Power Conversion from Milliamps to Amps at Ultra-High Efficiency (Up to 95%)

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INTRODUCTION

Efficiency is frequently the main goal for power supplies of portable computers and hand-held equipment. High efficiency converters are necessary in these applications to minimize power drain on the input source (batteries, etc.) and reduce heat buildup in the power components, allowing for smaller and lighter systems. As a result, power conversion efficiency must be in the 90% range in order to meet these goals. This application note features power supply circuits that satisfy these design requirements as well as attain efficiency in excess of 90% in a wide variety of applications.

The recent development of the LTC1147, LTC1148, and LTC1149 makes ultra-high efficiency conversion possible. In addition, the LTC1148 and LTC1149 are synchronous switching regulators, achieving high efficiency conversion at output currents in excess of 10A. These controllers feature a current-mode architecture which has an automatic low current operating mode called Burst Mode™ operation, making 90% efficiencies possible at output currents as low as 10mA. This feature maximizes battery life while a product is in a sleep or standby mode.

This is a preliminary release of Application Note 55. The complete application note will soon be available; therefore, contact your local Linear Technology representative or call the factory (408-432-1900) to receive the final version when it becomes available. In the meantime, application information can be found in the LTC1147, LTC1148, and LTC1149 Data Sheets. **Pay particular attention to the board layout information on decoupling and ground routing to achieve optimum performance.**

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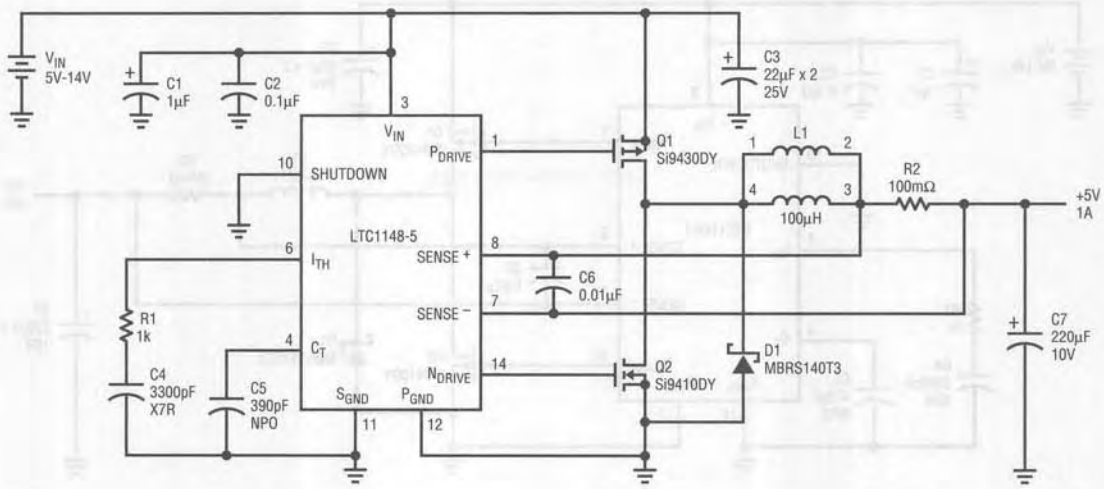


C1 (TA)
C3 AVX (TA) TPSD226K025R0200 ESR = 0.200Ω I_{RMS} = 0.775A
C7 AVX (TA) TPSE227K010R0080 ESR = 0.080Ω I_{RMS} = 1.285A
Q1 SILICONIX PMOS BV_{DSS} = 20V RDS_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
Q2 SILICONIX NMOS BV_{DSS} = 30V RDS_{ON} = 0.050Ω C_{RSS} = 160pF Q_g = 30nC
D1 MOTOROLA SCHOTTKY VBR = 40V
R2 KRL SP-1/2-A1-0R100J Pd = 0.75W
L1 COILTRONICS CTX100-4 DCR = 0.175Ω KOOL Mµ CORE

ALL OTHER CAPACITORS ARE CERAMIC

QUIESCENT CURRENT = 180µA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 200mA

AN54 • TA01

Figure 1A. LTC1148: (5V-14V to 5V/1A) Buck Converter with Surface Mount Technology

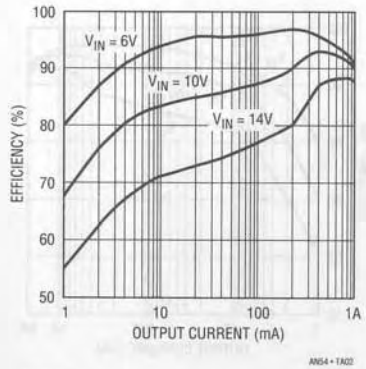
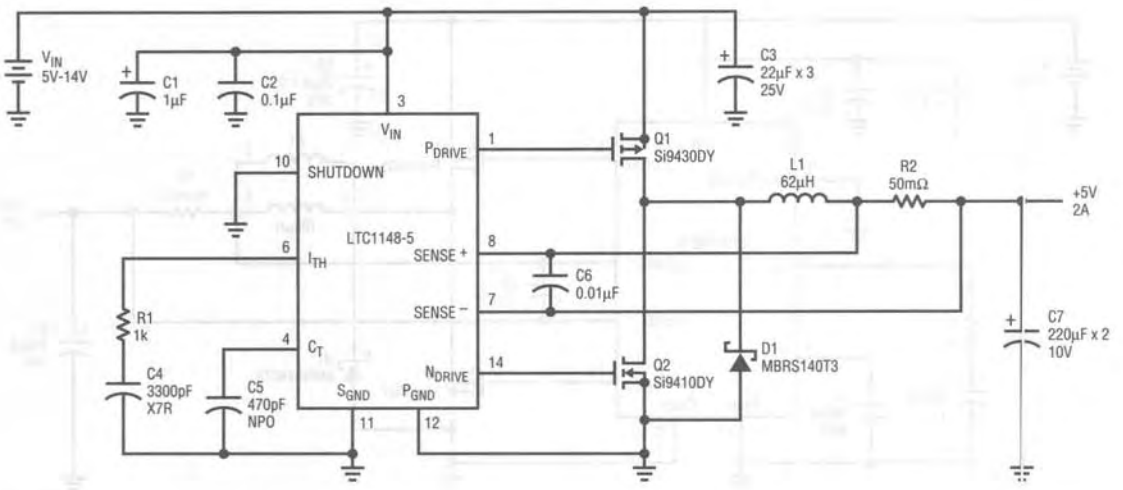


Figure 1B. LTC1148: (5V-14V to 5V/1A) Buck Converter Measured Efficiency



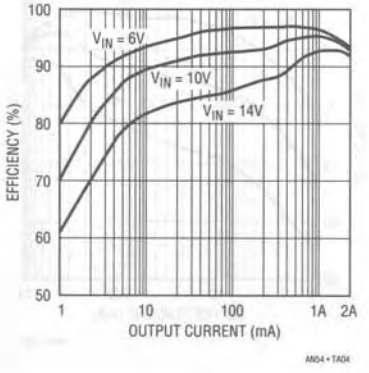
C1 (TA)
C3 AVX (TA) TPSD226K025R0200 ESR = 0.200Ω I_{RMS} = 0.775A
C7 AVX (TA) TPSE227K010R0080 ESR = 0.080Ω I_{RMS} = 1.285A
Q1 SILICONIX PMOS BV_{DSS} = 20V RDS_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
Q2 SILICONIX NMOS BV_{DSS} = 30V RDS_{ON} = 0.050Ω C_{RSS} = 160pF Q_g = 30nC
D1 MOTOROLA SCHOTTKY VBR = 40V
R2 KRL SL- 1-C1-0R050J Pd = 1W
L1 COILTRONICS CTX62-2-MP DCR = 0.040Ω MMP CORE (THROUGH HOLE)

QUIESCENT CURRENT = 180µA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 400mA

ALL OTHER CAPACITORS ARE CERAMIC

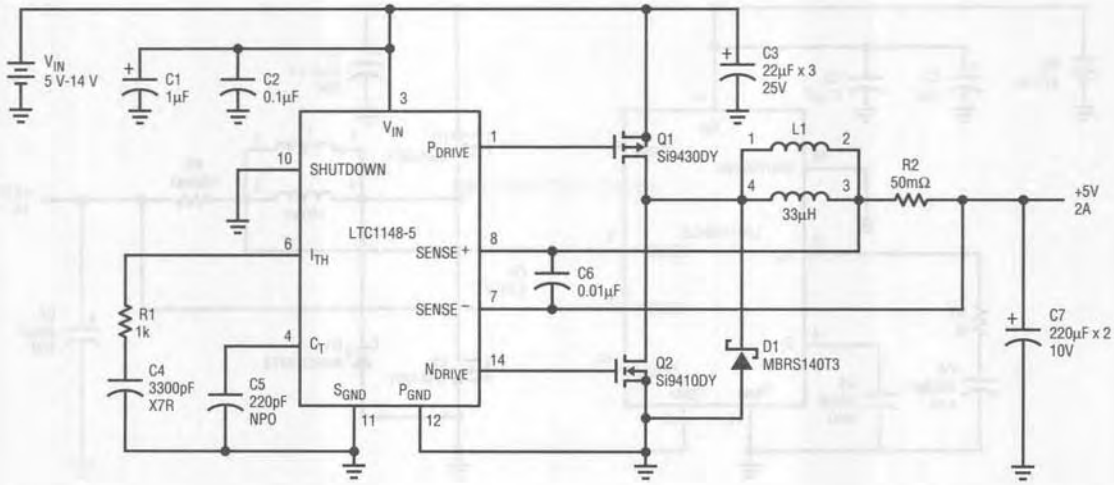
AN54 • TA03

Figure 2A. LTC1148: (5V-14V to 5V/2A) Buck Converter with Surface Mount Technology



