

The MilQor<sup>®</sup> series of high-reliability DC-DC converters brings SynQor's field proven high-efficiency synchronous rectifier technology to the Military/Aerospace industry. SynQor's innovative QorSeal<sup>®</sup> packaging approach ensures survivability in the most hostile environments. Compatible with the industry standard format, these converters operate at a fixed frequency, have no opto-isolators, and follow conservative component derating guidelines. They are designed and manufactured to comply with a wide range of military standards.

#### **Design Process**

- MQBL series converters are:
- Designed for reliability per NAVSO-P3641-A guidelines
- Designed with components derated per:
  - MIL-HDBK-1547A
  - NAVSO P-3641A

#### **Qualification Process**

MQBL series converters are qualified to:

- MIL-STD-810F
  - consistent with RTCA/D0-160E
- SynQor's First Article Qualification

   consistent with MIL-STD-883F
- SynQor's Long-Term Storage Survivability Qualification
- SynQor's on-going life test

#### **In-Line Manufacturing Process**

- AS9100 and ISO 9001 certified facility
- Full component traceability
- Temperature cycling
- Constant acceleration
- •24, 96, 160 hour burn-in
- Three level temperature screening



MQBL-28E-15E DC-DC CONVERTER 28Vin ±15Vout@1.3A

ASE

DESIGNED & MANUFACTURED IN THE USA FEATURING QORSEAL® HI-REL ASSEMBLY

#### Features

- Fixed switching frequency
- No opto-isolators
- Output over-voltage shutdown
- Clock synchronization
- Primary referenced enable
- Continuous short circuit and overload protection
- Input under-voltage and over-voltage shutdown

#### **Specification Compliance**

MQBL series converters (with MQHE filter) are designed to meet:

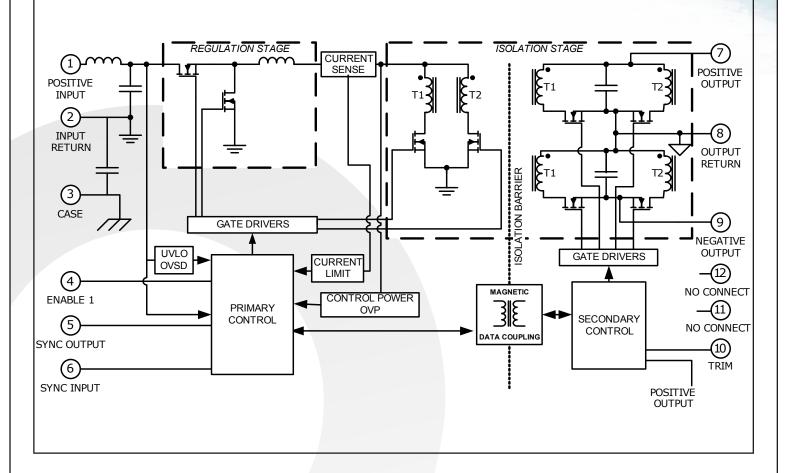
- MIL-HDBK-704-8 (A through F)
- RTCA/DO-160 Section 16, 17, 18
- MIL-STD-1275 (B, D) for  $V_{IN} > 16V$
- DEF-STAN 61-5 (part 6)/(5, 6) for V<sub>IN</sub> > 16V
- MIL-STD-461 (C, D, E, F)
- RTCA/DO-160(E, F, G) Section 22



