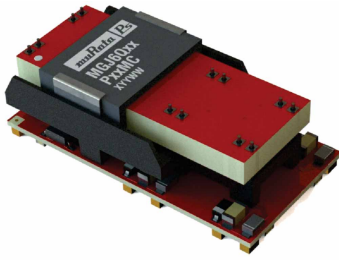


# MGJ6 Three Phase Bridge Series

5.2kVDC 6W Quad Output Isolated Gate Drive SM DC/DC Converters



## FEATURES

- No opto feedback
- Patents Pending
- Four isolated output voltages suitable for powering IGBT/SiC & Mosfet gate drives simultaneously in a three phase bridge configuration
- Reinforced insulation to UL60950 with 8mm creepage & clearance recognition pending
- ANSI/AAMI ES60601-1 recognition pending
- Characterised dv/dt immunity 80kV/μs at 1.6kV
- Characterised partial discharge performance
- 5.2kVDC isolation test voltage 'Hi Pot Test'
- Ultra low coupling capacitance typically 15pF
- DC link voltage 3kVDC
- 5V, 12V & 24V input voltages
- 105°C operating temperature

## PRODUCT OVERVIEW

Offering four isolated output voltages of 24V, the MGJ6 series of DC-DC converters is ideal for powering 'high side' and 'low side' gate drive circuits simultaneously for IGBTs, Silicon and Silicon Carbide Mosfets in three phase circuits. The MGJ6 series is characterised for high isolation and dv/dt requirements commonly seen in bridge circuits used in motor drives and inverters.



For full details go to  
[www.murata-ps.com/rohs](http://www.murata-ps.com/rohs)

## SELECTION GUIDE

Order Code <sup>1</sup>	Input Voltage Range	Output 1 VHA / Output 2 VHB Output 3 VHC			Output 4 VL		
		Rated Output Voltage	Rated Output Current	Output Power	Rated Output Voltage	Rated Output Current	Output Power
		V	mA	W	V	mA	W
<b>MGJ6Q05P24MC</b>	4.5 - 9	24					
<b>MGJ6Q12P24MC</b>	9 - 18	24	42	1	24	125	3
<b>MGJ6Q24P24MC</b>	18 - 36	24	42	1	24	125	3

## SELECTION GUIDE (Continued)

Order Code <sup>1</sup>	Input Voltage Range	Output 1 VHA / Output 2 VHB Output 3 VHC				Output 4 VL			
		Load Regulation (Typ)	Load Regulation (Max)	Ripple & Noise (Typ) <sup>2</sup>	Ripple & Noise (Max) <sup>2</sup>	Load Regulation (Typ)	Load Regulation (Max)	Ripple & Noise (Typ) <sup>2</sup>	Ripple & Noise (Max) <sup>2</sup>
		V	%	mVp-p	mVp-p	%	mVp-p	mVp-p	mVp-p
<b>MGJ6Q05P24MC</b>	4.5 - 9								
<b>MGJ6Q12P24MC</b>	9 - 18	2	3	70	120	2	3	70	120
<b>MGJ6Q24P24MC</b>	18 - 36	2	3	70	120	2	3	70	120

## SELECTION GUIDE (Continued)

Order Code <sup>1</sup>	Nominal Input Voltage	Input Current at Rated Load	Efficiency (Min)	Efficiency (Typ)	MTTF <sup>3</sup>	
					MIL 217	Telecordia
					V	mA
<b>MGJ6Q05P24MC</b>	5					
<b>MGJ6Q12P24MC</b>	12	600	82	84		
<b>MGJ6Q24P24MC</b>	24	300	83	85		

1. Components are supplied in tape and reel packaging, please refer to tape and reel specification section. Orderable part numbers are MGJ6Q05P24MC-R7 (23 pieces per reel), or MGJ6Q05P24MC-R13 (92 pieces per reel).

2. See ripple & noise test method.

3. Calculated using MIL-HDBK-217 FN2 and Telecordia SR-332 calculation model at TA=25°C with nominal input voltage at full load.

All specifications typical at TA=25°C, nominal input voltage and rated output current unless otherwise specified.

INPUT CHARACTERISTICS					
Parameter	Conditions	Min.	Typ.	Max.	Units
Voltage range	5V input types	4.5	5	9	V
	12V input types	9	12	18	
	24V input types	18	24	36	
Under voltage lock out	Turn on threshold MGJ6Q05		4.1		V
	Turn off threshold MGJ6Q05		3.0		
	Turn on threshold MGJ6Q12		8.1		
	Turn off threshold MGJ6Q12		7.5		
	Turn on threshold MGJ6Q24		16.7		
	Turn off threshold MGJ6Q24		16.3		
Input ripple current	5V input types				mA p-p
	12V input types		45		
	24V input types		25		

OUTPUT CHARACTERISTICS					
Parameter	Conditions	Min.	Typ.	Max.	Units
Minimum load	Below 10% load, output may rise to 30V maximum voltage	10			%
Voltage set point accuracy	All output types		+3 / -2		%
Total regulation				10	%
Line regulation	Low line to high line		0.5	1	%