AN54 • TA04

Figure 2B. LTC1148: (5V-14V to 5V/2A) Buck Converter Measured Efficiency



C1 (TA)
C3 AVX (TA) TPSD226K025R0200 ESR = 0.200Ω I_{RMS} = 0.775A
C7 AVX (TA) TPSE227K010R0080 ESR = 0.080Ω I_{RMS} = 1.285A
Q1 SILICONIX PMOS BV_{DSS} = 20V RDS_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
Q2 SILICONIX NMOS BV_{DSS} = 30V RDS_{ON} = 0.050Ω C_{RSS} = 160pF Q_g = 30nC
D1 MOTOROLA SCHOTTKY VBR = 40V
R2 KRL SL-1-C1-0R050J Pd = 1W
L1 COILTRONICS CTX33-4 DCR = 0.06Ω KOOL Mµ CORE

QUIESCENT CURRENT = 180µA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 400mA

ALL OTHER CAPACITORS ARE CERAMIC

AN54 • TA05

Figure 3A. LTC1148: (5V-14V to 5V/2A) High Frequency Buck Converter with Surface Mount Technology

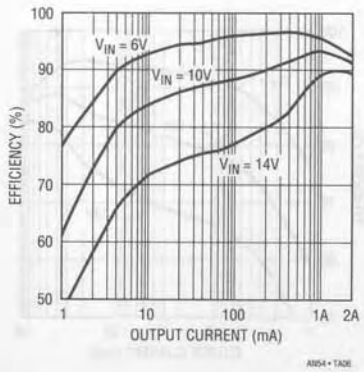
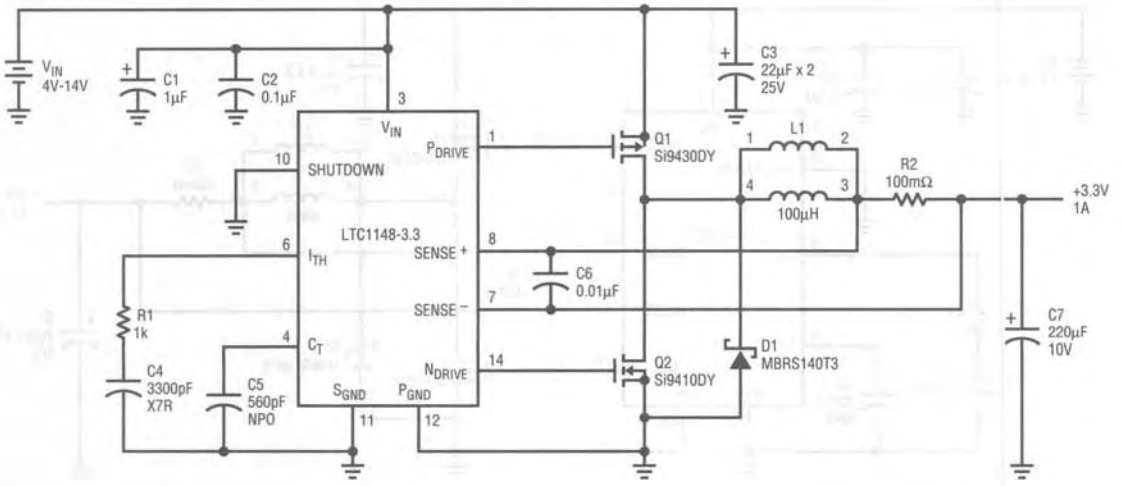


Figure 3B. LTC1148: (5V-14V to 5V/2A) High Frequency Buck Converter Measured Efficiency



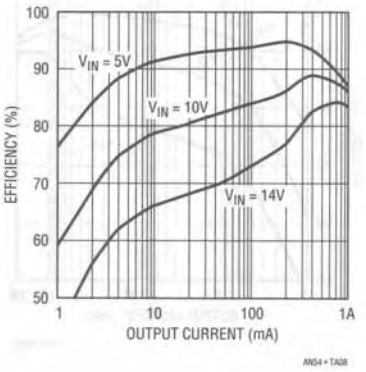
C1 (TA)
C3 AVX (TA) TPSD226K025R0200 ESR = 0.200Ω I_{RMS} = 0.775A
C7 AVX (TA) TPSE227K010R0080 ESR = 0.080Ω I_{RMS} = 1.285A
Q1 SILICONIX PMOS BV_{DSS} = 20V RDS_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
Q2 SILICONIX NMOS BV_{DSS} = 30V RDS_{ON} = 0.050Ω C_{RSS} = 160pF Q_g = 30nC
D1 MOTOROLA SCHOTTKY VBR = 40V
R2 KRL SP-1/2-A1-0R100J Pd = 0.75W
L1 COILTRONICS CTX100-4 DCR = 0.175Ω KOOL Mµ CORE

QUIESCENT CURRENT = 180µA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 250mA

ALL OTHER CAPACITORS ARE CERAMIC

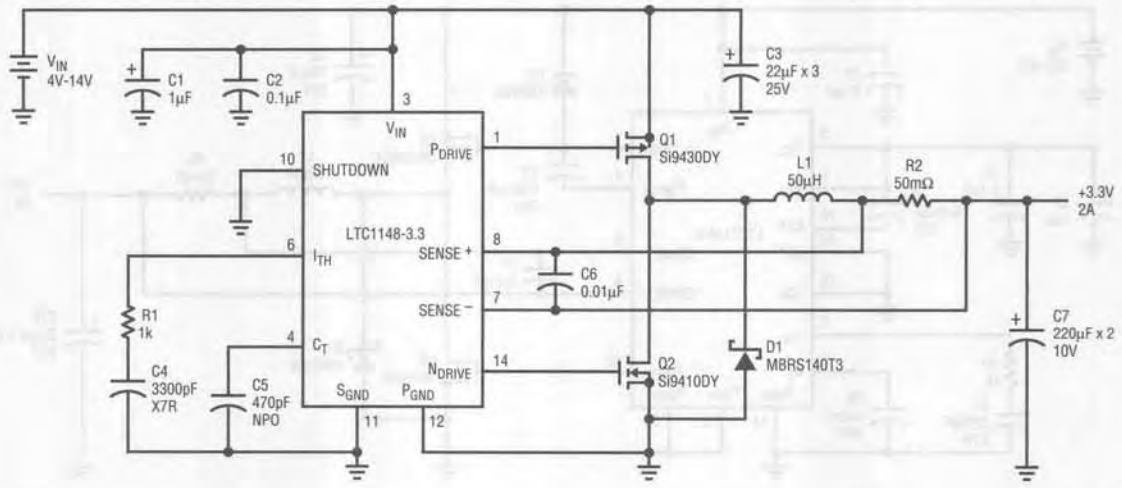
AN54 • TA07

Figure 4A. LTC1148: (4V-14V to 3.3V/1A) Buck Converter with Surface Mount Technology



AN54 • TA08

Figure 4B. LTC1148: (4V-14V to 3.3V/1A) Buck Converter Measured Efficiency



C1 (TA)
C3 AVX (TA) TPSD226K025R0200 ESR = 0.200Ω I_{RMS} = 0.775A
C7 AVX (TA) TPSE227K010R0080 ESR = 0.080Ω I_{RMS} = 1.285A
Q1 SILICONIX PMOS BV_{DSS} = 20V RDS_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
Q2 SILICONIX NMOS BV_{DSS} = 30V RDS_{ON} = 0.050Ω C_{RSS} = 160pF Q_g = 30nC
D1 MOTOROLA SCHOTTKY VBR = 40V
R2 KRL SL-1-C1-0R050J Pd = 1W
L1 COILTRONICS CTX50-2-MP DCR = 0.032Ω MMP CORE (THROUGH HOLE)

QUIESCENT CURRENT = 180µA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 450mA

ALL OTHER CAPACITORS ARE CERAMIC

AN54 • TA09

Figure 5A. LTC1148: (4V-14V to 3.3V/2A) Buck Converter with Surface Mount Technology

