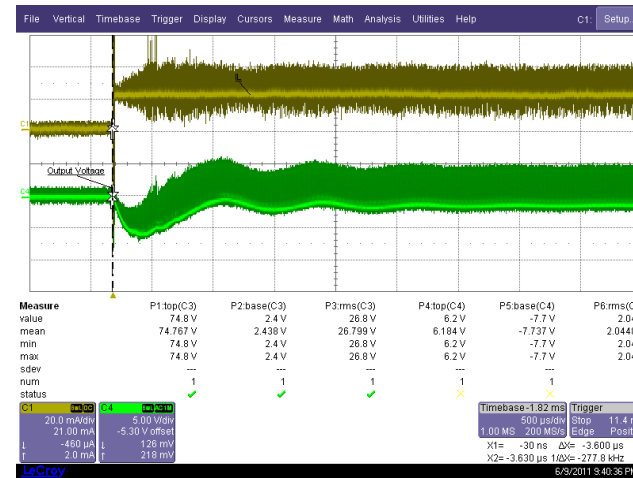


Figure12: Transient Response no Load to full load

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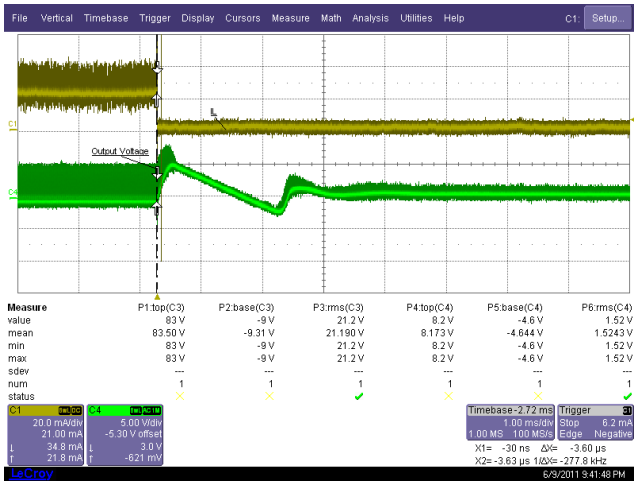


Figure12: Transient Response Full Load to No load

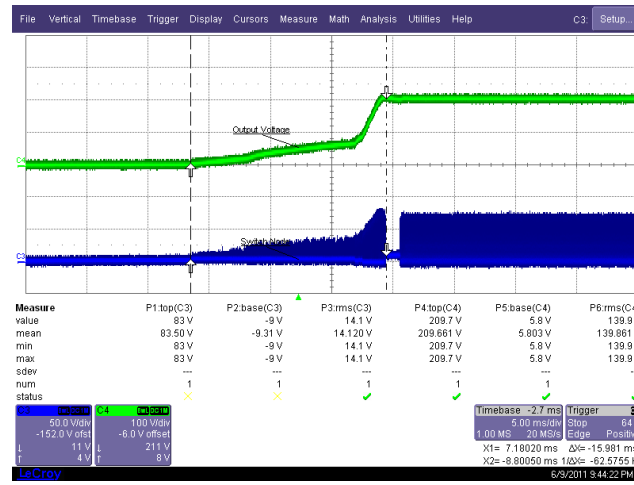


Figure14: CS5171 Soft Start with only compensation

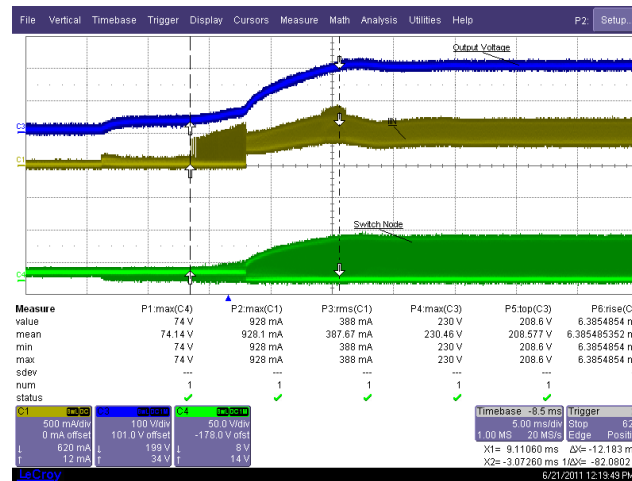


Figure15: Full load Soft Start with 2.2uF Extender Circuit

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