ISOLATION CHARACTERISTICS					
Parameter	Conditions	Min.	Typ.	Max.	Units
Isolation test voltage	Flash tested for 1 second (input to output)	4000			VAC
	Flash tested for 1 second (output to output)	2500			VAC
Resistance	Viso = 1kVDC	100			GΩ
Continuous barrier withstand voltage	Non-safety barrier application			3000	V
Creepage & clearance	Input to output			8	mm
	Output to output			8	
Isolation capacitance	Primary to Output 1 VHA		15		pF
	Primary to Output 2 VHB		15		
	Primary to Output 3 VHC		15		
	Primary to Output 4 VL		15		

GENERAL CHARACTERISTICS					
Parameter	Conditions	Min.	Typ.	Max.	Units
Power Consumption	Disabled pin pulled low		45		mW
Switching frequency			100		kHz

TEMPERATURE CHARACTERISTICS					
Parameter	Conditions	Min.	Typ.	Max.	Units
Operation	See derating graphs	-40		105	°C
Storage		-55		125	
Product temperature rise above ambient	100% Load, Nom V <sub>IN</sub> , Still Air		19		

ABSOLUTE MAXIMUM RATINGS	
Short-circuit protection	Continuous
Input voltage, MGJ6 5V input types	12V
Input voltage, MGJ6 12V input types	20V
Input voltage, MGJ6 24V input types	40V

### TECHNICAL NOTES

#### ISOLATION VOLTAGE

'Hi Pot Test', 'Flash Tested', 'Withstand Voltage', 'Proof Voltage', 'Dielectric Withstand Voltage' & 'Isolation Test Voltage' are all terms that relate to the same thing, a test voltage, applied for a specified time, across a component designed to provide electrical isolation, to verify the integrity of that isolation.

Murata Power Solutions MGJ6 series of DC/DC converters are all 100% production tested at their stated isolation voltage. this is 4kVACrms for 1 second from input to output and 2.5kVACrms for 1 second from output to output.

A question commonly asked is, "What is the continuous voltage that can be applied across the part in normal operation?"

When the insulation in the MGJ6 series is not used as a safety barrier , i.e. provides functional isolation only, continuous or switched voltages across the barrier up to 3kV are sustainable. Long term reliability testing at these voltages continues. Peak Inception voltages measured were in excess of 3.5kV when testing for partial discharge in accordance with IEC 60270. Please contact Murata for further information.

The MGJ6 series pending recognition by Underwriters Laboratory to 250 Vrms Reinforced Insulation, please see safety approval section below.

#### REPEATED HIGH-VOLTAGE ISOLATION TESTING

It is well known that repeated high-voltage isolation testing of a barrier component can actually degrade isolation capability, to a lesser or greater degree depending on materials, construction and environment. We therefore strongly advise against repeated high voltage isolation testing, but if it is absolutely required, that the voltage be reduced by 20% from specified test voltage.

### SAFETY APPROVAL

#### ANSI/AAMI ES60601-1

The MGJ6 series is pending recognition ANSI/AAMI ES60601-1.

#### UL 60950

The MGJ6 series pending recognition by Underwriters Laboratory (UL) to UL 60950 for reinforced insulation to a working voltage of 250Vrms with a maximum measured product operating temperature of 105°C.

Creepage and clearance 8mm, input to output & across outputs.

#### FUSING

The MGJ6 Series of converters are not internally fused so to meet the requirements of UL an anti-surge input line fuse should always be used with ratings as defined below.

Input Voltage, 5V 4A

Input Voltage, 12V 2A

Input Voltage, 24V 1A

All fuses should be UL recognized, 250Vac rated.

### CHARACTERISATION TEST METHODS

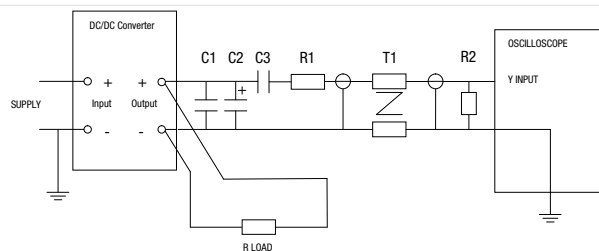
#### Ripple & Noise Characterisation Method

Ripple and noise measurements are performed with the following test configuration.

C1	1µF X7R multilayer ceramic capacitor, voltage rating to be a minimum of 3 times the output voltage of the DC/DC converter
C2	10µF tantalum capacitor, voltage rating to be a minimum of 1.5 times the output voltage of the DC/DC converter with an ESR of less than 100mΩ at 100 kHz
C3	100nF multilayer ceramic capacitor, general purpose
R1	450Ω resistor, carbon film, ±1% tolerance
R2	50Ω BNC termination
T1	3T of the coax cable through a ferrite toroid
RLOAD	Resistive load to the maximum power rating of the DC/DC converter. Connections should be made via twisted wires

Measured values are multiplied by 10 to obtain the specified values.

