



Paralleling Capability of SynQor Converters

Application Note

Summary

This application note provides an overview of the paralleling capabilities of the different SynQor power converter families.

Introduction

Many SynQor[®] power converters have built-in paralleling capability. This functionality allows increased total load power and, with output OR'ing FET's or diodes, allows a configuration for N+1 redundancy. The table that follows provides a summary of whether, for a given converter family, paralleling is built into the design. It also includes some additional information about how the converter design implements the current sharing feature. For converters that do not have built-in paralleling capability, the table indicates whether they may be made to operate in parallel with the addition of an external current sharing circuit that makes adjustment to the converter's Remote-Sense or Trim inputs.

Types of Current-Share Methods

Different current sharing methods are implemented in SynQor converters. These include analog control, digital control, and droop share. The following is a description of these methods.

Converters using an analog current-share method have a "share" control bus with a voltage that represents the average current per paralleled converter connected. With this current-share method all the converters operate without any single converter being in overall control, i.e., there is no master. An advantage of analog current sharing is that an individual converter in a power system can stop working and the remaining converters will continue to provide power to the load without interruption or shutdown.

The digital current-share method utilizes a high-speed two-wire serial communication bus to force each converter to share current equally. With this method one converter automatically becomes the master and all the remaining converters become slaves. If the master shuts down for any reason, the slaves also shut down. The slaves will then automatically restart and pick a new master. Advantages of the digital current-sharing method include superior current share accuracy during start-up and during transient events due to cycle-by-cycle matching of each converter's internal switching duty cycle and reduced input and output ripple and noise.

Converters designed for the droop current-share method reduce their output voltage as the output current increases. At lighter loads the output voltage is higher and at heavier loads it is lower. This is graphically represented as output voltage vs. output current, known as a load-line, that slopes downward as current is increased. Converters connected in parallel using the droop share method will share the current in accordance with how well their load-lines are matched. The advantage of this method of paralleling is ease of implementation since there is no share bus or serial communication between modules.

For best parallel operation and performance, please refer to the application guidelines in the product datasheet. There you will find helpful suggestions and example application circuits.

The tables below show, for each converter family, whether it has a built-in current sharing capability or whether it can be controlled to share with external components. Often there are several versions of converters available within a converter family. To determine the specific version that includes built-in current sharing, please check the ordering section of the individual product datasheet.

SynQor Converter Family	Converter Brick Size					Built-In Paralleling Capability	Paralleling Capability with External Circuit
	Sixteenth	Eighth	Quarter	Half	Full		
PowerQor							
PQ24			QB			No	Yes, except PQ24xxxQEx
PQ30		EB	QB			No	Yes
PQ40			QB			No	Yes
PQ48			QB			No	Yes
				HB		Yes, Analog Method	n/a
PQ60	SB	EB	QB			No	Yes, except PQ60xxxQEx and PQ60xxxQZx
				HB		Yes, Digital Method, (PQ60xxxHZxxxF) No, (PQ60xxxHEX) Yes, Analog Method, (PQ60xxxHxxxxF, most other non-HZ, consult datasheets)	n/a, Yes, n/a, Yes
PQ50			QB	HB		No	Yes
PQ55				HB		No	Yes, except PQ55xxxHEX
PQ65			QB			No	Yes
DualQor							
DQ61, 62, 63, 65			QB			No	No
BusQor							
BQ50			QB			Yes, Droop Method	n/a
BQ55, BQ57		EB	QB			Yes, Droop Method	n/a
PQ60120QEx17 PQ60120QEx25 PQ60120QZx33			QB			No	No
BQ60120HEX30				HB		No	No
PQ60120HZx50				HB		Yes, Droop Method	n/a
BQ35		EB				Yes, Droop Method	n/a
BQ4H		EB		HB	FB	Yes, Droop Method	n/a
SQ60		EB	QB	HB		Yes, Droop Method, except SQ60120QEx25	n/a
NiQor							
NQ04, NQ16	SIP and SMT					No	Yes
NQ15	SMT					Yes, Analog Method	No
NQ20		EB	QB			No	No
NQ40, NQ60, NQ90		EB	QB	HB		Yes, Analog Method, NQxxxxxHGx, No all others	No
iQor, ATCA							
IQ65			QB			No	No

Note: This chart is intended as a quick reference guide to the paralleling capabilities of SynQor converters.

