

# HIGH RELIABILITY DC-DC CONVERTER

16-40 V	16-50 V	±6.5 V	18 A	91% @ 9 A /90% @ 18 A
<b>Continuous Input</b>	Transient Input	Output	Output	Efficiency

Full Power Operation: -55 °C to +125 °C

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.





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

### Features

- Fixed switching frequency
- No opto-isolators
- Parallel operation with current share
- Clock synchronization
- Primary and secondary referenced enable
- Continuous short circuit and overload protection
- Input under-voltage and over-voltage shutdown
- Output voltage trim

#### **Specification Compliance**

MQFL series converters (with MQME filter) are designed to meet:

- MIL-HDBK-704-8 (A through F)
- RTCA/DO-160 Section 16, 17, 18
- MIL-STD-1275 (B, D)
- DEF-STAN 61-5 (part 6)/(5, 6)
- MIL-STD-461 (C, D, E, F)
- RTCA/DO-160(E, F, G) Section 22

## Design Process

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

### **Qualification Process**

MQFL 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**

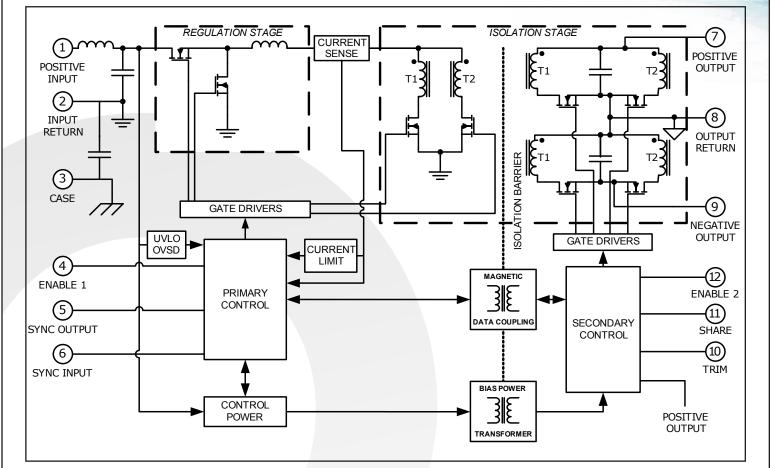
- AS9100 and ISO 9001 certified facility
- Full component traceability
- Temperature cycling
- Constant acceleration
- •24, 96, 160 hour burn-in
- Three level temperature screening