#### Differential Mode Noise Test Schematic



### RoHS COMPLIANCE, MSL AND PSL INFORMATION



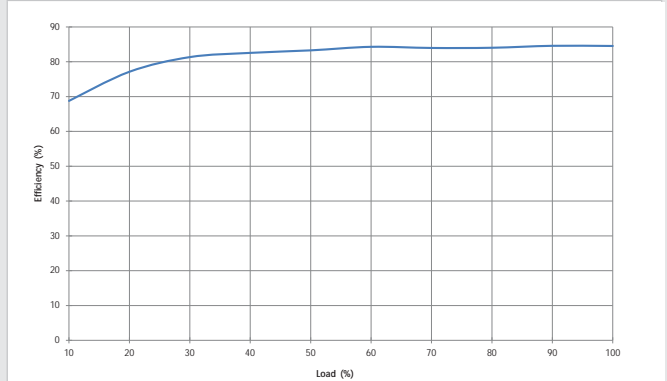
This series is compatible with Pb-Free soldering systems and is also backward compatible with Sn/Pb soldering systems. The MGJ6 three phase series has a process, moisture, and reflow sensitivity classification of MSL2 PSL R7F as defined in J-STD-020 and J-STD-075. This translates to: MSL2 = 1 year floor life, PSL R7F = Peak reflow temperature 245°C with a limitation on the time above liquidus (217°C) which for this series is 90sec max. The pin termination finish on this product series is Gold with Nickel Pre-plate.

### EFFICIENCY VS LOAD

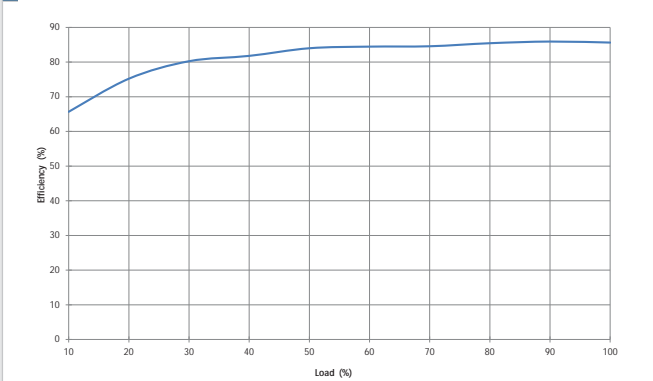
**MGJ6Q05P24MC**



**MGJ6Q12P24MC**



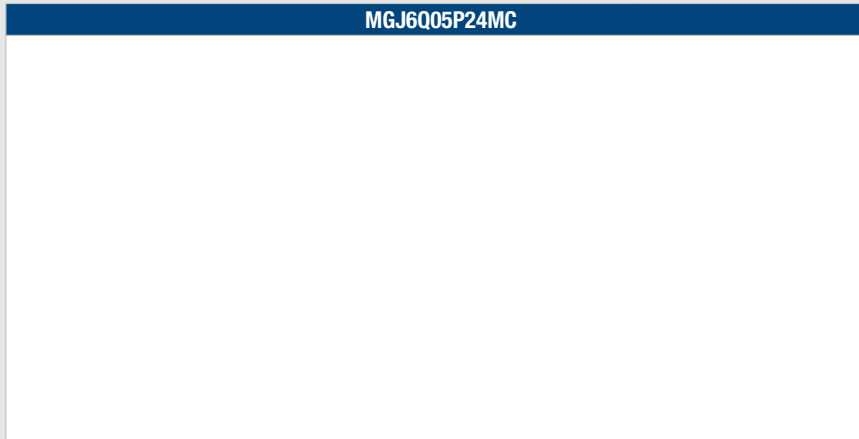
**MGJ6Q24P24MC**



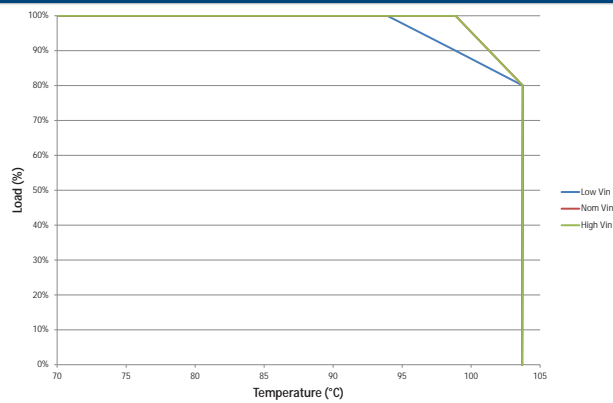
### DERATING GRAPHS

Derating curves are based on IPC-9592. With no derating some components may be operating at the manufacturers maximum temperature ratings.