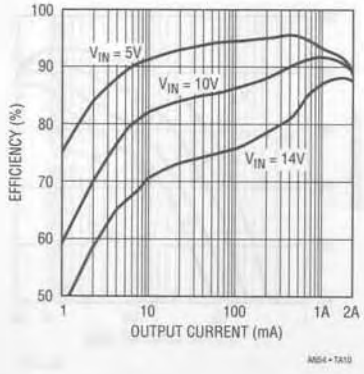


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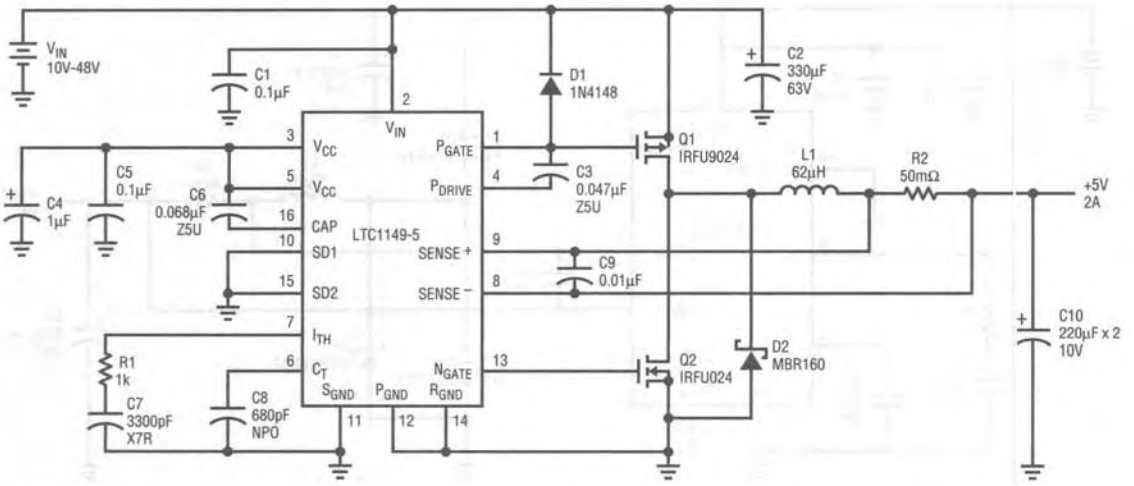
Figure 5B. LTC1148: (4V-14V to 3.3V/2A) Buck Converter Measured Efficiency



C2 UNITED CHEMI-CON (AL) LXF63VB331M12.5 x 30 ESR = 0.170Ω I_{RMS} = 1.280A
C4 (TA)
C10 SANYO (OS-CON) 10SA220M ESR = 0.035Ω I_{RMS} = 2.360A
Q1 IR PMOS BV_{DSS} = 60V RDS_{ON} = 0.280Ω C_{RSS} = 65pF Q_g = 19nC
Q2 IR NMOS BV_{DSS} = 60V RDS_{ON} = 0.100Ω C_{RSS} = 79pF Q_g = 28nC
D1 SILICON VBR = 75V
D2 MOTOROLA SCHOTTKY VBR = 60V
R2 KRL NP-1A-C1-0R050J Pd = 1W
L1 COILTRONICS CTX62-2-MP DCR = 0.040Ω MMP CORE

QUIESCENT CURRENT = 1.5mA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 570mA

ALL OTHER CAPACITORS ARE CERAMIC

Figure 6A. LTC1149: (10V-48V to 5V/2A) High Voltage Buck Converter

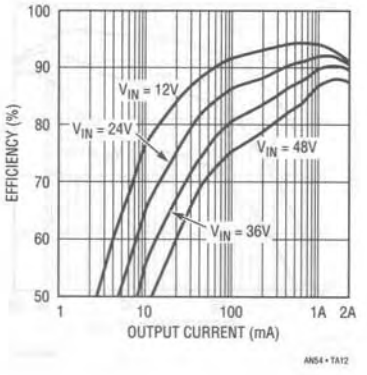
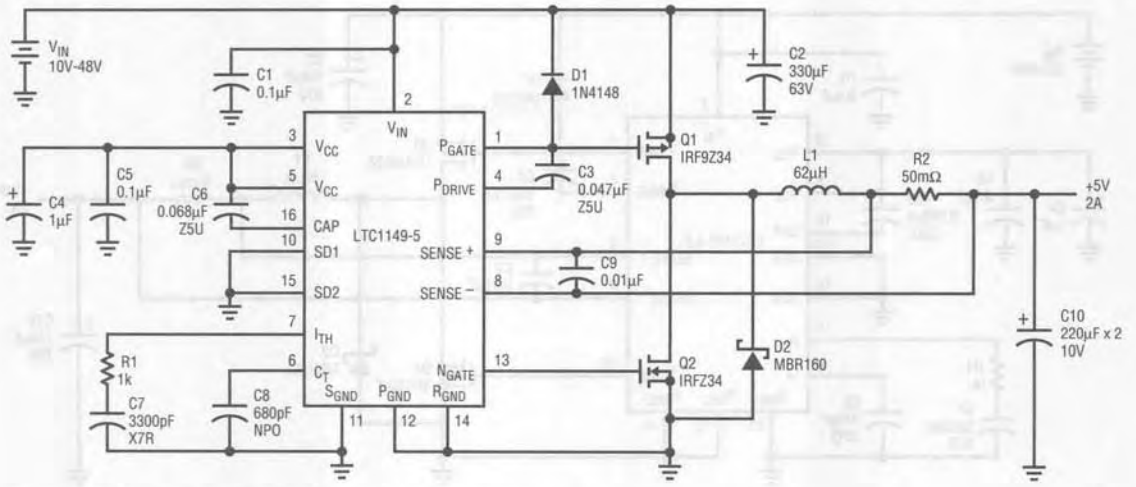


Figure 6B. LTC1149: (10V-48V to 5V/2A) High Voltage Buck Converter Measured Efficiency



C2 UNITED CHEMI-CON (AL) LXF63VB331M12.5 x 30 ESR = 0.170Ω I_{RMS} = 1.280A
C4 (TA)
C10 SANYO (OS-CON) 10SA220M ESR = 0.035Ω I_{RMS} = 2.360A
Q1 IR PMOS BV_{DSS} = 60V RDS_{ON} = 0.140Ω C_{RSS} = 100pF Q_g = 34nC
Q2 IR NMOS BV_{DSS} = 60V RDS_{ON} = 0.050Ω C_{RSS} = 100pF Q_g = 32nC
D1 SILICON VBR = 75V
D2 MOTOROLA SCHOTTKY VBR = 60V
R2 KRL NP-1A-C1-0R050J Pd = 1W
L1 COILTRONICS CTX62-2-MP DCR = 0.040Ω MMP CORE

QUIESCENT CURRENT = 1.5mA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 560mA

ALL OTHER CAPACITORS ARE CERAMIC

AN54 • TA13

Figure 7A. LTC1149: (10V-48V to 5V/2A) High Voltage Buck Converter with Large P-Channel and N-Channel MOSFETs

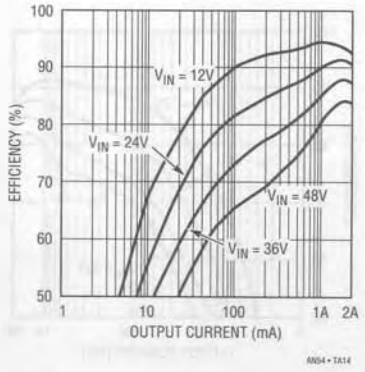
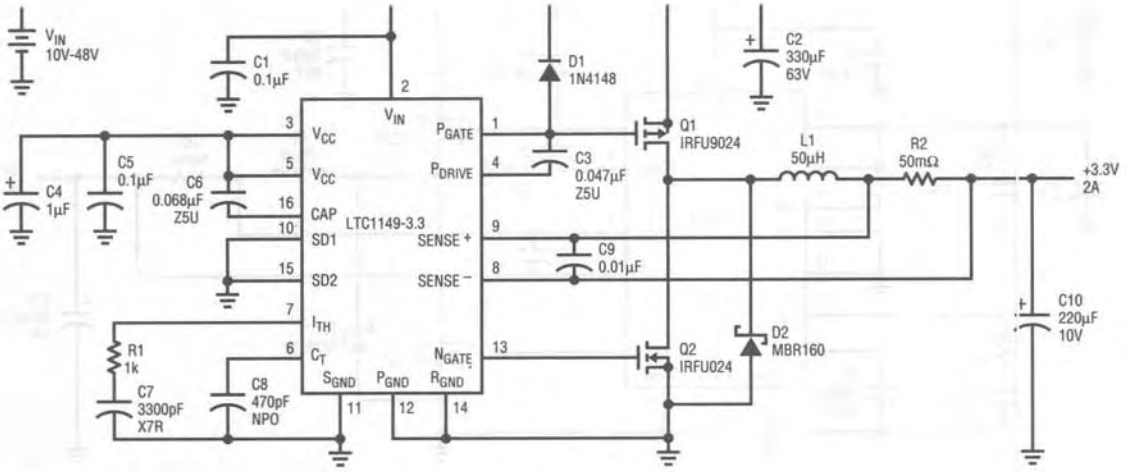


Figure 7B. LTC1149: (10V-48V to 5V/2A) Measured Efficiency with Large P-Channel and N-Channel MOSFETs



C2 UNITED CHEMI-CON (AL) LXF63VB331M12.5 x 30 ESR = 0.170Ω I_{RMS} = 1.280A
C4 (TA)
C10 SANYO (OS-CON) 10SA220M ESR = 0.035Ω I_{RMS} = 2.360A
Q1 IR PMOS BV_{DSS} = 60V RDS_{ON} = 0.280Ω C_{RSS} = 65pF Q_g = 19nC
Q2 IR NMOS BV_{DSS} = 60V RDS_{ON} = 0.100Ω C_{RSS} = 79pF Q_g = 28nC
D1 SILICON VBR = 75V
D2 MOTOROLA SCHOTTKY VBR = 60V
R2 KRL NP-1A-C1-0R050J Pd = 1W
L1 COILTRONICS CTX50-2-MP DCR = 0.032Ω MMP CORE

QUIESCENT CURRENT = 1.5mA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 570mA