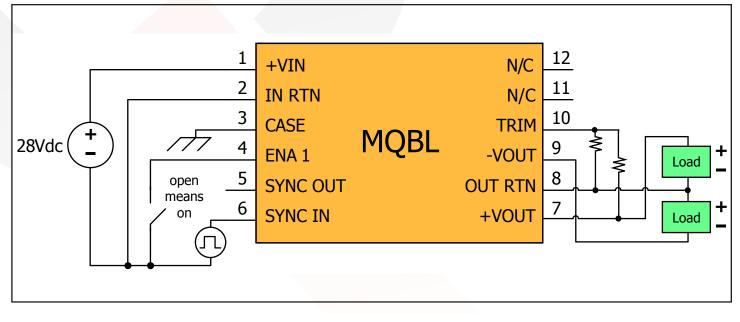
Current: 1.3A Total

JAN ANT

# **BLOCK DIAGRAM**



# TYPICAL CONNECTION DIAGRAM



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# MQBL-28E-15D

Output: ±15V

**Current: 1.3A Total** 

Allan . Contraction

Support Technical Specification

ABSOLUTE MAXIMUR PATINGS         Input Voltage           Input Voltage         100         V           See Note 1         100         V           Reverse Bias (Tosse = 125%C)         100         V           Reverse Bias (Tosse = 55°C)         12.2         V           Boardino Voltage (UD to ose, It to O)         -500         V           Continuous         -500         V           Transient (S10(µ)         -800         800           Operating Case Temperature         -55         12.5         V           Storage Case Temperature         -55         12.5         V           Operating Law Voltage Enceptone         -56         12.8         V           Turn-On Voltage Threshold         14.75         15.50         16.00         V           Turn-On Voltage Threshold         14.75         15.50         16.00         V           Turn-On Voltage Threshold         14.75         15.50         16.00         V           Turn-On Voltage Threshold         10.00         V         See Note 3         1, 2, 3           Turn-On Voltage Threshold         20.0         90.0         V         See Note 14         1, 2, 3           Diput Over Voltage Threshold         20.0         10.0	MODI - 20E-1ED ELECTO		CH/	DAC	TED	TETTCE	Constant of the
Specifications subject to change without notice         Subject to the subject						1511C5 Notos & Conditions	Crown
Specimications subject to running without notice         ree running (see Note 9) unless otherwise specified         ree Rota 1           Input Voltage Operating Operating Care 1258C)         100         V         See Note 1         100         V           Reverse Bas (Tcase = 158C)         -5.0         -5.0         -0.5         -			тур.	Max.	Units	Vin = 28V dc $\pm 5\%$ , +Iout = -Iout = 0.65A, CL = 0µF,	
Input Unlage         Input Unlage<							(see Note 11)
Non-Operating Operating Reverse Bias (Tose = 128°C)         100         V         See Note 1           Averse Bias (Tose = 128°C)         -0.8         V         -0.8         V           Averse Bias (Tose = 128°C)         -0.0         V         See Note 1         -0.0           Transient (Stabe - 35°C)         -0.0         500         V         -0.0         -0.0           Storage Case Temperature (35)         -500         500         V         -0.0         -0.0           Operating Torus         -55         125         *C         HB Grade Products, See Notes 2 & 15         -0.0           Operating Torus         -1.2         -0         V         -0.0         -0.0         -0.0           Turbus Over Voltage Struction         -1.2         -0         V         -0.0         -0.0         -0.0           Studiow Voltage Hysteresis         0.6         0.8         0.0         V         -0.0					1		
Operating Reverse Bias (Trace = 129C) Reverse Bias (Trace = -59C)				100	V		
Reverse Bias (Tcase = 125°C)         -0.8         V           Isolation Voltage (1/0 to case, 1 to 0)         -500         500         V           Operating Case Temperature         -500         500         V           Operating Case Temperature         -50         500         V           TIMPUT CHARACT ENTITICS         -1.2         28         70         V           Tamo To Voltage Threshold         14,75         15,50         V         Transcript Mage Threshold         1, 2, 3           Tum-Oft Voltage Threshold         14,75         15,50         V         See Note 3         1, 2, 3           Tum-Oft Voltage Threshold         800         95,0         0         V         See Note 3         1, 2, 3           Tum-Oft Voltage Threshold         800         95,0         V         See Note 3         1, 2, 3           Tum-Oft Voltage Threshold         800         95,0         V         See Note 3         1, 2, 3           Tum-Oft Voltage Threshold         800         95,0         V						See Note 1	
Isolation Voltage (I/D to case, I to O) Transient (\$100µS)         -500         500         V           Operating Case Temperature Voltage The Temporature Voltage The Temporature Voltage The Temporature Voltage The Temporature Voltage The Temporature Voltage The Temporature Turn-Of Voltage Threshold         16         28         70         V         Continuous         1, 2, 3           Input Under -Voltage Shutdown Turn-Of Voltage Threshold         16         28         70         V         Continuous         1, 2, 3           Turn-Of Voltage Threshold         14/25         15.50         V         Continuous         1, 2, 3           Turn-Of Voltage Threshold         14/25         15.50         V         Continuous         1, 2, 3           Turn-Of Voltage Threshold         14/25         15.50         V         See Note 3         1, 2, 3           Turn-Of Voltage Threshold         82.01         85.01         90.0         V         See Note 3         1, 2, 3           Turn-Of Voltage Threshold         82.01         85.01         90.0         V         See Note 3         1, 2, 3           Turn-Of Voltage Threshold         1.02         7         100         Transient, 1s         1, 2, 3           Input Current May         7.5         100         Transient, 1s         1, 2, 3           D	Reverse Bias (Tcase = 125°C)			-0.8			
Continuous         -500         500         V           Transient (100)s)         -800         800         V           Operating Case Temperature         -55         125         °C           Lead Temperature (205)         -1.2         300         °C           Voltage and temperature (205)         -1.2         300         °C           Voltage Threshold         14.75         15.50         16.00         V           Turn-Off Voltage Threshold         14.75         15.50         15.00         V           Shutdown Voltage Threshold         14.75         15.50         16.00         V           Turn-Off Voltage Threshold         14.75         15.50         16.00         V           Shutdown Voltage Threshold         14.75         15.50         16.00         V           Shutdown Voltage Threshold         82.0         80.0         90.0         V           Shutdown Voltage Threshold         82.0         80.0         90.0         V           Shutdown Voltage Threshold         82.0         9.0.0         17.0         MA           No Load Input Current Operating Input Cernating E St Point (Trase = 25°C)         700         MA         ENA         1.2.2.3           Output Voltage Threshold				-1.2	V		
Translent (± 100µs)         -800         800         V         HB Grade Products, See Notes 2 & 15           Storage Case Temperature         -55         1.25         °C           Lead Temperature (26)         -55         1.25         °C           Operating Case Temperature (26)         -50         1.25         °C           Operating Liput Violage Temperature (26)         -50         V         Continuous         1, 2, 3           Operating Liput Violage Threshold         14.75         15.50         V         Continuous         1, 2, 3           Tum-Oft Violage Threshold         14.75         15.50         V         See Note 3         1, 2, 3           Tum-Oft Violage Shutdown         -55         0.00.0         V         See Note 3         1, 2, 3           Tum-Oft Violage Threshold         14.00         14.75         15.00         V         See Note 3         1, 2, 3           Tum-Oft Violage Threshold         0.00.0         V         See Note 3         1, 2, 3         1, 2, 3           Tum-Oft Violage Threshold         1.00         Y         See Note 3         1, 2, 3         1, 2, 3           Tum-Oft Violage Threshold         1.00         Y         See Note 14         1, 2, 3         1, 2, 3           Tum-Oft Vio		-500		500	V		
Operating Case Temperature         -55         125         *C         HB Grade Products, See Notes 2.8.15           Lead Temperature (20s)         -5         300         *C         *           Overlage Temperature (20s)         -5         300         *C         *           Operating Tank Voltage Range         16         28         70         V         Continuous         1, 2, 3           Tum-Off Voltage Threshold         14.75         15.50         1.00         V         See Note 3         1, 2, 3           Tum-Off Voltage Threshold         14.75         15.50         V         See Note 3         1, 2, 3           Shutdown Voltage Hysteresis         0.65         0.85         1.05         V         See Note 3         1, 2, 3           Tum-Off Voltage Threshold         14.00         14.75         15.00         V         See Note 3         1, 2, 3           Tum-Off Voltage Threshold         82.0         86.0         90.0         V         See Note 3         1, 2, 3           Tum-Off Voltage Threshold         22.0         16.0         V         See Note 3         1, 2, 3           Different Current         10         17         mA         Bandwidth = 100kHz = -10MHz; see Figure 20         1, 2, 3           Ou							
Lead Temperature (20s)         300         *C           Voltage at EVA1         -1.2         50         V           Operating Input Voltage Range         16         28         70         V           Turn-Oft Voltage Studiown         16         28         70         V         Transient, 1s           Turn-Oft Voltage Threshold         14.00         14.75         15.50         16.00         V           Turn-Oft Voltage Threshold         14.00         14.75         15.50         V         11, 2, 3           Turn-Oft Voltage Threshold         14.00         14.75         15.50         V         11, 2, 3           Turn-Oft Voltage Threshold         90.0         95.0         100.0         V         See Note 3         11, 2, 3           Turn-Oft Voltage Threshold         30.0         90.0         92.0         100.0         V         Inturn-Oft Voltage Threshold         12, 2, 3           Turn-Oft Voltage Threshold         30.0         10.00         V         Inturn-Oft Voltage Threshold         12, 2, 3           Turn-Oft Voltage Threshold         30.0         17, 7         N         N         Bandwidth = 100kHz - 10WHz; see Figure 20         1, 2, 3           Turn-Oft Voltage Threshold         15.15         V         See	Operating Case Temperature	-55		125	°C	HB Grade Products, See Notes 2 & 15	
Voltage af ENA1         -1.2         50         V           Operating Input Voltage Range         16         28         70         V         Continuous         1, 2, 3           Input Under-Voltage Shutdown         16         28         80         V         Continuous         1, 2, 3           Input Under-Voltage Shutdown         16         28         80         V         See Note 3         1, 2, 3           Turn-Of Voltage Threshold         14,75         15,50         V         See Note 3         1, 2, 3           Shutdown Voltage Threshold         14,75         15,50         V         See Note 3         1, 2, 3           Turn-Of Voltage Threshold         62,0         66,0         90,0         V         See Note 3         1, 2, 3           Input Chrent Values Current         75         100         M         W         See Note 3         1, 2, 3           Output Voltage Threshold         20,0         75         100         MA         W         1, 2, 3           Input Chrent Values (L/C)         2,26,4         yr         MA         W         1, 2, 3           Output Voltage Intershold         75         100         MA         W         See Note 14         1, 2, 3           Output		-65					
UNDUT         Continuous         Iterating Input Voltage Range         16         28         70         V         Continuous         Iterating Input Voltage Range         Iterating Input Voltage Range <thiterating input="" range<="" td="" th<="" voltage=""><td></td><td>1.2</td><td></td><td></td><td></td><td></td><td></td></thiterating>		1.2					
Operating Input Voltage Range         16         28         70         V         Continuous         1, 2, 3           Input Under-Voltage Shutdown         16         28         80         V         Transient, 1s         See Note 3         1, 2, 3           Turn-Of Voltage Threshold         14.75         15.50         16         00         V         Transient Voltage Threshold         1, 2, 3           Shutdown Voltage Threshold         82.0         85.0         90.0         V         V         Transient Voltage Threshold         82.0         86.0         90.0         V           Shutdown Voltage Threshold         82.0         86.0         90.0         V         V         Phylip         Interned Voltage Threshold         82.0         86.0         90.0         V           Motage Threshold         82.0         86.0         90.0         V         V         Phylip         Interned Voltage Threshold         1, 2, 3           Diabled Input Current (perating)         75         100         mA         ENA         1, 2, 3           Diabled Input Current (perating)         75         100         mA         ENA         1, 2, 3           Diabled Input Current (perating)         14.73         15.00         15.2         V         See		-1.2		50			
Input Under Voltage Shutdown         16         28         80         V         Transient, 1s           Turn-Of Voltage Threshold         14,75         15,50         16,00         V         1, 2, 3           Stutdown Voltage Hysteresis         0,65         0,85         1,00         14,75         15,50         16,00         V         1, 2, 3           Turn-Of Voltage Shutdown         0         5         0,00         V         See Note 3         1, 2, 3           Turn-Of Voltage Shutdown         0         5         0,00         V         See Note 3         1, 2, 3           Turn-Of Voltage Threshold         90,0         15,0         V         See Note 3         1, 2, 3           Turn-Of Voltage Threshold         90,0         15,0         V         See Note 3         1, 2, 3           Diput Current Component Values (L(C)         2, 2/6,4         µ/µ/µ         Internal Values         1, 2, 3           Diput Current Current Rippt (0kpk)         10         17         TM         Bandwidth = 100kHz - 10MHz; see Figure 20         1, 2, 3           Output Voltage Est Point (Current Rippt (0kpk)         14,85         15,00         14,71         V         See Note 14         1           Output Voltage Est Point (Current Rippt (0kpk)         15,20		16	28	70	V	Continuous	1, 2, 3
Tum-On Voltage Threshold14.7515.5016.00VTum-Of Voltage Threshold14.0014.7515.5016.00VShutdown Voltage Hysteresis0.650.851.05VTum-Of Voltage Threshold90.095.0100.0VShutdown Voltage Threshold90.095.0100.0VTum-Of Voltage Threshold90.095.0100.0VShutdown Voltage Threshold90.095.0100.0VShutdown Voltage Threshold90.015.0VNo Load Threshold17.7AVin = 16V; +lout = -lout = 0.65ANo Load Thruge Current17.7ANin = 16V; +lout = -lout = 0.65AInput Teirnal Current Ripple (pk-pk)25.40Na Bandwidth = 100kHz = 10MHz; see Figure 201, 2, 3Output Voltage Set Point Cuer Temperature15.15VSee Note 141Positive Output Voltage Line Regulation-15.2215.0015.15VNegative Output Voltage Line Regulation125.015.0VSee Note 141, 2, 3Output Voltage Line Regulation10.6125WSee Note 141, 2, 3Resitive Output Voltage Range010.515.0VSee Note 141, 2, 3Output Voltage Range and Nose Regulation10.515.0VSee Note 141, 2, 3Output Voltage Range010.515.0VSee Note 141, 2, 3Output Voltage Range and Nose Regulation10.610.5VSee N	n	16	28	80	V		
Turn-Off Voltage Threshold         14,75         15,50         V           Shutdown Voltage Hysteresis         0.65         0.85         1.05         V           Turn-Off Voltage Threshold         82.0         86.0         90.0         V           Shutdown Voltage Hystershold         82.0         86.0         90.0         V           Shutdown Voltage Hystershold         82.0         86.0         90.0         V           Shutdown Voltage Hystershold         82.0         86.0         90.0         V           Maximu Input Current         1.7         A         Vin = 160?         Hues         1.2,2.3           Input Terminal Current Ripple (plcxpk)         75         100         mA         Bandwidth = 100kHz - 10MHz; see Figure 20         1, 2, 3           Output Voltage Set Point (Crease = 25°C)         75         15.00         15.15         V         See Note 14         2, 3           Positive Output         15.22         V         See Note 14         2, 3         1, 2, 3           Positive Output Voltage Line Regulation         760         0         60         mW         See Note 14         1, 2, 3           Positive Output Voltage Line Regulation         760         705         10.27         N         2, 3		1475	15 50	16.00		See Note 3	1 2 2
Shutdown Volfage Hysteresis         0.65         0.85         1.05         V         See Note 3           Turn-Off Volfage Threshold         9.0         95.0         100.0         V         See Note 3         100.0         V           Turn-Off Volfage Threshold         9.0         95.0         100.0         V         See Note 3         100.0         V           Shutdown Volfage Threshold         3.0         9.0         15.0         V         See Note 3         100.0         V           No Load Input Current Component Volfage Threshold         10         17         A         Nm         ENA         1.2, 3           Durbul Current Ripple (pk-pk)         25         40         mA         Bandwidth = 100kHz - 10MHz; see Figure 20         1, 2, 3           Output Voltage Set Point (Crase = 25°C)         14.85         15.00         15.22         V         See Note 14         2, 3           Positive Output Voltage Line Regulation         -50         0         15.22         V         See Note 14         2, 3           Positive Output Voltage Ripel and Noise Peak to Peak         12.00         14.76         15.00         14.78         V         See Note 14         2, 3           Positive Output Voltage Ine Regulation         -20         75         10							
Input Over-Voltage Shutdown         See Note 3           Turn-Of Voltage Threshold         90.0         95.0         100.0         V           Stutdown Voltage Threshold         82.0         86.0         90.0         V           Shutdown Voltage Threshold         82.0         86.0         90.0         V           Input Filter Component Values (L\C)         2.2\6.4         µH\µF         Internal Values         Vin = 16V; +1out = -Lout = 0.65A           No Load Input Current (operating)         75         100         mA         ENA         1, 2, 3           Input Terminal Current Kiple (pk-pk)         10         17         mA         ENA         1, 2, 3           Output Voltage Set Point (Case = 25°C)         10         17         mA         ENA         1           Output Voltage Set Point Over Temperature         15.00         14.85         V         See Note 14         1           Output Voltage Line Regulation         -50.0         14.78         V         See Note 14         1,2,3           Positive Output Voltage Line Regulation         -60         0         60         mV         See Note 14         1,2,3           Output Voltage Case Regulation         200         75         mV         See Note 14.4         40.40.40.40.40.40.40.40.40.40.							1, 2, 5
