

### FEATURES

- No opto feedback
- Patent protected
- Three isolated output voltages suitable for IGBT/SiC & Mosfet gate drives in a full 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
- 5.7kVDC 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 Three isolated output voltages of 24V, the MGJ6 series of DC-DC converters is ideal for simultaneously powering 'high side' and 'low side' gate drive circuits for IGBTs, Silicon and Silicon Carbide Mosfets in full bridge 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 VL		
		Rated Output Voltage	Rated Output Current	Output Power	Rated Output Voltage	Rated Output Current	Output Power
		V	mA	W	V	mA	W
<b>MGJ6T05F24MC</b>	4.5 - 9	24	62.5	1.5	24	125	3
<b>MGJ6T12F24MC</b>	9 - 18	24	62.5	1.5	24	125	3
<b>MGJ6T24F24MC</b>	18 - 36	24	62.5	1.5	24	125	3

### SELECTION GUIDE (Continued)

Order Code <sup>1</sup>	Input Voltage Range	Output 1 VHA / Output 2 VHB				Output 3 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>
		%	%	mVp-p	mVp-p	%	%	mVp-p	mVp-p
<b>MGJ6T05F24MC</b>	4.5 - 9	2	3	100	150	2	3	100	150
<b>MGJ6T12F24MC</b>	9 - 18	2	3	150	200	2	3	150	200
<b>MGJ6T24F24MC</b>	18 - 36	2	3	150	200	2	3	150	200

### 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
					kHrs	
<b>MGJ6T05F24MC</b>	5	1500	76	80		
<b>MGJ6T12F24MC</b>	12	600	81	84		
<b>MGJ6T24F24MC</b>	24	300	82	85		

1. Components are supplied in tape and reel packaging, please refer to tape and reel specification section. Orderable part numbers are MGJ6T05F24MC-R7 (23 pieces per reel), or MGJ6T05F24MC-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 T<sub>A</sub>=25°C with nominal input voltage at full load. All specifications typical at T<sub>A</sub>=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 MGJ6T05		3.8		V	
	Turn off threshold MGJ6T05		3.2			
	Turn on threshold MGJ6T12		8.1			
	Turn off threshold MGJ6T12		7.5			
	Turn on threshold MGJ6T24		16.7			
	Turn off threshold MGJ6T24		16.3			
Input ripple current	5V input types		30		mA p-p	
	12V input types		45			
	24V input types		30			

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				
	Qualification tested for 1 minute (input to output)	5700			VDC	
	Qualification tested for 1 minute (output to output)	3000				
Resistance	Viso = 1kVDC	100			GΩ	
Continuous barrier withstand voltage	Non-safety barrier application			3000	VDC	
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 VL		15			

GENERAL CHARACTERISTICS						
Parameter	Conditions	Min.	Typ.	Max.	Units	
Power Consumption	Disable 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 Vin, Still Air	5V input types	25			
		All other input types	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 4kVACrms for 1 second from input to output and 2.5kVACrms for 1 second from output to output. Also they are all qualification tested at 5.7kVDC for 1 minute from input to output and 3kVDC for 1 minute 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 is 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 is 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

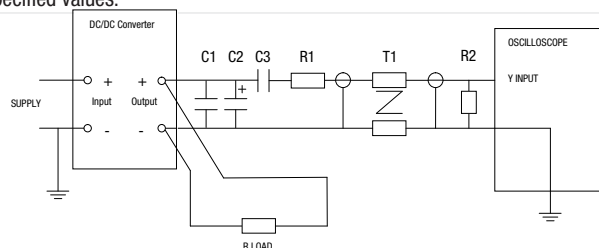
#### Ripple & Noise Characterisation Method

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



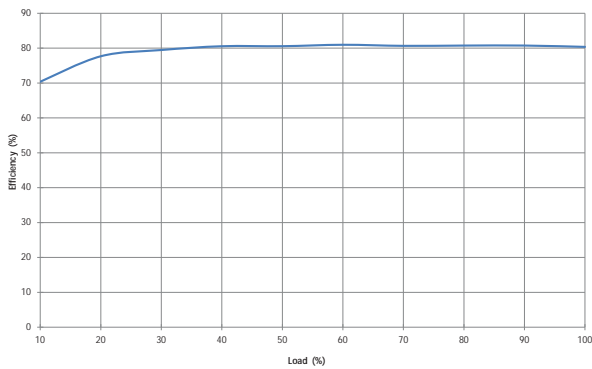
**RoHS COMPLIANCE, MSL AND PSL INFORMATION**



