

# Low $I_Q$ Boost/SEPIC/Inverting Converter with 1A, 60V Switch

## DESCRIPTION

Demonstration circuit 2018A features the **LT<sup>®</sup>8330**, a low  $I_Q$  boost/SEPIC/inverting converter with a 1A, 60V switch.

The LT8330 allows higher input and output voltages than comparable converters and also significantly reduces input current at light loads and no load. The LT8330 regulates either positive or negative outputs and has an internally programmed switching frequency of 2MHz.

DC2018A consists of two circuits: one circuit is a boost converter with an operating input voltage range from 10V to 36V and an output voltage of 48V. With a 12V input, the maximum output current for the boost is 135mA and the efficiency is 89%. The second circuit is an inverting converter which demonstrates a negative output. The operating input voltage range of the inverting converter is from 4V to 36V and the output voltage is -12V. With a 12V input, the maximum output current for the inverting converter is 270mA and the efficiency is 87%.

For each DC2018A circuit, the output voltage is programmed by resistor divider feedback. The voltage divider uses high resistance values that minimize current leakage, and the feedback network also includes a 4.7pF feed-forward capacitor. Each DC2018A circuit also uses a low leakage rectifier diode to further minimize input current

at light loads and no load. The input supply for power to the inductor can be separated from the LT8330  $V_{IN}$  pin to allow operation from two input sources.

A resistor divider from the input to the EN/UVLO pin programs the boost to turn off when the input falls below 9V and the inverting converter to turn off when the input falls below 3.6V. The position of the EN/UVLO CONTROL jumper either connects the EN/UVLO pin to the input supply through a resistor divider, shorts EN/UVLO to ground, or allows the EN/UVLO pin to be driven directly by a signal applied to the EN/UVLO terminal. A 50V tantalum polymer capacitor protects the input from ringing that may occur when the input is hot-plugged using long leads.

Low input current at light loads, a high voltage rating and negative output capability make the LT8330 attractive for battery-powered and extended voltage range regulator circuits. DC2018A features the LT8330ES6 in a small 6-lead TSOT-23 package. The LT8330 data sheet must be read in conjunction with this demo manual to properly use or modify DC2018A.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2018A>**

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## PERFORMANCE SUMMARY – BOOST CONVERTER

Specifications are at  $T_A = 25^\circ\text{C}$

PARAMETERS FOR BOOST CONVERTER	CONDITIONS	MIN	TYP	MAX
Minimum Input Voltage, $V_{IN}$				10V
Maximum Input Voltage, $V_{IN}$		36V		
Maximum Output Current, $I_{OUT}$	$V_{IN} = 10V$ $V_{IN} = 12V$ $V_{IN} = 24V$ $V_{IN} = 36V$	110mA 135mA 210mA 400mA		
Input EN/UVLO Turn-On Voltage, $V_{IN}$	$R5 = 1M$ 1%, $R6 = 215k$ 1%, $V_{IN}$ Rising		9.5V	
Input EN/UVLO Turn-Off Voltage, $V_{IN}$	$R5 = 1M$ 1%, $R6 = 215k$ 1%, $V_{IN}$ Falling		9.0V	
Output Voltage, $V_{OUT}$	$R1 = 1M$ 1%, $R2 = 34.8k$ 1%	45.8V		49.4V
Efficiency	$V_{IN} = 12V$ , $I_{OUT} = 135mA$		89%	
Switching Frequency	$V_{IN} = 12V$ , $I_{OUT} = 135mA$		2MHz	