Turn-On Voltage Threshold         82.0         86.0         90.0         V           Shutdown Voltage Hysteresis         3.0         9.0         15.0         V           Input Filter Component Values (L/C)         2.2/6.4         µH/W         Internal Values         17.7           Maximum Input Current (operating)         75         100         mA         Vin = 16V; +lout = -lout = 0.65A         1, 2, 3           Input Rement Current Ripple (pk-pk)         25         40         mA         Bandwidth = 100kHz - 10MHz; see Figure 20         1, 2, 3           Output Voltage Set Point (Crase = 25°C)         14.85         15.00         15.15         V         See Note 14         1           Output Voltage Set Point Cver Temperature Positive Output         -15.22         -14.85         V         See Note 14         2, 3           Positive Output Voltage Line Regulation         -10         12.2         -14.85         V         See Note 14         2, 3           Positive Output Voltage Line Regulation         -10         15.00         15.22         V         See Note 14         2, 3           Output Voltage Line Regulation         -10         15.30         V         See Note 14         2, 3           Output Voltage Crass Regulation         200         450         750	Input Over-Voltage Shutdown	0.00	0.00	1.00		See Note 3	
Studiown Voltage Hysteresis         3.0         9.0         15.0         V           Input Filter Component Values (L/C)         2.2\6.4         µH\W         Internal Values         Vin = 16V; +lout = -Iout = 0.65A           Maximum Input Current (operating)         75         100         mA         ENA         1, 2, 3           Disabled Input Current Ripple (pk pk)         10         17         mA         ENA         ENA         1, 2, 3           Output Voltage Set Point (Carse = 25°C)         25         40         mA         Bandwidth = 100kHz – 10MHz; see Figure 20         1, 2, 3           Output Voltage Set Point (Crase = 25°C)         14.85         15.00         12.15         V         See Note 14         1           Positive Output         -15.15         15.00         14.78         V         See Note 14         2, 3           Positive Output Voltage Ene Regulation         -60         0         60         mW         See Note 14         1, 2, 3           Positive Output Voltage Caros Regulation         -20         450         750         mW         See Note 14         1, 2, 3           Output Voltage Caros Regulation         -20         75         mV         See Note 14         1, 2, 3           Output Voltage Caros Regulation         -102	Turn-Off Voltage Threshold						
Input Filter Component Values (L\C)         Image: Component Values (L\C)							
Maximum Input CurrentI.7AVin = 16V; +Iout = -Iout = 0.65ANo Load Input Current (poperating)1017mAENADisabled Input Current (pipe (pk-pk)2540mAENADurut Voltage Set Point (Tcase = 25°C)2540mABandwidth = 100kHz - 10MHz; see Figure 201, 2, 3Output Voltage Set Point (Tcase = 25°C)14.8515.0015.15VSee Note 141Positive Output-15.15-14.85VVSee Note 141Output Voltage Set Point Over Temperature-17.715.0015.22VSee Note 142, 3Positive Output-15.22-15.00-14.78VSee Note 142, 3Positive Output Voltage Line Regulation-60060mWSee Note 141, 2, 3Positive Output Voltage Coas Regulation-10015.30VSee Note 141, 2, 3Output Voltage Riple and Noise Peak to Peak01.3A(+Tout) + (-tout)1, 2, 3Output Over-Voltage Shutdown16.818.421.3VSee Note 14See Note 14Output Voltage Lipe Regulation10.4AMaximum Hout or -1out1, 2, 32, 2, 3Output Output Current Range01.3A(+Tout) + (-fout)1, 2, 3Output Dut Current Range01.04AMaximum Hout or -1out1, 2, 3Output Dut Dutput Current Range01.04AMaximum Hout or -1out1, 2, 3Output Voltage Riple		3.0		15.0		Internal Values	
No Load Input Current (operating)         75         100         mA         1, 2, 3           Disabled Input Current Ripple (ok-pk)         25         40         mA         ENA           Output Terminal Current Ripple (ok-pk)         25         40         mA         Bandwidth = 100kHz - 10MHz; see Figure 20         1, 2, 3           Output Voltage Set Point (Tcase = 25°C)         14.85         15.00         15.15         V         See Note 14         1           Output Voltage Set Point Over Temperature Positive Output         14.78         15.00         15.22         V         See Note 14         1           Positive Output         14.78         15.00         15.22         V         See Note 14         2, 3           Positive Output         14.78         15.00         15.22         V         See Note 14         2, 3           Total Positive Output Voltage Regulation Positive Positive Output Voltage Regulation Positive Output Voltage Regulation Positive Output Voltage Regulation Positive Positive Output Voltage Regulation Positive Positi Positive Positive Positive Positive Positive Positive Positi Pos			2.2\0.4	1.7			
Disabled Input Current         10         17         mA         ENA         1, 2, 3           Input Terminal Current Ripple (pk-pk)         25         40         mA         Bandwidth = 100kHz - 10MHz; see Figure 20         1, 2, 3           Output Voltage Set Point (Tcase = 25°C)         V         See Note 14         1           Positive Output         -15.15         -15.00         14.85         V         See Note 14         1           Output Voltage Set Point Over Temperature Positive Output         -15.22         -15.00         -14.85         V         See Note 14         2, 3           Positive Output         -15.22         -15.00         -14.78         V         See Note 14         2, 3           Positive Output Voltage Line Regulation         -60         0         60         mV         See Note 14         1, 2, 3           Total Positive Output Voltage Range         14.70         15.00         15.30         V         See Note 14         1, 2, 3           Output Voltage End Regulation         -10.5         0         15.30         V         See Note 14         1, 2, 3           Output Voltage Range         1.72, 3         Single Output Voltage Range         1, 2, 3         1, 2, 3         1, 2, 3           Output Voltage Range         0			75				1, 2, 3
OUTPUT CHARACTERISTICS         V         See Note 14         1           Output Voltage Set Point (Tcase = 25°C) Positive Output         15.15         V         See Note 14         1           Negative Output         -15.15         -15.00         15.15         V         See Note 14         1           Output Voltage Set Point Over Temperature Positive Output         14.78         15.00         15.12         V         See Note 14         2, 3           Positive Output Voltage Load Regulation         -60         0         60         mV         See Note 14         2, 3           Positive Output Voltage Load Regulation         -125         0         125         mV         See Note 14         1, 2, 3           Total Positive Output Voltage Range         14.70         15.00         15.30         mV         See Note 14         1, 2, 3           Output Voltage Cross Regulation         200         450         750         mV         See Note 14         1, 2, 3           Output Voltage Range         0         1.3         A         (+lout) + (-lout)         1, 2, 3           Output Voltage Range         0         1.3         A         (+lout) + (-lout)         1, 2, 3           Single Output Voltage Range         0         1.48         1.75	Disabled Input Current						1, 2, 3
Output Voltage Set Point (Tcase = 25°C)Image of the set Note 14See Note 14Positive Output-15.15-15.00-14.85VOutput Voltage Set Point Over Temperature-15.15-15.00-14.85VPositive Output-15.22-15.00-14.78VPositive Output-15.22-15.00-14.78VPositive Output Voltage Load Regulation-60060mVPositive Output Voltage Load Regulation-1250125mVSee Note 14-15.30VSee Note 14-12, 23Output Voltage Cross Regulation200450750mVSee Note 14-100H12; CL=11µF on both outputs1, 2, 3Output Voltage Nutge Cross Regulation16.818.421.3VOutput Voltage Nutge Cross Regulation101.04AMaximum +Lout or -Lout1, 2, 3Operating Output Current Range01.04ASee Note 4; +Lout + -Lout; +Lout = -Lout1, 2, 3Operating Output Corrent-Limit while Enabled1050mASee Note 61, 2, 3Output Voltage Deviation Line Transient-000-00mWNear 1, 2, 31, 2, 3Output Voltage Corrent Limit while Disabled1050mA-100 both outputs1, 2, 3Output Voltage Note Point Range01.04ASee Note 61, 2, 3Output Voltage Deviation Load Current-000-000A-000ABack-Drive Current Limit while Enabled10 <td></td> <td></td> <td>25</td> <td>40</td> <td>mA</td> <td>Bandwidth = 100kHz – 10MHz; see Figure 20</td> <td>1, 2, 3</td>			25	40	mA	Bandwidth = 100kHz – 10MHz; see Figure 20	1, 2, 3
Positive Output         14.85         15.00         15.15         V         1           Negative Output         -15.15         -15.00         -14.85         V         See Note 14         1           Positive Output         14.78         15.00         15.22         V         See Note 14         2, 3           Negative Output         15.22         15.00         14.78         V         See Note 14         2, 3           Positive Output Voltage Load Regulation         -60         0         60         mV         See Note 14         1, 2, 3           Total Positive Output Voltage Range         14.70         15.00         15.30         V         See Note 14         1, 2, 3           Output Voltage Cross Regulation         200         450         750         mV         See Note 14         See Note 14         1, 2, 3           Output Voltage Ripple and Noise Peak to Peak         20         75         mV         Bandwidth = 10MHz; CL=11µF on both outputs         1, 2, 3           Single Output Power Range         0         1.3         A         (+tout) + (-tout)         1, 2, 3           Operating Output Power Range         0         1.95         W         Total on both outputs         1, 2, 3           Back-Drive Current Limit Mile Enabled					V	See Note 14	
Negative Output         -15.15         -15.00         -14.85         V         See Note 14         1           Output Voltage Set Point Over Temperature Positive Output         14.78         15.00         15.22         V         2, 3           Negative Output Voltage Line Regulation Positive Output Voltage Lad Regulation         -60         0         60         mV         See Note 14         2, 3           Total Positive Output Voltage Lad Regulation         -125         0         125         mV         See Note 14         1, 2, 3           Output Voltage Cross Regulation         120         450         750         mV         See Note 14         1, 2, 3           Output Voltage Cross Regulation         16.8         18.4         21.3         V         See Note 31 and 14; Vout@(+lout=-lout=0.26A) - 40ot@(+lout=-lout=0.26A) - 40ot@(+lout=-lout=0.26A		14.85	15.00	15.15			1
Positive Ouput14.7815.0015.22V2,3Negative Output Voltage Line Regulation-15.22-15.00-14.78VSee Note 142,3Positive Output Voltage Line Regulation-10060mVSee Note 141,2,3Positive Output Voltage Load Regulation-1250125mVSee Note 141,2,3Total Positive Output Voltage Cross Regulation-10045075mVSee Note 141,2,3Output Voltage Shutdown16.818.421.3VSee Note 13 and 14; vod@(+tod=-1od=-0.26A)1,2,3Output Voltage Ripple and Noise Peak to Peak2075mVBandwidth = 10MHz; CL=11µF on both outputs1,2,3Output Voltage Ripple and Noise Peak to Peak01.3A(+tout) + (-tout)1,2,3Operating Output Dever Range01.04AMaximum Hout or -fout1,2,3Output DC Current Limit Inception1.401.752.10ASee Note 4; +tout + -lout; +tout = -lout1,2,3Back-Drive Current Limit while Enabled0.90AA1,2,3A1,2,3Output Voltage Deviation Load Transient-600-300mVTotal on both outputs1,2,3For a Neg. Step Change in Load Current-00-300mVTotal on both outputs; see Note 74, 5, 6Output Voltage Deviation Line Transient-200200mVTotal on both outputs; see Note 74, 5, 6For a Neg. Step Change in Line Voltage-200200 <td< td=""><td></td><td>-15.15</td><td>-15.00</td><td>-14.85</td><td></td><td></td><td>1</td></td<>		-15.15	-15.00	-14.85			1
Negative Output-15.22-15.00-14.78VSee Note 142, 3Positive Output Voltage Load Regulation-00060mVSee Note 14, +Vout @(+lout=-lout=0.6) + +Vout @(+lout=-lout=0.65A)1, 2, 3Total Positive Output Voltage Range14.7015.0015.30VSee Note 14, +Vout @(+lout=-lout=0.6) + +Vout @(+lout=-lout=0.65A)1, 2, 3Output Voltage Cross Regulation450750mVSee Note 141, 2, 3Output Voltage Cross Regulation16.818.421.3VSee Note 14Output Voltage Ripple and Noise Peak to Peak2075mVBandwidth = 10MHz; CL=11µF on both outputs1, 2, 3Single Output Current Range01.04AMaximum +Lout or -Jout1, 2, 31, 2, 3Operating Output Current Range01.9.5WTotal on both outputs1, 2, 3Output DC Current-Limit Inception1.401.752.10AABack-Drive Current Limit while Enabled10.90A1, 2, 3ABack-Drive Current Limit while Enabled0.90AA1, 2, 3Maximum Output Capacitance00mVTotal on both outputs1, 2, 3Output Voltage Deviation Load Transient-600-300mVTotal on both outputs4, 5, 6For a Neg. Step Change in Line Voltage-200200mVTotal out step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6For a Neg. Step Change in Line Voltage-200200mV <t< td=""><td></td><td>1470</td><td>15.00</td><td>45.00</td><td></td><td>See Note 14</td><td>2.2</td></t<>		1470	15.00	45.00		See Note 14	2.2
Positive Output Voltage Line Regulation-60060mVSee Note 141, 2, 3Positive Output Voltage Load Regulation-1250125mVSee Note 14; +Vout@(+fout=-tout=0.65A)1, 2, 3Output Voltage Cross Regulation200450750mVSee Note 14; +Vout@(+fout=-tout=0.26A) - +Vout@(+fout=-1.04A, -tout=0.26A)1, 2, 3Output Voltage Cross Regulation16.818.421.3VSee Note 13 and 14; -Vout@(+fout=-tout=0.26A) - +Vout@(+fout=-1.04A, -tout=0.26A)1, 2, 3Output Voltage Shutdown16.818.421.3VSee Note 13 and 14; -Vout@(+fout=-tout=0.26A) - +Vout@(+fout=-1.04A, -tout=0.26A)1, 2, 3Output Voltage Ripple and Noise Peak to Peak2075mVBandwidth = 10MHz; CL=11µF on both outputs1, 2, 3Operating Output Operating Current Range01.04AMaximum +Iout or -Iout1, 2, 3Operating Output Power Range01.04ASee Note 14; +Iout + -Iout; +Iout = -Iout1, 2, 3Back-Drive Current Limit while Enabled0.90ASee Note 6; +Iout + -Iout; +Iout = -Iout1, 2, 3Back-Drive Current Limit while Disabled1050mASee Note 61, 2, 6Output Voltage Deviation Load Transient-600 $\mu$ For a Neg. Step Change in Load Current-600-300mVFor a Neg. Step Change in Line Voltage-200200mVVin step = 16V to 40V; CL=11µF on both outputs; see Note 74, 5, 6Output Voltage Deviation Line Transient <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td>2,3</td></td<>							2,3
Positive Output Voltage Load Regulation-1250125mVSee Note 14; +Vout @(+lout=-lout=0.6) + Vout @(+lout=-lout=0.65A)1, 2, 3Total Positive Output Voltage Case Regulation200450750mVSee Note 141, 2, 3Output Voltage Cross Regulation200450750mVSee Note 141, 2, 3Output Voltage Cross Regulation16.818.421.3VSee Note 13 and 14; Vout@(+lout=-lout=0.6A) - Vout@(+lout=1.04A, -lout=0.6A)1, 2, 3Output Voltage Cross Regulation16.818.421.3VSee Note 13 and 14; Vout@(+lout=-lout=0.6A) - Vout@(+lout=1.04A, -lout=0.6A)1, 2, 3Output Voltage Cross Regulation16.818.421.3VSee Note 14; +Vout @(+lout=-lout=0.6A) - Vout@(+lout=-1.04A, -lout=0.6A)1, 2, 3Output Voltage Cross Regulation16.818.421.3VSee Note 14; +Vout @(+lout=-lout=0.6A) - Vout@(+lout=-1.04A, -lout=0.6A)1, 2, 3Single Output Overent Range01.3A(+lout) + (-lout)1, 2, 3Output DC Current Limit Inception1.401.752.10ASee Note 4; +lout + -lout; +lout = -lout1, 2, 3Back-Drive Current Limit while Enabled0.90AAAAAAMaximum Uutput Capacitance600 $\mu$ FTotal on both outputs5ee Note 4; +lout + -lout; +lout = -lout4, 2, 3Output Voltage Deviation Load Transient-600 $\mu$ FTotal on both outputs4, 5, 6For a Neg. Step Change in Load Curren						See Note 14	
Total Positive Output Voltage Range14.7015.0015.0015.30VSee Note 141, 2, 3Output Voltage Cross Regulation200450750mVSee Notes 13 and 14; Vout@(+lout=-lout=-0.26A) - Vout@(+lout=-1.04A, -lout=0.26A)1, 2, 3Output Voltage Ripple and Noise Peak to Peak2075mVBandwidth = 10MHz; CL=11µF on both outputs1, 2, 3Operating Output Current Range01.33A(+lout) + (-lout)1, 2, 3Operating Output Operating Current Range01.04AMaximum -Iout or -lout1, 2, 3Output Operating Current Limit Inception1.401.752.10ASee Note 4; +lout + -lout; +lout = -lout1, 2, 3Output Current Limit while Enabled0.90AA1, 2, 31, 2, 31, 2, 3Maximum Output Capacitance600 $\mu$ $\mu$ Total on both outputs1, 2, 3Output Voltage Deviation Load Transient-600-300mVTotal on both outputs5ee Note 7For a Pos. Step Change in Load Current-600-300mVTotal lout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6Output Voltage Deviation Line Transient-200200mV**For a Reg. Step Change in Load Current-200-200mV*For a Reg. Step Change in Line Voltage-200-200mV**For a Reg. Step Change in Line Voltage-200200mV**Turn-On Transient-200-200<							1 1/2/3
Output Over-Voltage Shutdown16.818.421.3VSee NoteOutput Voltage Ripple and Noise Peak to Peak2075mVBandwidth = 10MHz; CL=11µF on both outputs1, 2, 3Operating Output Current Range01.3A(+Iout) + (-Iout)1, 2, 3Operating Output Operating Current Range01.04AMaximum +Iout or -Iout1, 2, 3Operating Output Power Range01.9.5WTotal on both outputs1, 2, 3Output DC Current-Limit Inception1.401.752.10ASee Note 4; +Iout + -Iout; +Iout = -Iout1, 2, 3Back-Drive Current Limit while Enabled0.90AASee Note 4; +Iout + -Iout; +Iout = -Iout1, 2, 3Back-Drive Current Limit while Disabled1050mA1, 2, 31, 2, 3Maximum Output Capacitance600µFTotal on both outputsSee Note 6DYNAMIC CHARACTERISTICS-600-300mVTotal on both outputs4, 5, 6Output Voltage Deviation Load Transient-600-300mVTotal lout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6For a Neg. Step Change in Load Current-200200mVTotal lout step = 16V to 40V; CL=11µF on both outputs; see Note 7For a Neg. Step Change in Line Voltage-200200mVTotal Sige Note 7*Turn-On Transient-200200mV**For a Neg. Step Change in Line Voltage-200200mV**T		-125	0			See Note 14; +Vout @(+Iout=-Iout=0A) - +Vout @(+Iout=-Iout=0.65A)	1, 2, 3
Output Voltage Ripple and Noise Peak to Peak2075mVBandwidth = 10MHz; CL=11µF on both outputs1, 2, 3Operating Output Current Range01.3A(+lout) + (-lout)1, 2, 3Single Output Operating Current Range01.04AMaximum +lout or -lout1, 2, 3Operating Output Power Range019.5WTotal on both outputs1, 2, 3Output DC Current-Limit Inception1.401.752.10ASee Note 4; +lout + -lout; +lout = -lout1, 2, 3Back-Drive Current Limit while Disabled0.90A1050mA1, 2, 3Maximum Output Capacitance1050mA1, 2, 31, 2, 3Output Voltage Deviation Load Transient-600-300mVTotal on both outputsSee Note 6Output Voltage Deviation Load Current-600-300mVTotal out step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6Output Voltage Deviation Line Transient-200200mV"Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs; see Note 7For a Neg. Step Change in Line Voltage-200200mV"Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs; see Note 7For a Neg. Step Change in Line Voltage-200200mV"Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs; see Note 7For a Neg. Step Change in Line Voltage-200200mV""Turn-On Transient-200200mV		14.70	15.00	125 15.30	mV V	See Note 14	1, 2, 3