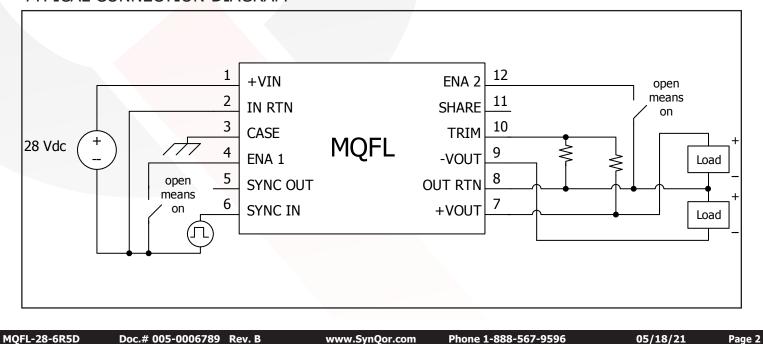
Current: 18 A Total

Unite

## **BLOCK DIAGRAM**



# TYPICAL CONNECTION DIAGRAM



PassOutcome and controls         International subject of only a finition where the specified         free running (see Note 10) unless otherwise specified         (see Note 1)           AbsOLUTE ANXINUM RATINOS         60         V         See Note 1         V           Operating Ingenetic Set (Table 5 °C)         -0.8         V         See Note 1         V           Reverse Bias (Table 5 °C)         -500         500         V         See Note 1         V           Insolution Values (Table 5 °C)         -500         500         V         File on the set o	Synce				L.I	MQFL-28-6R5I Output: ±6.5 Current: 18 A T	V
MCPL-28-6RSD ELECTRICAL         CHARACTERISTICS         Group           Parameter         Min.         Typ.         Max.         Units         More & Conditions         Min.         Typ.         Max.         Units         More & Conditions         Min.         Typ.         Max.         Units         More & Conditions         Min.         Typ.         Max.         Min.	Technical Specif	icel	ion	-		a manufi Head	
Specifications subject to change without noticeVin = 28 Vic $4^{\circ}$ y, $4^{\circ}$ and $a^{\circ}$ = $4^{\circ}$ ,	MQFL-28-6R5D ELECTR	ICAL	CHA	ARAC	CTER	ISTICS	
ABSOLUTE INAMUMUR INTINGSInput Vitage Mon-Operating Operating Tags (Tase = 125 °C)Image of the full of the full of the solution with the solution of the solution with the solution wi		Min.	тур.	мах.	Units	Vin=28 Vdc $\pm$ 5%, +Iout = -Iout = 9 A, CL=0 $\mu$ F,	Subgroup
Input Voltage Non-Operating Querating Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 55 °C)Image: Case = 125 °C) Reverse Bias (Case = 55 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) Reverse Bias (Case = 125 °C)Image: Case = 125 °C) <td></td> <td></td> <td></td> <td></td> <td></td> <td>free running (see Note 10) unless otherwise specified</td> <td>(see Note 14)</td>						free running (see Note 10) unless otherwise specified	(see Note 14)
Operating Reverse Bias (Tase = 125 eC) Reverse Bias (Tase = -155 eC)600 FileV FileSee Note 1Reverse Bias (Tase = -155 eC) Reverse Bias (Tase = -55 eC)-500 File500 FileV FileFileFileBodation Voltage (I/O to case = -55 eC) Transient (SLIP µp) Storage Case Temperature Lead Temperature (20 3)-500 FileV FileHB Grade Products, See Notes 2 & 16FileStorage Case Temperature Lead Temperature (20 3)-12 File500 FileV FileHB Grade Products, See Notes 2 & 16FileOperating Input Voltage Range Input Voltage Threshold16 12.8028 FileV FileContinuous File1, 2, Transient, 1 isFileTurn-Of Voltage Threshold14.75 File15.50 File15.00 FileVSee Note 3FileTurn-Of Voltage Threshold54.0 File55.0 File55.0 File500 FileVSee Note 3FileTurn-Of Voltage Threshold54.0 File55.0 File51.0 FileFileVFileFileTurn-Of Voltage Threshold54.0 File55.0 FileFileFileFileFileTurn-Of Voltage Threshold54.0 File55.0 FileFileFileFileFileTurn-Of Voltage Threshold54.0 File55.0 FileFileFileFileFileTurn-Of Voltage Threshold54.0 File55.0FileVFileFileFileTurn-Of Voltage Threshold <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>							
Reverse Bias (Tase = 125 °C) Reverse Bias (Tase = 55 °C) Isolation Voltage (I/O to case, 1 to 0) Continuous Transient (\$100 µs)-500 -500-1.2 -7.2 -	Non-Operating						
Reverse Bias (Tase = -55 °C) (Solation Voltage (V) to case, I to 0) Continuous-1.2VIsolation Voltage (S) to case, I to 0) Continuous-500500VPortaing Case Temperature-55125°CLead Temperature (20 s)-1.2500VUndrag et ARMA, EliA2-1.2500VOperating Turbu Voltage Range162840VOperating Turbu Voltage Threshold14.7515.5016.00VTurm-Of Voltage Threshold14.7515.5016.00VTurm-Of Voltage Threshold14.7515.5016.00VTurm-Of Voltage Threshold14.7515.5016.00VTurm-Of Voltage Threshold14.7515.5016.00VTurm-Of Voltage Threshold14.7515.5016.00VTurm-Of Voltage Threshold50.051.454.056.860.0VTurm-Of Voltage Threshold50.051.454.056.860.0VTurm-Of Voltage Threshold50.051.454.056.860.0VTurm-Of Voltage Threshold50.051.454.0V56.860.0VTurm-Of Voltage Threshold50.051.454.0V56.860.0VTurm-Of Voltage Threshold50.051.450.0Vmaintain tailou tail						See Note 1	
Isolation voltage (I/O to case, I to 0) Continuous Transient (\$100 µs)-500500V 800V V VOperating Case Femperature Lead Temperature (20.3)-1.2500VVUsed Temperature (20.3)-1.2500VVOperating Case Femperature (20.3)-1.2500VUsed Temperature (20.3)-1.2500VOperating Input Voltage Range Turn-Oft Voltage Threshold1628400VOperating Input Voltage Range Turn-Oft Voltage Threshold13.8014.4015.00VTurn-Oft Voltage Threshold13.8014.4015.00VTurn-Oft Voltage Threshold54.055.466.0VTurn-Oft Voltage Threshold54.055.466.0VTurn-Oft Voltage Threshold54.055.466.0VTurn-Oft Voltage Threshold52.053.880VTurn-Oft Voltage Threshold54.056.466.0VTurn-Oft Voltage Threshold52.053.480.0VTurn-Oft Voltage Threshold52.054.464.01.2Turn-Oft Voltage Threshold52.054.450.0VTurn-Oft Voltage Threshold52.054.654.0VTurn-Oft Voltage Threshold52.054.6VTurn-Oft Voltage Threshold52.054.6VTurn-Oft Voltage Threshold52.054.6VTurn-Oft Voltage Threshold54.055.054.0<							
Continuous Transient (S100 µs)-500500V 800V 900Operating Case Temperature-55125 $^{\circ}$ CStorage Case Temperature-55125 $^{\circ}$ CViltage Itemperature (20 s)-1.250VViltage Attent (20 s)-1.250VOperating Input Voltage Renege162850VInput Under-Voltage Intershold14.7515.5016.00VTurn-Of Voltage Threshold13.8014.4015.00VTurn-Of Voltage Threshold54.056.860.0VTurn-Of Voltage Threshold50.051.454.054.0Surdoval Case Intershold50.051.454.0VTurn-Of Voltage Threshold50.051.454.0VTurn-Of Voltage Threshold50.051.454.0VTurn-Of Voltage Threshold50.051.454.0VTurn-Of Voltage Threshold50.051.456.8VTurn-Of Voltage Threshold50.051.456.8VTurn-Of Voltage Threshold50.051.456.8VNo Load Input Current (perating)1116mANo Load Input Current (perating)1220.26.6VOutput Voltage Set Point (Case = 25 °C)6.446.506.57VPositive Output-6.576.566.50VVoltage Under Set Point (Case = 25 °C)6.446.506.57VOutput Voltage Ent				1.2	v		
Operating Case Temperature         -55         12.5         *C         HB Grade Products, See Notes 2.8.16           Storage Case Temperature (20.5)         -55         -300         °C           Voltage at ENAL, ENA2         -1.2         50         V           Operating Input Voltage Range         16         28         40         V           Operating Input Voltage Range         16         28         40         V           Turn-Of Voltage Threshold         14.75         15.50         16.00         V           Turn-Of Voltage Threshold         14.75         15.50         16.00         V         See Note 3         1, 2,	Continuous						
Storage Case Temperature-65135 $^{\circ}$ CLead Temperature (20 s)-1.250 $^{\circ}$ CVoltage at ENAL, ENA2-1.250VOperating Input Voltage Range162840VTurn-Or Voltage Threshold14.7515.5016.00VTurn-Or Voltage Threshold13.8014.4015.00VTurn-Or Voltage Threshold13.8014.4015.00VTurn-Or Voltage Threshold13.8014.4015.00VTurn-Or Voltage Threshold50.51.11.8VTurn-Or Voltage Threshold50.051.454.056.860.0Shutdown Voltage Hysteresis2.05.38.0VTurn-Or Voltage Threshold50.051.454.056.860.0Shutdown Voltage Hysteresis2.02.022.6 $\mu$ HupInternal ValuesNo Load Input Current (operating)110160mA1.2Disabiled Input Current (FMA1)2.25mA1.2Disabiled Input Current (FMA2)6.546.506.57VOutput Voltage Sch Poin (Cares = 25 °C)6.54VSee Note 12Output Voltage Range Colput6.576.506.64VVegative Output6.576.506.64VVegative Output6.576.506.64VVegative Output7.255557.4Vegative Output Voltage Range6.376.506.64V<	Transient (≤100 μs)					LID Grade Directurate Cae Nation 2.9.10	
Lead Temperature (20 s)300°CVoltage at RAN, ENAZ-1.250Voltage at RAN, ENAZ-1.250Operating Input Voltage Range162840Operating Input Voltage Range162840Input Under Voltage Inteshold14,7515.5016.00Turn-Or Voltage Threshold13.8014.4015.00Input Voltage Hysteresis0.51.11.8Input Voltage Hysteresis0.51.11.8Turn-Or Voltage Threshold50.051.454.0See Noteage Threshold50.051.454.0Turn-Or Voltage Hysteresis2.05.38.0Turn-Or Voltage Hysteresis2.05.38.0Turn-Or Voltage Hysteresis2.05.38.0Underst (Component Voltage (LC))2.02.469.5Maximum Input Current6.4065.7No eskel End (Chiling)1010Disbeld Input Current (ENA2)6.575.0Input Terrent (ENA2)6.575.0Negative Output6.446.506.57Voltage Line Regulation2.02.02.02.35.45.4Voltage Set Point Over Temperature6.575.6Positive Output6.446.506.53Voltage Line Regulation2.02.0Output Voltage Range End Roise Peak to Peak020Output Voltage Range End Regulation2.02.01002.0350mv </td <td></td> <td></td> <td></td> <td></td> <td></td> <td>HB Grade Products, see Notes 2 &amp; 16</td> <td></td>						HB Grade Products, see Notes 2 & 16	
Voltage at ENA1, ENA2* (INPUT CHARACTERISTICS50VOperating Input Voltage Range Input Voltage Range Input Voltage Range Under-Voltage Lockout162840VContinuous Transient, 1 s See Note 31, 2, Transient, 1 s See Note 3Input Under-Voltage Intershold Turn-Of Voltage Threshold14.7515.5016.00V1, 2, Transient, 1 s See Note 31, 2, Transient, 1 s See Note 121, 2, <br< td=""><td></td><td>0.5</td><td></td><td></td><td></td><td></td><td></td></br<>		0.5					
Operating Input Voltage Range162840VContinuous1, 2Operating Input Voltage Range162850VTransient, 1 sSee Note 31, 2Turn-Oft Voltage Inteshold13,8014,4015,00V1, 2See Note 31, 2Lockout Voltage Preshold13,8014,4015,00VSee Note 31, 2Turn-Oft Voltage Inteshold54,056,860,0VSee Note 31Turn-Oft Voltage Preshold50,051,454,0VSee Note 31Turn-Oft Voltage Inteshold50,051,454,0VSee Note 31Maximum Input Current (FNA1)2,05,860,0V11Disabled Input Current (FNA1)2,550mA1,211Disabled Input Current (FNA2)6,446,556,57VSee Note 1211Output Voltage Set Point (Tcase = 25 °C)6,446,506,57VSee Note 12211Negative Output-6,616,506,60VSee Note 122111<	Voltage at ENA1, ENA2	-1.2					
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		10	20	40	M	Cantinuaus	1.2.2
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$							1, 2, 3
Turn-On Voltage Threshold14.7515.5016.00VTurn-Off Voltage Threshold13.8014.4015.00VLockout Voltage Hysteresis0.51.11.8VTurn-Off Voltage Threshold54.055.860.0VTurn-Off Voltage Threshold50.051.454.055.8Input Filter Component Voltage Threshold50.051.454.0VMaximum Input Current60.011.0160mANo Load Input Current (perating)110160mA1, 2Disabled Input Current (ENA1)2550mADisabled Input Current (ENA2)2550mAmA1, 2Output Voltage Set Point (Tase = 25 °C)6.446.506.57VSee Note 12Positive Output6.446.506.60VSee Note 122Output Voltage Line Regulation253545VSee Note 122Output Voltage Line Regulation253545VVSee Note 122Output Voltage Line Regulation253545VVSee Note 1222Output Voltage Line Regulation100200350mVHoute = 100 Hz; -10 Hz; See Nies 1, 1, 222Output Voltage Range6.374.506.63VSee Note 12222Output Voltage Line Regulation100200350mVHoute = 100 Hz; -10 Hz; C= 11 µF on both outputs <t< td=""><td></td><td>10</td><td>20</td><td>50</td><td>V</td><td></td><td></td></t<>		10	20	50	V		
$ \begin{array}{c cccc} Lockout Voltage Hysteresis \\ Turn-Oft Voltage Dreshold \\ Turn-Oft Voltage Threshold \\ Turn-Oft Voltage Threshold \\ Turn-Oft Voltage Threshold \\ Turn-Oft Voltage Threshold \\ Subtraction Voltage Voltage $	Turn-On Voltage Threshold		15.50	16.00	V		1, 2, 3