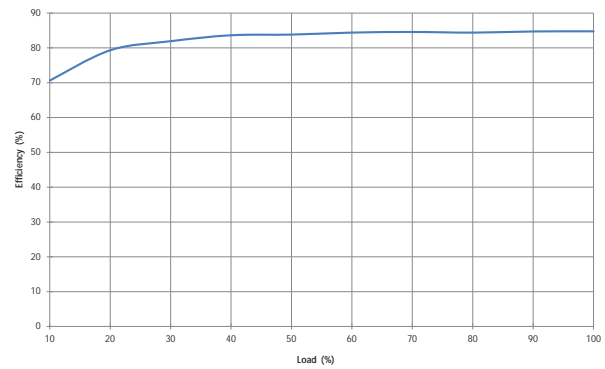
This series is compatible with Pb-Free soldering systems and is also backward compatible with Sn/Pb soldering systems. The MGJ6 full bridge series has a process, moisture, and reflow sensitivity classification of MSL2 PSL R7F as defined in J-STD-020 and J-STD-075. This translates to: MSL2 = 1 year floor 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**

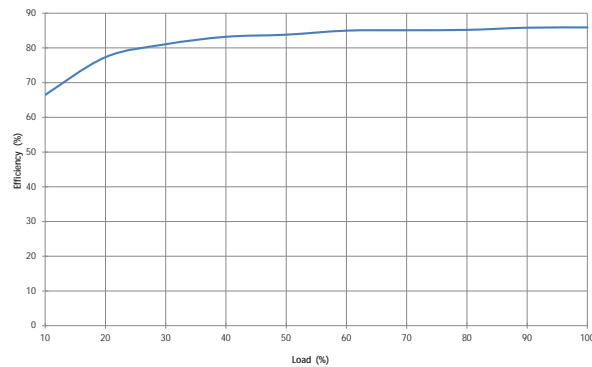
**MGJ6T05F24MC**



**MGJ6T12F24MC**

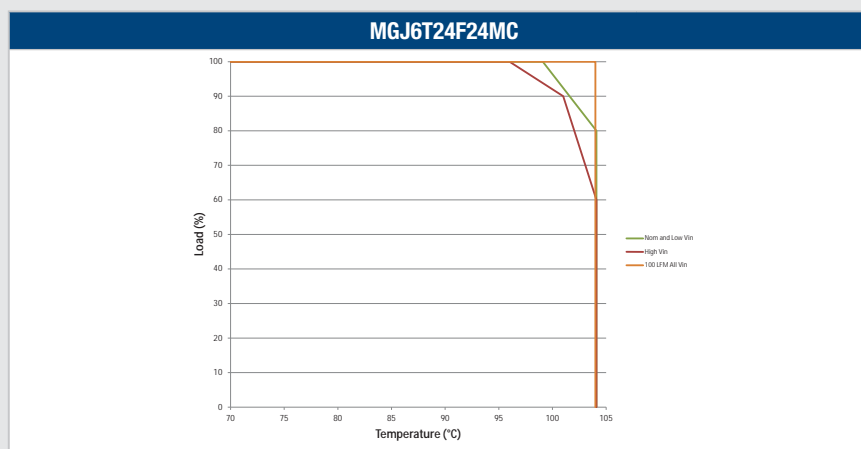
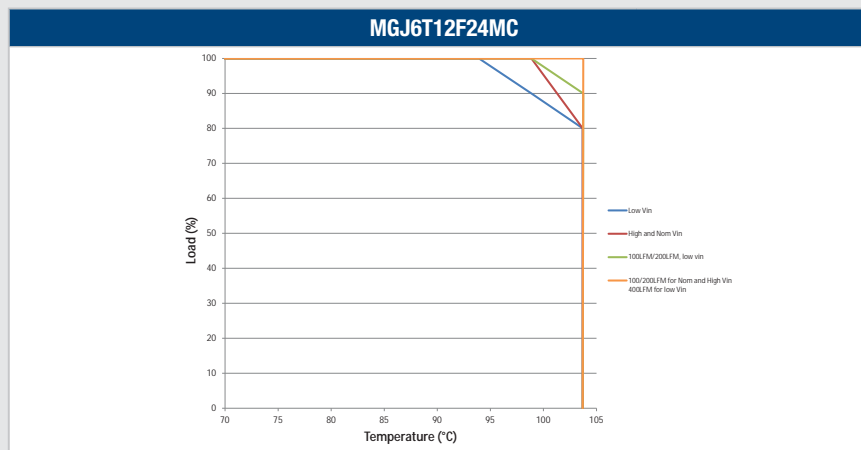
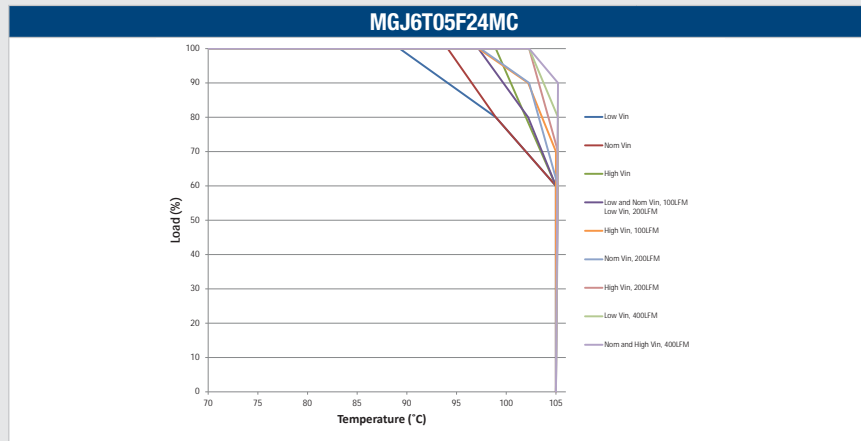