Operating Output Current Range01.3A(+Iout) + (-Iout)1, 2, 3Single Output Operating Current Range01.04AMaximum +Iout or -Iout1, 2, 3Operating Output Power Range01.95WTotal on both outputs1, 2, 3Output DC Current-Limit Inception1.401.752.10ASee Note 4; +Iout + -Iout; +Iout = -Iout1, 2, 3Back-Drive Current Limit while Enabled0.90A1, 2, 31, 2, 31, 2, 31, 2, 3Back-Drive Current Limit while Disabled1050mA1, 2, 31, 2, 31, 2, 3Maximum Output Capacitance600µFTotal on both outputs1, 2, 31, 2, 3Output Voltage Deviation Load Transient-600-300mVTotal on both outputsSee Note 6For a Pos. Step Change in Load Current-600-300mVTotal out step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6Output Voltage Deviation Line Transient-200200mV"Vin step = 16V to 40V; CL=11µF on both outputs; see Note 7For a Neg. Step Change in Line Voltage-200200mV"Vin step = 16V to 40V; CL=11µF on both outputs; see Note 7Turn-On Transient-200200mV"See See Note 8& 104, 5, 6Output Voltage Overshoot02%Resistive load4, 5, 6Turn-On Delay, Rising Vin5.58.0msENA = 5V; see Notes 8 & 104, 5, 6Turn-On Delay, Rising ENA3.06.0ms	Output Voltage Cross Regulation	14.70 200	15.00 450	125 15.30 750	mV V mV	See Note 14	1, 2, 3 1, 2, 3
Single Output Operating Current Range Operating Output Power Range01.04AMaximum +Iout or -Iout Total on both outputs1, 2, 3Operating Output Power Range Output DC Current-Limit Inception1.401.752.10ASee Note 4; +Iout + -Iout; +Iout = -Iout1, 2, 3Output DC Current-Limit While Enabled Back-Drive Current Limit while Disabled1.041.752.10ASee Note 4; +Iout + -Iout; +Iout = -Iout1, 2, 3Maximum Output Capacitance0.90A1.050mA1, 2, 3Maximum Output Capacitance1050mA1, 2, 3Output Voltage Deviation Load Transient For a Neg. Step Change in Load Current-600-300mVTotal on both outputsSee Note 6Output Voltage Deviation Line Transient For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage Output Voltage Deviation Line Transient Output Voltage Rise Time-200200mVmVFor a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Vol	Output Voltage Cross Regulation Output Over-Voltage Shutdown	14.70 200	15.00 450 18.4	125 15.30 750 21.3	mV V mV V	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A)	1, 2, 3 1, 2, 3 See Note 5
Operating Output Power Range019.5WTotal on both outputs1, 2, 3Output DC Current-Limit Inception1.401.752.10ASee Note 4; +Iout + -Iout; +Iout = -Iout1, 2, 3Back-Drive Current Limit while Disabled0.90A1, 2, 3Back-Drive Current Limit while Disabled1050mA1, 2, 3Maximum Output Capacitance600 $\mu$ FTotal on both outputsSee Note 4; +Iout + -Iout; +Iout = -Iout1, 2, 3Output Voltage Deviation Load Transient600 $\mu$ FTotal on both outputsSee NoteFor a Pos. Step Change in Load Current-300mVTotal Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6Output Voltage Deviation Line Transient-200200mV"4, 5, 6For a Pos. Step Change in Line Voltage For a Neg. Step Change in Line Voltage -200-200200mV"Furn-On Transient-200200mV"4, 5, 6Output Voltage Rise Time610ms+Vout = 1.5V to 13.5V; Full Resistive Load4, 5, 6Output Voltage Overshoot02%Resistive load4, 5, 6Turn-On Delay, Rising Vin5.58.0msENA = 5V; see Notes 8 & 104, 5, 6Turn-On Delay, Rising ENA3.06.0msSee Note 104, 5, 6Restart Inhibit Time100150msSee Note 104, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak	14.70 200 16.8	15.00 450 18.4	125 15.30 750 21.3 75	mV V mV V mV	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11 $\mu$ F on both outputs	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3
Back-Drive Current Limit while Enabled0.90A1, 2, 3Back-Drive Current Limit while Disabled1050mA1, 2, 3Maximum Output Capacitance600µFTotal on both outputsSee NoteDYNAMIC CHARACTERISTICS600-300mVTotal on both outputsSee Note 6Output Voltage Deviation Load Transient-600-300mVTotal Jout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6For a Neg. Step Change in Load Current-600-300mVTotal Jout step = 16V to 40V; CL=11µF on both outputs; see Note 7For a Neg. Step Change in Line Voltage-200200mV"*For a Neg. Step Change in Line Voltage-200200mV*For a Neg. Step Change in Line Voltage-200200mV**For a Neg. Step Change in Line Voltage-200200mV**Output Voltage Overshoot02%Resistive load4, 5, 6Output Voltage Overshoot02%Resistive load4, 5, 6Turn-On Delay, Rising Vin5.58.0msENA = 5V; see Notes 8 & 104, 5, 6Turn-On Delay, Rising ENA3.06.0msSee Note 104, 5, 6Restart Inhibit Time100150msSee Note 104, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range	14.70 200 16.8 0	15.00 450 18.4	125 15.30 750 21.3 75 1.3	mV V mV V mV A	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout)	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3
Back-Drive Current Limit while Disabled1050mA1, 2, 3Maximum Output Capacitance600 $\mu$ FTotal on both outputsSee NoteDYNAMIC CHARACTERISTICSOutput Voltage Deviation Load Transient-600-300mVTotal Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6For a Neg. Step Change in Load Current-600-300mVTotal Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6Output Voltage Deviation Line Transient-600-200mV"*4, 5, 6For a Neg. Step Change in Line Voltage-200200mV"*4, 5, 6For a Neg. Step Change in Line Voltage-200200mV**4, 5, 6Output Voltage Rise Time610ms+Vout = 1.5V to 13.5V; Full Resistive Load4, 5, 6Output Voltage Overshoot02%Resistive loadSee Notes 8 & 104, 5, 6Turn-On Delay, Rising Vin5.58.0msENA = 5V; see Notes 8 & 104, 5, 6Turn-On Delay, Rising ENA3.06.0msSee Note 104, 5, 6Restart Inhibit Time100150msSee Note 104, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range	14.70 200 16.8 0 0 0	15.00 450 18.4 20	125 15.30 750 21.3 75 1.3 1.04 19.5	mV V mV V MV A A	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3
Maximum Output CapacitanceImage: Constraint of the second sec	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception	14.70 200 16.8 0 0 0	15.00 450 18.4 20 1.75	125 15.30 750 21.3 75 1.3 1.04 19.5	mV V mV A A W A	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3 1, 2, 3
DYNAMIC CHARACTERISTICS         Output Voltage Deviation Load Transient         For a Pos. Step Change in Load Current       -600         For a Neg. Step Change in Load Current       -600         Output Voltage Deviation Line Transient       -600         For a Pos. Step Change in Load Current       300         Output Voltage Deviation Line Transient       -200         For a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Por a Neg. Step Change in Line Voltage       -200         Resistive Load	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled	14.70 200 16.8 0 0 0	15.00 450 18.4 20 1.75 0.90	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10	mV V mV A A W A A A	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3
For a Pos. Step Change in Load Current-600-300mVTotal Jout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs4, 5, 6For a Neg. Step Change in Line Voltage300600mV"4, 5, 6Output Voltage Deviation Line Transient-200200mV"*For a Neg. Step Change in Line Voltage-200-200200mV*For a Neg. Step Change in Line Voltage-200-200mV**For a Neg. Step Change in Line Voltage-200200mV**Turn-On Transient-200200mV***Output Voltage Rise Time610ms+ Vout = 1.5V to 13.5V; Full Resistive Load4, 5, 6Output Voltage Overshoot02%Resistive load4, 5, 6Turn-On Delay, Rising Vin5.58.0msENA = 5V; see Notes 8 & 104, 5, 6Turn-On Delay, Rising ENA3.06.0msSee Note 104, 5, 6Restart Inhibit Time100150msSee Note 104, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled	14.70 200 16.8 0 0 0	15.00 450 18.4 20 1.75 0.90	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10	mV V mV A A W A A M A M	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3
For a Neg. Step Change in Load Current300600mV"4, 5, 6Output Voltage Deviation Line Transient-200200mVVin step = 16V to 40V; CL=11µF on both outputs; see Note 7For a Neg. Step Change in Line Voltage-200200mVFor a Neg. Step Change in Line Voltage-200200mVTurn-On Transient-200200mVOutput Voltage Rise Time610msOutput Voltage Overshoot02%Turn-On Delay, Rising Vin5.58.0msEINA = 5V; see Notes 8 & 104, 5, 6Restart Inhibit Time100150msSee Note 104, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance	14.70 200 16.8 0 0 0	15.00 450 18.4 20 1.75 0.90	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10	mV V mV A A W A A M A M	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3
Output Voltage Deviation Line Transient       Image: Construction Line Voltage       -200       200       mV         For a Pos. Step Change in Line Voltage       -200       -200       200       mV       -200       200       mV         For a Neg. Step Change in Line Voltage       -200       -200       200       mV       -200       200       mV         Turn-On Transient       -200       -200       0       200       mV       -200       -200       -200       -200       -200       -200       mV       -200       -200       -200       -200       -200       -200       -200       -200       -200       -200       -200       -200       -200       -200       -200 <td>Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance DYNAMIC CHARACTERISTICS Output Voltage Deviation Load Transient</td> <td>14.70 200 16.8 0 0 0 1.40</td> <td>15.00 450 18.4 20 1.75 0.90 10</td> <td>125 15.30 750 21.3 75 1.3 1.04 19.5 2.10</td> <td>mV V mV A A W A A M A A M A F</td> <td>See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6</td> <td>1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 See Note 5</td>	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance DYNAMIC CHARACTERISTICS Output Voltage Deviation Load Transient	14.70 200 16.8 0 0 0 1.40	15.00 450 18.4 20 1.75 0.90 10	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10	mV V mV A A W A A M A A M A F	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 See Note 5
For a Pos. Step Change in Line Voltage For a Neg. Step Change in Line Voltage Turn-On Transient-200200mVTurn-On Transient Output Voltage Rise Time-200610ms+Vout = 1.5V to 13.5V; Full Resistive Load4, 5, 6Output Voltage Overshoot02%Resistive loadSee Note5ee NoteTurn-On Delay, Rising Vin5.58.0msENA = 5V; see Notes 8 & 104, 5, 6Turn-On Delay, Rising ENA3.06.0msSee Note 104, 5, 6Restart Inhibit Time100150msSee Note 104, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance DYNAMIC CHARACTERISTICS Output Voltage Deviation Load Transient For a Pos. Step Change in Load Current	14.70 200 16.8 0 0 0 1.40	15.00 450 18.4 20 1.75 0.90 10	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600	mV V mV A A W A A M M A M M M W M M W	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 5ee Note 5 4, 5, 6
For a Neg. Step Change in Line Voltage Turn-On Transient-200mVmVOutput Voltage Rise Time610ms+Vout = 1.5V to 13.5V; Full Resistive Load4, 5, 6Output Voltage Overshoot02%Resistive loadSee NoteTurn-On Delay, Rising Vin5.58.0msENA = 5V; see Notes 8 & 104, 5, 6Turn-On Delay, Rising ENA3.06.0msSee Note 104, 5, 6Restart Inhibit Time100150msSee Note 104, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance <b>DYNAMIC CHARACITERISTICS</b> Output Voltage Deviation Load Transient For a Pos. Step Change in Load Current For a Neg. Step Change in Load Current	14.70 200 16.8 0 0 0 1.40	15.00 450 18.4 20 1.75 0.90 10	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600	mV V mV A A W A A M M A M M M W M M W	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6 Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs "	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 4, 5, 6
Output Voltage Rise Time         6         10         ms         +Vout = 1.5V to 13.5V; Full Resistive Load         4, 5, 6           Output Voltage Overshoot         0         2         %         Resistive load         See Note           Turn-On Delay, Rising Vin         5.5         8.0         ms         ENA = 5V; see Notes 8 & 10         4, 5, 6           Turn-On Delay, Rising ENA         3.0         6.0         ms         See Note 10         4, 5, 6           Restart Inhibit Time         100         150         ms         See Note 10         4, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance <b>DYNAMIC CHARACTERISTICS</b> Output Voltage Deviation Load Transient For a Neg. Step Change in Load Current For a Neg. Step Change in Load Current Output Voltage Deviation Line Transient	14.70 200 16.8 0 0 0 1.40 -600	15.00 450 18.4 20 1.75 0.90 10	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600	mV V mV A A W A A W A A mA µF	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6 Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs "	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 4, 5, 6
Output Voltage Overshoot         0         2         %         Resistive load         See Note           Turn-On Delay, Rising Vin         5.5         8.0         ms         ENA = 5V; see Notes 8 & 10         4, 5, 6           Turn-On Delay, Rising ENA         3.0         6.0         ms         See Note 10         4, 5, 6           Restart Inhibit Time         100         150         ms         See Note 10         4, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance <b>DYNAMIC CHARACTERISTICS</b> Output Voltage Deviation Load Transient For a Neg. Step Change in Load Current For a Pos. Step Change in Line Voltage For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage	14.70 200 16.8 0 0 1.40 -600	15.00 450 18.4 20 1.75 0.90 10	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600	mV V mV A A W A A W A A M A W M A M M M M M V mV	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6 Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs "	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 4, 5, 6
Turn-On Delay, Rising Vin         5.5         8.0         ms         ENA = 5V; see Notes 8 & 10         4, 5, 6           Turn-On Delay, Rising ENA         3.0         6.0         ms         See Note 10         4, 5, 6           Restart Inhibit Time         100         150         ms         See Note 10         4, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance <b>DYNAMIC CHARACTERISTICS</b> Output Voltage Deviation Load Transient For a Neg. Step Change in Load Current For a Neg. Step Change in Load Current For a Neg. Step Change in Load Current For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage Turn-On Transient	14.70 200 16.8 0 0 1.40 -600	15.00 450 18.4 20 1.75 0.90 10 -300 300	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600 600 200 200	mV V mV A A W A A W A A W A M W A M M W M M V mV mV	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11 $\mu$ F on both outputs (+Iout) + (-Iout) Maximum + Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6 Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11 $\mu$ F on both outputs Vin step = 16V to 40V; CL=11 $\mu$ F on both outputs; see Note 7	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 See Note 5 4, 5, 6 4, 5, 6
Turn-On Delay, Rising ENA         3.0         6.0         ms         See Note 10         4, 5, 6           Restart Inhibit Time         100         150         ms         See Note 10         4, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance <b>DYNAMIC CHARACTERISTICS</b> Output Voltage Deviation Load Transient For a Neg. Step Change in Load Current For a Neg. Step Change in Load Current For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage Turn-On Transient Output Voltage Rise Time	14.70 200 16.8 0 0 1.40 -600	15.00 450 18.4 20 1.75 0.90 10 -300 300	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600 600 200 200 200 200	mV V mV A A A W A A A W A A M W A M M W M M W mV mV mV mV mV	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11µF on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6 Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11µF on both outputs Vin step = 16V to 40V; CL=11µF on both outputs; see Note 7 +Vout = 1.5V to 13.5V; Full Resistive Load	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 5ee Note 5 4, 5, 6 4, 5, 6 4, 5, 6 4, 5, 6
Restart Inhibit Time         100         150         ms         See Note 10         4, 5, 6	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance <b>DYNAMIC CHARACTERISTICS</b> Output Voltage Deviation Load Transient For a Pos. Step Change in Load Current For a Neg. Step Change in Load Current For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage Turn-On Transient Output Voltage Rise Time Output Voltage Overshoot	14.70 200 16.8 0 0 1.40 -600	15.00 450 18.4 20 1.75 0.90 10 -300 300	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600 50 600 200 200 200 200 200 200	mV V mV A A A W A A A W A A M W A M M W M M V mV mV mV mV mV mV mV	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11 $\mu$ F on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6 Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11 $\mu$ F on both outputs Vin step = 16V to 40V; CL=11 $\mu$ F on both outputs; see Note 7 +Vout = 1.5V to 13.5V; Full Resistive Load Resistive load	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 5ee Note 5 4, 5, 6 4, 5, 6 5ee Note 5
	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance <b>DYNAMIC CHARACITERISTICS</b> Output Voltage Deviation Load Transient For a Pos. Step Change in Load Current For a Neg. Step Change in Load Current For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage Turn-On Transient Output Voltage Devershoot Turn-On Delay, Rising Vin	14.70 200 16.8 0 0 1.40 -600	15.00 450 18.4 20 1.75 0.90 10 -300 300 -300 -300 -5.5	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600 50 600 200 200 200 200 200 200 200 200 20	mV V mV A A W A A M A M M V M V mV mV mV mV mV mV mS % ms	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11 $\mu$ F on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6 Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11 $\mu$ F on both outputs Vin step = 16V to 40V; CL=11 $\mu$ F on both outputs; see Note 7 +Vout = 1.5V to 13.5V; Full Resistive Load Resistive load ENA = 5V; see Notes 8 & 10	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 See Note 5 4, 5, 6 4, 5, 6 See Note 5 4, 5, 6
	Output Voltage Cross Regulation Output Over-Voltage Shutdown Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range Single Output Operating Current Range Operating Output Power Range Output DC Current-Limit Inception Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled Maximum Output Capacitance <b>DYNAMIC CHARACTERISTICS</b> Output Voltage Deviation Load Transient For a Pos. Step Change in Load Current For a Neg. Step Change in Load Current For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage Turn-On Transient Output Voltage Overshoot Turn-On Delay, Rising Vin Turn-On Delay, Rising ENA Restart Inhibit Time	14.70 200 16.8 0 0 0 1.40 -600 -200 -200	15.00 450 18.4 20 1.75 0.90 10 -300 300 -300 300 	125 15.30 750 21.3 75 1.3 1.04 19.5 2.10 50 600 50 600 200 200 200 200 200 200 200 200 20	mV V mV A A W A A W A A W A M W M V mV mV mV mV mV mV mS ms ms	See Note 14 See Notes 13 and 14; -Vout@(+Iout=-Iout=0.26A)Vout@(+Iout=1.04A, -Iout=0.26A) Bandwidth = 10MHz; CL=11 $\mu$ F on both outputs (+Iout) + (-Iout) Maximum +Iout or -Iout Total on both outputs See Note 4; +Iout + -Iout; +Iout = -Iout Total on both outputs See Note 6 Total Iout step = 0.65A to 1.3A, 0.13A to 0.65A; CL=11 $\mu$ F on both outputs Vin step = 16V to 40V; CL=11 $\mu$ F on both outputs; see Note 7 +Vout = 1.5V to 13.5V; Full Resistive Load Resistive load ENA = 5V; see Notes 8 & 10 See Note 10	1, 2, 3 1, 2, 3 See Note 5 1, 2, 3 1, 2, 3 5ee Note 5 4, 5, 6 4, 5, 6 See Note 5 4, 5, 6 See Note 5 3, 5, 6 See Note 5 3, 5, 6 5, 7 5, 6 5, 7 5, 6 5, 7 5, 7 5