Please feel free to contact SynQor technical support for further assistance when paralleling any specific SynQor converter.

SynQor Converter Family	Converter Brick Size					Built-In Paralleling Capability	Paralleling Capability with External Circuit
	Sixteenth	Eighth	Quarter	Half	Full		
InQor							
IQ12, IQ18	SB		QB	HB		No	Yes
IQ24	SB		QB			No	Yes
				HB		Yes for IQ24xxxHZxxxNRF Digital Method, No all others	Yes, except IQ24xxxHEX and IQ24xxxHZx
IQ32			QB			No	Yes
				HB		Yes for IQ32xxxHZxxxNRF Digital Method, No all others	Yes, except IQ24xxxHZx
IQ36	SB		QB	HB		No	Yes
IQ48	SB		QB			No	Yes
				HB		Yes for IQ48xxxHZxxxNRF Digital Method, No all others	Yes, except IQ24xxxHZx
IQ64, IQ68, IQ70, IQ72, IQ90, IQ1B			QB	HB		No	Yes
IQ2H			QB			No	Yes
IQ4H			QB			No	Yes
				HB	FB	Yes, Analog Method	Yes
InQor DC Filters							
IQxxxPFQQT			QB			No	No
RailQor							
RQ18, RQ68, RQ72, RQ90 RQ1B			QB	HB		Yes for RQxxxxHEX, Analog Method	Yes, except RQxxxxHEX
CFQor							
CF12, CF24, CF48			QB			No	Yes
ACuQor							
G-Series AQ0800-AQ1400			All			No	No
E-Series AQ0300 - AQ1500			All			Yes, Droop Method	n/a
PFCQor							
PFCU390Pxxx			QB	HB		Yes for Half Brick Analog Method, No for Quarter Brick	No
PFICQor							
PFICUxxxHTxxxNRS				HB		No	No
PFICUxxxHTxxxNRD				HB		Yes, Droop Method	n/a
AC Filters							
ACLFxxxHT				HB		No	No

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SynQor Converter Family	Converter Size	Built-In Paralleling Capability	Paralleling Capability with External Circuit
Hi-REL Single Output			
MQFL-28, MQFL-28E, MQFL-28V, MQFL-28VE	FL Package	Yes, Analog Method	n/a
MQFL-270, MQFL-270L	FL Package	Yes, Analog Method	n/a
MQHL-28, MQHL-28E	HL Package	No	Yes
MQBL-28, MQBL-28E	BL Package	No	Yes
MQSA-28, MQSA-28E	SA Package	No	Yes
Hi-REL Dual Output			
MQFL-28, MQFL-28E, MQFL-28V, MQFL-28VE	FL Package	Yes, Analog Method	n/a
MQFL-270	FL Package	Yes, Analog Method	n/a
MQHL-28, MQHL-28E	HL Package	No	No
MQBL-28, MQBL-28E	BL Package	No	No
MQSA-28, MQSA-28E	SA Package	No	No
Hi-Rel BusQor			
MQBQ-28, MQBQ-270	FL Package	Yes, Droop Method	n/a
Hi-Rel DC Filters			
MQME-28, MQME-28E, MQME-270, MQME-270L	FL Package	No	No
MQHE-28, MQHE-28E, MQHE-270, MQHE-270L	HL Package	No	No