AN54 • TA15

ALL OTHER CAPACITORS ARE CERAMIC

Figure 8A. LTC1149: (10V-48V to 3.3V/2A) High Voltage Buck Converter

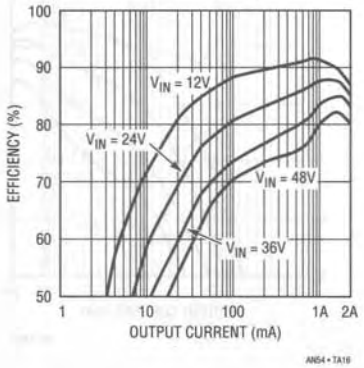


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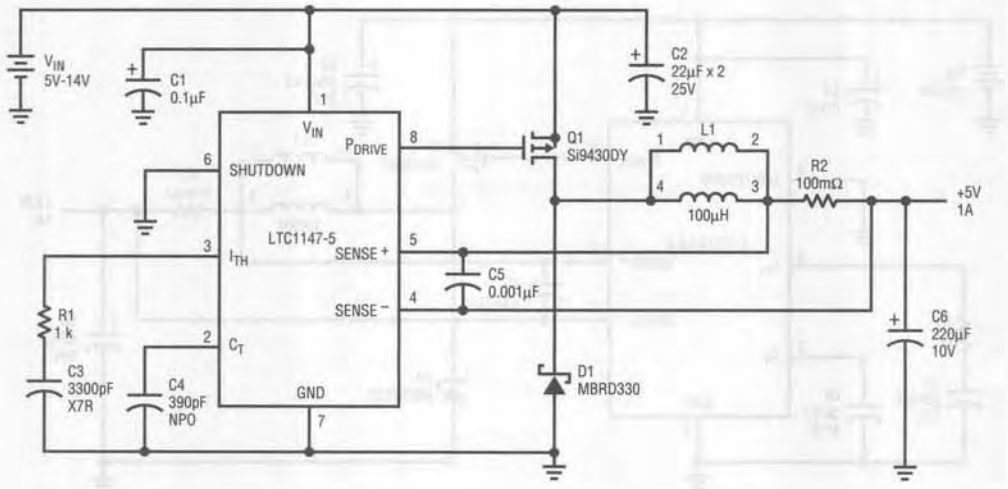
Figure 8B. LTC1149: (10V-48V to 3.3V/2A) High Voltage Buck Converter Measured Efficiency



C2 AVX (TA) TPSD226K025R0200 ESR = 0.200Ω I_{RMS} = 0.775A
C5 AVX (TA) TPSE227K010R0080 ESR = 0.080Ω I_{RMS} = 1.285A
Q1 SILICONIX PMOS BV_{DSS} = 20V RDS_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
D1 MOTOROLA SCHOTTKY VBR = 30V
R2 KRL SP-1/2-A1-0R100J Pd = 0.75W
L1 COILTRONICS CTX100-4 DCR = 0.175Ω KOOL Mµ CORE

QUIESCENT CURRENT = 190µA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 170mA

ALL OTHER CAPACITORS ARE CERAMIC

AN54 • TA17

Figure 9A. LTC1147: (5V-14V to 5V/1A) Buck Converter with Surface Mount Technology

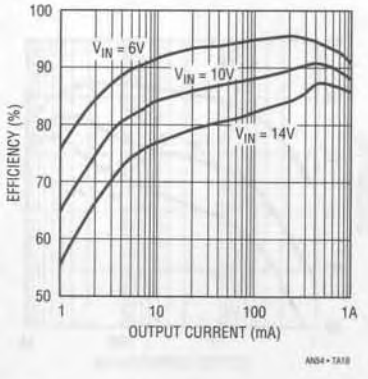
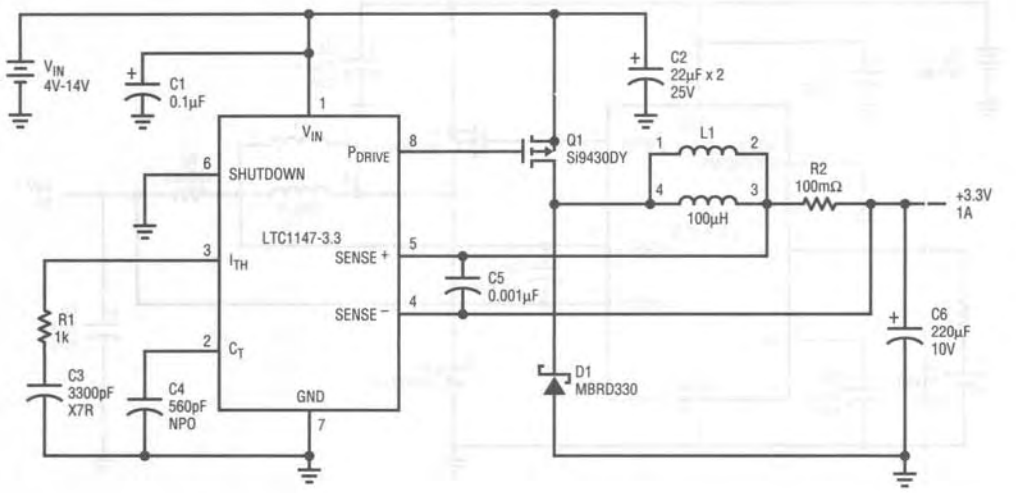


Figure 9B. LTC1147: (5V-14V to 5V/1A) Buck Converter Measured Efficiency



C2 AVX (TA) TPSD226K025R0200 ESR = 0.200Ω I_{RMS} = 0.775A
C6 AVX (TA) TPSE227K010R0080 ESR = 0.080Ω I_{RMS} = 1.285A
Q1 SILICONIX BV_{DSS} = 20V DCR_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
D1 MOTOROLA
R2 KRL SP-1/2-A1-0R100 Pd = 0.75W
L1 COILTRONICS CTX100-4 DCR = 0.175Ω KOOL Mµ CORE

QUIESCENT CURRENT = 170µA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 170mA

AN54 • TA19

Figure 10A. LTC1147: (4V-14V to 3.3V/1A) Buck Converter with Surface Mount Technology

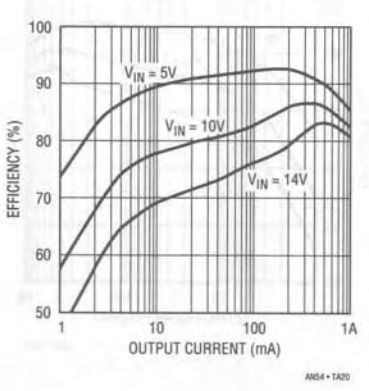


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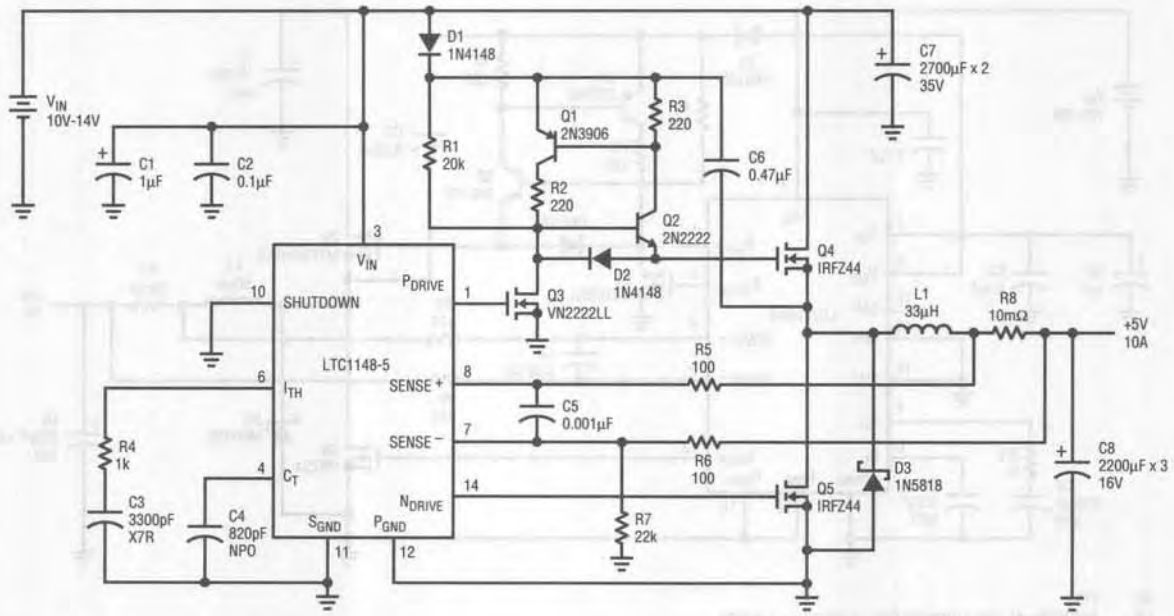
Figure 10B. LTC1147: (4V-14V to 3.3V/1A) Buck Converter Measured Efficiency