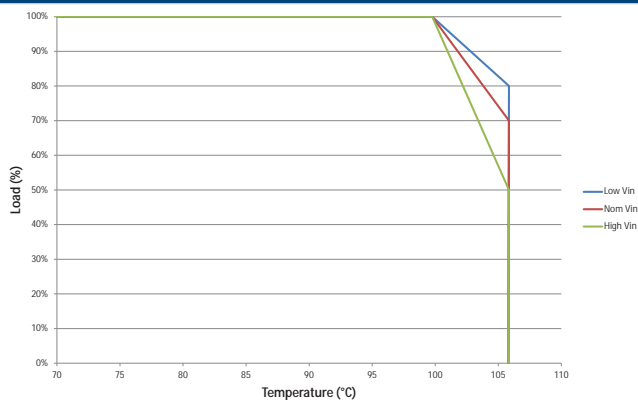
#### MGJ6Q05P24MC



#### MGJ6Q12P24MC



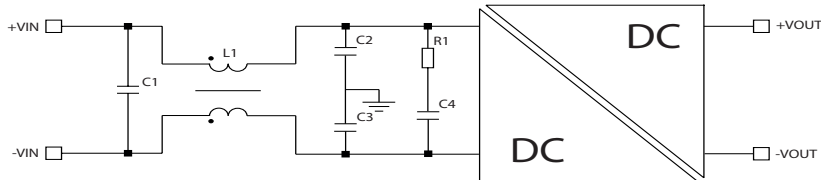
#### MGJ6Q24P24MC



## EMC FILTERING AND SPECTRA

### FILTERING

The following filter circuit and filter table shows the input filters typically required to meet EN 55022 Curve B, Quasi-Peak EMC limit, as shown in the following plots. The following plots show positive and negative quasi peak and CISPR22 Average Limit B (purple line) and Quasi Peak Limit B (pink line) adherence limits.



**C1, C2 & C3** Polyester or ceramic capacitor

**C4** Electrolytic capacitor (note R1 could be omitted if C4 has ESR  $\geq$  R1)

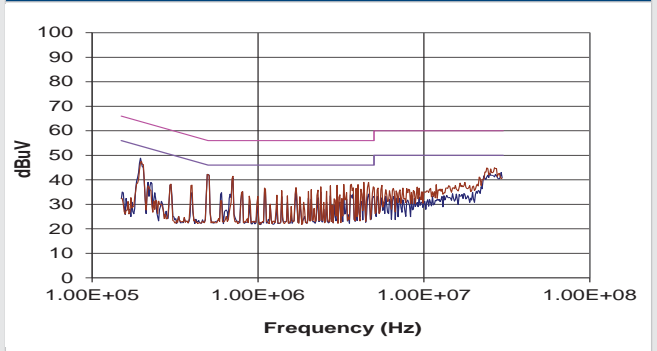
#### TO MEET CURVE B

Part Number	C1	L1	Part Number	C2	C3	R1	C4
MGJ6Q05P24MC							
MGJ6Q12P24MC	10 $\mu$ F	1mH	51105C	1nF	1nF	1 $\Omega$	470 $\mu$ F
MGJ6Q24P24MC	10 $\mu$ F	1mH	51105C	1nF	1nF	1 $\Omega$	470 $\mu$ F

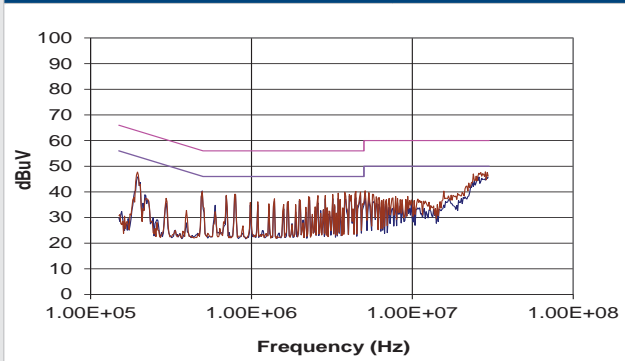
### MGJ6Q05P24MC



### MGJ6Q12P24MC



### MGJ6Q24P24MC



### APPLICATION NOTES

#### Start-up times

Typical start up times for this series, with recommended maximum additional output capacitance are:

Part No.	Start-up times
	ms
<b>MGJ6Q05P24MC</b>	30
<b>MGJ6Q12P24MC</b>	30
<b>MGJ6Q24P24MC</b>	30

Output capacitance must not exceed:

Output Voltage	Maximum output capacitance
V	µF
24 VHA	18
24 VHB	18
24 VHC	18
24 VL	56

#### Disable/Frequency synchronisation

Please refer to application notes for further information.

		Min	Typ	Max	Units
Disable/Synch <sup>1</sup>	Pull Down Current		0.5		mA
	Input High	2		5	V
	Input Low	0		0.8	V
Synchronisation	Frequency Range	90	100	110	kHz
	Duty Cycle	25		75	%

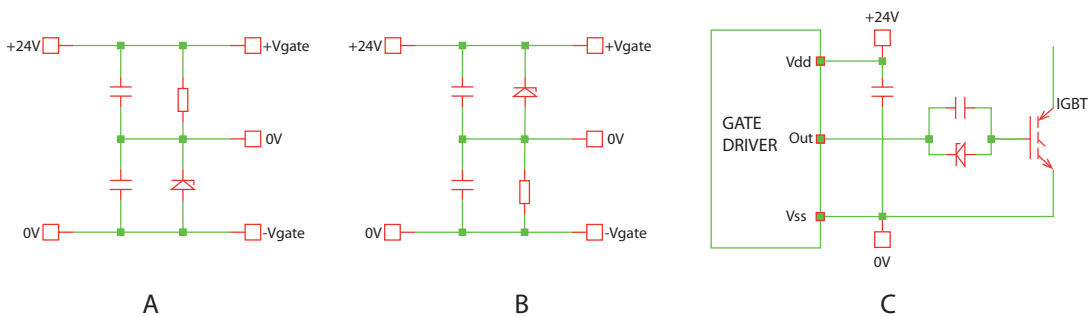
1. Disable/Synch pin is active low.