Input Over-Voltage ShutdownSee Note 3Turn-Or Voltage Threshold50.051.454.0VShutdown Voltage Hysteresis2.05.380.0VInput Eilter Component Values (L/C)2.0/24.6 $\mu$ H/µFInternal ValuesMaximum Input Current (operating)110160mANo Load Input Current (ENA1)25mADisabled Input Current (PAA)2.550mADisabled Input Current Ripple (peak to peak)4065mABandwidth = 100 kHz - 10 MHz; see Figure 201, 2,Output Voltage Set Point (Tcase = 25 °C)6.446.506.67Positive Output6.466.506.60VNegative Output6.606.506.60VNegative Output6.606.506.60VNegative Output6.636.536.63VOutput Voltage Load Regulation223545mVTotal Output Voltage Range6.376.506.63VOutput Voltage Incas Regulation20350mVVertur Voltage Range011.4AMaximum Hout or -Jout Woltage Chart Range014.4Negative Output100200350mVVoltage Chart Range014.4Maximum Hout or -Jout (B) (Hout = 14.4 A, 1, 2, 2)Output Voltage Range014.4Maximum Hout or -Jout (B) (Hout = 14.4 A, 1, 2, 2)Output Voltage Range011.44Output Voltage Range </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1, 2, 3</td>							1, 2, 3
Turn-Of Voltage Threshold54.056.860.0VTurn-Of Voltage Threshold50.051.454.0VInput Filter Component Values (L(C)2.05.38.0VMaximum Input Current (PA1)2.02.05.4VDisabled Input Current (PA1)25mADisabled Input Current (FNA1)2.550mADisabled Input Current (FNA2)2.550mADisabled Input Current (FNA2)2.550mADutput Voltage Set Point (Tcase = 25 °C)6.446.506.57VNegative Output-6.57-6.506.64VNegative Output-6.57-6.60-6.60VNegative Output-6.61-6.506.64VNegative Output-6.62-6.60VSee Note 12Output Voltage Load Regulation2.03.5400VOutput Voltage Load Regulation2.03.550mVOutput Voltage Cross Regulation100200350mVOutput Voltage Rome Range014.4AMaximum Hout C-Iout1.2Output Voltage Rome		0.5	1.1	1.8	V	See Note 2	
Turn-On Voltage Threshold50.051.454.0VShutdown Voltage Hysteresis2.05.38.0VInput Filter Component Values (L(C)2.0(24.6 $\mu$ H\µFInternal ValuesMaximum Input Current (operating)110160mADisabled Input Current (FNA1)25mADisabled Input Current (FNA2)2550mAOutput Voltage Set Point (Tcase = 25 °C)6.44655mAOutput Voltage Set Point (Tcase = 25 °C)6.446.57VNegative Output-6.50-6.60VNegative Output-6.506.64VVegative Output-6.506.60VNegative Output-6.506.64VOutput Voltage Cade Regulation20020VOutput Voltage Cade Regulation100200350mVOutput Voltage Range6.376.506.63VSee Note 12-Vout @ (+Iout = -Iout = 3.6 A)Vout @ (+Iout = -Iout = 9.4) - +Vout@ (+Iout = -Iout		54.0	56.8	60.0	V	See Note S	
Shutdown Voltage Hysteresis2.05.38.0VInput Filter Component Values (L/C)2.0/24.69.5AMaximum Input Current (operating)110160mADisabled Input Current (ENA1)25mADisabled Input Current (ENA2)2.550mAInput Terminal Current Kipple (peak to peak)4065mAOutput Voltage Set Point Over Temperature6.446.506.57VPositive Output-6.50-6.44VSee Note 12Output Voltage Load Regulation2.535mVOutput Voltage Load Regulation2.535mVOutput Voltage Cross Regulation100200350mVOutput Voltage Ripe and Noise Peak to P	Turn-On Voltage Threshold						
Maximum Input Current9.5AVin = 16 V; +Iout = -Iout = 9 ASee NotNo Load Input Current (ENA1)160mA1, 2Disabled Input Current (ENA1)25mADisabled Input Current (ENA2)2550mAInput Terminal Current Ripple (peak to peak)4065mAOutput Voltage Set Point (Tcase = 25 °C)6.446.506.57-6.50Positive Output6.606.506.64VSee Note 12Output Voltage Set Point Over Temperature6.406.506.60VPositive Output-6.60-6.50-6.60VSee Note 12Output Voltage Load Regulation-20020mVTotal Output Voltage Range6.376.506.63VSee Note 12Output Voltage Range6.376.506.63VSee Note 12-2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,	Shutdown Voltage Hysteresis						
No Load Input Current (operating)110160mAmADisabled Input Current (ENA1)25mADisabled Input Current (ENA2)2550mADurput Terminal Current Ripple (peak to peak)4065mAOutput Voltage Set Point (Tcase = 25 °C)6.446.506.57VPositive Output-6.57-6.50-6.44VOutput Voltage Set Point Over Temperature-6.50-6.44VPositive Output-6.60-6.50-6.40VOutput Voltage Load Regulation-20020mVYoutgut Voltage Load Regulation-20020mVOutput Voltage Cass Regulation100200350mVOutput Voltage Ripple and Noise Peak to Peak2080mVOutput Voltage Ripple and Noise Peak to Peak2080mVOutput Voltage Ripple and Noise Peak to Peak2080mVOutput Voltage Ripple and Noise Peak to Peak2080mVDigle Output Courrent Range014.4AMaximum Flout - Tout3.6 A)Vout @ (+Iout = 14.4 A, 1, 2, 2)Output Voltage Ripple and Noise Peak to Peak1050mAmaximum Flout - Tout1.2Output Doperating Output Current Range014.4AMaximum Flout - Tout, 2, 2, 44.1Output Voltage Ripple and Noise Peak to Peak010050mAmaximum Flout - Tout, 2, 2, 44.1Output Voltage Ripple and Noise Peak to Peak0<			2.0\24.6				Coo Note F
Disabled Input Current (ENA2) Disabled Input Current Ripple (peak to peak)25mA endmA mAmA Bandwidth = 100 kHz - 10 MHz; see Figure 201, 2Output Voltage Step form (Trase = 25 °C) Positive Output6.446.506.57VSee Note 121Output Voltage Step form Output Negative Output6.406.506.60VSee Note 1222Output Voltage Step form Output Negative Output6.606.506.60VSee Note 1222Output Voltage Line Regulation Output Voltage Cross Regulation20350mVVout @ (+Iout=-Iout=0.4) - +Vout@(+Iout=-Iout=9.4); See Note 121, 2Output Voltage Cross Regulation100200350mV-Vout @ (+Iout=-Iout=3.6 A)Vout @ (+Iout==14.4 A, -Iout=3.6 A) - eNot @ (+Iout==10.4 A, -Iout=3.6 A) - eN			110			VIII = 16 V; +100t = -100t = 9 A	See Note 5
Disabled Input Current (ENA2)2550mAmanual current Ripple (peak to peak)1, 2Input Terminal Current Ripple (peak to peak)4065mABandwidth = 100 kHz - 10 MHz; see Figure 201, 2Output Voltage Set Point (Tcase = 25 °C)6.446.506.57V1Positive Output6.476.506.64V2,Output Voltage Set Point Over Temperature6.406.506.60V2,Positive Output6.60-6.50-6.40V2,Output Voltage Load Regulation253545mVSee Note 12Output Voltage Load Regulation253545mV+Vout@(+Iout=-Iout=0A) - +Vout@(+Iout=-Iout=9A); See Note 121, 2,Output Voltage Cross Regulation100200350mVBandwidth = 100 kHz - 10 MHz; C_ = 11 µF on both outputs1, 2,Output Voltage Ripple and Noise Peak to Peak2080mVBandwidth = 100 kHz - 10 MHz; C_ = 11 µF on both outputs1, 2,Output Voltage Ripple and Noise Peak to Peak2080mVBandwidth = 100 kHz - 10 MHz; C_ = 11 µF on both outputs1, 2,Single Output Current Range0117WTotal on both outputs1, 2,Operating Output Current Limit Mile Enabled6A+Iout + -Iout; +IoutIout, See Note 41, 2,Short Circuit Output Current Limit while Enabled6A+Iout + -Iout; +IoutIout, See Note 5See NoteOutput Voltage Deviation Load Current50mASee Note 6<							1, 2, 3
OUTPUT CHARACTERISTICS Output Voltage Set Point (Tcase = 25 °C) Positive OutputSee Note 12Positive Output6.446.506.57VNegative Output-6.57-6.44VVPositive Output-6.50-6.40VOutput Voltage Set Point Over Temperature-6.60-6.00VPositive Output-6.60-6.00VOutput Voltage Line Regulation200020Output Voltage Load Regulation253545mVTotal Output Voltage Range6.376.50-6.63VOutput Voltage Range6.376.506.63VOutput Voltage Range100200350mVOutput Voltage Range018AOutput Voltage Range0117WOutput Voltage Range0117WOutput Voltage Range0117Output Voltage Range0114.4AMaximum Hout or -Iout1, 2Single Output Operating Output Power Range0117Output Voltage Range0117Output Voltage Deviation Load Transient6AFor a Neg. Step Change in Load Current-350mVMa	Disabled Input Current (ENA2)			50			1, 2, 3
Output Voltage Set Point (Tcase = 25 °C)ooosee Note 12Positive Output-6.57-6.50-6.74V1Output Voltage Set Point Over Temperature-6.57-6.50-6.44VSee Note 121Positive Output-6.60-6.50-6.40VV2,2,Voltage Load Regulation-20020WSee Note 121, 2,Output Voltage Load Regulation-20020WSee Note 121, 2,Total Output Voltage Cross Regulation100200350mV+Vout@(+Tout=-Tout=0 A) - +Vout@(+Tout=-Iout=9 A); See Note 121, 2,Output Voltage Cross Regulation100200350mV-Vout @(+Lout = -Iout = 3.6 A)Vout @ (+Lout = 14.4 A, + 1, 2,1, 2,Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range018A + (+Lout) + (-Lout)+Iout + 3.6 A); See Note 121, 2,Output Voltage Current Range0117WTotal on both outputs1, 2,Output Dut Overrent_imit Inception192225A + Hout + -Lout; + LoutLout, See Note 41, 2,Output Clarent-Limit Mile Enabled6A AA + Vout ≤ 1.2 VSee Note 5See Note 5DynAmic Circla Untput Current212426A + Vout ≤ 1.2 VBack-Drive Current Limit while Enabled6-A ABack-Drive Current Limit while Enabled6-A A<			40	65	mA	Bandwidth = 100 kHz – 10 MHz; see Figure 20	1, 2, 3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $						See Note 12	
Negative Output-6.57-6.50-6.44VSee Note 121Output Voltage Set Point Over Temperature Positive Output6.406.506.60V2,Negative Output-6.60-6.50-6.40V2,Output Voltage Line Regulation-20020mVSee Note 121, 2,Output Voltage Load Regulation253545mV+vout@(+lout=-lout=0.A) - +Vout@(+lout=-lout=9.A); See Note 121, 2,Total Output Voltage Range6.376.506.63VSee Note 121, 2,Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range018A(+lout) + -lout = -lout = 3.6 A); See Note 11, 121, 2,Single Output Operating Current Range014.4AMaximum +lout or -lout1, 2,Output Voltage Current Range0117WTotal on both outputs1, 2,Output Current Range0117WTotal on both outputs1, 2,Short Circuit Output Current212426A+Vout ≤ 1.2 VSee Note 41, 2,Back-Drive Current Limit Mile Enabled6AAATotal on both outputs; See Note 5See Note 101, 2,Output Voltage Deviation Load Transient-530-350mVmVTotal on both outputs; See Note 5See Note 61, 2,Output Voltage Deviation Load Current-350500mVsee Note 610%4, 5,For a Neg, Step Change in Load Current </td <td></td> <td>6.44</td> <td>6.50</td> <td>6.57</td> <td>V</td> <td>See Note 12</td> <td>1</td>		6.44	6.50	6.57	V	See Note 12	1
Positive Output6.406.506.60VVProduct (V)Product (V)Produc	Negative Output						1
Negative Output-6.60-6.50-6.40VVOutput Voltage Line Regulation-20020mVSee Note 121, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,						See Note 12	
Output Voltage Line Regulation-20020mVSee Note 121, 2,Output Voltage Load Regulation253545mV+vout@(+Iout=-Iout=0A) - +Vout@(+Iout=-Iout=9A); See Note 121, 2,Total Output Voltage Range6.376.506.63VSee Note 121, 2,Output Voltage Cross Regulation100200350mV-Vout @ (+Iout = -Iout = 3.6 A)Vout @ (+Iout = 14.4 A, -Iout = 3.6 A); See Notes 11, 121, 2,Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range018A(+Iout) + (-Iout) + (-Iout)1, 2,Single Output Operating Current Range014.4AMaximum +Iout or -Iout1, 2,Output DC Current-Limit Inception192225A+Iout + -Iout; +Iout -Iout, See Note 41, 2,Output DC Current Limit while Enabled1050mATotal on both outputs1, 2,2,Back-Drive Current Limit while Enabled6AA+Vout ≤ 1.2 VSee Note 41, 2,Back-Drive Current Limit while Disabled1050mA5ee Note 5See Note 5See Note 5DYNAMIC CHARACTERISTICS-450-350mVTotal on both outputs; See Note 54, 5,Output Voltage Deviation Load Current For a Neg. Step Change in Load Current-450-350mVTotal on both outputs; See Note 64, 5,Output Voltage Deviation Line Transient For a Neg. Step Change in Line Voltage-500500mVSee Note 74, 5,							2, 3