#### **MQBL-28E-15D** Output: ±15V Current: 1.3A Total A. J. A. NO ALT **Technical Specification** MOBL-28E-15D ELECTRICAL CHARACTERISTICS (Continued) Min. | Typ. | Max. | Units | Notes & Conditions Parameter Vin = 28V dc $\pm$ 5%, +Iout = -Iout = 0.65A, CL = 0 $\mu$ F, Specifications subject to change without notice free running (see Note 9) unless otherwise specified EFFICIENCY Iout = 1.3 A (16 Vin)88 % Iout = 0.65 A (16 Vin)86 % Iout = 1.3 A (28 Vin)81 86 % Iout = 0.65 A (28 Vin)85 %

1, 2, 3 Iout = 1.3 A (70 Vin)83 % Iout = 0.65 A (70 Vin)83 % Iout = 1.3 A (80 Vin) 82 % Load Fault Power Dissipation W 1.3 Sustained short circuit on output ISOLATION CHARACTERISTICS Dielectric strength **Isolation Voltage** Input RTN to Output RTN 500 V Any Input Pin to Case 500 V 1 500 Any Output Pin to Case V Isolation Resistance (IN RTN to OUT RTN) 100 MO 1 Isolation Resistance (any pin to CASE) 100 MΩ 1 Isolation Capacitance (IN RTN to OUT RTN) 22 nF 1 FEATURE CHARACTERISTICS 500 550 600 kHz 1, 2, 3 Switching Frequency (free running) Synchronization Input 500 700 kHz Frequency Range 1, 2, 3 Logic Level High 20 55 V 1, 2, 3 Logic Level Low -0.5 0.8 V 1, 2, 3 Duty Cycle 20 80 % See Note 5 Synchronization Output Pull Down Current 20 mΑ VSYNC OUT = 0.8VSee Note 5 Duty Cycle 40 60 % Output connected to SYNC IN of other MOBL unit See Note 5 Enable Control (ENA) **Off-State Voltage** 0.8 V 1, 2, 3 Module Off Pulldown Current 80 μA Current drain required to ensure module is off See Note 5 **On-State Voltage** 2 V 1, 2, 3 Module On Pin Leakage Current 20 μA Imax draw from pin allowed with module still on See Note 5 4.0 V Pull-Up Voltage 3.2 4.8 See Figure A Output Voltage Trim Range -10 10 % See Figure E 1, 2, 3 RELIABILITY CHARACTERISTICS Calculated MTBF (MIL-STD-217F2) 2540 103 Hrs. GB (a) Tcase =  $70^{\circ}$ C AIF @ Tcase = 70°C 192 103 Hrs. WEIGHT CHARACTERISTICS

#### **Electrical Characteristics Notes**

Device Weight

1. Converter will undergo input over-voltage shutdown.

2. Derate output power for continuous operation per Figure 11.

3. High or low state of input voltage must persist for about 200µs to be acted on by the shutdown circuitry.

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4. Current limit inception is defined as the point where the output voltage has dropped to 90% of its nominal value. See Current Limit discussion in

a

Features Description section. 5. Parameter not tested but guaranteed to the limit specified.

6. Load current transition time  $\geq$  10µs.

7. Line voltage transition time  $\geq 100$  us.

8. Input voltage rise time  $\leq 250 \mu s$ .

9. Operating the converter at a synchronization frequency above the free running frequency will cause the converter's efficiency to be slightly reduced and it may also cause a slight reduction in the maximum output current/power available. For more information consult the factory.

10. After a disable or fault event, module is inhibited from restarting for 100ms. See Shut Down section of the Control Features description. 11. Only the ES and HB grade products are tested at three temperatures. The C grade products are tested at one temperature. Please refer to the Construction and Environmental Stress Screening Options table for details.

12. These derating curves apply for the ES- and HB- grade products. The C- grade product has a maximum case temperature of 100°C.

13. The regulation stage operates to control the positive output. The negative ouput displays the cross regulation.

14. All +Vout and -Vout voltage measurements are made with Kelvin probes on the ouput leads.

15. The specified operating case temperature for ES grade products is -45°C to 100°C. The specified operating case temperature for C grade products is 0°C to 70°C

MOBL-28E-15D

Doc.# 005-0006549 Rev. A

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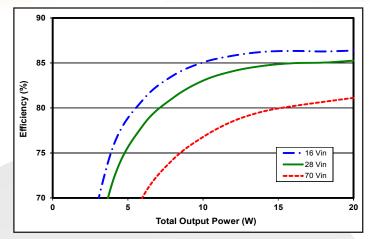
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**Group A** 

Subgroup

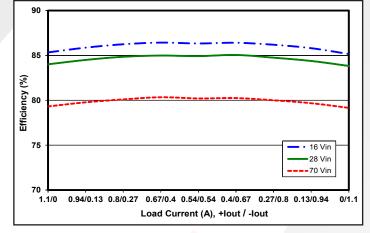
(see Note 11)

Current: 1.3A Total



Technical Figures

**Figure 1**: Efficiency vs. output power, from zero load to full load with equal load on the +15V and -15V outputs at minimum, nominal, and maximum input voltage at Tcase= $25^{\circ}C$ .



**Figure 3**: Efficiency vs. output power, with total output current fixed at 80% load (15.6W) and loads split as shown between the +15V and -15V outputs at minimum, nominal, and maximum input voltage at Tcase= $25^{\circ}$ C.

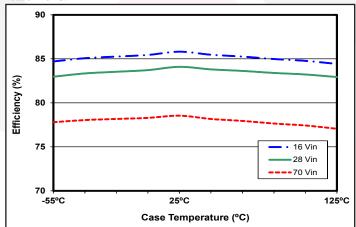


Figure 5: Efficiency at 60% load (0.39A load on +15V and 0.39A load on -15V) versus case temperature for Vin = 16V, 28V and 70V.