dc2018af

## PERFORMANCE SUMMARY – INVERTING CONVERTER Specifications are at $T_A = 25^\circ\text{C}$

PARAMETERS FOR INVERTING CONVERTER	CONDITIONS	MIN	TYP	MAX
Minimum Input Voltage, $V_{IN}$				4
Maximum Input Voltage, $V_{IN}$		36V		
Maximum Output Current, $I_{OUT}$	$V_{IN} = 4\text{V}$ $V_{IN} = 12\text{V}$ $V_{IN} = 24\text{V}$ $V_{IN} = 36\text{V}$	170mA 270mA 280mA 280mA		
Input EN/UVLO Turn-On Voltage, $V_{IN}$	$R7 = 1\text{M } 1\%$ , $R8 = 806\text{k } 1\%$ , $V_{IN}$ Rising		3.8V	
Input EN/UVLO Turn-Off Voltage, $V_{IN}$	$R7 = 1\text{M } 1\%$ , $R8 = 806\text{k } 1\%$ , $V_{IN}$ Falling		3.6V	
Output Voltage, $V_{OUT}$	$R1 = 1\text{M } 1\%$ , $R2 = 71.5\text{k } 1\%$	-12.5V		-11.5V
Efficiency	$V_{IN} = 12\text{V}$ , $I_{OUT} = 270\text{mA}$		87%	
Switching Frequency	$V_{IN} = 12\text{V}$ , $I_{OUT} = 270\text{mA}$		2MHz	

## QUICK START PROCEDURE

To evaluate the performance of the LT8330 using either the boost or inverting circuits of DC2018A, refer to Figure 1 for the proper measurement equipment setup, the Performance Summary for the maximum output current versus input voltage and then follow the procedure below.

**NOTE:** When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the  $V_{IN}$  or  $V_{OUT}$  terminals. See Figure 2 for proper scope probe technique.

1. Make sure the EN/UVLO CONTROL jumper JP1 or JP2 is in the ON position.
2. Connect the EN/UVLO terminal to GND with a clip-on lead. Connect the power supply (with power off), load, and meters as shown in Figure 1.

3. After all connections are made, turn on the input power and verify that the input voltage is between 10V and 36V for the boost or between 4V and 36V for the inverting circuit.
4. Remove the clip-on lead from EN/UVLO. Verify that the output voltage is 48V for the boost or -12V for the inverting circuit.

**NOTE:** If the output voltage is low, temporarily disconnect the load to make sure that it is not set too high.

Once the proper output voltage is established, adjust the input voltage and load within the operating ranges and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