Output Voltage Load Regulation253545mV+Vout@(+Iout=-Iout=0 A) - +Vout@(+Iout=-Iout=9 A); See Note 121, 2,Total Output Voltage Range6.376.506.63VSee Note 121, 2,Output Voltage Cross Regulation100200350mV-Vout@ (+Iout = -Iout = 3.6 A); See Notes 11, 121, 2,Output Voltage Ripple and Noise Peak to Peak2080mVBandwidth = 100 kHz - 10 MHz; C_ = 11 $\mu$ F on both outputs1, 2,Output Voltage Ripple and Noise Peak to Peak018A(+Iout) + (-Iout)1, 2,Single Output Current Range018A(+Iout) + (-Iout)1, 2,Operating Output Power Range0117WTotal on both outputs1, 2,Output DC Current-Limit Inception192225A+Iout + -Iout; +IoutIout, See Note 41, 2,Short Circuit Output Current212426A+Vout ≤ 1.2 VSee Note 41, 2,Back-Drive Current Limit while Enabled6AA10000 $\mu$ FTotal on both outputs; See Note 5See Note Note 121, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 3, 2, 2, 3, 2, 2, 3, 2, 2, 3, 2, 2, 3, 2, 2, 3, 2, 2, 3, 2, 2, 3, 3, 3, 2, 2, 2, 3, 4, 3, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,						See Note 12	1, 2, 3
Output Voltage Cross Regulation100200350mV-Vout @ (+Iout = -Iout = 3.6 A)Vout @ (+Iout = 14.4 A, -Iout = 3.6 A); See Notes 11, 121, 2, -Iout = 3.6 A); See Notes 11, 12Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range018AMVBandwidth = 100 kHz - 10 MHz; C_ = 11 µF on both outputs1, 2, (+Iout)1, 2, (+Iout)<							1, 2, 3
Output Voltage Closs Regulation100200300Inv-lout = 3.6 A); See Notes 11, 121, 2,Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range080mVBandwidth = 100 kHz - 10 MHz; $C_L = 11 \mu F$ on both outputs1, 2,Output Operating Current Range018.4A(+Iout) + (-Iout)1, 2,Operating Output Operating Current Range0117WTotal on both outputs1, 2,Output DC Current-Limit Inception192225A+Iout + -Iout; +IoutIout, See Note 41, 2,Short Circuit Output Current212426A+Vout ≤ 1.2 VSee Note 41, 2,Back-Drive Current Limit while Enabled6A100000µFTotal on both outputs; See Note 5See Note <b>DVNAMIC CHARACTERISTICS</b> 10050mVTotal on both outputs; See Note 5See NoteOutput Voltage Deviation Load Current-450-350mVTotal on both outputs; See Note 5See NoteFor a Pos. Step Change in Load Current-450-350mVTotal Iout Step = 9 A $\leftrightarrow$ 18 A, 1.8 A $\leftrightarrow$ 9 A; CL= 11 µF on both outputs4, 5,Seetling Time (either case)100300µsSee Note 7See Note 84, 5,Output Voltage Deviation Line Transient-500500mVVin step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 µF on both outputs4, 5,	Total Output Voltage Range	6.37	6.50	6.63	V		1, 2, 3
Output Voltage Ripple and Noise Peak to Peak Operating Output Current Range2080mVBadwidth = 100 kHz - 10 kHz - 11 µF on both outputs1, 2,Single Output Operating Current Range018A(+Iout) + (-Iout)1, 2,Single Output Operating Current Range014.4AMaximum +Iout or -Iout1, 2,Operating Output Power Range0117WTotal on both outputs1, 2,Output DC Current-Limit Inception192225A+Iout + -Iout; +IoutIout, See Note 41, 2,Short Circuit Output Current212426A+Vout ≤ 1.2 VSee Note 41, 2,Back-Drive Current Limit while Enabled6A1050mA1, 2,Maximum Output Capacitance10000 $\mu$ FTotal on both outputs; See Note 5See Note 5Output Voltage Deviation Load Transient-450-350mVTotal Iout Step = 9 A $\leftrightarrow$ 18 A, 18 A $\leftrightarrow$ 9 A; CL= 11 µF on both outputs4, 5,For a Pos. Step Change in Load Current-450-350mVSee Note 6*For a Pos. Step Change in Line Voltage-500500mVSee Note 8*Output Voltage Deviation Line Transient-500500mVNi step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 µF on both outputsFor a Neg. Step Change in Line Voltage-500500mVNi step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 µF on both outputs	Output Voltage Cross Regulation	100	200	350	mV	-Vout @ (+Iout = -Iout = 3.6 A)Vout @ (+Iout = 14.4 A, Iout = 2.6 A) - See Notes 11, 12	1, 2, 3
Operating Output Current Range018A(+Iout) + (-Iout)1, 2,Single Output Operating Current Range014.4AMaximum +Iout or -Iout1, 2,Operating Output Power Range0117WTotal on both outputs1, 2,Output DC Current-Limit Inception192225A+Iout + -Iout; +IoutIout, See Note 41, 2,Short Circuit Output Current212426A+Vout ≤ 1.2 VSee Note 41, 2,Back-Drive Current Limit while Enabled6AA10000 $\mu$ FTotal on both outputs; See Note 5See Note 5Output Voltage Deviation Load Transient10000 $\mu$ FTotal on both outputs; See Note 5See Note 5See Note 6For a Neg. Step Change in Load Current-450-350mVSee Note 7Not See Note 74, 5, 56Settling Time (either case)100300 $\mu$ SSee Note 8Not See Note 74, 5, 56Output Voltage Deviation Line Transient-500500mVNot see Step Change in Line Voltage-500500mV			20	80	mV	Bandwidth = $100 \text{ kHz} - 10 \text{ MHz} \cdot \text{C} = 11 \text{ µF on both outputs}$	1, 2, 3
Single Output Operating Current Range014.4AMaximum +Iout or -Iout1, 2,Operating Output Power Range0117WTotal on both outputs1, 2,Output DC Current-Limit Inception192225A+Iout + -Iout; +IoutIout, See Note 41, 2,Short Circuit Output Current212426A+Vout $\leq 1.2$ VSee Note 41, 2,Back-Drive Current Limit while Enabled6A1050mA1, 2,Maximum Output Capacitance1050mA1, 2,Output Voltage Deviation Load Transient-450-350mVSee Note 65For a Neg. Step Change in Load Current-450-350mVSee Note 7See Note 74, 5,Output Voltage Deviation Line Transient-450500500mVSee Note 7See Note 84, 5,For a Pos. Step Change in Line Voltage-500500mVVin step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 µF on both outputs4, 5,	Operating Output Current Range	0				(+Iout) + (-Iout)	1, 2, 3
Output DC Current-Limit Inception192225A+Iout + -Iout; +IoutIout, See Note 41, 2,Short Circuit Output Current212426A+Vout $\leq 1.2$ VSee Note 41, 2,Back-Drive Current Limit while Enabled6A1, 2,Back-Drive Current Limit while Disabled6A1, 2,Maximum Output Capacitance1050mA1, 2,Output Voltage Deviation Load Transient1050mA1, 2,For a Neg. Step Change in Load Current-450-350mVTotal on both outputs; See Note 5See NoteOutput Voltage Deviation Line Transient-450-350mVSee Note 6*********************************					A	Maximum +Iout or -Iout	1, 2, 3
Short Circuit Output Current212426A+Vout $\leq 1.2$ VSee NotBack-Drive Current Limit while Enabled6A1, 2,Back-Drive Current Limit while Disabled1050mA1, 2,Maximum Output Capacitance1050mA1, 2,Output Voltage Deviation Load Transient-450-350mVTotal on both outputs; See Note 5See NoteFor a Pos. Step Change in Load Current-450-350mVNVTotal Iout Step = 9 A $\leftrightarrow$ 18 A, 1.8 A $\leftrightarrow$ 9 A; CL= 11 µF on both outputs4, 5,Settling Time (either case)100300µsSee Note 7See Note 84, 5,Output Voltage Deviation Line Transient-500500mVSee Note 7See Note 84, 5,For a Neg. Step Change in Line Voltage-500500mVSee Note 7See Note 84, 5,For a Neg. Step Change in Line Voltage-500500mVSee Note 7See Note 84, 5,For a Neg. Step Change in Line Voltage-500500mVSee Note 7See Note 84, 5,For a Neg. Step Change in Line Voltage-500500mVSee Note 7See Note 6500See Note 8500For a Neg. Step Change in Line Voltage-500500mVSee Note 7See Note 8500See Note 8500See Note 8500For a Neg. Step Change in Line Voltage-500500mVSee Note 50 V; Cl = 11 µF on both outputs500See Note 85005			22				1, 2, 3
Back-Drive Current Limit while Enabled Back-Drive Current Limit while Disabled6A1, 2,Back-Drive Current Limit while Disabled1050mA1, 2,Maximum Output Capacitance10000 $\mu$ FTotal on both outputs; See Note 5See Note 5 <b>DYNAMIC CHARACTERISTICS</b> 10000 $\mu$ FTotal on both outputs; See Note 5See Note 5Output Voltage Deviation Load Transient-450-350mVSee Note 6For a Neg. Step Change in Load Current-450350450mVSettling Time (either case)100300 $\mu$ sSee Note 7Output Voltage Deviation Line Transient-500500mVSee Note 8For a Neg. Step Change in Line Voltage-500500mVVin step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 $\mu$ F on both outputs							See Note 5
Back-Drive Current Limit while Disabled1050mA1, 2,Maximum Output Capacitance10000 $\mu$ FTotal on both outputs; See Note 5See Note 5DYNAMIC CHARACTERISTICSSee Note 6See Note 6See Note 6Output Voltage Deviation Load Transient-450-350mVTotal out Step = 9 A $\leftrightarrow$ 18 A, 1.8 A $\leftrightarrow$ 9 A; CL= 11 $\mu$ F on both outputs4, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5,				20			1, 2, 3
DYNAMIC CHARACTERISTICSSee Note 6Output Voltage Deviation Load Transient For a Pos. Step Change in Load Current Settling Time (either case)-450-350mVTotal Jout Step = 9 A $\leftrightarrow$ 18 A, 1.8 A $\leftrightarrow$ 9 A; CL= 11 µF on both outputs4, 5, 4, 5, 4, 5,Output Voltage Deviation Line Transient For a Neg. Step Change in Line Voltage-500500mVSee Note 6For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage-500500mVVin step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 µF on both outputs			10				1, 2, 3
Output Voltage Deviation Load Transient       -450       -350       mV       See Note 6         For a Pos. Step Change in Load Current       -450       -350       mV       Total Jout Step = 9 A ↔ 18 A, 1.8 A ↔ 9 A; CL= 11 µF on both outputs       4, 5,         For a Neg. Step Change in Load Current       -350       450       mV       See Note 6       ************************************				10000	μF	Total on both outputs; See Note 5	See Note 5
For a Pos. Step Change in Load Current For a Neg. Step Change in Load Current Settling Time (either case)-450 $350$ -350 $450$ mV $100$ Total Iout Step = 9 A $\leftrightarrow$ 18 A, 1.8 A $\leftrightarrow$ 9 A; CL= 11 µF on both outputs $4, 5,$ $4, 5,$ $4, 5,$ See Note 7 See Note 8450 $4, 5,$ See Note 8Output Voltage Deviation Line Transient For a Neg. Step Change in Line Voltage For a Neg. Step Change in Line Voltage-500 $-500$ 500 $500$ mVTotal Iout Step = 9 A $\leftrightarrow$ 18 A, 1.8 A $\leftrightarrow$ 9 A; CL= 11 µF on both outputs See Note 7 See Note 84, 5, $4, 5,$						See Note 6	
For a Neg. Step Change in Load Current Settling Time (either case)350450mV"4, 5,Output Voltage Deviation Line Transient For a Pos. Step Change in Line Voltage For a Neg. Step Change in Line Voltage-500500mVSee Note 7 See Note 8450mVSolution Line Transient For a Neg. Step Change in Line Voltage-500500mVVin step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 µF on both outputs4, 5, 500		-450	-350		mV		4, 5, 6
Output Voltage Deviation Line Transient For a Pos. Step Change in Line Voltage For a Neg. Step Change in Line Voltage-500 -500See Note 8 V Note the VoltageSee Note 8 Vin step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 µF on both outputs	For a Neg. Step Change in Load Current		350		mV	n	4, 5, 6
For a Pos. Step Change in Line Voltage-500500mVVin step = 16 V $\leftrightarrow$ 50 V; C <sub>L</sub> = 11 µF on both outputsFor a Neg. Step Change in Line Voltage-500500mV	Settling Time (either case)		100	300	μs		
For a Neg. Step Change in Line Voltage -500 500 mV		-500		500	m\/		
						$v_{\rm int}$ step = 10 v $\leftrightarrow$ 30 v, $c_{\rm L}$ = 11 µr on both outputs	
	Settling Time (either case)	500	250	500	μs	See Note 7	
Turn-On Transient	Turn-On Transient						
						+Vout = 0.65 V -> 5.85 V	4, 5, 6
						FNA1 FNA2 = 5 V' See Note 9	See Note 5 4, 5, 6
							4, 5, 6
							4, 5, 6