**MGJ6T24F24MC**



### DERATING GRAPHS

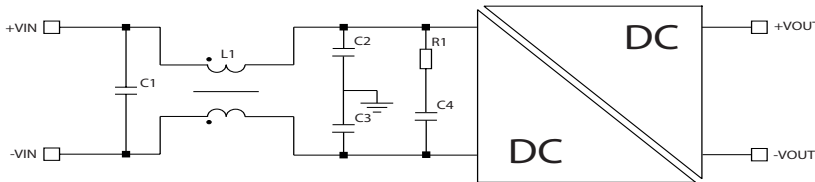
Derating curves are based on IPC-9592. With no derating some components may be operating at the manufacturers maximum temperature ratings.



## EMC FILTERING AND SPECTRA

### FILTERING

The following filter circuit and filter table shows the input filters typically required to meet conducted emissions limits for EN 55022 curve B using Quasi-Peak (pink line) and average (green line) detectors according to CISPR22. The following plots show measurements of the positive (L1) and negative (L2) inputs for both Quasi-peak limit B adherence and Average limit B adherence.



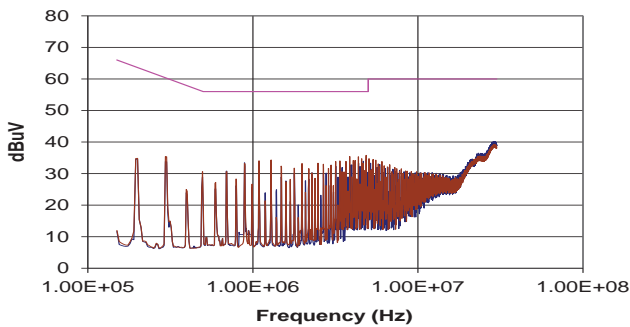
**C1, C2 & C3** Polyester or ceramic capacitor

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

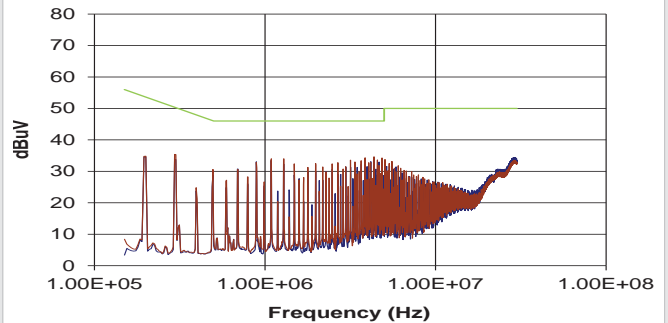
#### TO MEET CURVE B

Part Number	C1	L1	Part Number	C2	C3	R1	C4
MGJ6T05F24MC	10 $\mu$ F	1mH	51105C	1nF	1nF	1 $\Omega$	470 $\mu$ F
MGJ6T12F24MC	10 $\mu$ F	1mH	51105C	1nF	1nF	1 $\Omega$	470 $\mu$ F
MGJ6T24F24MC	10 $\mu$ F	1mH	51105C	1nF	1nF	1 $\Omega$	470 $\mu$ F