QUICK START PROCEDURE

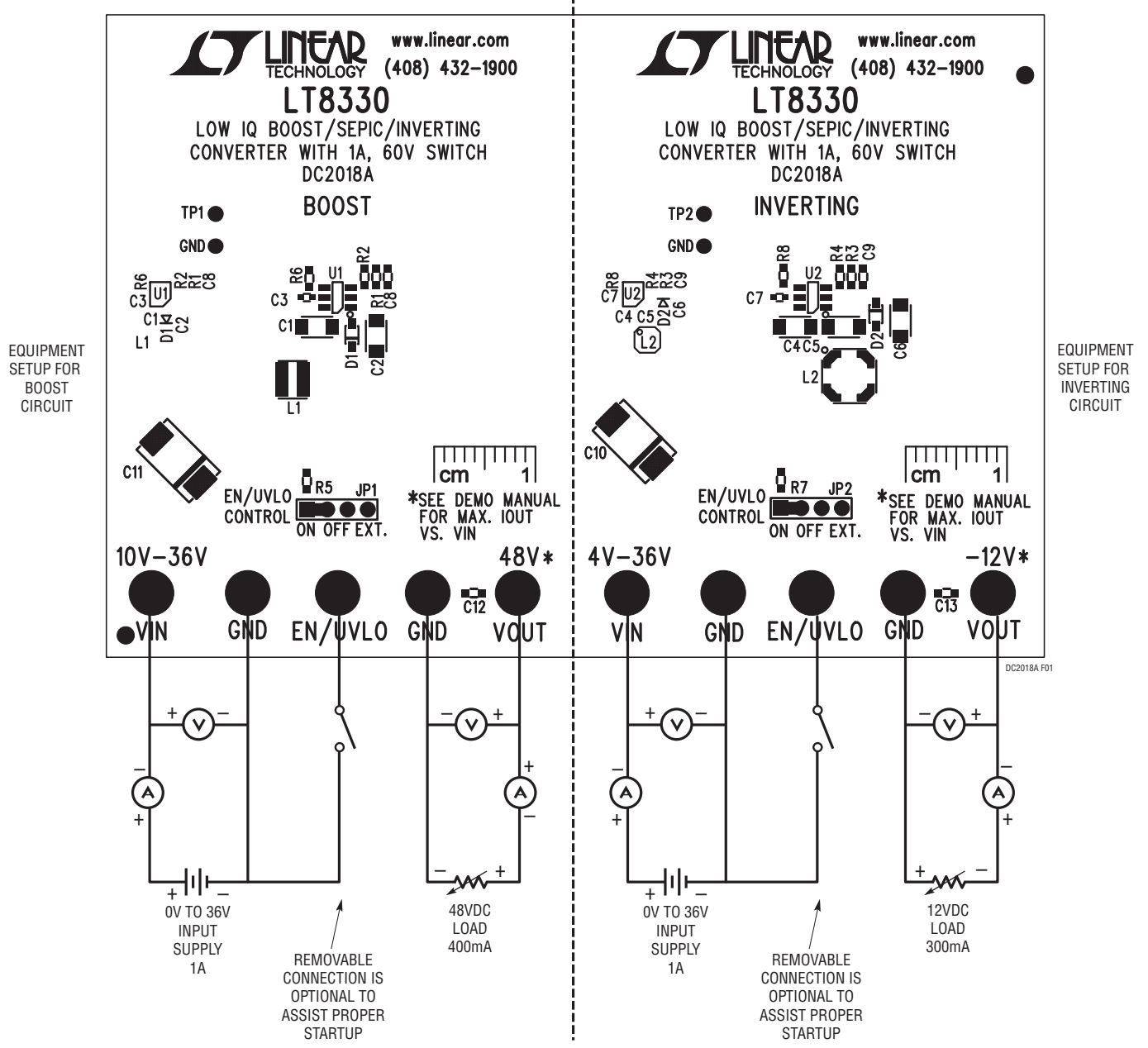


Figure 1: Proper Measurement Equipment Setup for DC2018A

## QUICK START PROCEDURE

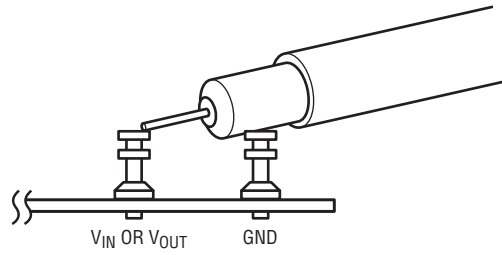


Figure 2: Proper Scope Probe Technique

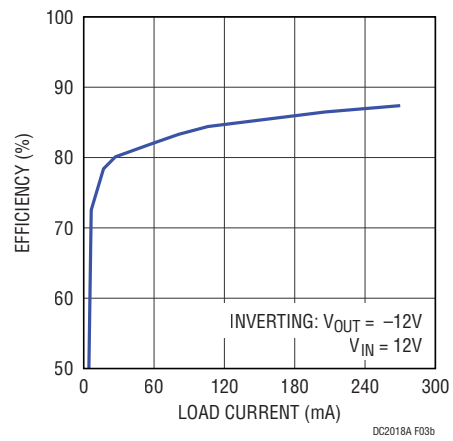
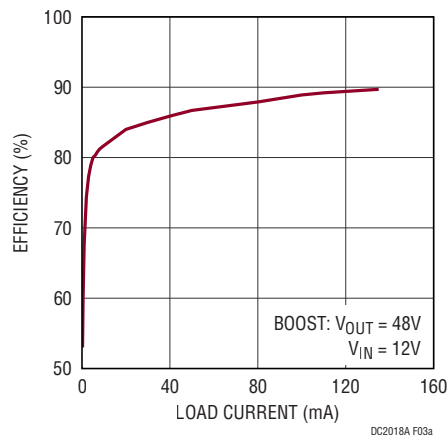