4

Page 3

## **MQFL-28-6R5D**

Output: ±6.5 V

-June

**Current: 18 A Total** 

TO BET

**Jechnical** Specification

**MQFL-28-6R5D ELECTRICAL CHARACTERISTICS (Continued)** Min | Typ | Max | Units | Notes & Conditions Darameter

Parameter	Min.	Typ.	Max.	Units		Group A
Specifications subject to change without notice					Vin=28 Vdc $\pm$ 5%, +Iout = -Iout = 9 A, CL=0 $\mu$ F, free running (see Note 10) unless otherwise specified	Subgroup (see Note 14)
EFFICIENCY						
Iout = 18 A (16 Vin)	85	89		%		
Iout = 9 A (16 Vin)	88	92		%		
Iout = 18 A (28 Vin)	85	90		%		1, 2, 3
Iout = 9 A (28 Vin)	88	91		%		
Iout = 18 A (40 Vin)	84	88		%		
Iout = $9 \text{ A} (40 \text{ Vin})$	87	90		%		
Load Fault Power Dissipation		18	32	W	Iout at current limit inception point; See Note 4	1
Short Circuit Power Dissipation		20	33	W	+Vout $\leq$ + 1.2 V; -Vout $\geq$ -1.2 V	1
ISOLATION CHARACTERISTICS						
Isolation Voltage					Dielectric strength	
Input RTN to Output RTN	500			V		1
Any Input Pin to Case	500			V		1
Any Output Pin to Case	500			V		1
Isolation Resistance (input rtn to output rtn)	100			MΩ		1
Isolation Resistance (any pin to case)	100			MΩ		1
Isolation Capacitance (input rtn to output rtn)		44		nF		1
FEATURE CHARACTERISTICS						
Switching Frequency (free running)	500	550	600	kHz		1, 2, 3
Synchronization Input						
Frequency Range	500		700	kHz		1, 2, 3
Logic Level High	2		10	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			mA	VSYNC OUT = 0.8 V	See Note 5
Duty Cycle	25		75	%	Output connected to SYNC IN of another MQFL unit	See Note 5
Enable Control (ENA1 and ENA2)						
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	Maximum current draw from pin allowed with module still on	See Note 5
Pull-Up Voltage	3.2	4.0	4.5	V	See Figure A	1, 2, 3
Output Voltage Trim Range	-0.7		0.5	V	(+Vout) - 6.5 V; See Figure E	See Note 5
RELIABILITY CHARACTERISTICS						
Calculated MTBF (MIL-STD-217F2)		2000		10211		
GB @ Tcase = $70  ^{\circ}\text{C}$		2800		10 <sup>3</sup> Hrs.		
AIF @ Tcase = $70 ^{\circ}\text{C}$		420		10 <sup>3</sup> Hrs.	7 	
WEIGHT CHARACTERISTICS		70				
Device Weight		79		g		

#### **Electrical Characteristics Notes**

1. Converter will undergo input over-voltage shutdown.

2. Derate output power to 50% of rated power at Tcase = 135 °C. 135 °C is above specified operating range.

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

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

5. Parameter not tested but guaranteed to the limit specified.

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

7. Settling time measured from start of transient to the point where the output voltage has returned to  $\pm 1\%$  of its final value.

8. Line voltage transition time  $\geq$  100 µs.

9. Input voltage rise time  $\leq$  250 µs.

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

The regulation stage operates to control the positive output. The Negative output displays cross regulation.
 All +Vout and -Vout voltage measurements are made with Kelvin probes on the output leads.

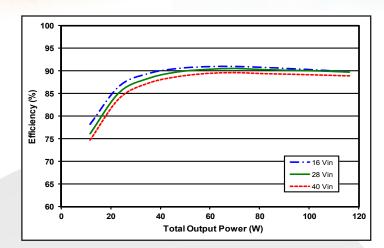
13. SHARE pin outputs a power failure warning pulse during a fault condition. See Current Share section.

14. 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.

15. These derating curves apply for the ES and HB grade products. The C- grade product has a maximum case temperature of 70 °C and a maximum junction temperature rise of 20 °C at full load.

16. 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.

Current: 18 A Total



Technical Figures

Figure 1: Efficiency vs. output power, from zero load to full load with equal load on the +6.5 V and -6.5 V outputs at minimum, nominal, and maximum input voltage at 25 °C.

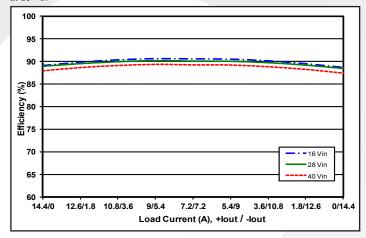


Figure 3: Efficiency vs. output current, with total output current fixed at 80% load (93.6 W) and loads split as shown between the +6.5 V and -6.5 V outputs at minimum, nominal, and maximum input voltage at 25 °C.

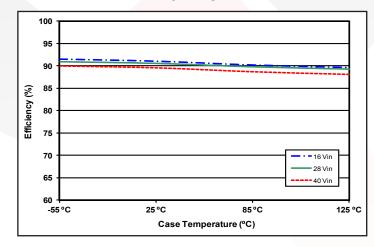


Figure 5: Efficiency at 60% load (5.4 A load on +6.5 V and 5.4 A load on -6.5 V) versus case temperature for Vin = 16 V, 28 V, and 40 V.

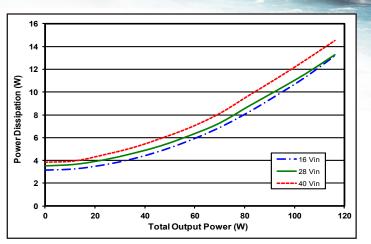


Figure 2: Power dissipation vs. output power, from zero load to full load with equal load on the +6.5 V and -6.5 V outputs at minimum, nominal, and maximum input voltage at 25 °C.

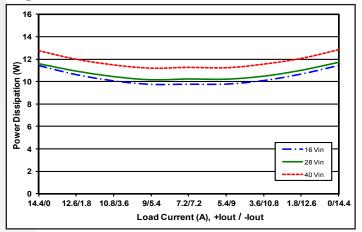


Figure 4: Power dissipation vs. output current, with total output current fixed at 80% load (93.6 W) and loads split as shown between the +6.5 V and -6.5 V outputs at minimum, nominal, and max input voltage at 25 °C.

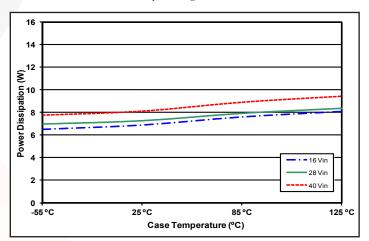


Figure 6: Power dissipation at 60% load (5.4 A load on +6.5 V and 5.4 A load on -6.5 V) versus case temperature for Vin =16 V, 28 V, and 40 V.

Current: 18 A Total

# Technical Figures

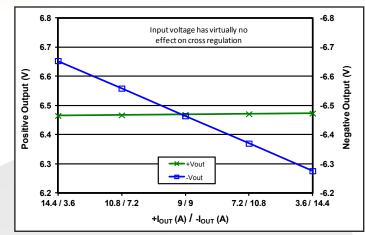


Figure 7: Load regulation vs. load current with power fixed at full load (117 W) and load currents split as shown between the +6.5 V and -6.5 V outputs, at nominal input voltage and Tcase = 25 °C.

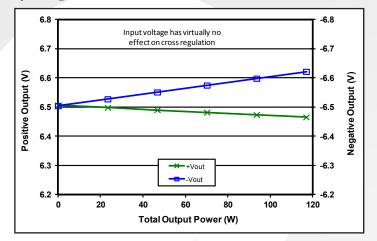


Figure 9: Load regulation vs. total output power from zero to to full load where +Iout equals three times -Iout at nominal input voltage and Tcase = 25 °C.

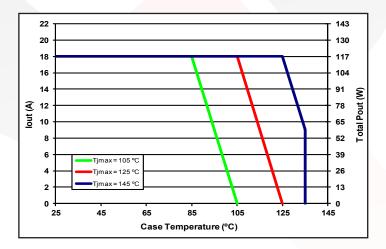


Figure 11: Total Output Current / Total Output Power derating curve as a function of Tcase and the maximum desired power MOSFET junction temperature at Vin = 28 V (see Note 15).

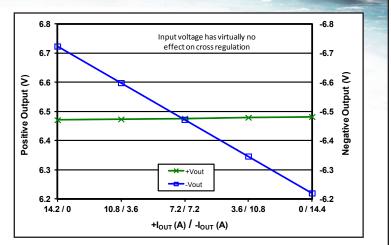


Figure 8: Load regulation vs. load current with power fixed at 80% load (93.6 W) and load currents split as shown between the +6.5 V and -6.5 V outputs, at nominal input voltage and Tcase = 25 °C.