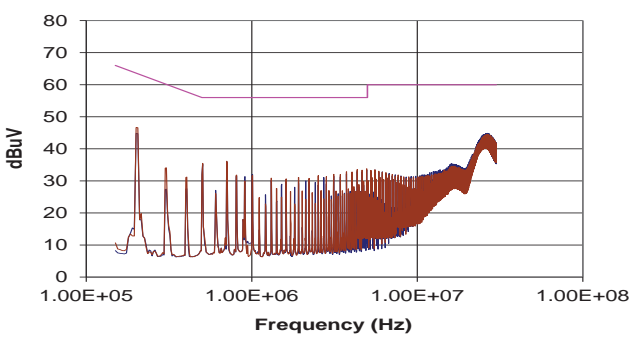
**MGJ6T05F24MC (Quasi Peak)**



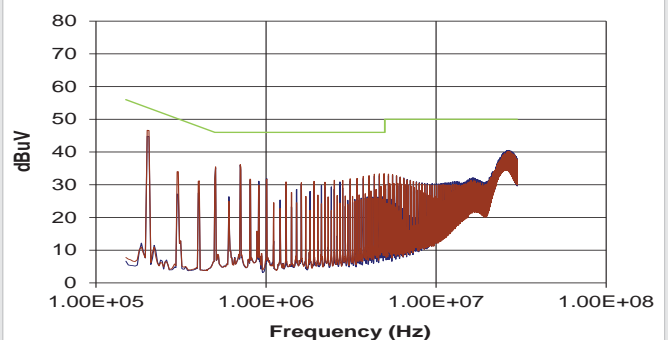
**MGJ6T05F24MC (Average)**



**MGJ6T12F24MC (Quasi Peak)**

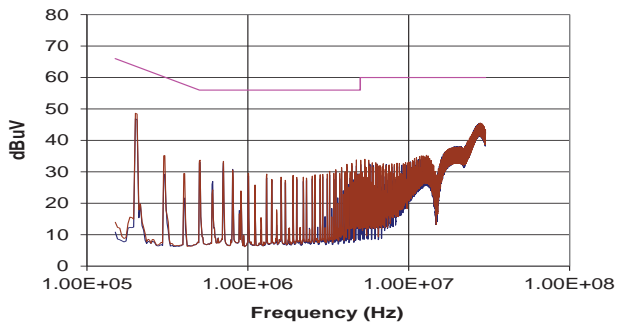


**MGJ6T12F24MC (Average)**

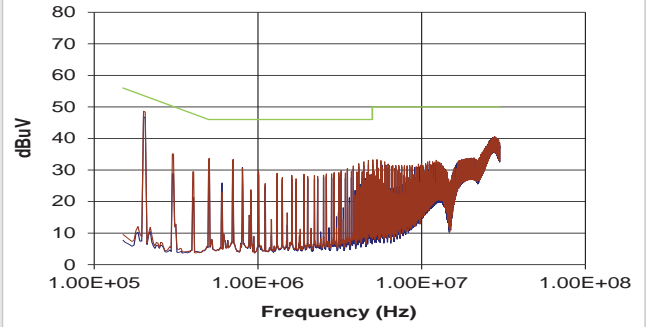


## EMC FILTERING AND SPECTRA

MGJ6T24F24MC (Quasi Peak)



MGJ6T24F24MC (Average)



### 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>MGJ6T05F24MC</b>	30
<b>MGJ6T12F24MC</b>	30
<b>MGJ6T24F24MC</b>	30

Output capacitance must not exceed:

Output Voltage	Maximum output capacitance
V	μF
24 VHA	27
24 VHB	27
24 VL	56

#### Disable/Frequency synchronisation

Please refer to application notes for further information.

		Min	Typ	Max	Units
Disable/Synch (Pin is active low)	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	%

The Disable/Synchronization pin has three modes:

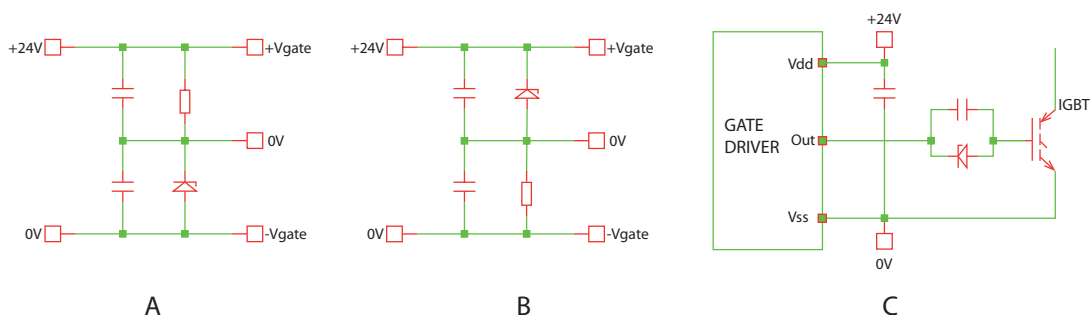
1. When a dc logic low voltage is applied to this pin the MGJ6 is disabled and enters a low quiescent current sleep mode.
2. When this pin is left floating or a dc logic high (CMOS/TTL compatible) voltage is applied the MGJ6 is enabled and operates at the programmed frequency of 100kHz.
3. When a square wave of between 90kHz and 110kHz is applied to this pin, the switcher operates at the same frequency as the square wave. The falling edge of the square wave corresponds to the start of the switching cycle. If the signal is slower than 25Hz, it will be interpreted as enabling and disabling the part. If the MGJ6 is disabled, it must be disabled for 7 clock cycles before being re-enabled.

