LTC3626EUDC
20V, 2.5A Synchronous Monolithic Step-Down Regulator with Current and Temperature Monitoring

DESCRIPTION

Demonstration circuit 1768A is a step-down converter, using the LTC3626 monolithic synchronous buck regulator, which has current and temperature monitoring capabilities. The 1768A has an input voltage range of 3.6V to 20V, and is capable of delivering up to 2.5A of output current. The output voltage of the 1768A can be set as low as 0.6V, the reference voltage of the LTC3626. At light load currents, the 1768A is capable of operating in Burst Mode™, which makes for greater efficiency, and during shutdown, it consumes less than 2µA of quiescent current. In continuous mode operation, the 1768A is a high efficiency circuit over 90%. The 1768A can also track another voltage with the LTC3626 track function. Because of the current and temperature monitoring and limiting capabilities of the LTC3626, the 1768A input or output current, as well as its maximum temperature can be limited or clamped. The 1768A uses low profile surface mount components, due to the high switching frequency capability of the LTC3626, which is programmable up to 3MHz. All these features make the 1768A an ideal circuit for use in industrial applications.

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

PERFORMANCE SUMMARY

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		3.6V –20V
Output Voltage Range		0.6V-6V
Run/Shutdown		GND = Shutdown
		V_{IN} = Run
Output Voltage Regulation	V_{IN} = 3.6V to 20V, I_{OUT} = 0A to 2.5A	1.2V ±2% Typ. (1.176V – 1.224V)
	V_{IN} = 3.6V to 20V, I_{OUT} = 0A to 2.5A	1.8V ±2% Typ. (1.764V – 1.836V)
	V_{IN} = 4V to 20V, I_{OUT} = 0A to 2.5A	3.3V ±2% Typ. (3.234V – 3.366V)
Typical Output Ripple Voltage	V_{IN} = 12V, V_{OUT} = 1.8V I_{OUT} = 2.5A (20MHz BW)	< 20mV_{P-P}
Burst Mode-to-Continuous Mode Transition Current Values	V_{IN} = 12V, V_{OUT} = 1.2V	I_{OUT} < 680mA
	V_{IN} = 12V, V_{OUT} = 1.8V	I_{OUT} < 880mA
	V_{IN} = 12V, V_{OUT} = 3.3V	I_{OUT} < 1.2A
Mode	Mode Pin = $INTV_{CC}$	Burst Mode
	Mode = GND	FCM (Forced Continuous Mode)
	Mode = Floating	Synchronized or Burst Mode
Nominal Switching Frequency	R_T = 324k	1MHz ±20%
	R_T connected to $INTV_{CC}$	2MHz ±30%

QUICK START PROCEDURE

Demonstration Circuit 1768A is easy to set up to evaluate the performance of the LTC3626. For proper measurement equipment configuration, set up the circuit according to the diagram in Figure 1. Before proceeding to test, check that the shunts are inserted into the default locations: 1.2V position of the output voltage header JP1, the SS position of the soft-start/track header JP5, the FCM (Forced Continuous Mode) position of the MODE header JP6, the ON position of RUN header JP7, the 1MHz position of the frequency header JP8, the EXT position of the I_{TH} header JP9, the SET/OFF position of the temperature set header JP10, the OFF position of the temp. monitoring header JP11, the OFF position of the output current monitoring header JP12, and the OFF position of the input current monitoring header JP13.

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} and GND terminals. See Figure 2 for proper scope probe measurement technique.

With the 1768A set up according to the proper measurement configuration and equipment in Figure 1, apply 6.3V at V_{IN} (Do not hot-plug V_{IN} or increase V_{IN} over the rated maximum supply voltage of 20V, or the part may be damaged.). Measure V_{OUT}; it should read 1.2V (If desired, the quiescent current of the circuit can be monitored now by swapping the shunt in header JP7 into the OFF position.). The output voltage should be regulating. Measure V_{OUT} it should measure 1.2V ±1% (1.188V to 1.212V).

Vary the input voltage from 3.6V to 20V and adjust the load current from 0 to 2.5A. V_{OUT} should regulate around 1.2V ±2% (1.176V to 1.224V). Measure the output ripple voltage; it should measure less than 20mVAC. Set the input voltage to 12V and the output current to any current less than 1.25A. Observe the discontinuous mode of operation at the switch node, and measure the output ripple voltage. It should measure less than 50mV. Change the shunt position on the MODE header from BM to FCM (Forced Continuous Mode) and observe the voltage waveform at the switch pins (the other side of the inductor from the output). Verify the switching frequency is between 850kHz and 1.2MHz (T = 1.17µs and 833ns), and that the switch node waveform is rectangular in shape.