C1 (TA)
C7 UNITED CHEMI-CON (AL) LXF35VB272M16 X 40 ESR = 0.018Ω I_{RMS} = 2.900A
C8 NICHICON (AL) UPL1C222MRH ESR = 0.028Ω I_{RMS} = 2.010A
Q4, Q5 IR NMOS BV_{DSS} = 60V DCR_{ON} = 0.028Ω C_{RSS} = 310pF Q_g = 69nC
D1, D2 MOTOROLA SILICON VBR = 75V
D3 MOTOROLA SCHOTTKY VBR = 30V
R8 KRL NP-2A-C1-0R010J Pd = 3W
L1 COILTRONICS CTX33-10-KM DCR = 0.010Ω KOOL Mµ CORE QUIESCENT CURRENT = 22mA

ALL OTHER CAPACITORS ARE CERAMIC

AN54 • TA21

Figure 11A. LTC1148: (10V-14V to 5V/10A) High Current Buck Converter

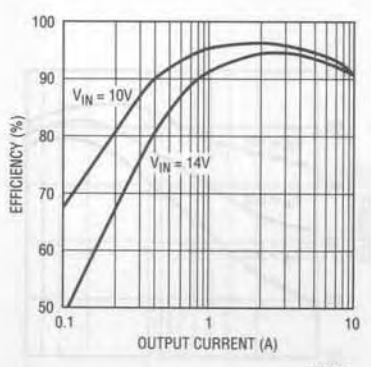


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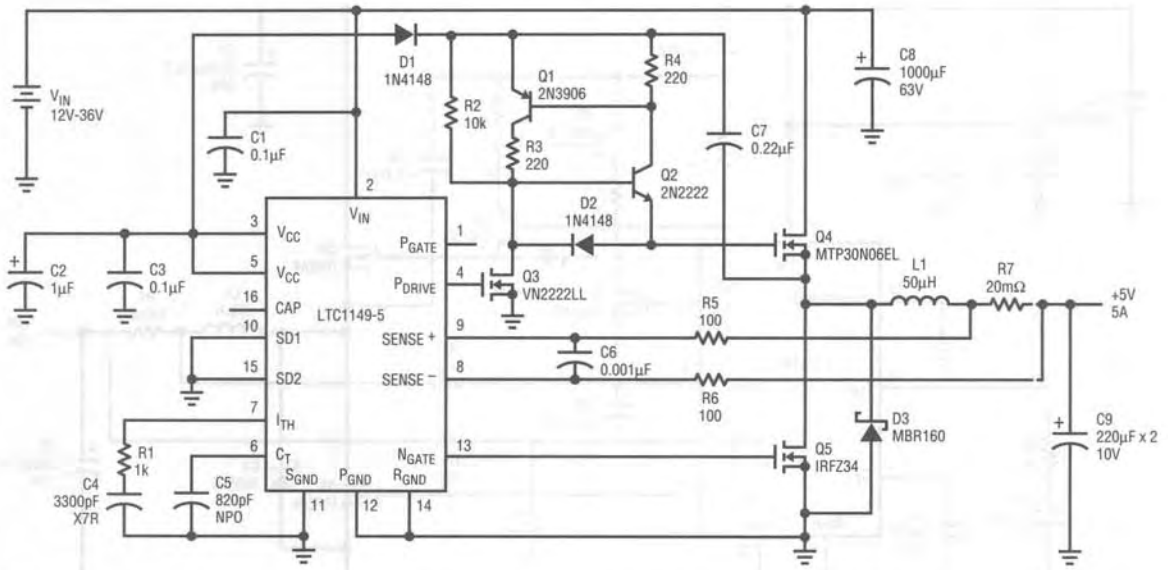
Figure 11B. LTC1148: (10V-14V to 5V/10A) High Current Buck Converter Measured Efficiency



C2 (TA)
C8 NICHICON (AL) UPL1J102MRH ESR = 0.027Ω I_{RMS} = 2.370A
C9 SANYO (OS-CON) 10SA220M ESR = 0.035Ω I_{RMS} = 2.360A
Q1 PNP BV_{CEO} = 30V
Q2 NPN BV_{CEO} = 40V
Q3 SILICONIX NMOS BV_{DSS} = 60V RDS_{ON} = 5.000Ω
Q4 MOTOROLA NMOS BV_{DSS} = 60V RDS_{ON} = 0.050Ω C_{RSS} = 100pF Q_g = 40nC
Q5 IR NMOS BV_{DSS} = 60V RDS_{ON} = 0.050Ω C_{RSS} = 100pF Q_g = 32nC
D1, D2 SILICON VBR = 75V
D3 MOTOROLA SCHOTTKY VBR = 60V
R7 KRL NP-2A-C1-0R020J Pd = 3W
L1 COILTRONICS CTX50-5-52 DCR = 0.021Ω #52 IRON POWDER CORE

ALL OTHER CAPACITORS ARE CERAMIC

AN54 • TA23

Figure 12A. LTC1149: (12V-36V to 5V/5A) High Current, High Voltage Buck Converter

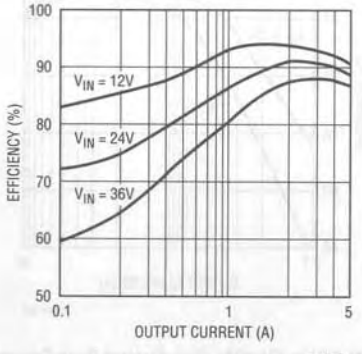


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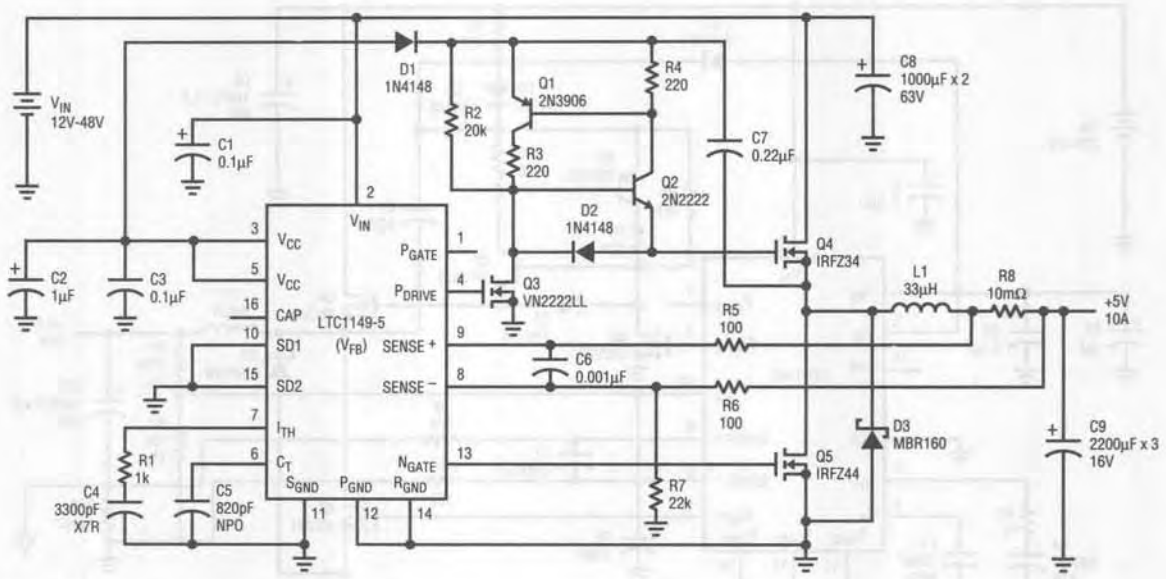
Figure 12B. LTC1149: (12V-36V to 5V/5A) High Current, High Voltage Buck Converter Measured Efficiency



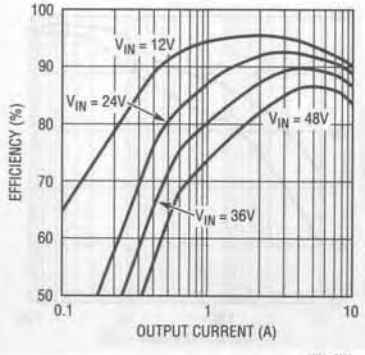
C2 (TA)
C8 NICHICON (AL) UPL1J102MRH ESR = 0.027Ω I_{RMS} = 2.370A
C9 NICHICON (AL) UPL1C222MRH ESR = 0.028Ω I_{RMS} = 2.010A
Q1 PNP BV_{CEO} = 30V
Q2 NPN BV_{CEO} = 40V
Q3 SILICONIX NMOS BV_{DSS} = 60V RDS_{ON} = 5.000Ω
Q4 IR NMOS BV_{DSS} = 60V RDS_{ON} = 0.050Ω C_{RSS} = 100pF Q_g = 32nC
Q5 IR NMOS BV_{DSS} = 60V RDS_{ON} = 0.028Ω C_{RSS} = 310pF Q_g = 69nC
D1, D2 SILICON VBR = 75V
D3 MOTOROLA SCHOTTKY VBR = 60V
R8 KRL NP-2A-C1-0R010J Pd = 3W
L1 COILTRONICS CTX33-10-KM DCR = 0.010Ω KOOL Mµ CORE