Figure 3:  $V_{IN} = 12V$  Boost and Inverting Converter Efficiencies

## QUICK START PROCEDURE

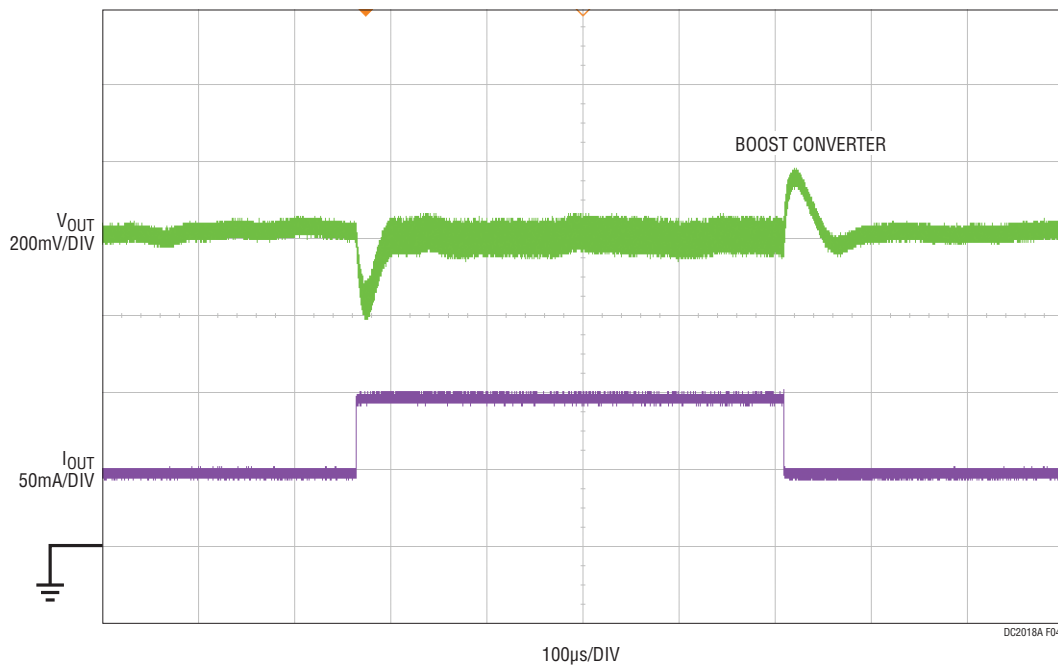


Figure 4. Output Voltage Load Transient Response for Boost Converter,  $V_{IN} = 12V$ ,  $V_{OUT} = 48V$ ,  $I_{OUT} = 50mA$  to  $100mA$  to  $50mA$