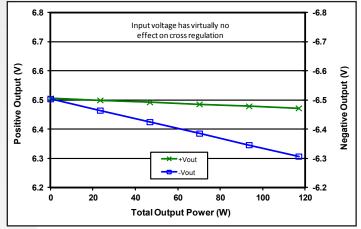


Figure 10: Load regulation vs. total output power from zero to to full load where -lout equals three times +lout at nominal input voltage and Tcase = 25 °C.

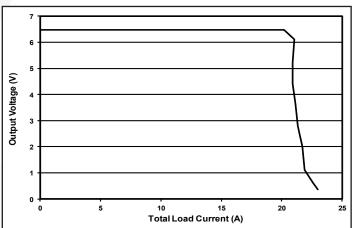


Figure 12: Positive output voltage vs. total load current, evenly split, showing typical current limit curves at Vin = 28 V.

**Current: 18 A Total** 

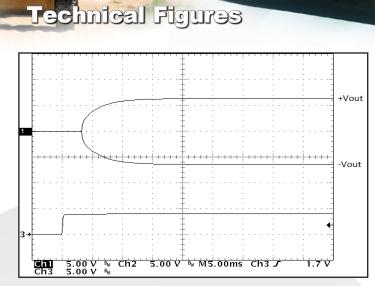


Figure 13: Turn-on transient at full rated load current (resistive load) (5 ms/div). Input voltage pre-applied. Ch 1: +Vout (5 V/div); Ch 2: -Vout (5 V/div); Ch 3: Enable1 input (5 V/div).

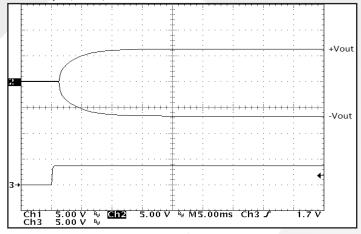


Figure 15: Turn-on transient at full rated load current (resistive load) (5 ms/div). Input voltage pre-applied. Ch 1: + Vout (5 V/div); Ch 2: - Vout (5 V/div); Ch 3: Enable2 input (5 V/div).

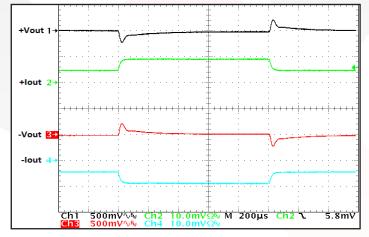


Figure 17: Output voltage response to step-change in total load current (50%-100%-50%) of total lout (max) split 50%/50%. Load cap: 1 µF ceramic cap and 10 μF, 100 mΩ ESR tantalum cap. Ch 1: +Vout (500 mV/div); Ch 2: +Iout (10 A/ div); Ch 3: -Vout (500 mV/div); Ch 4: -Iout (10 A/div)

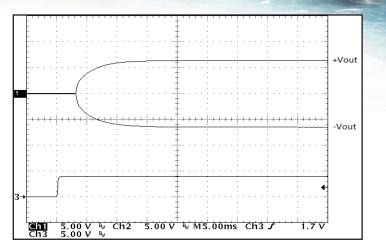


Figure 14: Turn-on transient at zero load current (5 ms/div). Input voltage preapplied. Ch 1: +Vout (5 V/div); Ch 2: -Vout (5 V/div); Ch 3: Enable1 input (5 V/ div).

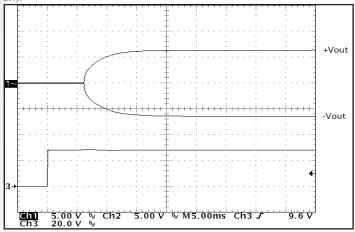


Figure 16: Turn-on transient at full load, after application of input voltage (ENA 1 and ENA 2 logic high) (5 ms/div). Ch 1: +Vout (5 V/ div); Ch 2: -Vout (5 V/div); Ch 3: Vin (10 V/div).

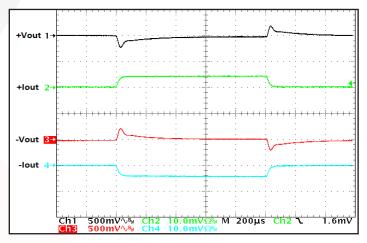
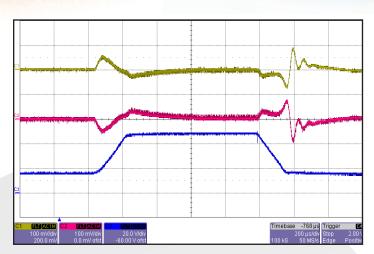


Figure 18: Output voltage response to step-change in total load current (0%-50%-0%) of total lout (max) split 50%/50%. Load cap: 1  $\mu$ F ceramic cap and 10  $\mu$ F, 100 mΩ ESR tantalum cap. Ch 1: +Vout (500 mV/div); Ch 2: +Iout (10 A/div); Ch 3: -Vout (500 mV/div); Ch 4: -Iout (10 A/div).

05/18/21

Current: 18 A Total

JAN ANT



Technical Figures

Figure 19: Output voltage response to step-change in input voltage (16 V - 50 V - 16 V). Load cap:  $10 \mu$ F,  $100 m\Omega$  ESR tantalum cap and  $1 \mu$ F ceramic cap. Ch 1: +Vout (100 mV/div); Ch 2: -Vout (100 mV/div); Ch 3: Vin (20 V/div).

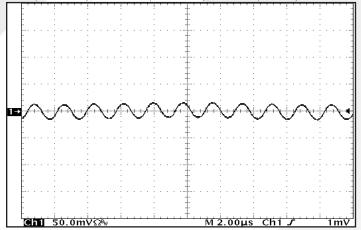


Figure 21: Input terminal current ripple, ic, at full rated output current and nominal input voltage with SynQor MQ filter module (50 mA/div). Bandwidth: 20 MHz. See Figure 20.

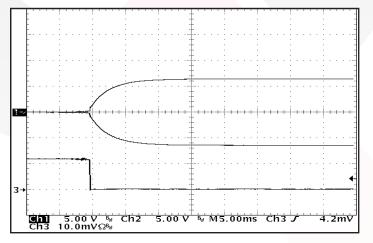


Figure 23: Rise of output voltage after the removal of a short circuit across the positive output terminals. Ch 1: +Vout (5 V/div); Ch 2: -Vout (5 V/div); Ch 3: +Iout (10 A/div).

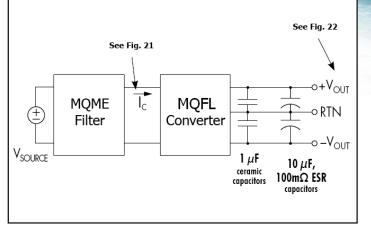


Figure 20: Test set-up diagram showing measurement points for Input Terminal Ripple Current (Figure 21) and Output Voltage Ripple (Figure 22).

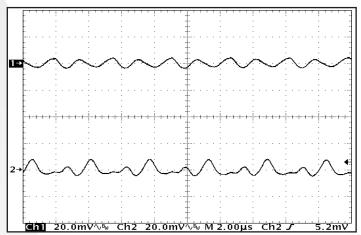


Figure 22: Output voltage ripple, +Vout (Ch 1) and -Vout (Ch 2), at nominal input voltage and full load current evenly split (20 mV/ div). Load capacitance: 1  $\mu$ F ceramic cap and 10  $\mu$ F tantalum cap. Bandwidth: 10 MHz. See Figure 20.

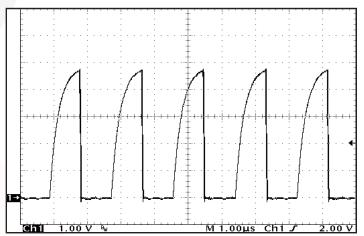
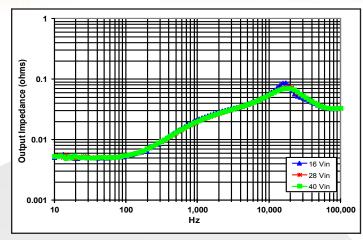


Figure 24:SYNC OUT vs. time, driving SYNC IN of a second SynQor MQFL converter.

Current: 18 A Total



**Technical Figures** 

Figure 25: Magnitude of incremental output impedance of +6.5 V output (+Zout = +vout /+iout) for minimum, nominal, and maximum input voltage at full rated power.

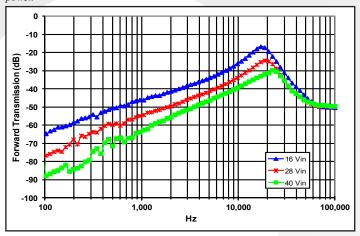


Figure 27: Magnitude of incremental forward transmission of +6.5 V output (+FT = +vout /vin) for minimum, nominal, and maximum input voltage at full rated power.

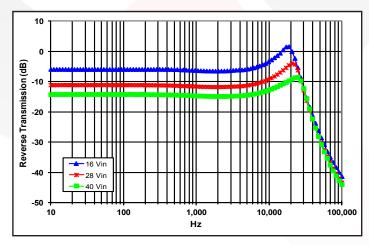


Figure 29: Magnitude of incremental reverse transmission from +6.5 V output (+RT = iin/+iout) for minimum, nominal, and maximum input voltage at full rated power.

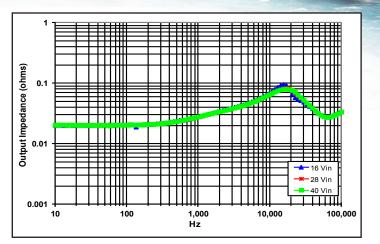


Figure 26: Magnitude of incremental output impedance of -6.5 V output (-Zout = -vout /-iout) for minimum, nominal, and maximum input voltage at full rated power.

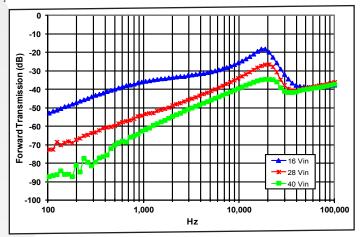
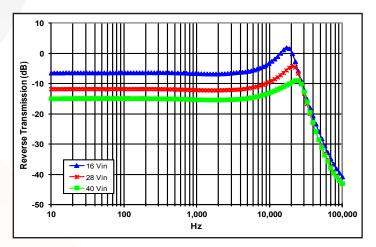


Figure 28: Magnitude of incremental forward transmission of -6.5 V output (-FT = -vout /vin) for minimum, nominal, and maximum input voltage at full rated power.