#### Output configurations for power switches

There are several zener based divider circuits that can be used to configure a bipolar output for gate drives as shown below. The table below shows suggested component values for various power switches using circuit A.

Component	IGBT	SIC	MOSFET
Zener diode <sup>1</sup>	9V1	5V1	9V1
Resistor	15K	18K	15K

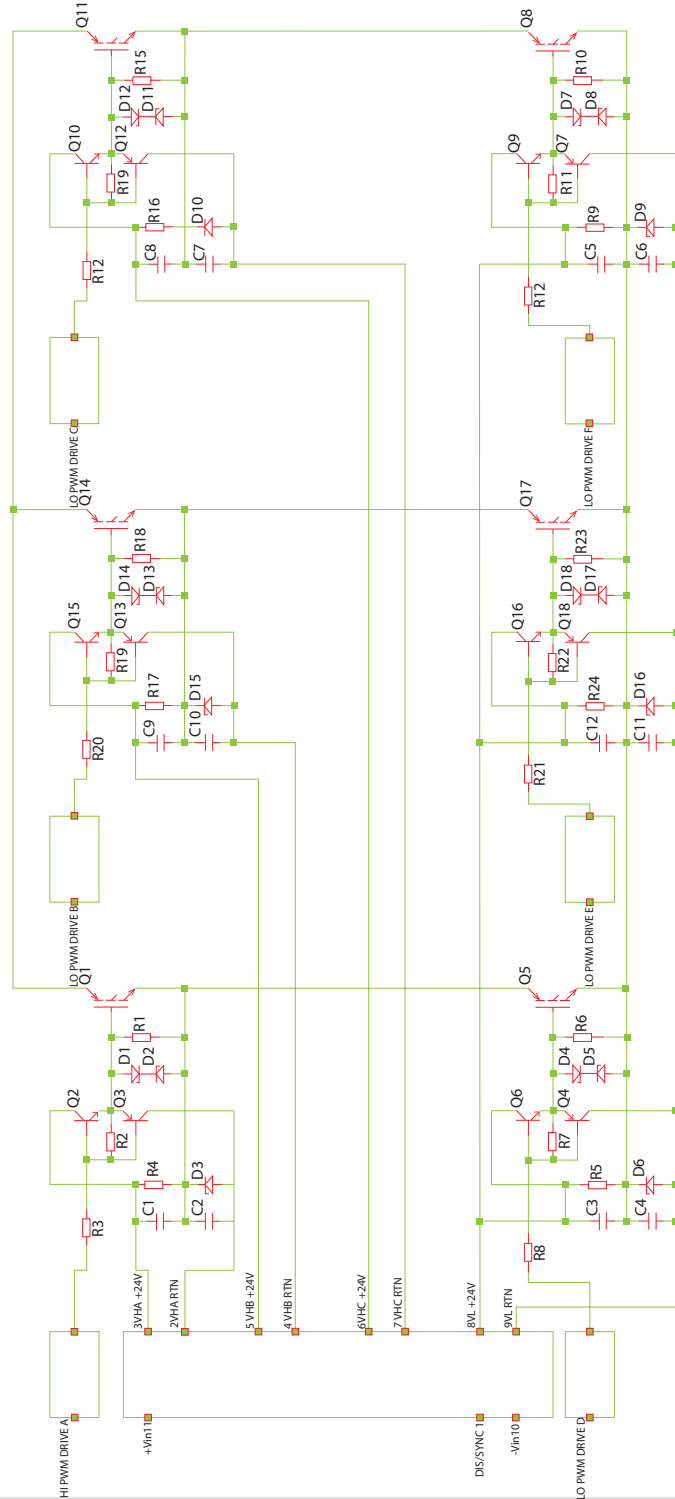
1. Suggested zener diode is BZX84C.



**APPLICATION NOTES (Continued)**

**Schematic for driving IGBT**

The following circuit shows an example of a complete three phase bridge and how the DC-DC would be connected using the zener divider in circuit A (page 7).