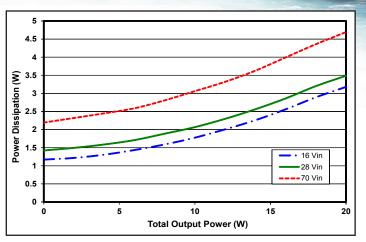
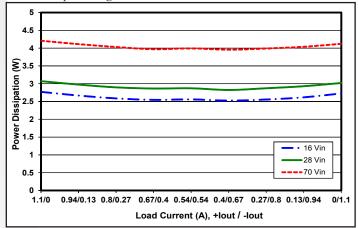
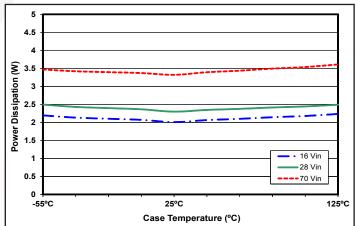


Figure 2: Power dissipation vs. output power, from zero load to full load with equal load on the +15V and -15V outputs at minimum, nominal, and maximum input voltage at Tcase= $25^{\circ}$ C.



**Figure 4**: Power dissipation vs. output power, with total output current fixed at 80% load (15.4W) and loads split as shown between the +15V and -15V outputs at minimum, nominal, and maximum input voltage at Tcase=25°C.

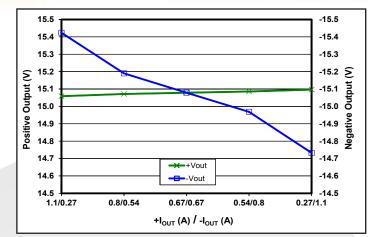


*Figure 6*: Power Dissipation at 60% load (0.39A load on +15V and 0.39A load on -15V) versus case temperature for Vin = 16V, 28V and 70V.

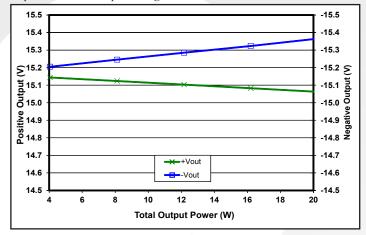
Current: 1.3A Total

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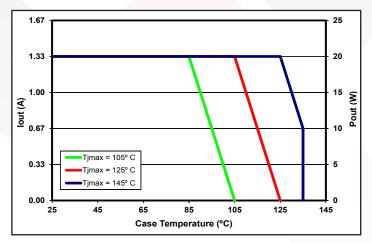
# Technical Figures



**Figure** 7: Load regulation vs. load current with power fixed at full load (19.5W) and load currents split as shown between the +15V and -15V outputs, at niminal input voltage and Tcase =  $25^{\circ}$ C.



**Figure 9**: Load regulation vs. total output power from zero to full load where +lout equals three times -lout a nominal input voltage and Tcase =  $25^{\circ}$ C.



*Figure 11*: Output Current / Output Power derating curve as a function of Tcase and the Maximum desired power MOSFET junction temperature at Vin = 28V (see Note 12).

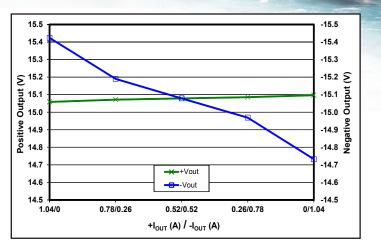
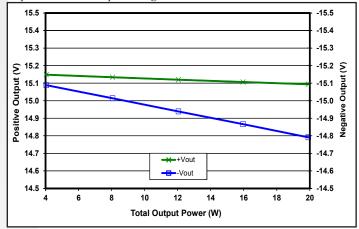
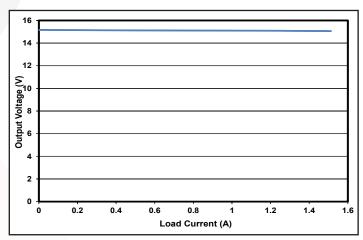


Figure 8: Load regulation vs. load current with power fixed at 80% load (15.6W) and load currents split as shown between the +15V and -15V outputs, at niminal input voltage and Tcase =  $25^{\circ}$ C.

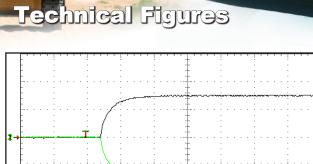


*Figure 10*: Load regulation vs. total output power from zero to full load where -lout equals three times +lout a nominal input voltage and Tcase =  $25^{\circ}$ C.



*Figure 12:* Positive output voltage vs. total load current, evenly split, showing typical current limit curves at Vin = 28V.

Current: 1.3A Total



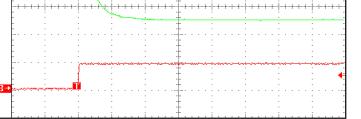


Figure 13: Turn-on transient at full load current (resistive load) (5ms/ div). Input voltage pre-applied. Ch 1: +Vout (10V/div); Ch 2: -Vout (10V/ div); Ch 3: Enable1 input (5V/div).

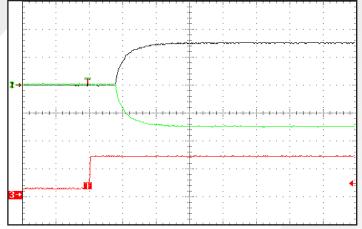


Figure 15: Turn-on transient at full load current, after application of input voltage (ENA 1 logic high) (5ms/div). Input voltage pre-applied. Ch 1: +Vout (10V/div); Ch 2: -Vout (10V/div); Ch 3: Vin (20V/div).

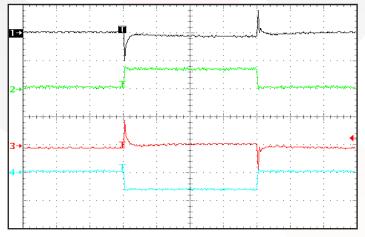


Figure 17: Output voltage response to step-change in total load current (0%-50%-0%) of total lout (max) split 50%/50%. Load cap: 1µF ceramic cap and 10µF, 100mΩ ESR tantalum cap (2ms/div). Ch 1: +Vout (500mV/div); Ch 2: +Iout (1.0A/ div); Ch 3: -Vout (500mV/div); Ch 4: -Iout (1.0A/div).

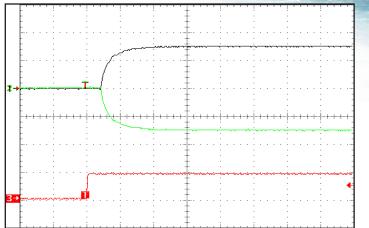


Figure 14: Turn-on transient at zero load current (5ms/div). Input voltage pre-applied. Ch 1: +Vout (10V/div); Ch 2: -Vout (10V/div); Ch 3: Enable1 input (5V/div)

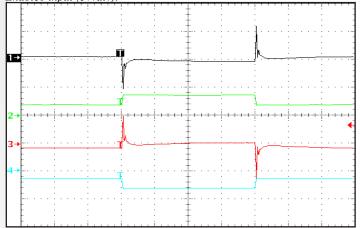


Figure 16: Output voltage response to step-change in total load current (50%-100%-50%) of total lout (max) split 50%/50%. Load cap: 1µF ceramic cap and  $10\mu F$ ,  $100m\Omega$  ESR tantalum cap (2ms/div). Ch 1: +Vout (200mV/div); Ch 2: +Iout (1.0A/div); Ch 3: -Vout (200mV/div); Ch 4: -Iout (1.0A/div).

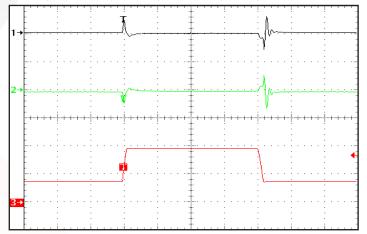


Figure 18: Output voltage response to step-change in input voltage (16V-40V-16V). Load cap:  $1\mu F$  ceramic cap and  $10\mu F$ ,  $100m\Omega$  ESR tantalum cap (1ms/div). Ch 1: +Vout (200mV/div); Ch 2: -Vout (200mV/div); Ch 3: Vin (20V/div).

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Current: 1.3A Total

# **Technical Figures**

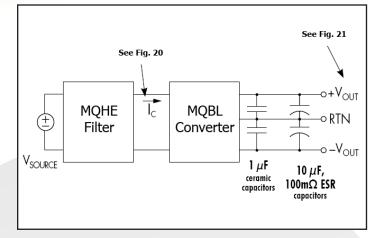
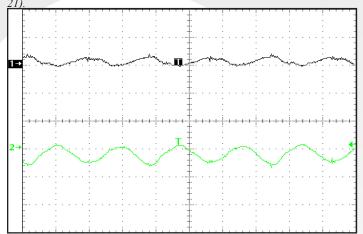
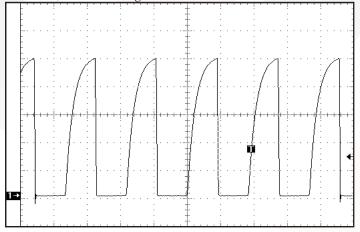


Figure 19: Test set-up diagram showing measurement points for Input Terminal Ripple Current (Figure 20) and Output Voltage Ripple (Figure



**Figure 21**: Output voltage ripple, +Vout (Ch 1) and -Vout (Ch 2), at nominal input voltage and full load current evenly split (50mV/div), (1us/div). Load capacitance: 1µF ceramic cap and 10µF tantalum cap.. Bandwidth; 10MHz. See Figure 19.



*Figure 23*: SYNC OUT vs. time, driving SYNC IN of a second SynQor MQBL converter (lus/div).

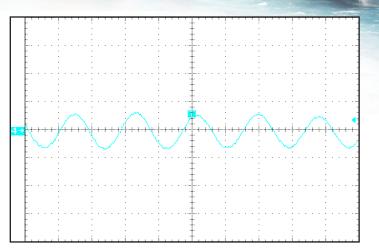
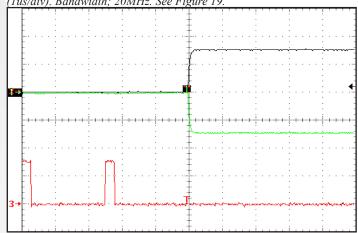
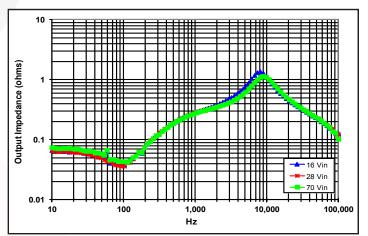


Figure 20: Input terminal current ripple, ic, at full rated output current and nominal input voltage with SynQor MQ filter module (50mA/div), (1us/div). Bandwidth; 20MHz. See Figure 19.

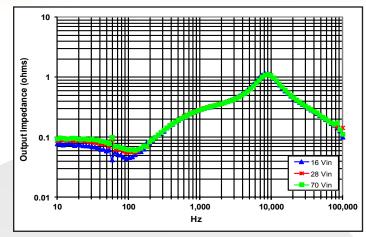


*Figure 22*: *Rise of output voltage after the removal of a short across the positive output terminals (50ms/div). Ch l: +Vout (10V/div); Ch 2: -Vout (10V/div); Ch 3:+Iout (1A/div).* 



**Figure 24**: Magnitude of incremental output impedance of +15V output (+Zout =+ vout/+iout) for minimum, nominal, and maximum input voltage at full rated power (80-20 split).

Current: 1.3A Total



**Technical Figures** 

**Figure 25**: Magnitude of incremental output impedance of -15V output (-Zout = -vout/-iout) for minimum, nominal, and maximum input voltage at full rated power (80-20 split).

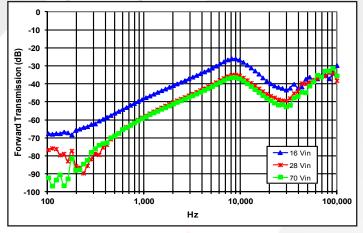
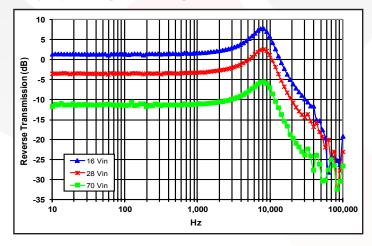
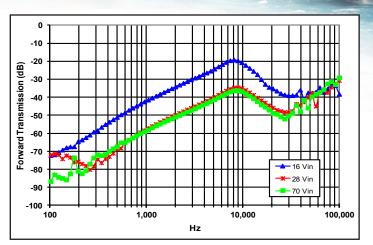


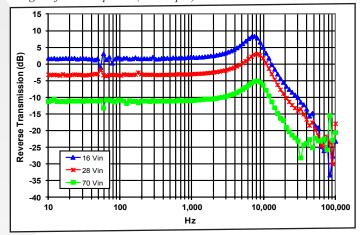
Figure 27: Magnitude of incremental forward transmission of -15V output (-FT = -vout/-vin) for minimum, nominal, and maximum input voltage at full rated power (80-20 split).



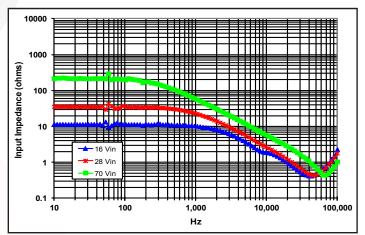
**Figure 29**: Magnitude of incremental reverse transmission of -15V output (-RT = -iin/-iout) for minimum, nominal, and maximum input voltage at full rated powe (80-20 split).



**Figure 26**: Magnitude of incremental forward transmission of +15V output (+FT = +vout/+vin) for minimum, nominal, and maximum input voltage at full rated power (80-20 split).