*Figure 30: Magnitude of incremental reverse transmission from -6.5 V output (-RT = iin /-iout) for minimum, nominal, and maximum input voltage at full rated power.* 

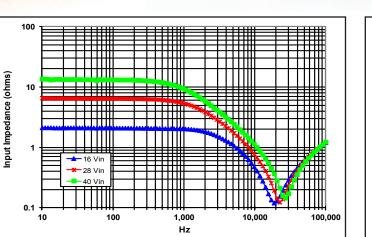


Figure 31: Magnitude of incremental input impedance (Zin = vin/iin) for minimum, nominal, and maximum input voltage at full rated power with 50% / 50% split.

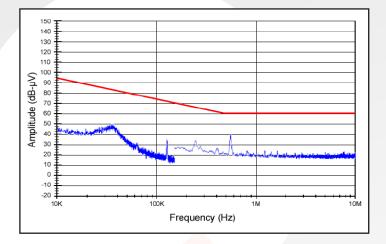


Figure 33: High frequency conducted emissions of MQFL-28-05S, 5 Vout module at 120 W output with MQFL-28-P filter, as measured with Method CE102. Limit line shown is the 'Basic Curve' for allapplications with a 28 V source.

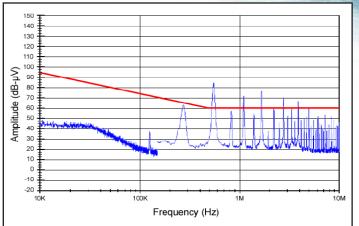


Figure 32: High frequency conducted emissions of standalone MQFL-28-05S, 5 Vout module at 120 W output, as measured with Method CE102. Limit line shown is the 'Basic Curve' for all applications with a 28 V source.



## MQFL-28-6R5D Output: ±6.5 V Current: 18 A Total

## BASIC OPERATION AND FEATURES

The MQFL 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 MQFL 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 MQFL converters employ a "backdrive current limit" to keep this negative output terminal current small.

There is a control circuit on both the input and output sides of the MQFL converter that determines the conduction state of the power switches. These circuits communicate with each other across the isolation barrier through a magnetically coupled device. No opto-isolators are used.

A separate bias supply provides power to both the input and output control circuits. Among other things, this bias supply permits the converter to operate indefinitely into a short circuit and to avoid a hiccup mode, even under a tough start-up condition. An input under-voltage lockout feature with hysteresis is provided, as well as an input over-voltage shutdown. There is also an output current limit that is nearly constant as the load impedance decreases to a short circuit (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.

The MQFL converter's control circuit does not implement an output over-voltage limit or an over-temperature shutdown.

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

## CONTROL FEATURES

**ENABLE:** The MQFL converter has two enable pins. Both must have a logic high level for the converter to be enabled. A logic low on either pin will inhibit the converter.

The ENA1 pin (pin 4) is referenced with respect to the converter's input return (pin 2). The ENA2 pin (pin 12) is referenced with respect to the converter's output return (pin 8). This permits the converter to be inhibited from either the input or the output side.

Regardless of which pin is used to inhibit the converter, the regulation and the isolation stages are turned off. However, when the converter is inhibited through the ENA1 pin, the bias supply is also turned off, whereas this supply remains on when the converter is inhibited through the ENA2 pin. A higher input standby current therefore results in the latter case.

Both enable pins are internally pulled high so that an open connection on both pins will enable the converter. Figure A shows the equivalent circuit looking into either enable pins. It is TTL compatible.

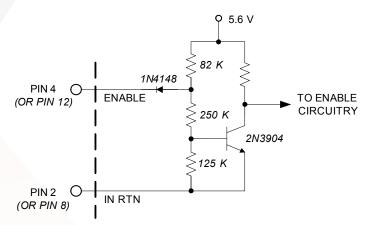


Figure A: Circuit diagram shown for reference only, actual circuit components may differ from values shown for equivalent circuit.

MQFL-28-6R5D Output: ±6.5 V Current: 18 A Total

**SYNCHRONIZATION:** The MQFL 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 0.8 V to be guaranteed to be interpreted as a logic low, and its high value should be above 2.0 V to be guaranteed to be interpreted as a logic high. The transition time between the two states should be less than 300 ns.

plication Section

If the MQFL 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, the MQFL converter will revert to its free-running frequency.

The MQFL 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 MQFL 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 synchronization signal at the SYNC IN pin, or the synchronization frequency if there is.

The SYNC OUT signal is available only when the DC input voltage is above approximately 12 V and when the converter is not inhibited through the ENA1 pin. An inhibit through the ENA2 pin will not turn the SYNC OUT signal off.

NOTE: An MQFL converter that has its SYNC IN pin driven by the SYNC OUT pin of a second MQFL converter will have its start of its switching cycle delayed approximately 180 degrees relative to that of the second converter.

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

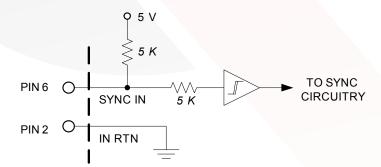


Figure B: Equivalent circuit looking into the SYNC IN pin with respect to the IN RTN (input return) pin.

**CURRENT SHARE:** When several MQFL converters are placed in parallel to achieve either a higher total load power or N+1 redundancy, their SHARE pins (pin 11) should be connected together. The voltage on this common SHARE node represents the average current delivered by all of the paralleled converters. Each converter monitors this average value and adjusts itself so that its output current closely matches that of the average.

Since the SHARE pin is monitored with respect to the OUTPUT RETURN (pin 8) by each converter, it is important to connect all of the converters' OUTPUT RETURN pins together through a low DC and AC impedance. When this is done correctly, the converters will deliver their appropriate fraction of the total load current to within +/- 10% at full rated load.

Whether or not converters are paralleled, the voltage at the SHARE pin could be used to monitor the approximate average current delivered by the converter(s). A nominal voltage of 1.0 V represents zero current and a nominal voltage of 2.2 V represents the maximum rated current, with a linear relationship in between. The internal source resistance of a converter's SHARE pin signal is 2.5 kW. During an input voltage fault or primary disable event, the SHARE pin outputs a power failure warning pulse. The SHARE pin will go to 3 V for approximately 14 ms as the output voltage falls.

NOTE: Converters operating from separate input filters with reverse polarity protection (such as the MQME-28-T filter) with their outputs connected in parallel may exhibit hiccup operation at light loads. Consult factory for details.

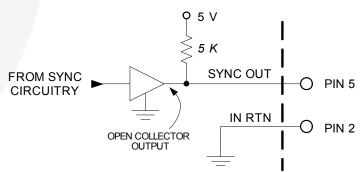


Figure C: Equivalent circuit looking into SYNC OUT pin with respect to the IN RTN (input return) pin.

Current: 18 A Total

**OUTPUT VOLTAGE TRIM:** If desired, it is possible to increase the MQFL dual converter's output voltage above its nominal value. To increase the output voltage a resistor, Rup, should be connected between the 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:

oplication Section

$$Rup = 10 \times \left( \frac{Vnom - 2.5}{Vout - Vnom} - 2 \times Vnom + 5 \right)$$

where:

Vnom = the converter's nominal output voltage,

Vout = the desired output voltage (greater than Vnom), and

Rup is in kiloOhms ( $k\Omega$ ).

The maximum value of output voltage that can be achieved is 0.5 V above the nominal output.

To decrease the output voltage a resistor, Rdown, should be connected between the TRIM pin and the POSITIVE OUTPUT pin (pin 7), as shown in Figure D. The value of this resistor should be determined according to the following equation:

$$Rdown = 10 \times \left[ \frac{Vnom}{2.5} - 1 \right] \times \left[ \frac{Vout - 2.5}{Vnom - Vout} - 5 \right]$$

where:

Vnom = the converter's nominal output voltage, Vout = the desired output voltage (less than Vnom), and Rdown is in kiloOhms ( $k\Omega$ ).

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.

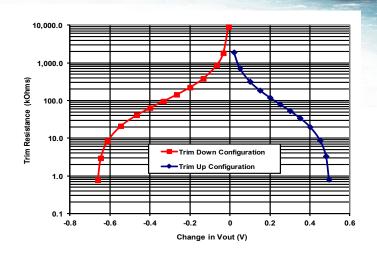


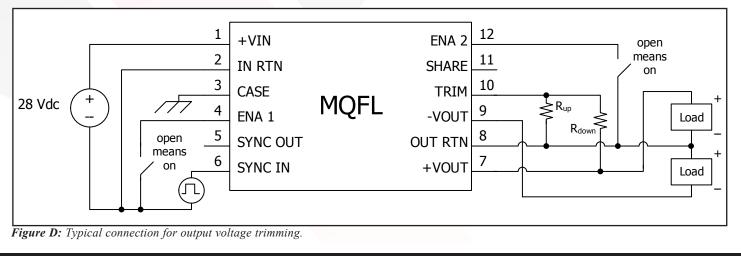
Figure E: Output Voltage Trim Graph

**INPUT UNDER-VOLTAGE LOCKOUT:** The MQFL converter has an under-voltage lockout feature that ensures the converter will be off if the input voltage is too low. The threshold of input voltage at which the converter will turn on is higher that the threshold at which it will turn off. In addition, the MQFL converter will not respond to a state of the input voltage unless it has remained in that state for more

than about 200  $\mu s.$  This hysteresis and the delay ensure proper operation when the source impedance is high or in a noisy environment.

**INPUT OVER-VOLTAGE SHUTDOWN:** The MQFL 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.

**SHUT DOWN:** The MQFL converter will shut down in response to only four conditions: ENA1 input low, ENA2 input low, VIN input below under-voltage lockout threshold, or VIN input above over-voltage shutdown threshold. Following a shutdown event, there is a startup inhibit delay which will



Page 13

MQFL-28-6R5D Output: ±6.5 V Current: 18 A Total

prevent the converter from restarting for approximately 300 ms. After the 300 ms 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 0 V 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.

oplication Section

**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 shortor 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, or where the current share feature does not adequately ensure sharing during the startup or shutdown transitions. 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 MQFL 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.

**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.



MQFL-28-6R5D Output: ±6.5 V Current: 18 A Total

CONSTRUCTION AND ENVIRONMENTAL STRESS SCREENING OPTIONS											
	Screening	Consistent with MIL-STD-883F			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.