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SynQor Converter Family	Converter Brick Size					Built-In Paralleling Capability	Paralleling Capability with External Circuit
	Sixteenth	Demi	Quarter	Half	Full		
MilQor MCOTS							
MCOTS-C-28	SB	DB	QB			No	Yes, except -28-xx-QE, and -28-xxD-DM
				HB	FB	Yes, Digital Method, -28-xx-HZ-xxF, No all others	Yes, except -28-xx-xZ
MCOTS-C-28E		DB		HB		Yes, Digital Method, -28E-xx-HZ-xxF, No all others	No, except -28E-xxS-DM
MCOTS-C-28V, -28VE			QB			No	Yes
				HB		Yes, Digital Method, -28V-xx-HZ-xxF, No all others	Yes, except -28V-xx-HZ
MCOTS-C-48	SB		QB			No	Yes
				HB		Yes, Digital Method, -48-xx-HZ-xxF, No all others	Yes, except -48-xx-HZ
MCOTS-C-150			QB			No	Yes
MCOTS-C-270			QB			No	Yes
				HB	FB	Yes, Analog Method	Yes
MCOTS-C-270N				HB		Yes, Analog Method	Yes
MCOTS-C-270H					FB	Yes, Analog Method	Yes
MCOTS BusQor							
MCOTS-B-270, -600				HB		Yes, Droop Method	n/a
MCOTS Non-Isolated							
MCOTS-N-28V-60			QB	HB		Yes, Analog Method, MCOTS-N-28V-60-HG-x No all others	No
MCOTS-N-28VE-90			QB	HB		Yes, Analog Method, MCOTS-N-28VE-90-HG-x No all others	No
MCOTS-N-12-Q3P1N-QT			QB			No	No
MPFCQor							
MPFC-U-390			QB			No	No
				HB		Yes, Analog Method	No
MPFC-115-270			QB			No	No
				HB		Yes, Analog Method	No
MPFC-115-3PH-270-FP					FB	No	No
MPFC-115-3PH-270P-FP					FB	Yes, Droop Method	No
MPFICQor							
MPFIC-U-xx-HT-x-x				HB		No	No
MPFIC-U-xx-HT-x-x-D				HB		Yes, Droop Method	n/a
MCOTS DC Filter							
MCOTS -F-28, -48, -270		DB	QB	HB		No	No
MCOTS AC Filter							
MACF-xxx-230				HB		No	No
MACF-115-3PH-UNV-HT				HB		No	No
MACF-U-230-ET		EB				No	No

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SynQor Converter Family	Converter Size	Built-In Paralleling Capability	Paralleling Capability with External Circuit
MultiQor			
MTQ-Px-DC28T	All	Yes for P3 only, digital method, paralleling only for two or three -28-xx-HZ-x half bricks within the assembly but not with other MTQ assemblies. (No for P1, P2, and P4)	P1 & P3 Yes, except -28-xx-Q-xE and -28-xx-HZ-x P2 Yes, except -28-xx-QE-x P4 Yes, except -28-xx-QE-x and -28-xx-HZ-x
MTQ-Px-28	All	No	No
VPX			
VPX-3U-DC28P-001	3U	Yes, digital on +12V Main, analog on +5V and +3.3V Main, No paralleling on Aux outputs.	No for Auxillary Outputs
VPX-6U-DC28P-001	6U	Yes, digital on +12V Main, analog on +5V Main. No paralleling on Aux outputs.	No for Auxillary Outputs
UPS, See page 7			
EBM			
EBM-1000-2U-28-3000	2U	Yes	n/a
MPC			
MPC-1500-1U	1U	Yes for AC output and DC2 output (droop method), No for DC1 output	No for DC1 Output
MPS			
MPS-4000-1U	1U	Yes	n/a

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UPS-1500 or UPS-3000 Output Sharing	UPS	Output Power ¹	Battery Pack Size	Height	AC Input Freq	AC Output Voltage ¹	AC Output Neutral Wire ¹	AC Output Freq ¹	DC Input/DC2 Output ¹	DC1 Output	Additional Options
To Share Only the AC Output	UPS	1500 or 3000	x	x	x	115 or 230	F or R	5,6, or 4	x	No	x
To Share Only the DC Output	UPS	1500 or 3000	x	x	x	x	x	x	M or R	No	x
To Share AC and DC Output	UPS	1500 or 3000	x	x	x	115 or 230	F or R	5,6, or 4	M or R	No	x

UPS-1250 Output Sharing	UPS	Output Power	Battery Pack Size	Height	AC Input Freq	DC Regulation Type ¹	DC Output Voltage ¹	DC Input	RSVD	Additional Options
To Share the DC Output	UPS	1250	x	x	x	D	28	x	n/a	x

Note 1: Sharing units must have this same feature (see separate datasheets for details)

x = any feature

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