Insert the JP7 shunt into the OFF position and move the shunt in the 1.2V output JP1 header into any of the two remaining output voltage option headers: 1.8V (JP2) or 3.3V (JP3). Just as in the 1.2V V_{OUT} test, the output voltage should read V_{OUT} ±1% tolerance under static line and load conditions and ±1% tolerance under dynamic line and load conditions ±2% total). Also, the circuit operation in discontinuous mode will be the same.

Monitor the input and output currents, and the die temperature, by changing the shunts on headers JP13, JP12, and JP11, respectively. The currents and temperature can even be limited using headers JP13, JP12, and JP10 – the TSET header, and adjusting the values of resistors R12, R13, and R14 (Consult the Input/Output Current and On-Die Temperature Monitor and Limit section of the LTC3626 datasheets for more details.).

When finished, turn off the circuit by inserting the shunt in header JP7 into the OFF position.

QUICK START PROCEDURE

Table 1. Jumper Description

JUMPER	FUNCTION	RANGE/SETTING (DEFAULT)
JP1	Output Voltage Setting.	1.2V
JP5	Soft-Start (TRACK or SS)	TRACK – (SS)
JP6	MODE/SYNC: Forced Continuous Mode (FCM), Burst Mode, or SYNC	(FCM) – BM – SYNC
JP7	RUN	(ON) – OFF
JP8	Frequency (FREQ)	(1MHz) – 2MHz
JP9	ITH: External Comp. (EXT) or Internal ($INTV_{CC}$) Comp. (INT)	(EXT) – INT
JP10	Temperature Setting (TSET): Externally Set (EXT SET) or Internally Set ($INTV_{CC}$) or Off (SET/OFF)	EXT SET – (SET/OFF)
JP11	Temperature Monitoring (TMON)	ON – (OFF)
JP12	Output Current Monitoring (I_{OUT})	ON – (OFF)
JP13	Input Current Monitoring (I_{IN})	ON – (OFF)