MQFL-28-6R5D

# Support Technical Specifications

MQFL-28-6R5D Output: ±6.5 V Current: 18 A Total

Showard Lines

A. 1945

Ν	AIL-STD-	-810F (	Dualific	ation 1	esting

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				
High Tomporatura	501.4 - Procedure I	Storage: 135 °C / 3 hrs				
High Temperature	501.4 - Procedure II	Operating: 100 °C / 3 hrs				
Low Temperature	502.4 - Procedure I	Storage: -65 °C / 4 hrs				
Low lemperature	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	5 <mark>14.5</mark> - 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				
Sand and Dust	510.4 - Procedure II	Blowing Sand				

# Support Technical Specifications

MQFL-28-6R5D Output: ±6.5 V Current: 18 A Total

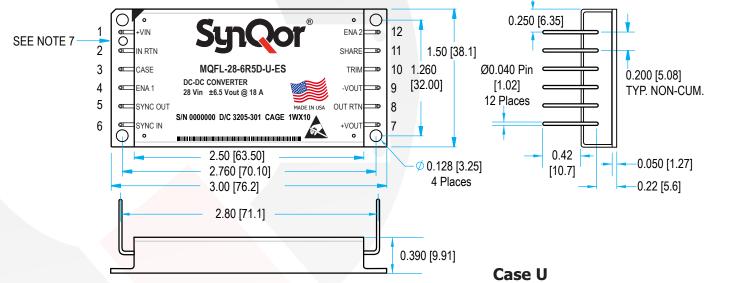
Eleventer Line of and

A. J. A. S.

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"						

Page 1<u>7</u>

MQFL-28-6R5D Output: ±6.5 V **Current: 18 A Total** Jan 18 Mechanical Diagrams 0.250 [6.35] +VIN ENA 2 12 1 SEE NOTE 7 0 2 IN RTN SHARE 11 1.50 [38.1] 0 0.200 [5.08] MQFL-28-6R5D-X-ES 3 CASE TRIM 10 1.260 0 TYP. NON-CUM. DC-DC CONVERTER [32.00] ENA 1 -VOUT 9 4 28 Vin ±6.5 Vout @ 18 A 0 SYNC OUT 1ADE IN USA OUT RTN 8 5 Ø 0.040 [1.02] S/N 0000000 D/C 3205-301 CAGE 1WX10 SYNC IN +VOUT 6 7 0 PIN  $\bigcirc$  $\bigcirc$ 0 . 2.50 [63.50] Ø 0.128 [3.25] 0.050 [1.27] 2.760 [70.10] 3.00 [76.2] 0.22 [5.6] 2.96 [75.2] 0.228 [5.79] 0.390 [9.91] Case X

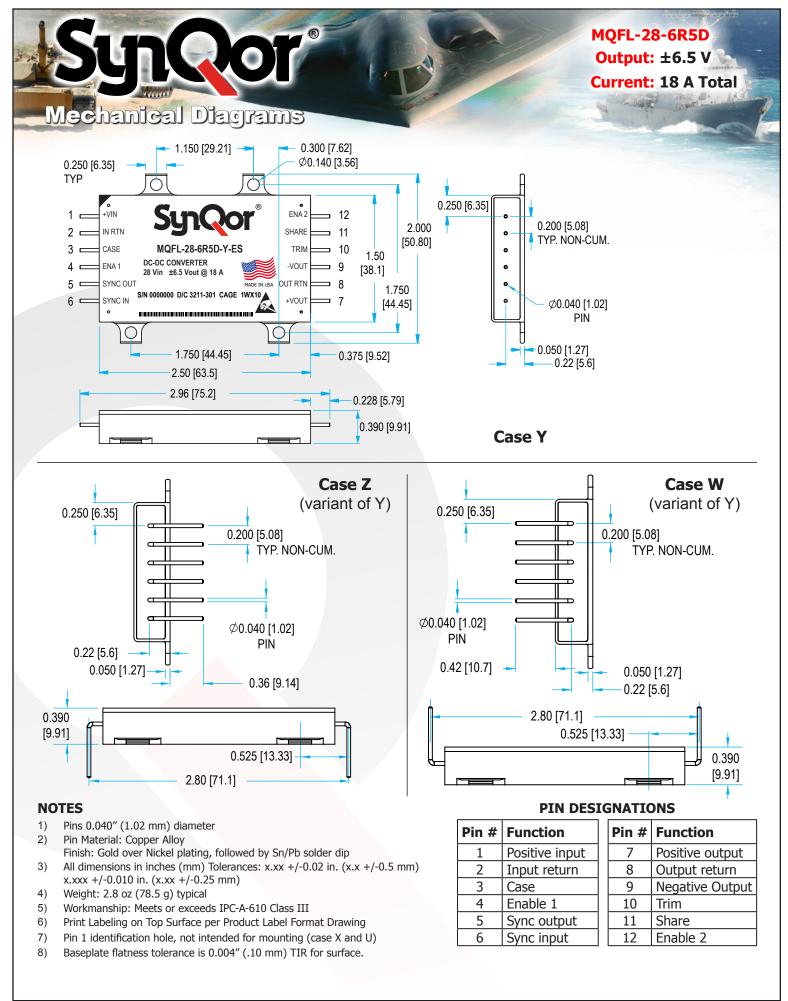


#### NOTES

- 1) Pins 0.040" (1.02 mm) diameter
- Pin Material: Copper Alloy Finish: Gold over Nickel plating, followed by Sn/Pb solder dip
   All dimensions in inches (mm) Tolerances: x.xx +/-0.02 in. (x.x +/-0.5 mm)
- All dimensions in inches (mm) Tolerances: x.xx +/-0.02 in. (x.x +/-0.5 mm)
   x.xxx +/-0.010 in. (x.xx +/-0.25 mm)
- 4) Weight: 2.8 oz (78.5 g) typical
- 5) Workmanship: Meets or exceeds IPC-A-610 Class III
- 6) Print Labeling on Top Surface per Product Label Format Drawing
- 7) Pin 1 identification hole, not intended for mounting (case X and U)  $\,$
- 8) Baseplate flatness tolerance is 0.004" (.10 mm) TIR for surface.

#### **PIN DESIGNATIONS**

Pin #	Function	Pin #	Function
1	Positive input	7	Positive output
2	Input return	8	Output return
3	Case	9	Negative Output
4	Enable 1	10	Trim
5	Sync output	11	Share
6	Sync input	12	Enable 2



Page 19



## 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.

					Sind	le Ou	tput					D	al Out	out †
Full Size	1.5 V (1R5S)	1.8 V (1R8S)	2.5 V (2R5S)	3.3 V (3R3S)	5 V (05S)	6 V (06S)	7.5 V (7R5S)	9 V (09S)	12 V (12S)	15 V (15S)	28 V (28S)	5 V (05D)	12 V (12D)	15 V (15D)
<b>MQFL-28</b> 16-40 Vin Cont. 16-50 Vin 1 s Trans.* Absolute Max Vin = 60 V	40 A	40 A	40 A	30 A	24 A	20 A	16 A	13 A	10 A	8 A	4 A	24 A Total	10 A Total	8 A Total
MQFL-28E 16-70 Vin Cont. 16-80 Vin 1 s Trans.* Absolute Max Vin =100 V	40 A	40 A	40 A	30 A	24 A	20 A	16 A	13 A	10 A	8 A	4 A	24 A Total	10 A Total	8 A Total
MQFL-28 V 16-40 Vin Cont. 5.5-50 Vin 1 s Trans.* Absolute Max Vin = 60 V	40 A	40 A	40 A	30 A	20 A	17 A	13 A	11 A	8 A	6.5 A	3.3 A			
MQFL-28 VE 16-70 Vin Cont. 5.5-80 Vin 1 s Trans.* Absolute Max Vin = 100 V	40 A	40 A	40 A	30 A	20 A	17 A	13 A	11 A	8A	6.5A	3.3A			
MQFL-270 155-400 Vin Cont. 155-475 Vin 1 s Trans.* Absolute Max Vin = 550 V	40A	40A	40A	30A	24A	20A	16A	13 A	10A	8 A	4 A	24 A Total	10 A Total	8 A Total
<b>MQFL-270L</b> 65-350 Vin Cont. 65-475 Vin 1 s Trans.* Absolute Max Vin = 550 V	40 A	40 A	30 A	22 A	15 A	12 A	10 A	8 A	6 A	5 A	2.7 A	15 A Total	6 A Total	5 A Total
	4 = 3/	1.01/	0.514	0.01/		le Ou	1	0.1/	101/	4=3/	221/		ial Out	
Half Size	1.5 V (1R5S)	1.8 V (1R8S)	2.5 V (2R5S)	3.3 V (3R3S)	5 V (05S)	6 V (06S)	7.5 V (7R5S)	9 V (09S)	12 V (12S)	15 V (15S)	28 V (28S)	5 V (05D)	12 V (12D)	15 V (15D)
<b>MQHL-28</b> 16-40 Vin Cont. 16-50 Vin 1 s Trans.* Absolute Max Vin = 60 V	20 A	20 A	20 A	15 A	10 A	8 A	6.6 A	5.5 A	4 A	3.3 A	1.8 A	10 A Total	4 A Total	3.3 A Total
MQHL-28E 16-70 Vin Cont. 16-80 Vin 1 s Trans.* Absolute Max Vin =100 V	20 A	20 A	20 A	15 A	10 A	8 A	6.6 A	5.5 A	4 A	3.3 A	1.8 A	10 A Total	4 A Total	3.3 A Total
<b>MQHR-28</b> 16-40 Vin Cont. 16-50 Vin 1 s Trans.* Absolute Max Vin = 60 V	10 A	10 A	10 A	7.5 A	5 A	4 A	3.3 A	2.75 A	2 A	1.65 A	0.9 A	5 A Total	2 A Total	1.65 A Total
<b>MQHR-28E</b> 16-70 Vin Cont. 16-80 Vin 1 s Trans.* Absolute Max Vin = 100 V	10 A	10 A	10 A	7.5 A	5 A	4 A	3.3 A	2.75 A	2 A	1.65 A	0.9 A	5 A Total	2 A Total	1.65 A Total

Check with factory for availability.

\*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	Input	Output Voltage(s)		Package Outline/	Screening
Name	Voltage Range	Single Output	Dual Output	Pin Configuration	Grade
MQFL MQHL MQHR	28 28E 28V 28VE 270 270L	1R5S 1R8S 2R5S 3R3S 05S 06S 6R5S 7R5S 08S 09S 12S 15S 28S	05D 6R5D 12D 15D	U X Y W Z	C ES HB

## Example: MQFL-28-6R5D-Y-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:

#### 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:

6,896,526 6,927,987 7,050,309 7,085,146 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.