**Figure 28**: Magnitude of incremental reverse transmission of +15V output (+RT = +iin/+iout) for minimum, nominal, and maximum input voltage at full rated power (80-20 split).



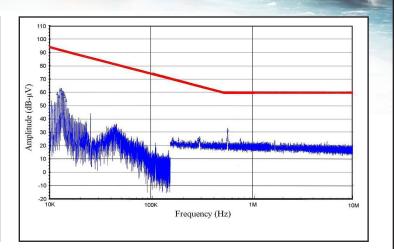
*Figure 30*: Magnitude of incremental input impedance (Zin = vin/iin) for minimum, nominal, and maximum input voltage at full rated power (80-20 split).

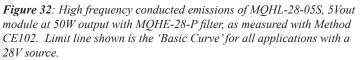
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# (N<sup>+</sup>-Q) point (Hz)

**Technical Figures** 

Figure 31: High frequency conducted emissions of standalone MQHL-28-05S, 5Vout module at 50W output, as measured with Method CE102. Limit line shown is the 'Basic Curve' for all applications with a 28V source.







# BASIC OPERATION AND FEATURES

The MQBL DC/DC converter uses a two-stage power conversion topology. The first, or regulation, stage is a buck-converter that keeps the output voltage constant over variations in line, load, and temperature. The second, or isolation, stage uses transformers to provide the functions of input/output isolation and voltage transformation to achieve the output voltage required.

In the dual output converter there are two secondary windings in the transformer of the isolation stage, one for each output. There is only one regulation stage, however, and it is used to control the positive output. The negative output therefore displays "Cross-Regulation", meaning that its output voltage depends on how much current is drawn from each output.

Both the positive and the negative outputs share a common OUTPUT RETURN pin.

Both the regulation and the isolation stages switch at a fixed frequency for predictable EMI performance. The isolation stage switches at one half the frequency of the regulation stage, but due to the push-pull nature of this stage it creates a ripple at double its switching frequency. As a result, both the input and the output of the converter have a fundamental ripple frequency of about 550 kHz in the free-running mode.

Rectification of the isolation stage's output is accomplished with synchronous rectifiers. These devices, which are MOSFETs with a very low resistance, dissipate far less energy than would Schottky diodes. This is the primary reason why the MQBL converters have such high efficiency, particularly at low output voltages.

Besides improving efficiency, the synchronous rectifiers permit operation down to zero load current. There is no longer a need for a minimum load, as is typical for converters that use diodes for rectification. The synchronous rectifiers actually permit a negative load current to flow back into the converter's output terminals if the load is a source of short or long term energy. The MQBL converters employ a "backdrive current limit" to keep this negative output terminal current small.

There is a control circuit in the MQBL converter that determines the conduction state of the power switches. It communicates across the isolation barrier through a magnetically coupled device. No opto-isolators are used.

An input under-voltage shutdown feature with hysteresis is provided, as well as an input over-voltage shutdown and an output over-voltage limit. There is also an output current limit that is nearly constant as the load impedance decreases (i.e., there is not fold-back or fold-forward characteristic to the output current under this condition). When a load fault is removed, the output voltage rises exponentially to its nominal value without an overshoot. If a load fault pulls the output voltage below about 60% of nominal, the converter will shut down to attempt to clear the load fault. After a short delay it will try to auto-restart.

The MQBL converter's control circuit does not implement an over-temperature shutdown.

The following sections describe the use and operation of additional control features provided by the MQBL converter.

# CONTROL FEATURES

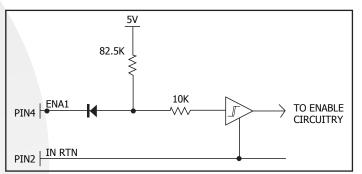


Figure A: Circuit diagram shown for reference only, actual circuit components may differ from values shown for equivalent circuit.

**ENABLE:** The MQBL converter has one enable pin, ENA1 (pin 4), which is referenced with respect to the converter's input return (pin 2). It must have a logic high level for the converter to be enabled; a logic low inhibits the converter.

The enable pin is internally pulled high so that an open connection will enable the converter. Figure A shows the equivalent circuit looking into the enable pin. It is TTL compatible and has hysteresis.

**SHUT DOWN:** The MQBL converter will shut down in response to only five conditions: ENA input low, VIN input below under-voltage shutdown threshold, VIN input above over-voltage shutdown threshold, output voltage below the output under-voltage threshold, and output voltage above the output over-voltage threshold. Following any shutdown event, there is a startup inhibit delay which will prevent the converter from restarting for approximately 100ms. After the 100ms delay elapses, if the enable inputs are high and the input voltage is within the operating range, the converter

will restart. If the VIN input is brought down to nearly 0V and back into the operating range, there is no startup inhibit, and the output voltage will rise according to the "Turn-On Delay, Rising Vin" specification.

pplication Section

**SYNCHRONIZATION:** The MQBL converter's switching frequency can be synchronized to an external frequency source that is in the 500 kHz to 700 kHz range. A pulse train at the desired frequency should be applied to the SYNC IN pin (pin 6) with respect to the INPUT RETURN (pin 2). This pulse train should have a duty cycle in the 20% to 80% range. Its low value should be below 0.8V to be guaranteed to be interpreted as a logic low, and its high value should be above 2.0V to be guaranteed to be interpreted as a logic low. The transition time between the two states should be less than 300ns.

If the MQBL converter is not to be synchronized, the SYNC IN pin should be left open circuit. The converter will then operate in its free-running mode at a frequency of approximately 550 kHz.

If, due to a fault, the SYNC IN pin is held in either a logic low or logic high state continuously, or the SYNC IN frequency is outside the 500-700 kHz range, the MQBL converter will revert to its free-running frequency.

The MQBL converter also has a SYNC OUT pin (pin 5). This output can be used to drive the SYNC IN pins of as many as ten (10) other MQBL converters. The pulse train coming out of SYNC OUT has a duty cycle of 50% and a frequency that matches the switching frequency of the converter with which it is associated. This frequency is either the free-running frequency if there is no valid synchronization signal at the SYNC IN pin, or the synchronization frequency if there is.

The synchronization feature is entirely compatible with that of SynQor's MQFL family of converters.

Figure B shows the equivalent circuit looking into the SYNC IN pin and Figure C shows the equivalent circuit looking into the SYNC OUT pin.

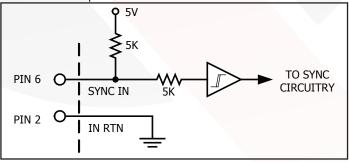


Figure B: Equivalent circuit looking into the SYNC IN pin with respect to the IN RTN (input return) pin.

**OUTPUT VOLTAGE TRIM:** If desired, it is possible to increase or decrease the MQBL dual converter's output voltage from its nominal value. To increase the output voltage a resistor, Rtrim up, should be connected between TRIM pin (pin 10) and the OUTPUT RETURN pin (pin 8), as shown in Figure D. The value of this resistor should be determined according to the following equation from Figure E:

 $Rtrim up(\Omega) = \frac{8300\Omega*Vnom}{Vout - Vnom} - 41700\Omega$ 

where:

Vnom = the converter's nominal output voltage, Vout = the desired output voltage (greater than Vnom), and Rtrim up is in Ohms.

As the output voltage is trimmed up, it produces a greater voltage stress on the converter's internal components and may cause the converter to fail to deliver the desired output voltage at the low end of the input voltage range at the higher end of the load current and temperature range. Please consult the factory for details. To trim the output voltage below its nominal value, connect an external resistor (Rtrim down) between the TRIM pin and the POSITIVE OUTPUT pin (pin 7), and another resistor (Rtrim sense) connected between the TRIM pin and the OUTPUT RETURN pin as shown in Figure D. The values of these trim down resistors should be chosen according to the following equation or from Figure E:

Rtrim down(
$$\Omega$$
) =  $\frac{50100\Omega * Vout - 27500\Omega * Vnom}{Vnom - Vout}$  - 137500 $\Omega$ 

Rtrim sense( $\Omega$ ) = 0.43 \* Rtrim down( $\Omega$ )

where:

Vnom = the converter's nominal output voltage, Vout = the desired output voltage (less than Vnom), and

Rtrim down and Rtrim sense are in Ohms.

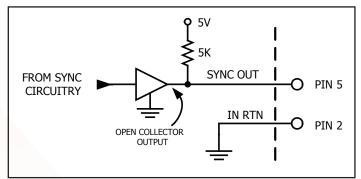


Figure C: Equivalent circuit looking into SYNC OUT pin with respect to the IN RTN (input return) pin.



**INPUT UNDER-VOLTAGE SHUTDOWN:** The MQBL converter has an under-voltage shutdown feature that ensures the converter will be off if the input voltage is too low. The input voltage turn-on threshold is higher than the turn-off threshold. In addition, the MQBL converter will not respond to a state of the input voltage unless it has remained in that state for more than about 200µs. This hysteresis and the delay ensure proper operation when the source impedance is high or in a noisy environment.

**INPUT OVER-VOLTAGE SHUTDOWN:** The MQBL converter also has an over-voltage feature that ensures the converter will be off if the input voltage is too high. It also has a hysteresis and time delay to ensure proper operation.

**OUTPUT OVER-VOLTAGE SHUTDOWN:** The MQBL converter will shut down if the voltage at its power output pins ever exceeds about 130% of the nominal value. The shutdown threshold does not change with output trim or sense drops; excessive trim-up or output wiring drops may cause an output over-voltage shutdown event. After a startup inhibit delay, the converter will attempt to restart.

**OUTPUT UNDER-VOLTAGE SHUTDOWN:** The MQBL converter will also shut down if the voltage at its power output pins ever dips below 60% of the nominal value for more than a few milliseconds. Output voltage reduction due to output current overload (current limit) is the most common trigger for this shutdown. The shutdown threshold does not change with output trim but at only 10%, trim-down should not trigger this event. After a startup inhibit delay, the converter will attempt to restart. This shutdown is disabled during startup.

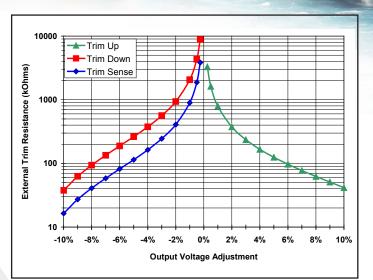
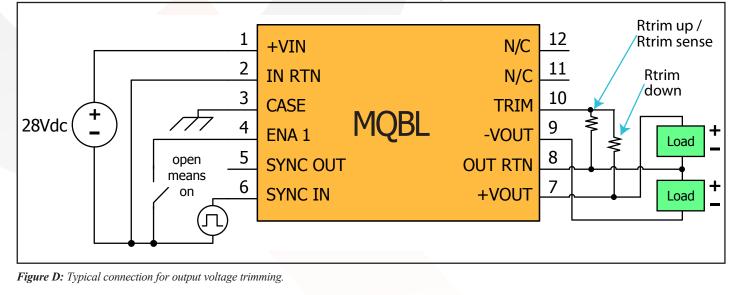


Figure E: Trim up and Trim down as a function of external trim resistance.

**BACK-DRIVE CURRENT LIMIT:** Converters that use MOSFETs as synchronous rectifiers are capable of drawing a negative current from the load if the load is a source of short- or long-term energy. This negative current is referred to as a "back-drive current".

Conditions where back-drive current might occur include paralleled converters that do not employ current sharing. It can also occur when converters having different output voltages are connected together through either explicit or parasitic diodes that, while normally off, become conductive during startup or shutdown. Finally, some loads, such as motors, can return energy to their power rail. Even a load capacitor is a source of back-drive energy for some period of time during a shutdown transient.



To avoid any problems that might arise due to back-drive current, the MQBL converters limit the negative current that the converter can draw from its output terminals. The threshold for this back-drive current limit is placed sufficiently below zero so that the converter may operate properly down to zero load, but its absolute value (see the Electrical Characteristics page) is small compared to the converter's rated output current.

pplication Section

**CURRENT LIMIT:** In the event of excess load, the MQBL converter will quickly reduce its output voltage to keep the load current within safe limits (see Figure 12). If the overload persists for more than 14 milliseconds, the converter will shut off, wait a restart delay, and then automatically attempt to re-start. The timeout is internally implemented with an integrator: counting up whenever current limit is active, and counting down at 1/5th the rate whenever current limit becomes inactive. In this way a series of short-duration overloads will not cause the converter to shut down, while it will shut down in response to sustained overloads.

**THERMAL CONSIDERATIONS:** Figure 11 shows the suggested Power Derating Curves for this converter as a function of the case temperature and the maximum desired power MOSFET junction temperature. All other components within the converter are cooler than its hottest MOSFET, which at full power is no more than 20 °C higher than the case temperature directly below this MOSFET.

The Mil-HDBK-1547A component derating guideline calls for a maximum component temperature of 105 °C. Figure 11 therefore has one power derating curve that ensures this limit is maintained. It has been SynQor's extensive experience that reliable long-term converter operation can be achieved with a maximum component temperature of 125 °C. In extreme cases, a maximum temperature of 145 °C is permissible, but not recommended for long-term operation where high reliability is required. Derating curves for these higher temperature limits are also included in Figure 11. The maximum case temperature at which the converter should be operated is 135 °C.