QUICK START PROCEDURE

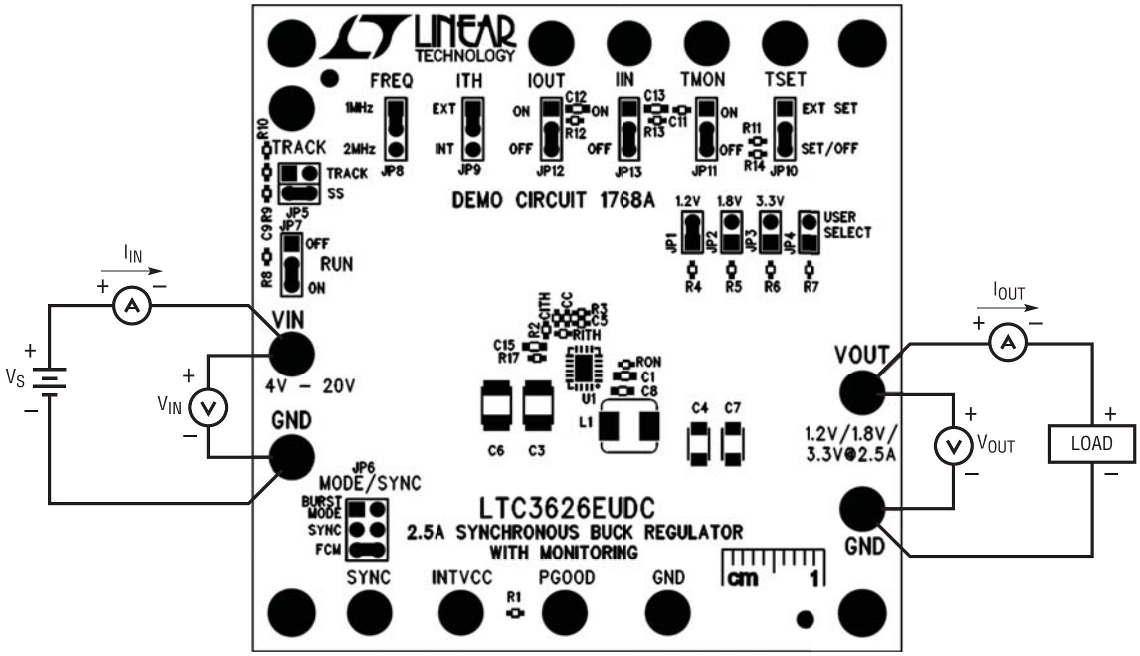


Figure 1. Proper Equipment Measurement Set-Up

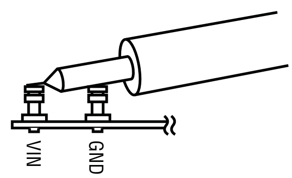


Figure 2. Measuring Input or Output Ripple

QUICK START PROCEDURE

Normal Switching Frequency and Output Ripple Voltage Waveforms

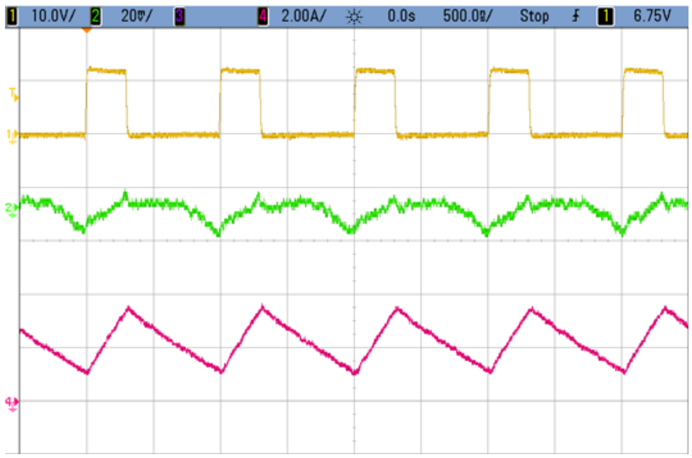


Figure 3. Switch Node Voltage, Output Ripple Voltage & Inductor Ripple Current Waveforms
V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 2.5A, f_{SW} = 1MHz Trace 1: Switch Voltage (10V/DIV)
Trace 2: Output Ripple Voltage (20mV/DIV AC) Trace 4: Inductor Ripple Current (2A/DIV)

Load Step Response Waveforms

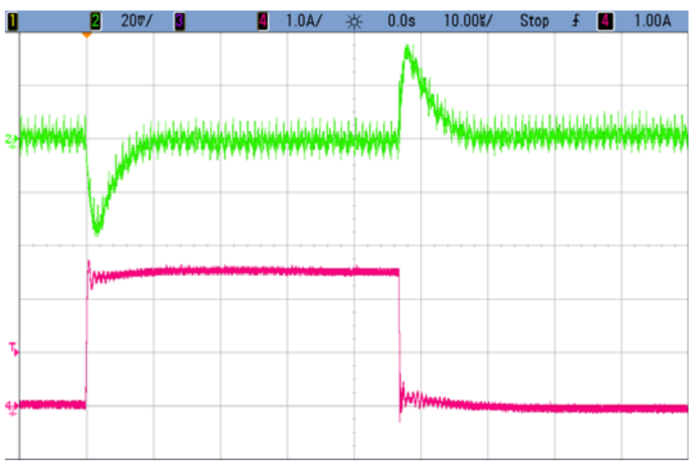


Figure 4. Load Step Response V_{IN} = 12V. V_{OUT} = 1.2V, 2.5A Load Step (0A-2.5A)
Forced Continuous Mode, f_{SW} = 1MHz. Trace 2: Output Voltage (20mV/DIV AC)
Trace 4: Output Current (1A/DIV)

QUICK START PROCEDURE

Load Step Response Waveforms

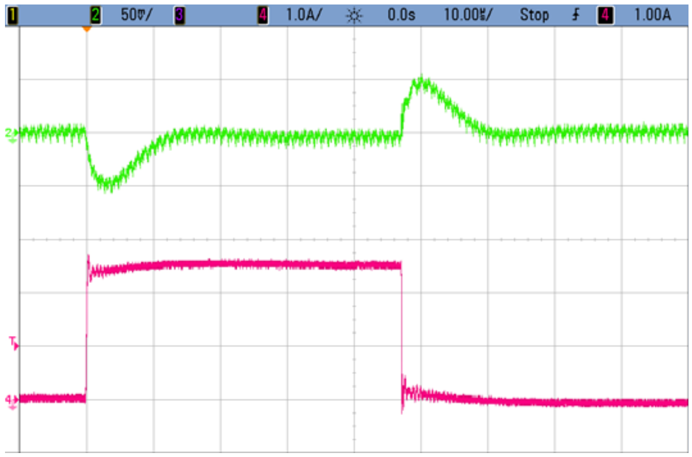


Figure 5. Load Step Response V_{IN} = 12V, V_{OUT} = 1.8V, 2.5A Load Step (0A-2.5A) Forced Continuous Mode f_{SW} = 1MHz Trace 2: Output Voltage (50mV/DIV AC) Trace 4: Output Current (1A/DIV)