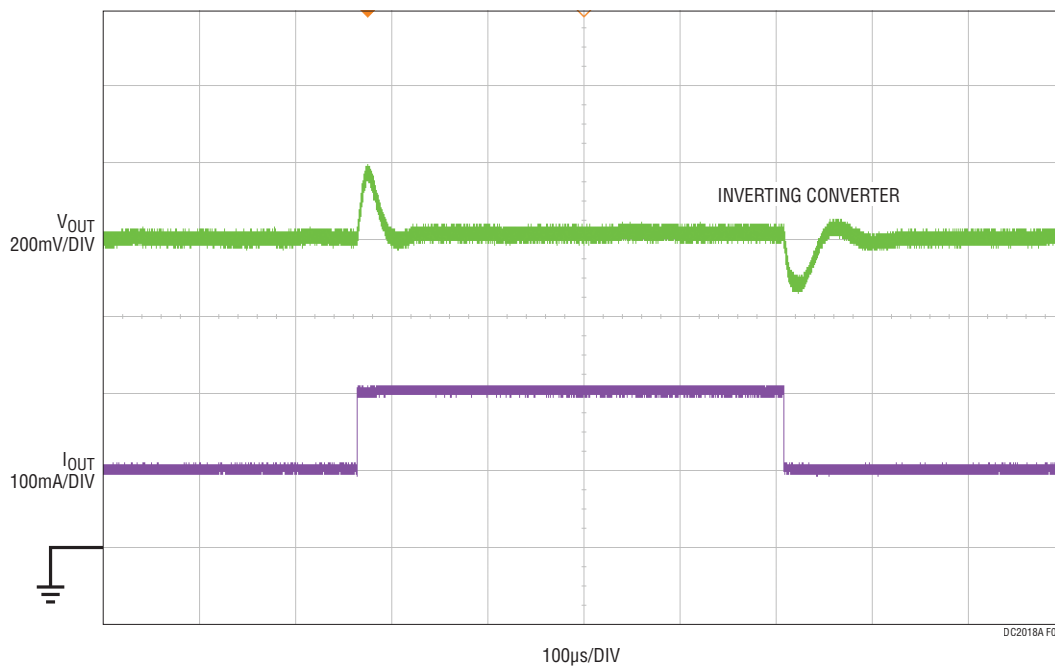


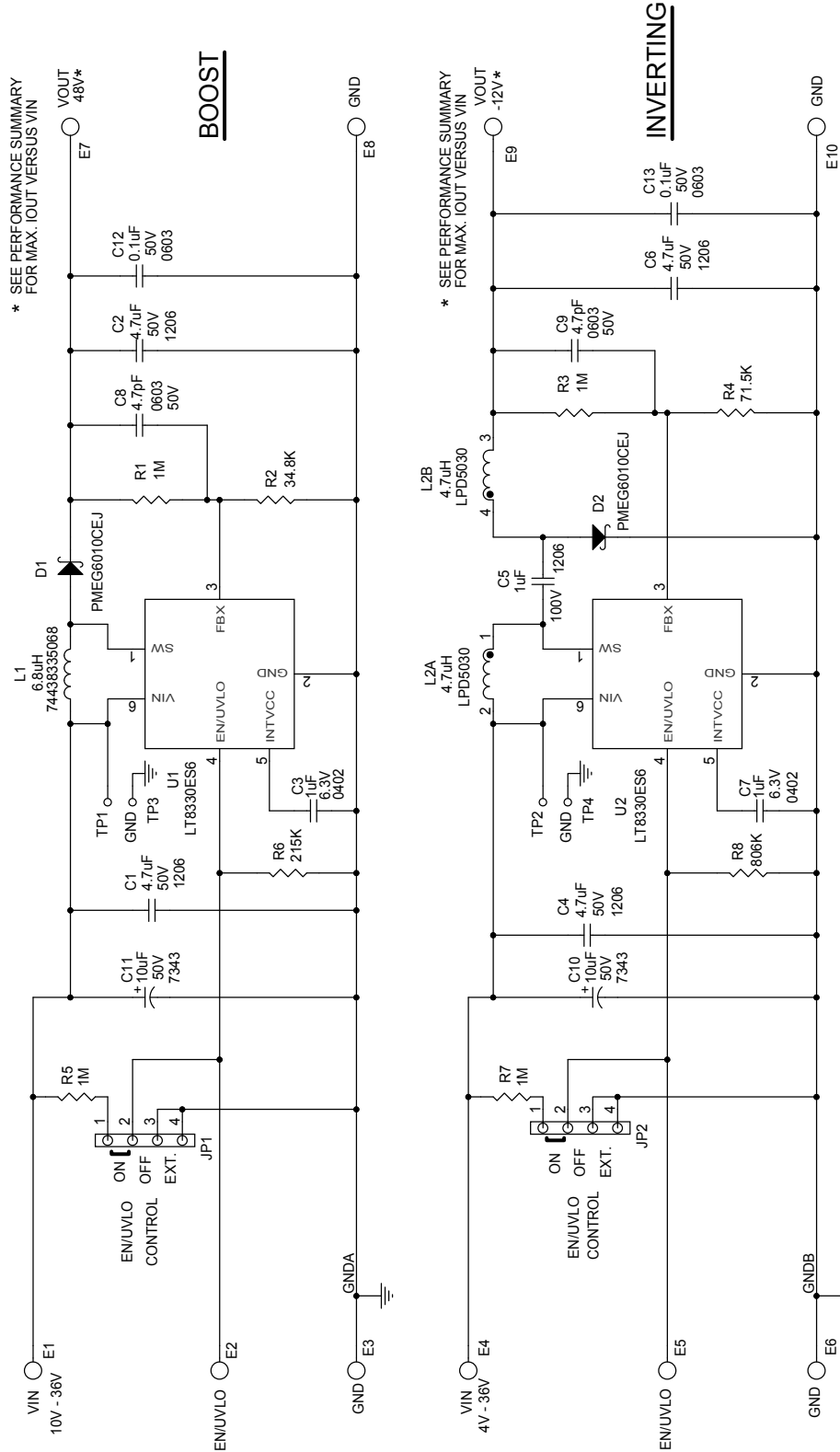
Figure 5. Output Voltage Load Transient Response for Inverting Converter,  $V_{IN} = 12V$ ,  $V_{OUT} = -12V$ ,  $I_{OUT} = 100mA$  to  $200mA$  to  $100mA$