QUIESCENT CURRENT = 26mA

ALL OTHER CAPACITORS ARE CERAMIC

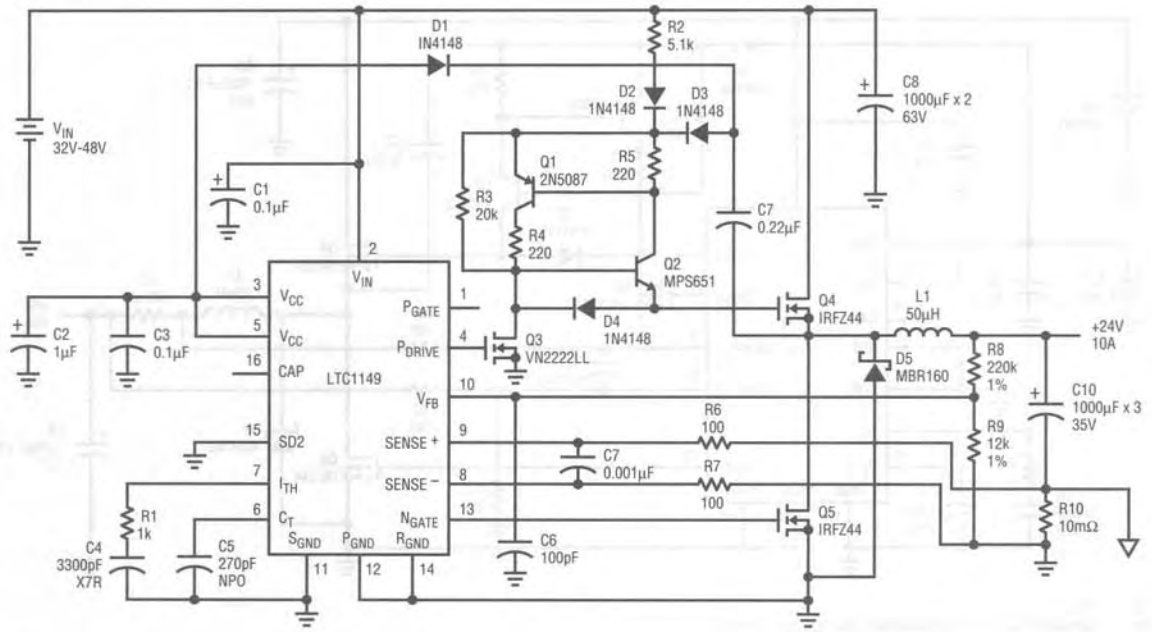
AN54 • TA25

Figure 13A. LTC1149: (12V-48V to 5V/10A) High Current, High Voltage Buck Converter



AN54 • TA26

Figure 13B. LTC1149: (12V-48V to 5V/10A) High Current, High Voltage Buck Converter Measured Efficiency

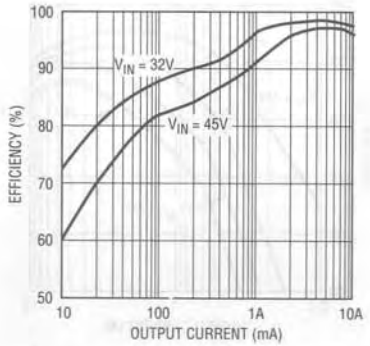


C2	(TA)	
C9	NICHICON (AL) UPL1J102MRH ESR = 0.027Ω I_{RMS} = 2.370A	
C10	NICHICON (AL) UPL1V102MRH ESR = 0.029Ω I_{RMS} = 1.980A	
Q4, Q5	IR NMOS BV_{DSS} = 60V RDS_{ON} = 0.028Ω C_{RSS} = 310pF Q_g = 69nC	
Q1	PNP BV_{CEO} = 50V	
Q2	NPN BV_{CEO} =	
D1, D2, D3, D4	SILICON VBR = 75V	
D5	MOTOROLA SCHOTTKY VBR = 60V	V_{OUT} = 1.25V (1 + R8/R9)
R10	KRL NP-2A-C1-0R010J Pd = 3W	QUIESCENT CURRENT = 2mA
L1	COILTRONICS CTX50-10-KM DCR = 0.010Ω KOOL Mµ CORE	TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 1.5A

AN54 • TA27

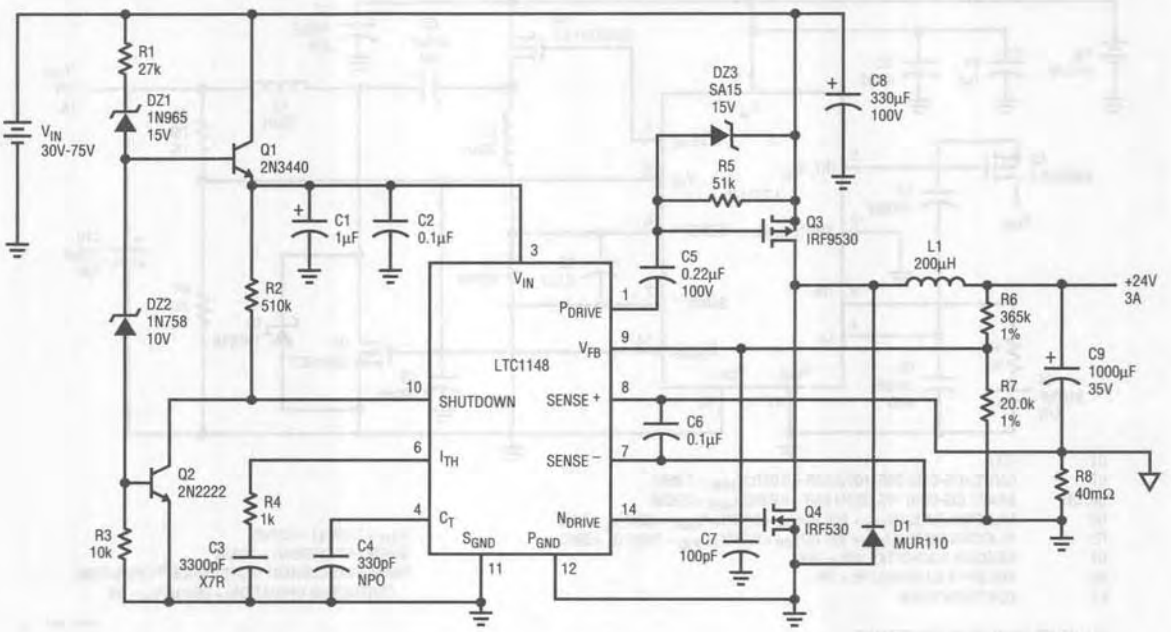
ALL OTHER CAPACITORS ARE CERAMIC

Figure 14A. LTC1149: (32V-48V to 24V/10A) High Current, High Voltage Buck Converter



AN54 • TA28

Figure 14B. LTC1149: (32V-48V to 24V/10A) High Current, High Voltage Buck Converter Measured Efficiency



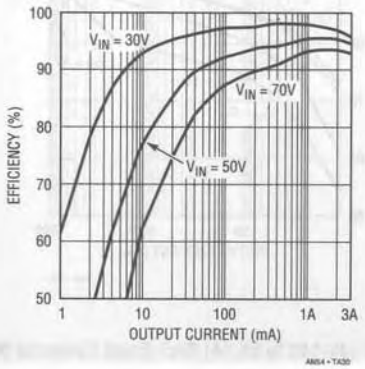
C1 (TA)
C8 UNITED CHEMI-CON (AL) KMF100VB221M16 X 25 ESR = 0.090Ω I_{RMS} = 1.440A
C9 UNITED CHEMI-CON (AL) LXF35VB10212.5 X 30 ESR = 0.030Ω I_{RMS} = 1.950A
Q1 MOTOROLA NPN $V(BR)_{CEO}$ = 200V Pd = 1W hFE = 40
Q2 MOTOROLA NPN $V(BR)_{CEO}$ = 30V hFE = 50
Q3 IR PMOS BV_{DSS} = 100V DCR_{ON} = 0.250Ω C_{RSS} = 100pF Q_g = 25nC
Q4 IR NMOS BV_{DSS} = 100V DCR_{ON} = 0.120Ω C_{RSS} = 44pF Q_g = 17nC
DZ3 MOTOROLA V_Z = 15V Pd = 3W
D1 MOTOROLA SILICON VBR = 100V
R7 KRL NP-1A-C1-0R040J Pd = 1W
L1 COILTRONICS CTX200-3-KM DCR = 0.044Ω KOOL Mμ CORE

V_{OUT} = 1.25V (1 + R6/R7)
QUIESCENT CURRENT = 1mA
TRANSITION CURRENT (BURST MODE™ OPERATION/CONTINUOUS OPERATION) = 340mA

ALL OTHER CAPACITORS ARE CERAMIC

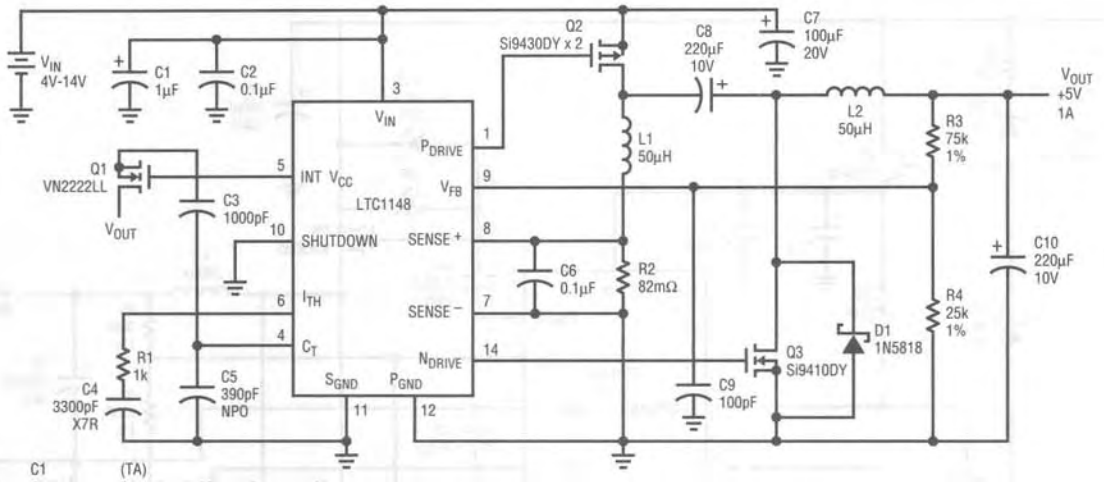
AN54 • TA29

Figure 15A. LTC1148: (30V-75V to 24V/3A) High Voltage Buck Converter



AN54 • TA30

Figure 15B. LTC1148: (30V-75V to 24V/3A) High Voltage Buck Converter Measured Efficiency