Load Step Response Waveforms

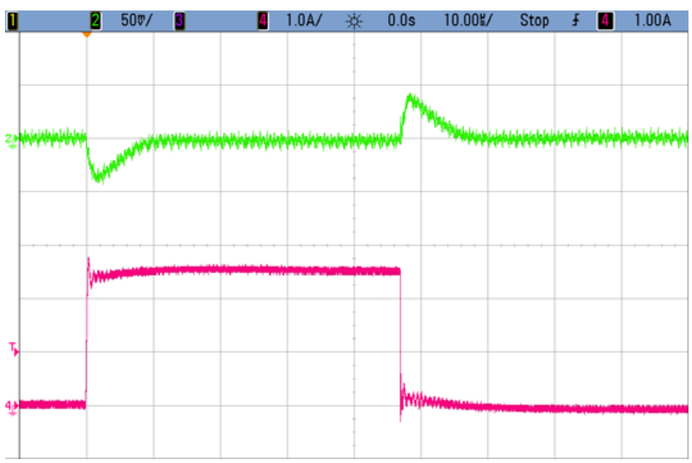


Figure 6. Load Step Response V_{IN} = 12V, V_{OUT} = 3.3V, 2.5A Load Step (0A-2.5A) Forced Continuous Mode f_{SW} = 1MHz Trace 2: Output Voltage (50mV/DIV AC) Trace 4: Output Current (1A/DIV)

QUICK START PROCEDURE

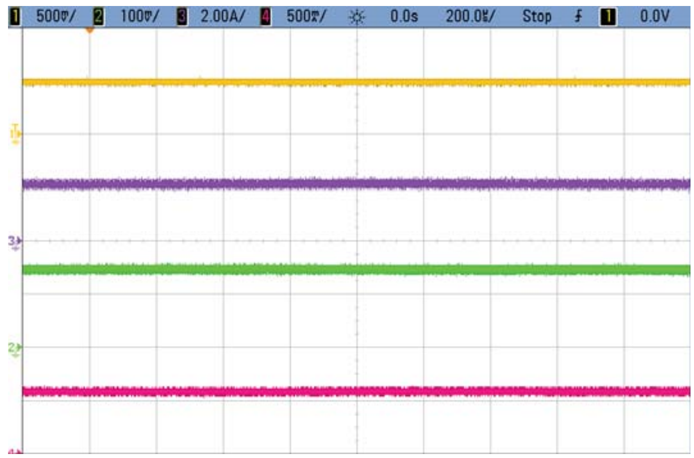


Figure 7. Input and Output Current Monitoring V_{IN} = 12V, I_{IN} = 620mA, V_{OUT} = 3.3V, I_{OUT} = 2A, f_{SW} = 1MHz
Trace 1: I_{OUTMON} Voltage (0.5V/DIV) Trace 2: I_{INMON} Voltage (0.1V/DIV) Trace 3: I_{OUT} Current (2A/DIV)
Trace 4: I_{IN} Current (500mA/DIV)

With a Current Sense Resistor of 4.02k Connected to Both The Input and Output Current Monitors, Their Voltages Equate to:

$$V_{IOUTMON} = 2A/16000 \times 4.02k = 0.503V$$

$$V_{INMON} = 620mA/16000 \times 4.02k = 0.156V$$

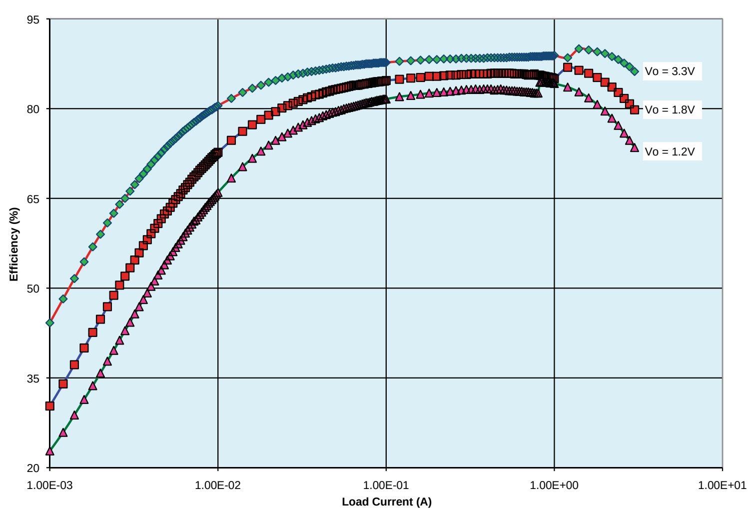
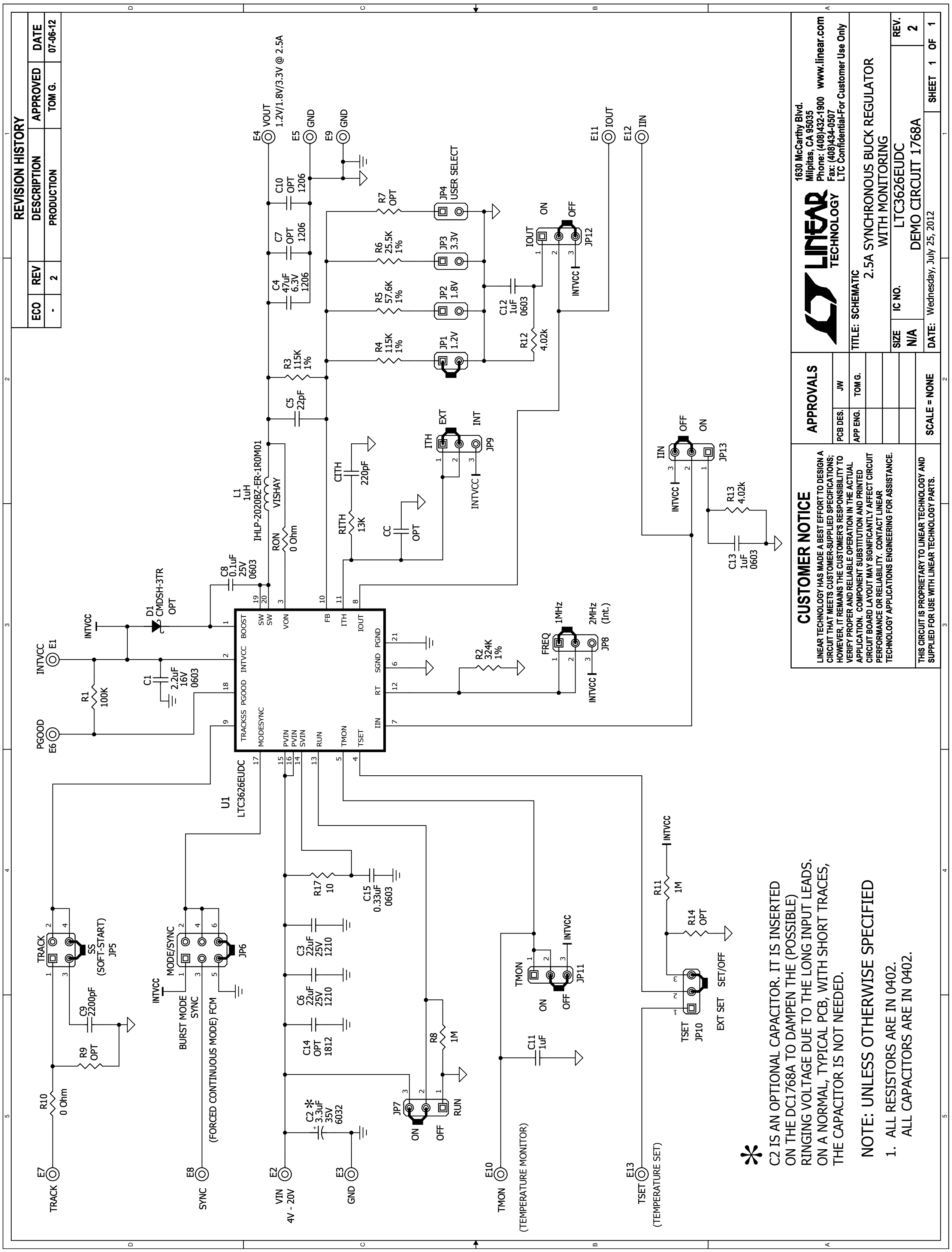