#### 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.

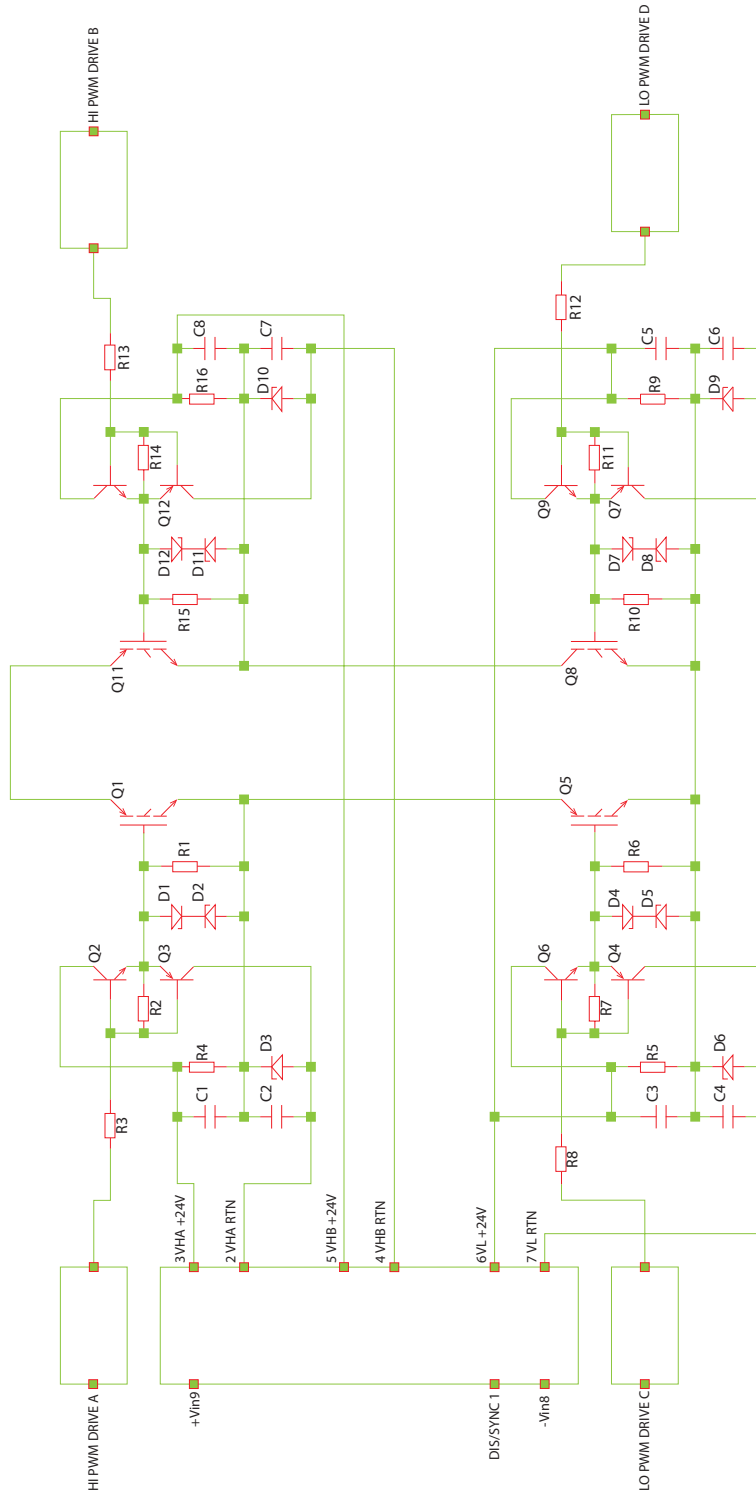




**APPLICATION NOTES (Continued)**

**Schematic for driving IGBT**

The following circuit shows an example of a complete full bridge and how the DC-DC would be connected using the zener divider in circuit A (page 8).