C1	(TA)
C7	SANYO (OS-CON) 20SA100M ESR = 0.037Ω I_{RMS} = 2.250A
C8, C10	SANYO (OS-CON) 10SA220M ESR = 0.035Ω I_{RMS} = 2.360A
Q2	SILICONIX PMOS BV_{DSS} = 20V RDS_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
Q3	SILICONIX NMOS BV_{DSS} = 30V RDS_{ON} = 0.050Ω C_{RSS} = 160pF Q_g = 30nC
D1	MOTOROLA SCHOTTKY VBR = 30V
R2	KRL NP-1A-C1-0R082J Pd = 1W
L1	COILTRONICS 082

ALL OTHER CAPACITORS ARE CERAMIC

V_{OUT} = 1.25V (1 + R2/R3)
QUIESCENT CURRENT = 200µA
TRANSITION CURRENT (BURST MODE™ OPERATION/
CONTINUOUS OPERATION) = 250mA/V_{IN} = 5V

AN54 • TA31

Figure 16A. LTC1148: (4V-14V to 5V/1A) Buck-Boost Converter

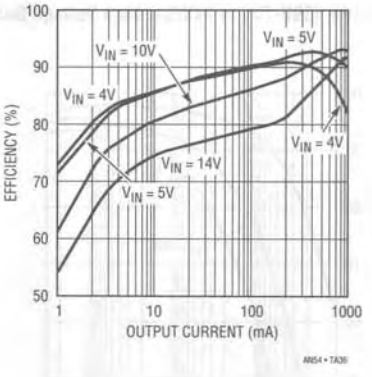


Figure 16B. LTC1148: (4V-14V to 5V/1A) Buck-Boost Converter Measured Efficiency

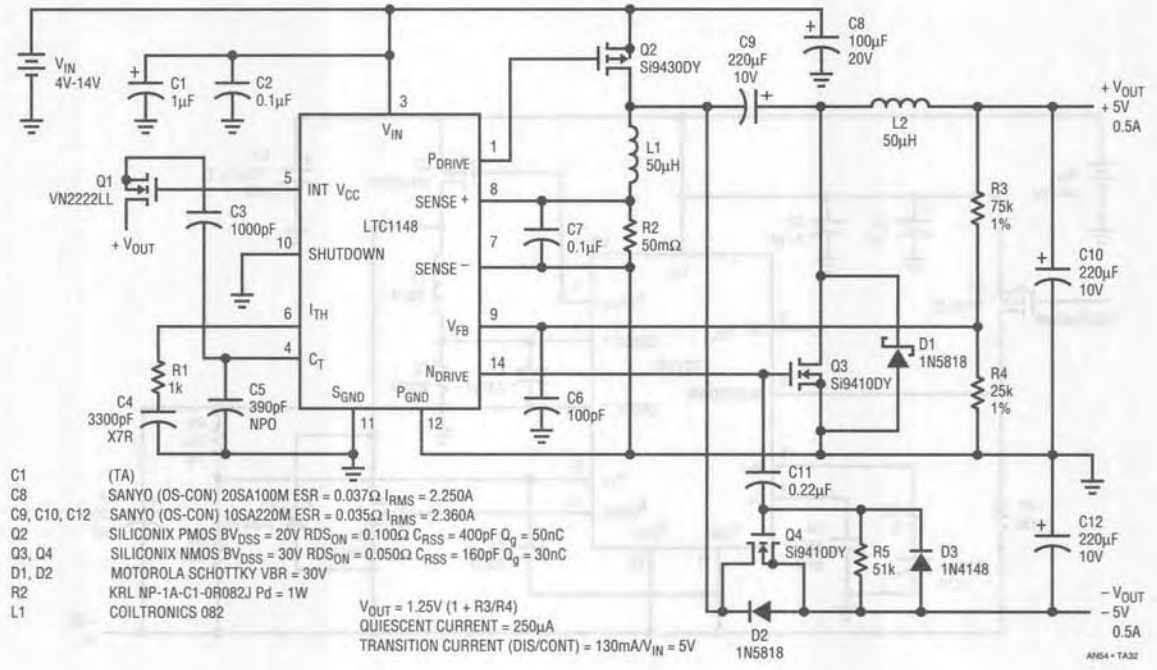


Figure 17A. LTC1148: (4V-14V to +5V/0.5A, –5V/0.5A) Split Supply Converter

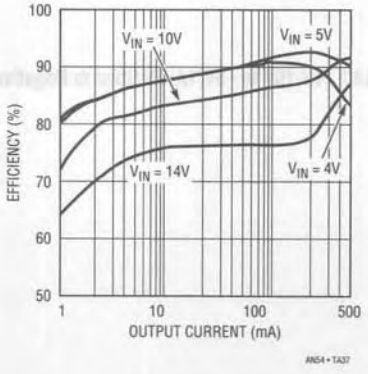
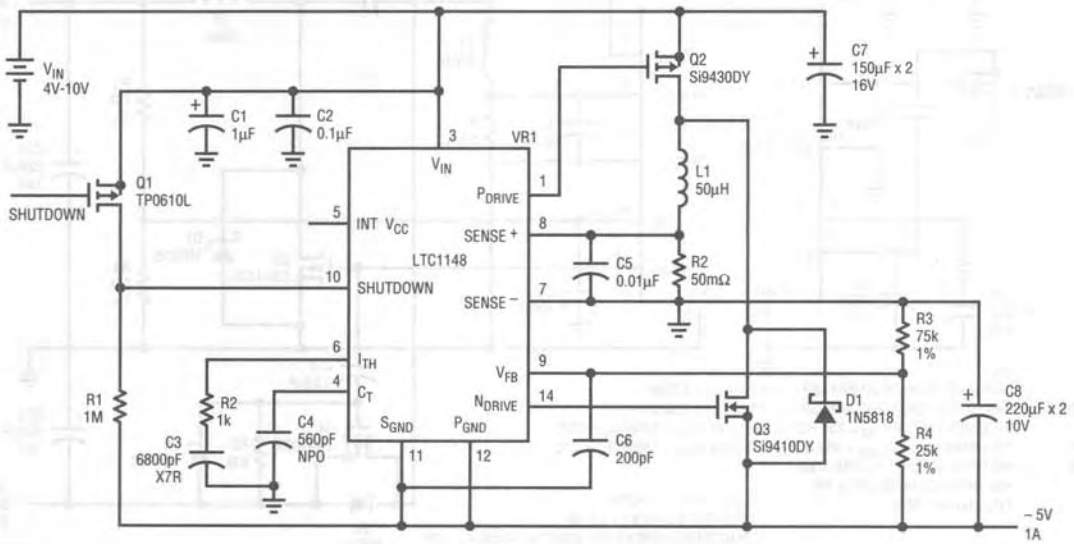


Figure 17B. LTC1148: (4V-14V to +5V/0.5A, –5V/0.5A) Split Supply Converter Measured Efficiency