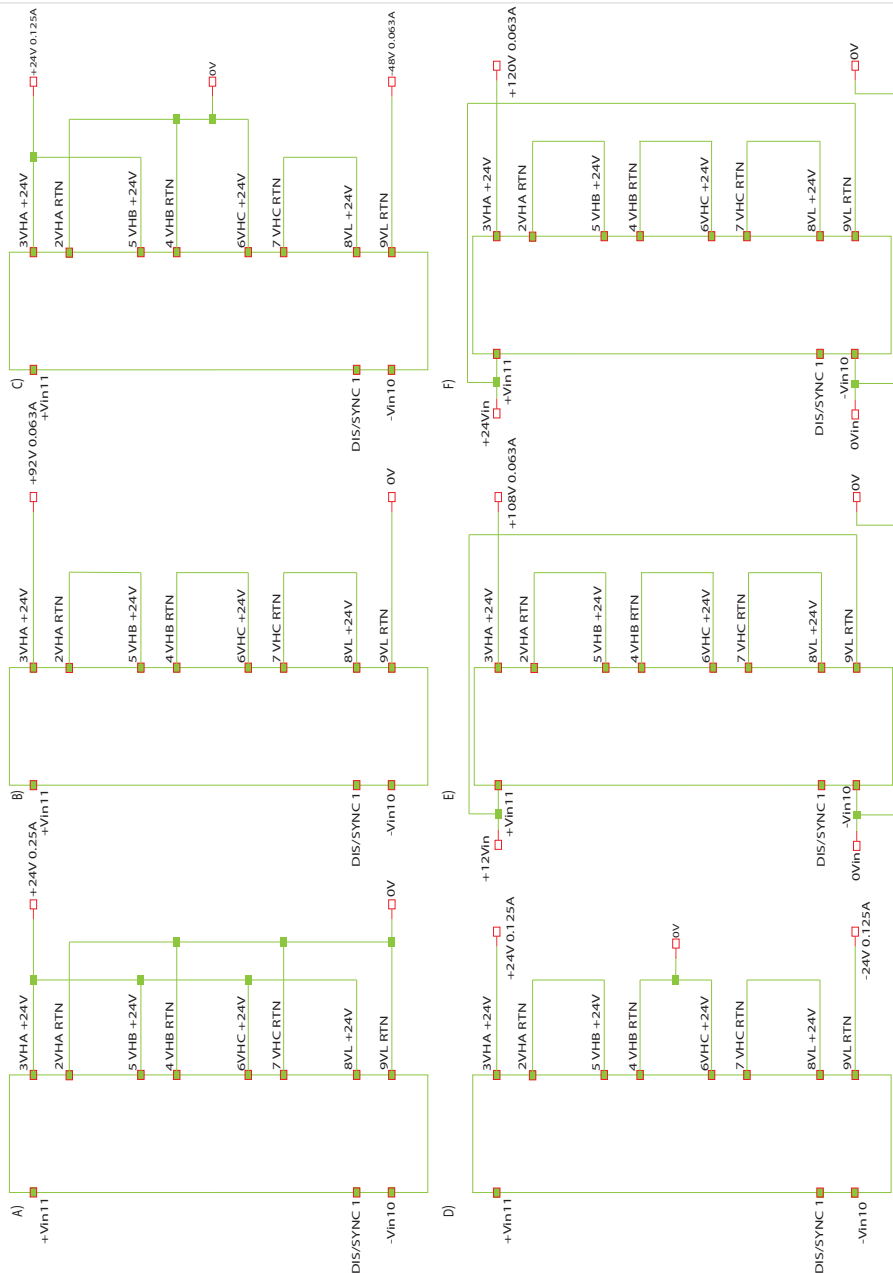
### APPLICATION NOTES (Continued)

For convenience the four isolated 24V outputs have been labelled VHA (Voltage A for high side), VHB (Voltage B for high side), VHC (Voltage C for high side) and VL (Voltage for low side) however they can be swapped if this helps to improve system layout. It is recommended however that if VHA, VHB or VHC are used in place of VL that an additional 4.7uF ceramic capacitor is added close to the output pins to reduce ripple voltage.

Any output can be connected in parallel with another and all three outputs can also be connected in series with one another. With the possibility of series and parallel output connections a number of output configurations are possible. Some are shown below:

- A) 24V @ 0.25A
- B) 96V @ 0.063A output
- C) +24V/-48V @ 0.063A
- D) +/-48V @ 0.063A
- E) Non-isolated +12V to +108V boost converter @0.063A
- F) Non-isolated +24V to +120V boost converter @0.063A

Note: Any single 24V output can deliver up to 3W however the output power from all outputs combined must not exceed 6W