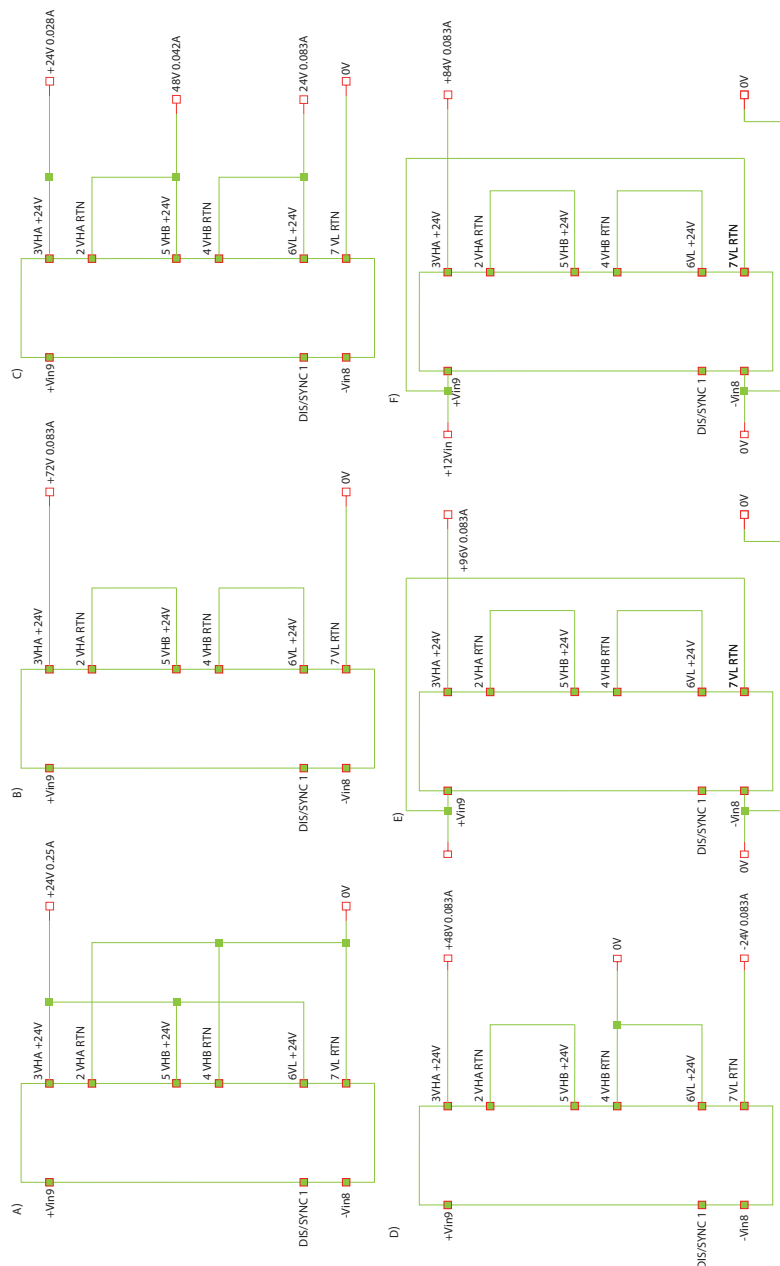
### APPLICATION NOTES (Continued)

For convenience the three isolated 24V outputs have been labelled VHA (Voltage A for high side), VHB (Voltage B 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 or VHB 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) 72V @ 0.083A output
- C) 72V @ 0.028A, 48V @ 0.042A and 24V @ 0.083A
- D) +48V/-24V @ 0.083A
- E) Non-isolated +24V to +96V boost converter @ 0.083A
- F) Non-isolated +12V to +84V boost converter @ 0.083A