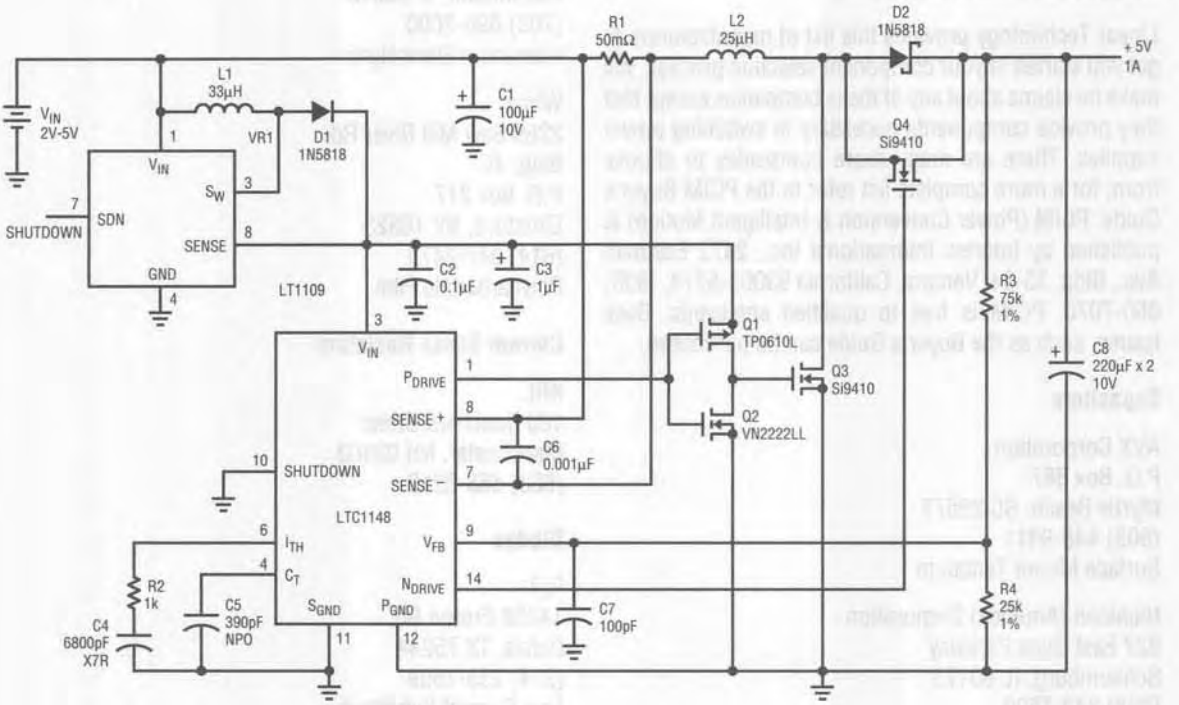
C1 (TA)
C7 SANYO (OS-CON) 16SA150M ESR = 0.035Ω I_{RMS} = 2.280A
C8 SANYO (OS-CON) 10SA220M ESR = 0.035Ω I_{RMS} = 2.360A
Q2 SILICONIX PMOS BV_{DSS} = 20V RDS_{ON} = 0.100Ω C_{RSS} = 400pF Q_g = 50nC
Q3 SILICONIX NMOS BV_{DSS} = 30V RDS_{ON} = 0.050Ω C_{RSS} = 160pF Q_g = 30nC
D1 MOTOROLA SCHOTTKY VBR = 30V
R2 KRL NP-1A-C1-0R050J
L1 COILTRONICS CTX50-2-MP DCR = 0.032Ω MMP CORE

V_{OUT} = 1.25V (1 + R3/R4)

ALL OTHER CAPACITORS ARE CERAMIC

AN54 • TA33

Figure 18. LTC1148: (4V-10V to –5V/1A) Positive to Negative Converter



C1	SANYO (OS-CON) 10SA100M ESR = 0.045Ω I_{RMS} = 1.870A	
C3	(TA)	
C8	SANYO (OS-CON) 10SA220M ESR = 0.035Ω I_{RMS} = 2.360A	
Q3, Q4	SILICONIX NMOS BV_{DSS} = 30V RDS_{ON} = 0.050Ω C_{RSS} = 160pF Q_g = 30nC	
D1, D2	MOTOROLA SCHOTTKY VBR = 30V	
R2	KRL SL-1-C1-0R050J Pd = 1W	
L1	COILTRONICS CTX33-1 DCR = 0.220Ω KOOL Mµ CORE	V_{OUT} = 1.25V (1 + R3/R4)
L2	COILTRONICS	

AN54 • TA34

Figure 19. LTC1148: (2V-5V to 5V/1A) Boost Converter

WARNING!!!
This is a preliminary circuit!
Contact Brian Huffman at the factory if you have any problems.

APPENDIX A

SUGGESTED MANUFACTURERS

Linear Technology provides this list of manufacturers to get you started in your component selection process. We make no claims about any of these companies except that they provide components necessary in switching power supplies. There are many more companies to choose from; for a more complete list refer to the PCIM Buyer's Guide. PCIM (Power Conversion & Intelligent Motion) is published by Intertec International Inc., 2472 Eastman Ave., Bldg. 33-34, Ventura, California 93003-5774, (805) 650-7070. PCIM is free to qualified applicants. Back issues, such as the Buyer's Guide can be purchased.

Capacitors

AVX Corporation
P.O. Box 867
Myrtle Beach, SC 29577
(803) 448-9411
Surface Mount Tantalum

Nichicon (America) Corporation
927 East State Parkway
Schaumburg, IL 60173
(708) 843-7500
Aluminum Electrolytic

Philips Components Disc. Prod. Div.
Division Headquarters
2001 W. Blue Heron Blvd.
Riviera Beach, FL 33404
(800) 881-3200
Low ESR filter capacitors-Solid Aluminum Electrolytic Capacitors

Sanyo Video Components (USA) Corp.
2001 Sanyo Ave.
San Diego, CA 92073
(619) 661-6835
Low ESR filter capacitors-Solid Aluminum Electrolytic Capacitors (OS-CON)

United Chemi-Con, Inc.
9801 West Higgins Road
Rosemount, IL 60018
(708) 696-2000
Aluminum Electrolytic

Wima
2269 Saw Mill River Rd.
Bldg. 4C
P.O. Box 217
Elmsford, NY 10523
(914) 347-2474
Polycarbonate Film

Current Sense Resistors

KRL
160 Bouchard Street
Manchester, NH 03103
(603) 668-3210

Diodes

Fuji
14368 Proton Rd.
Dallas, TX 75244
(214) 233-1589
Low Current Schottkys

General Instruments
600 W John St. CS620
Hickville, NY 11802
(516) 933-3333

Motorola Inc.
3102 North 56th St.
MS 56-126
Phoenix, AZ 85018
(800) 521-6274
Full Line

Philips Components Disc. Prod. Div.
Division Headquarters
2001 W. Blue Heron Blvd.
Riviera Beach, FL 33404
(800) 881-3200

Ferrite Beads

Fair-Rite Products Corp.
1 Commerial Row
P.O. Box J
Wallkill, NY 12589
(914) 895-2055

Toshiba America Elec. Components
9775 Toledo Way
Irvine, CA 92718
(714) 455-2000

Heat Sinks

Aavid Engineering, Inc.
One Kool Path Box 400
Laconia, NH 03247
(603) 528-3400

Thermalloy
2021 W. Valley View Lane
P.O. Box 810839
Dallas, TX 75381
(214) 243-4321

Mounting Hardware

Bergquist
5300 Edina Industrial Blvd.
Minneapolis, MN 55439
(612) 835-2322
Thermally Conductive Insulators

Stockwell Rubber
4749 Tolbut St.
Philadelphia, PA 19136
(800) 523-0123
Thermally Conductive Insulators

Thermalloy
2021 W. Valley View Lane
P.O. Box 810839
Dallas, TX 75381
(214) 243-4321
Power Sockets, Thermal Compounds, and Adhesives
Thermally Conductive Insulators, Mounting Kits

Power MOSFETs

International Rectifier Corp.
233 Kansas St.
El Segundo, CA 90245
(310) 322-3331

Motorola Inc.
3102 North 56th St.
MS 56-126
Phoenix, AZ 85018
(800) 521-6274

Siliconix
2201 Laurelwood Rd.
Santa Clara, CA 96056
(800) 554-5565

Inductors and Transformers

Caddell-Burns
285 East Second St.
Mineola, NY 11501
(516) 746-2310

Coilcraft
1102 Silver Lake Rd.
Cary, IL 60013
(800) 322-2645

Coiltronics
984 SW 13th Ct.
Pompano Beach, FL 33069
(305) 781-8900
Full Line including Surface Mount Inductors

Gowanda Electronics Corp.
1 Industrial Place
Gowanda, NY 14070
(716) 532-2234

Hurricane Electronics Lab
P.O. Box 1280
Hurricane Industrial Park
Hurricane, UT 84737
(801) 635-2003

Murata Erie North America
2200 Lake Park Drive
Smyrna, GA 30080
(404) 436-1300

Renco
60 E. Jefryn Blvd.
Deerpark, NY 11729
(516) 586-5566

Sumida Electronic
637 E. Golf Rd. Suite 209
Arlington Heights, IL 60005
(708) 956-0666

TDK Corp. of America
1600 Feehanville Dr.
Mt. Prospect, IL 60056
(708) 803-6100

Toko America Incorparated
1250 Feehanville Dr.
Mount Propsect, IL 60056
(312) 297-0700

Magnetic Materials

Fair-Rite Products Corp.
1 Commerial Row
P.O. Box J Wallkill, NY 12589
(914) 895-2055
Ferrite

Micrometals, Inc.
1190 N. Hawk Circle
Anaheim, CA 92807
(800) 356-5977
Powdered Iron

Magnetics Div. Spang & Co
P.O. Box 391
Bulter, PA 16003-0391
(412) 282-8282
Powdered Iron, Molypermalloy, Powdered High Flux,
Kool Mμ, Ferrite

Philips Components Disc. Prod. Div. Materials Group
5083 King Highway
Saugerties, NY 12477
(914) 246-2811
Ferrite

Pyroferric International, Inc.
200 Madison St.
Toledo, IL 62468
(217) 849-3300
Powdered Iron

Siemens Components, Inc.
186 Wood Ave. S
Iselin, NJ 08830
(908) 906-4300
Ferrite

TDK Corp. of America
1600 Feehanville Dr.
Mt. Prospect, IL 60056
(708) 803-6100
Ferrite

Bipolar Transistors

Motorola Inc.
3102 North 56th St.
MS 56-126
Phoenix, AZ 85018
(800) 521-6274
Full Line

Zetex
87 Modular Ave.
Commack, NY 11725
(516) 543-7100
High Gain Bipolar Switching Transistors
including Surface Mount Devices