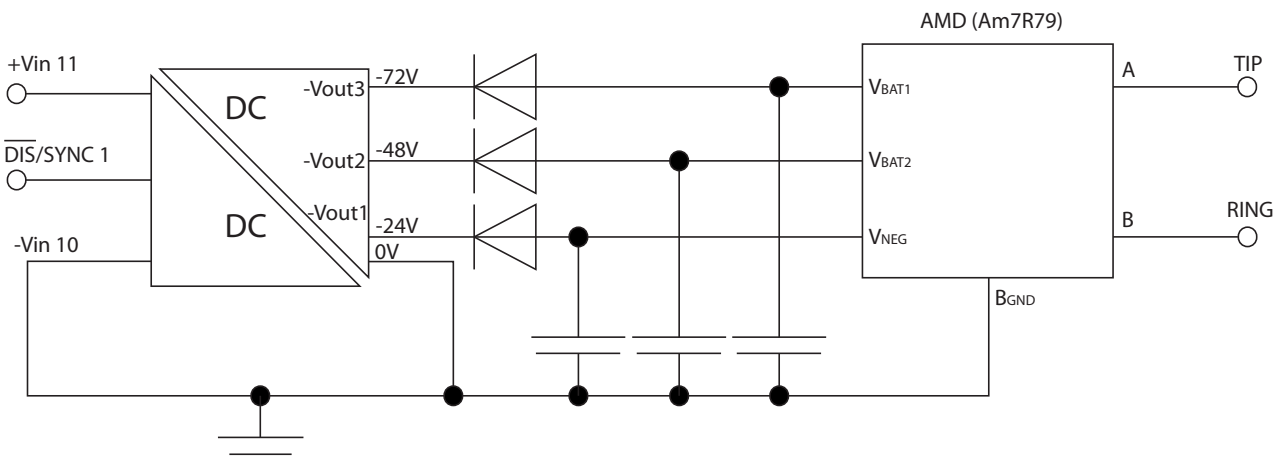


**APPLICATION NOTES (Continued)**

**SLIC Circuits**

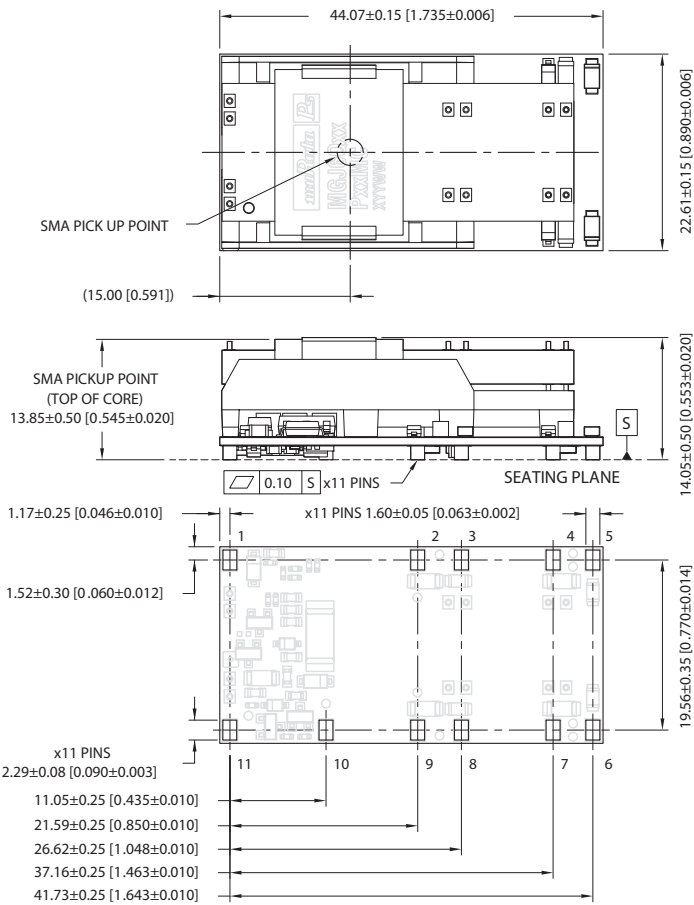
Power source is preferred to the telephone system power due to either the power quality of the telecommunications system power supply or to avoid potential power line disturbances, such as lightning strikes and access switching, which will affect the target circuit function.

Another application area is in fibre-in-the-loop (FITL) or radio-in-the-loop (RITL) interfacing via a standard telecommunication SLIC, where the usual telecommunication battery voltage is not available due to the transmission media in use (fibre or radio). In particular, FITL/RITL interfaces directly on PC cards, in local monitor and boost circuits and at exchanges between the fibre/radio and wire media. The supply rails can be used for ringing generators as well as SLIC circuits or where both are combined, such as in the AMD AM79R79 Ringing SLIC device (see figure 2). The -72V rail is used primarily for the generation of the ringing signal (VBAT1), the -48V rail is used to supply in line access circuitry (VBAT2) and the -24V supply for the on-chip regulator for the logic interface (VNEG). Alternative devices from other manufacturers could use the +/-24V outputs for their internal circuit supply and -72V for ringing.



**PACKAGE SPECIFICATIONS**

**MECHANICAL DIMENSIONS**



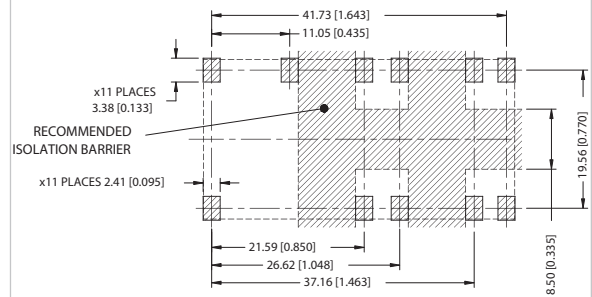
All dimensions in mm (inches), Controlling dimensions is mm.  
Tolerance (unless otherwise stated) ±0.25 (0.010).  
Component layout is shown for reference only.