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

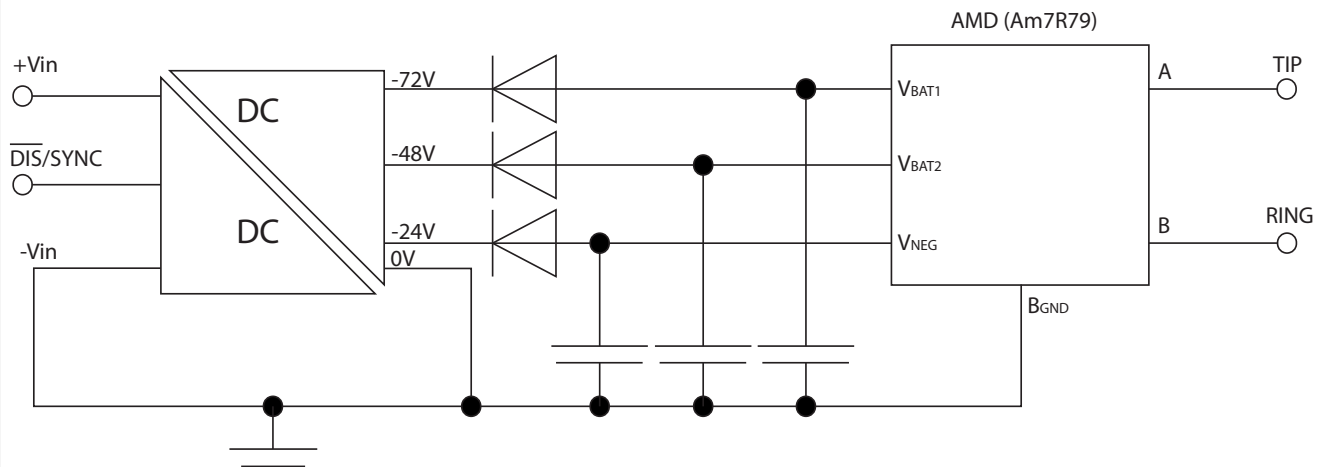


**APPLICATION NOTES (Continued)**

**SLIC Circuits**

The output configuration shown below could be used for subscriber line interface circuits (SLIC's), particularly for the Integrated Services Digital Network (ISDN) and also for standard telecommunications circuits where a local 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.

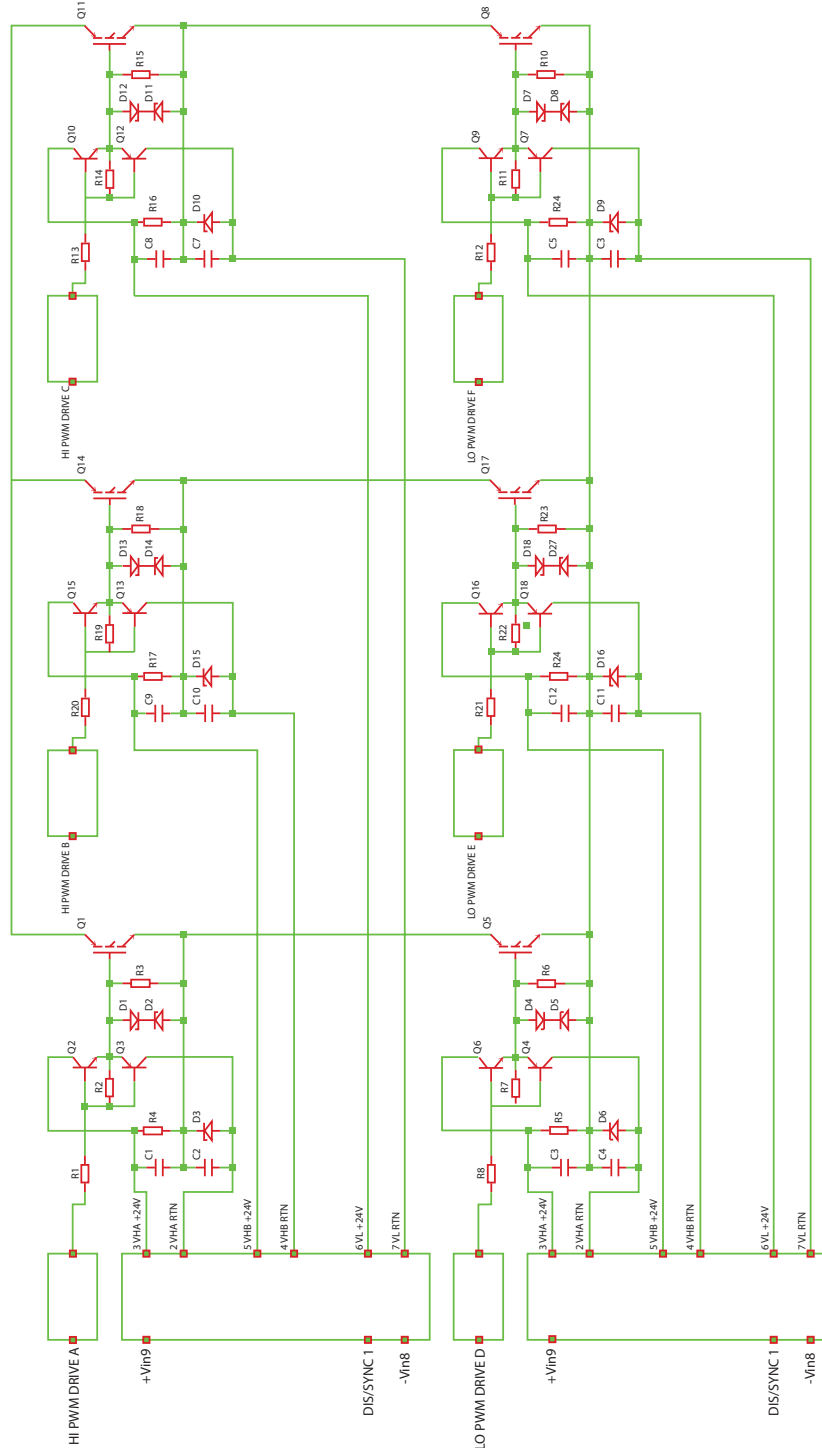
Another application area is in fibre-in-the-loop (FITL) or radio-in-the-loop (RITL) interfacing via a standard telecommunication SLIC, where the usual telecommunication battery voltage is not available due to the transmission media in use (fibre or radio). In particular, FITL/RITL interfaces directly 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 output for their internal circuit supply and -72V for ringing.