Figure 8. Efficiency Graph V_{IN} = 12V, Burst Mode,
f_{SW} = 1MHz L:1 µH Vishay IHLP-2020BZ-ER-1R0-M01

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C_{ITH}	Cap., NP0, 220pF, 25V, 10%, 0402	AVX, 04023A221KAT2A
2	1	C1	Cap., X5R, 2.2µF, 16V, 20%, 0603	TDK, C1608X5R1C225M
3	2	C3, C6	Cap., X7R, 22µF, 25V, 20%, 1210	MURATA, GRM32ER71E226M
4	1	C4	Cap., X5R, 47µF, 6.3V, 20%, 1206	Taiyo Yuden, JMK316BJ476ML-T
5	1	C5	Cap., NP0, 22pF, 50V, 10% 0402	AVX, 04025A220KAT
6	1	C8	Cap., X7R, 0.1µF, 25V, 10% 0603	TDK, C1608X7R1E104K
7	1	C11	Cap., X5R, 1µF, 6.3V, 10% 0402	AVX, 04026D105KAT2A
8	1	L1	Inductor, 1.0µH IHLP-2020BZ-01	Vishay IHLP-2020BZER1R0M01
9	1	RITH	Res., Chip, 13k, 0.06W, 5% 0402	VISHAY, CRCW040213K0JNED
10	2	R3, R4	Res., Chip, 115k, 0.06W, 1% 0402	VISHAY, CRCW0402115KFKED
11	1	U1	IC. LTC3626EUDC, 3 × 4mm, 20 QFN	LINEAR TECH., LTC3626EUDC#PBF
Additional Demo Board Circuit Components				
12	0	CC(OPT)	Cap., 0402	
13	1	C2	Cap., Tant. 3.3µF, 35V, 20%, 6032	AVX, TAJW335M035R
14	0	C7, C10(OPT)	Cap., 1206	
15	1	C9	Cap., X7R, 2200pF, 25V, 20%, 0402	AVX, 04023C225MAT
16	2	C12, C13	Cap., X5R, 1µF, 25V, 10%, 0603	TDK, C1608X5R1E105K
17	0	C14(OPT)	Cap., 1812	
18	1	C15	Cap., X5R, 0.33µF, 25V, 20%, 0603	AVX, 06033D334MAT
19	0	D1(OPT)	Schottky Diode, SOD-323	
20	2	R10, R_{ON}	Res., Chip, 0Ω, 0.06W, 0402	VISHAY, CRCW04020000Z0ED
21	1	R1	Res., Chip, 100k, 0.06W, 5%, 0402	VISHAY, CRCW0402100KFKED
22	1	R2	Res., Chip, 324k, 0.06W, 1%, 0402	NIC, NRC04F3243TRF
23	1	R5	Res., Chip, 57.6k, 0.06W, 1%, 0402	VISHAY, CRCW040257K6FKED
24	1	R6	Res., Chip, 25.5k, 0.06W, 1%, 0402	VISHAY, CRCW040225K5FKED
25	0	R7, R9, R14(OPT)	Res., 0402	
26	2	R8, R11	Res., Chip, 1M, 0.06W, 5%, 0402	VISHAY, CRCW04021M00JNED
27	2	R12, R13	Res., Chip, 4.02k, 0.06W, 1%, 0402	VISHAY, CRCW04024K02FKED
28	1	R17	Res., Chip,10Ω, 0.06W, 5%, 0402	VISHAY, CRCW040210R0JNED
Hardware: For Demo Board Only				
29	13	E1-E13	Turret,Testpoint	Mill Max2501-2-00-80-00-00-07-0
30	4	JP1, JP2, JP3, JP4	2 PIN 0.079 SINGLE ROW HEADER	SAMTEC, TMM102-02-L-S
31	1	JP5	2X2, 0.079 DOUBLE ROW HEADER	SAMTEC, TMM102-02-L-D
32	1	JP6	2X3, 0.079 DOUBLE ROW HEADER	SAMTEC, TMM103-02-L-D
33	7	JP7-JP13	3 PIN 0.079 SINGLE ROW HEADER	SAMTEC, TMM103-02-L-S
34	10	XJP1, XJP5-XJPP13	SHUNT, .079" CENTER	SAMTEC, 2SN-BK-G
35	4	MH1-MH4	STAND-OFF, NYLON 0.25"	KEYSTONE, 8831(SNAP ON)

SCHEMATIC DIAGRAM



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