Weight:17.7g

**PIN CONNECTIONS**

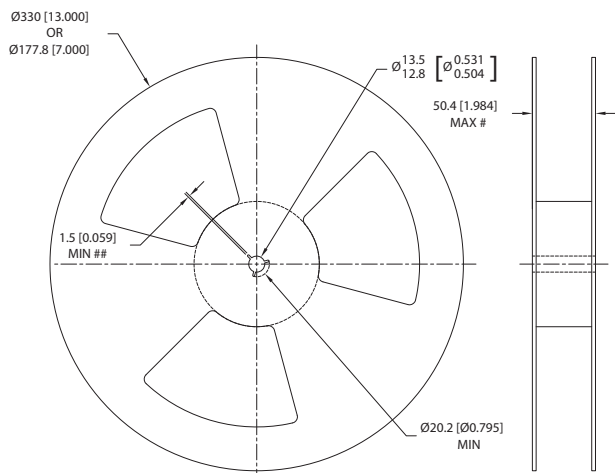
Pin	Function
1	Dis/Sync
2	VHA RTN
3	VHA +24V
4	VHB RTN
5	VHB +24V
6	VHC +24V
7	VHC RTN
8	VL +24V
9	VL RTN
10	-Vin
11	+Vin

**RECOMMENDED FOOTPRINT DETAILS**



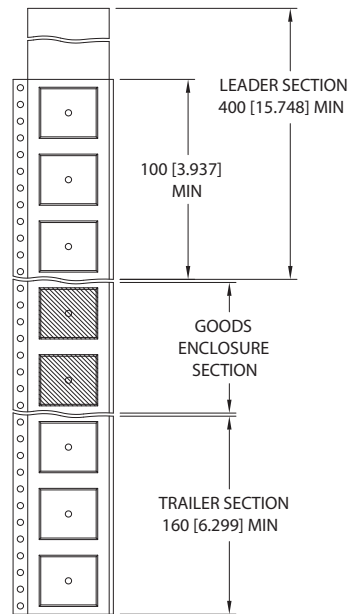
### TAPE & REEL SPECIFICATIONS

#### REEL OUTLINE DIMENSIONS



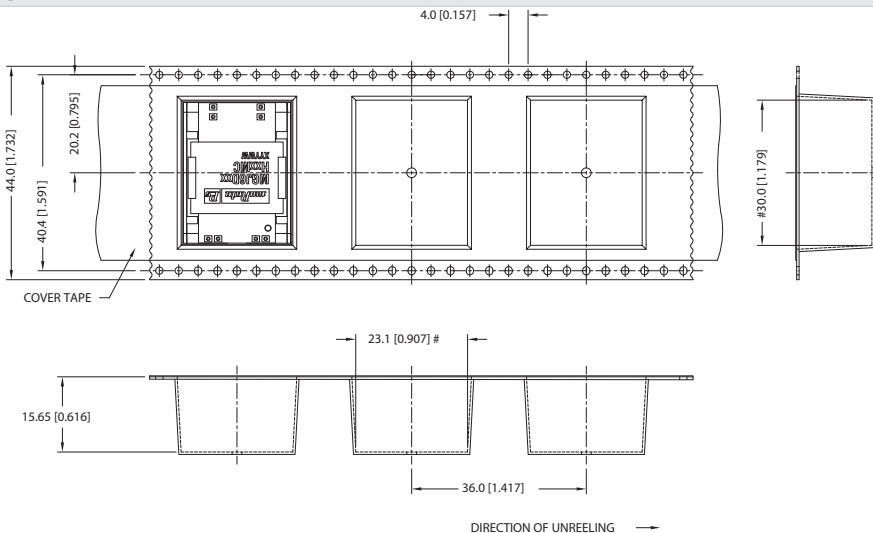
Tape & Reel specifications shall conform with current EIA-481 standard  
 Unless otherwise stated all dimensions in mm(inches)  
 Controlling dimension is mm  
 # Measured at hub  
 ## Six equi-spaced slots on 180mm/7" reel

#### REEL PACKAGING DETAILS



Reel Quantity: 7" - 23 or 13" - 92

#### TAPE OUTLINE DIMENSIONS



Tape & Reel specifications shall conform with current EIA-481 standard  
 Unless otherwise stated all dimensions in mm(inches)  $\pm 0.1\text{mm}$  ( $\pm 0.004$  Inches)  
 Controlling dimension is mm  
 Components shall be orientated within the carrier tape as indicated  
 # Measured on a plane 0.3mm above the bottom pocket

Murata Power Solutions, Inc.  
 11 Cabot Boulevard, Mansfield, MA 02048-1151 U.S.A.  
 ISO 9001 and 14001 REGISTERED



This product is subject to the following **operating requirements** and the **Life and Safety Critical Application Sales Policy**:  
 Refer to: <http://www.murata-ps.com/requirements/>

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