When the converter is mounted on a metal plate, the plate will help to make the converter's case bottom a uniform temperature. How well it does so depends on the thickness of the plate and on the thermal conductance of the interface layer (e.g. thermal grease, thermal pad, etc.) between the case and the plate. Unless this is done very well, it is important not to mistake the plate's temperature for the maximum case temperature. It is easy for them to be as much as 5-10°C different at full power and at high temperatures. It is suggested that a thermocouple be attached directly to the converter's case through a small hole in the plate when investigating how hot the converter is getting. Care must also be made to ensure that there is not a large thermal resistance between the thermocouple and the case due to whatever adhesive might be used to hold the thermocouple in place.

**INPUT SYSTEM INSTABILITY:** This condition can occur because any dc-dc converter appears incrementally as a negative resistance load. A detailed application note titled "Input System Instability" is available on the SynQor website which provides an understanding of why this instability arises, and shows the preferred solution for correcting it.

Phone 1-888-567-9596



Current: 1.3A Total

CONSTRUCTION AND ENVIRONMENTAL STRESS SCREENING OPTIONS								
Screening	Consistent with MIL-STD-883F	C-Grade ( specified from 0 °C to +70 °C )	ES-Grade ( specified from (-45 °C to +100 °C )	HB-Grade ( specified from ( -55 °C to +125 °C )				
Element Evaluation		No	Yes	Yes				
Internal Visual	IPC-A-610 Class 3	Yes	Yes	Yes				
Temperature Cycle	Method 1010	No	Condition B (-55 °C to +125 °C)	Condition C (-65 °C to +150 °C)				
Constant Acceleration	Method 2001 (Y1 Direction)	No	500 g	Condition A (5000 g)				
Burn-in	Method 1015	24 Hrs @ +125 °C	96 Hrs @ +125 °C	160 Hrs @ +125 °C				
Final Electrical Test	Method 5005 (Group A)	+25 °C	-45, +25, +100 °C	-55, +25, +125 °C				
Mechanical Seal, Thermal, and Coating Process			Full QorSeal	Full QorSeal				
External Visual	Method 2009	Yes	Yes	Yes				
Construction Process			QorSeal	QorSeal				

MilQor<sup>®</sup> Hi-Rel converters and filters are offered in three variations of environmental stress screening options. All ES-Grade and HB-Grade MilQor Hi-Rel converters use SynQor's proprietary QorSeal<sup>®</sup> Hi-Rel assembly process that includes a Parylene-C coating of the circuit, a high performance thermal compound filler, and a nickel barrier gold plated aluminum case. Each successively higher grade has more stringent mechanical and electrical testing, as well as a longer burn-in cycle. The ES- and HB-Grades are also constructed of components that have been procured through an element evaluation process that pre-qualifies each new batch of devices.

# **Un Co**f **Technical Specifications**

MQBL-28E-15D Output: ±15V **Current: 1.3A Total** 

100

#### **MIL-STD-810F** Qualification Testing

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MIL-STD-810F Test	Method	Description					
Fungus	508.5	Table 508.5-I					
	500.4 - Procedure I	Storage: 70,000 ft / 2 hr duration					
Altitude	500.4 - Procedure II	Operating: 70,000 ft / 2 hr duration; Ambient Temperature					
Rapid Decompression	500.4 - Procedure III	Storage: 8,000 ft to 40,000 ft					
Acceleration	513.5 - Procedure II	Operating: 15 g					
Salt Fog	509.4	Storage					
Lich Terrere erstung	501.4 - Procedure I	Storage: 135 °C / 3 hrs					
High Temperature	501.4 - Procedure II	Operating: 100 °C / 3 hrs					
Low Townshing	502.4 - Procedure I	Storage: -65 °C / 4 hrs					
Low Temperature	502.4 - Procedure II	Operating: -55 °C / 3 hrs					
Temperature Shock	503.4 - Procedure I - C Storage: -65 °C to 135 °C; 12 cycles						
Rain	506.4 - Procedure I	Wind Blown Rain					
Immersion	512.4 - Procedure I	Non-Operating					
Humidity	507.4 - Procedure II	Aggravated cycle @ 95% RH (Figure 507.5-7 aggravated temp - humidity cycle, 15 cycles)					
Random Vibration	514.5 - Procedure I	10 - 2000 Hz, PSD level of 1.5 g <sup>2</sup> /Hz (54.6 g <sub>rms</sub> ), duration = 1 hr/axis					
Shock	516.5 - Procedure I	20 g peak, 11 ms, Functional Shock (Operating no load) (saw tooth)					
SHOCK	516.5 - Procedure VI	Bench Handling Shock					
Sinusoidal vibration	514.5 - Category 14	Rotary wing aircraft - helicopter, 4 hrs/axis, 20 g (sine sweep from 10 - 500 Hz)					
Sand and Dust	510.4 - Procedure I	Blowing Dust					
	510.4 - Procedure II	Blowing Sand					

# Support Technical Specifications

MQBL-28E-15D Output: ±15V Current: 1.3A Total

Street Links

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First Article Testing consistent with MIL-STD-883F									
MIL-STD-883F Test	Method	Description							
Electrical Tests	5005								
Physical Dimensions test	2016								
Resistance to Solvents test	2015.13								
Solderability test	2003.8								
Lead Integrity test	2004.5								
Salt Atmosphere test	1009.8	Condition "A"							
Adhesion of Lead Finish test	2025.4								
Altitude Operation test	1001	Condition "C"							
ESD Sensitivity	3015.7	Class 2							
Stabilization Bake test	1008.2	Condition "C"							
Vibration Fatigue test	2005.2	Condition "A"							
Random Vibration test	2026	Condition "II K"							
Sequential Test Group #1									
Life Test – Steady State test	1005.8								
Life Test – Intermittent Duty test	1006								
Sequential Test Group #2									
Temperature Cycle test	1010.8	Condition "C"							
Constant Acceleration test	2001.2	Condition "A"							
Sequential Test Group #3									
Thermal Shock test	1011.9	Condition "B"							
Temperature Cycle test	1010.8	Condition "C"							
Moisture Resistance test	1004.7	With Sub cycle							
Sequential Test Group #4									
Mechanical Shock test	2002.4	Condition "B"							
Variable Frequency Vibration test	2007.3	Condition "A"							

ALL C

Current: 1.3A Total

And States **Mechanical Diagrams** PIN DESIGNATIONS Pin # Function Positive input 1 2 Input return 3 Case 4 Enable 1 0.330 [8.382] MAX 0.091 [2,30] 0.094 [2,39] CASE CLEARANCE AROUND PINS 5 Sync output 0.253 [6,43] 1.200 [30,48] 1.381 [35,08] J 0.175 - [4,45]0.350 [8,89] 6 Sync input ۰. - ® 0.020 [0,51] 8 7 Positive output SynQor 0 12 8 Output return 0 II 0 I0 2 🔘 0.525 MQBL-28E-15D-S-ES 3 🔘 9 Negative output 0.700 DC-DC CONVERTER 28Vin ±15Vout @ 1.3A 4 🞯 1.506 [38,25] 9 10 Trim 5 🔘 **(**) 8 1.000
[25,40] No connection 11 6 () () 12 No connection -Ø0.040 [1,02] Ŕ 0.24 [6,1] Case S NOTES 1) Pins: Diameter: 0.040" (1.02mm) Material: Copper Alloy Finish: Gold over Nickel plate 2) Case: 1.381 [35,08] Material: Aluminum 0.700 [17,78] Finish: Gold over Nickel plate 0.330 MAX [8,38] 0.350 [8,89] 1.200 [30,48] 3) All dimensions are in inches (mm) 0.341 [8,65] 0.091
[2,30] 0.050 , 30 0.175 1.500 [4,45] 12,70] x.xx": +/-0.02" Tolerances: Ο 0  $\bigcirc$ () $\cap$ (x.xmm: +/-0.5mm) 0.020 [0,51] 0.350 [8,89] **A** x.xxx": +/-0.010" SynQor 12 (x.xxmm +/-0.25mm) 2 6 2.000 [50,80] 0 11 0.525 [13,34] 4) Weight: MQBL-28E-15D-F-ES 700 7 78] 0 10 3 🔘 0. [i DC-DC CONVERTER 28Vin ±15Vout @ 1.3A Standard: 1.17oz (33.3g) C 4 6 1,749 [44,43] **)** 9 1.000 **)** 8 5 🔘 Flanged: 1.24oz (35.1g) 5) Flanged version can be mounted using 1.506 [38,25] 6 🧭 the 2 center holes or the 4 outer holes à 6) Workmanship: Meets or exceeds Ø0.040 0  $\bigcirc$  $\bigcirc$  $\bigcirc$ 0 IPC-A-610C Class III 0.125 Ø0.128 [3,25] 0.24 [6,1] Case F



#### **MilQor Converter FAMILY MATRIX**

The tables below show the array of MilQor converters available. When ordering SynQor converters, please ensure that you use the complete part number according to the table in the last page. Contact the factory for other requirements.

	Single Output										Dua	l Outp	ut †			
	1.5V	1.8V	2.5V	3.3V	5V	6V	7.5V	9V	12V	15V	28V		5V	12V	15V	
	(1R5S)	(1R8S)	(2R5S)	(3R3S)	(05S)	(06S)	(7R5S)	( <b>09</b> S)	(125)	(15S)	(285)	(	(05D)	(12D)	(15D)	
MQHL-28																
16-40Vin Cont.	20A	20A	20A	15A	10A	8A	6.6A	5.5A	4A	3.3A	1.8A		10A	4A	3.3A	
16-50Vin 1s Trans.*	20A	20A	20A	IJA	IUA	оA	0.0A	5.5A	4A	3.3A	1.0A		Total	Total	Total	
Absolute Max Vin = 60V																
MQHL-28E																
16-70Vin Cont.	20A	20A	20A	15 1	15A 10A	8A	6.6A	5.5A	4A 3.3/	2.24	3.3A 1.8A		10A	4A	3.3A	
16-80Vin 1s Trans.*	20A		20A							3.3A			Total	Total	Total	
Absolute Max Vin =100V																
MQHR-28																
16-40Vin Cont.	10A	10A	104	10A	7.5A	5A	A 4A		2.75A	2.75A 2A	4 05 4			5A	2A	1.65A
16-50Vin 1s Trans.*	TUA	IUA	IUA	7.5A	ЪА	4A	3.3A	2.75A	ZA	1.65A	0.9A		Total	Total	Total	
Absolute Max Vin = 60V																
MQHR-28E																
16-70Vin Cont.	104	10.1		10A	7.5A	5A			2.75A	2A	1.65A			5A	2A	1.65A
16-80Vin 1s Trans.*	10A	10A	IUA	AC.1	SA	4A	3.3A	2.10A	ZA	Aco.1	0.9A		Total	Total	Total	
Absolute Max Vin = 100V																

	Single Output								Dual Output <sup>†</sup>					
	1.5V	1.8V	2.5V	3.3V	5V	6V	7.5V	9V	12V	15V	28V	5V	12V	15V
	(1R5S)	(1R8S)	(2R5S)	(3R3S)	(05S)	(06S)	(7R5S)	( <b>09S</b> )	(125)	(15S)	(285)	(05D)	(12D)	(15D)
MQBL-28														
16-40Vin Cont.	8A	8A	8A	6A	4A	3.3A	2.6A	2.2A	1.6A	1.3A	0.7A	4A	1.6A	1.3A
16-50Vin 1s Trans.*	0.1	0,1	0,1	0,1		010/1	2.071				0	Total	Total	Total
Absolute Max Vin = 60V														
MQBL-28E														
16-70Vin Cont.	8A	8A	8A	6A	4A	3.3A	2.6A	2.2A	1.6A	1.3A	0.7A	4A	1.6A	1.3A
16-80Vin 1s Trans.*	0A	0A	UA	UA	ΨA	5.5A	2.0A	2.2A	1.0A	1.3A	0.7A	Total	Total	Total
Absolute Max Vin =100V														

Check with factory for availability. †80% of total output current available on any one output. \*Converters may be operated at the highest transient input voltage, but some component electrical and thermal stresses would be beyond MIL-HDBK-1547A guidelines.



### PART NUMBERING SYSTEM

The part numbering system for SynQor's MilQor DC-DC converters follows the format shown in the table below.

Not all combinations make valid part numbers, please contact SynQor for availability. See the Product Summary web page for more options.

Model	odel Input Output Voltage(s)		Package Outline/	Screening	
Name	Voltage Range	Single Output	Dual Output	Pin Configuration	Grade
MQBL	28 28E	1R5S 1R8S 2R5S 3R3S 05S 06S 7R5S 09S 12S 15S 28S	05D 12D 15D	S F	C ES HB

Example: MQBL-28E-15D-F-ES

#### **APPLICATION NOTES**

A variety of application notes and technical white papers can be downloaded in pdf format from the SynQor website.

#### **Contact SynQor for further information and to order:**

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Web:	www.synqor.com
Address:	155 Swanson Road
	Boxborough, MA 01719
	USA

#### PATENTS

SynQor holds numerous U.S. patents, one or more of which apply to most of its power conversion products. Any that apply to the product(s) listed in this document are identified by markings on the product(s) or on internal components of the product(s) in accordance with U.S. patent laws. SynQor's patents include the following:

6,545,890 6,894,468 6,896,526 6,927,987 7,050,309 7,085,146 7,119,524 7,765,687 7,787,261 8,149,597 8,644,027

#### Warranty

SynQor offers a two (2) year limited warranty. Complete warranty information is listed on our website or is available upon request from SynQor.