# DEMO MANUAL DC2018A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components – Boost</b>				
1	2	C1, C2	CAP., X7R, 4.7µF, 50V, 10% 1206	MURATA, GRM31CR71H475KA12L
2	1	C3	CAP., X5R, 1.0µF, 6.3V, 10% 0402	TDK, C1005X5R0J105K
3	1	C8	CAP., X7R, 4.7pF, 50V, ±0.1pF 0603	MURATA, GRM1885C1H4R7BA01D
4	1	D1	60V, 1A, SCHOTTKY RECTIFIER, SOD323	NXP, PMEG6010CEJ
5	1	L1	INDUCTOR, 6.8µH	WURTH ELEKTRONIK, 74438335068
6	2	R1, R5	RES., CHIP, 1MΩ, 1/10W, 1% 0603	VISHAY, CRCW06031M00FKEA
7	1	R2	RES., CHIP, 34.8k, 1/10W, 1% 0603	VISHAY, CRCW060334K8FKEA
8	1	R6	RES., CHIP, 215k 1/10W, 1% 0603	VISHAY, CRCW0603215KFKEA
9	1	U1	IC., BOOST/INVERTING CONVERTER, TSOT-23	LINEAR TECH., LT8330ES6#PBF
<b>Required Circuit Components – Inverting</b>				
1	2	C4, C6	CAP., X7R, 4.7µF, 50V, 10% 1206	MURATA, GRM31CR71H475KA12L
2	1	C7	CAP., X5R, 1.0µF, 6.3V, 10% 0402	TDK, C1005X5R0J105K
3	1	C5	CAP., X7R, 1.0µF, 100V, 10% 1206	MURATA, GRM31CR72A105KA01L
4	1	C9	CAP., X7R, 4.7pF, 50V, ±0.1pF 0603	MURATA, GRM1885C1H4R7BA01D
5	1	D2	60V, 1A, SCHOTTKY RECTIFIER, SOD323	NXP, PMEG6010CEJ
6	1	L2	INDUCTOR, COUPLED, 4.7µH, LPD5030	COILCRAFT, LPD5030-472MEC
7	2	R3, R7	RES., CHIP, 1MΩ, 1/10W, 1% 0603	VISHAY, CRCW06031M00FKEA
8	1	R4	RES., CHIP, 71.5k, 1/10W, 1% 0603	VISHAY, CRCW060371K5FKEA
9	1	R8	RES., CHIP, 806k 1/10W, 1% 0603	VISHAY, CRCW0603806KFKEA
10	1	U2	IC., BOOST/INVERTING CONVERTER, TSOT-23	LINEAR TECH., LT8330ES6#PBF
<b>Optional Demo Circuit Components</b>				
1	2	C10, C11	CAP., TANT. POLYMER, 10µF, 50V, 7343	AVX., TCJD106M050R0120
2	2	C12, C13	CAP., X7R, 0.1µF, 50V, 10% 0603	MURATA, GRM188R71H104KA93D
<b>Hardware</b>				
1	10	E1-E10	TESTPOINT, TURRET, 0.094" PBF	MILL-MAX, 2501-2-00-80-00-00-07-0
2	2	JP1, JP2	HEADER, 4-PIN 0.079 SINGLE ROW	SULLINS, NRPN041PAEN-RC
3	2	JP1, JP2	SHUNT, 0.079" CENTER	SAMTEC, 2SN-BK-G

**SCHEMATIC DIAGRAM**



# DEMO MANUAL DC2018A

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