**APPLICATION NOTES (Continued)**

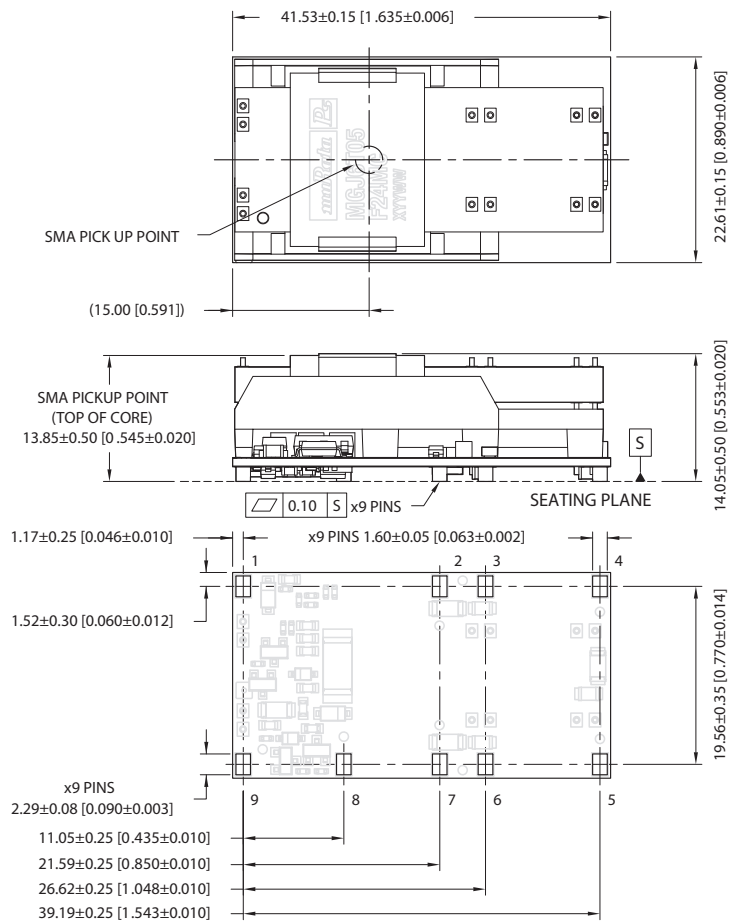
**Schematic for Powering Three Phase Drivers on Electrical Vehicle Systems**

For three phase drives on an Electric Vehicle system it is sometimes necessary, for safety and diagnostic reasons to power the high side switches independently to the Low side switches. This means that if a fault occurs on a the high side switch it is possible to disable all of the high side switches without disabling the low side switches. The circuit below shows how two Full bridge MGJ6 units can be connected to achieve this.



### PACKAGE SPECIFICATIONS

#### MECHANICAL DIMENSIONS



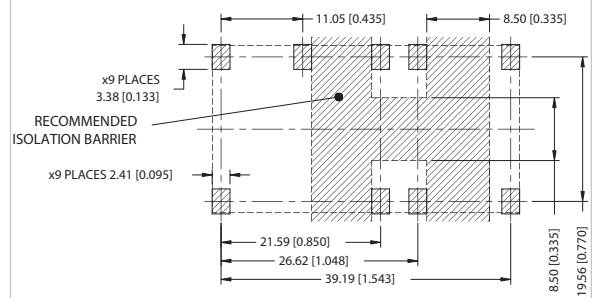
All dimensions in mm (inches). Controlling dimensions is mm.  
Tolerance (unless otherwise stated)  $\pm 0.25$  (0.010).  
Component layout is shown for reference only

Weight: 17.3g

#### PIN CONNECTIONS

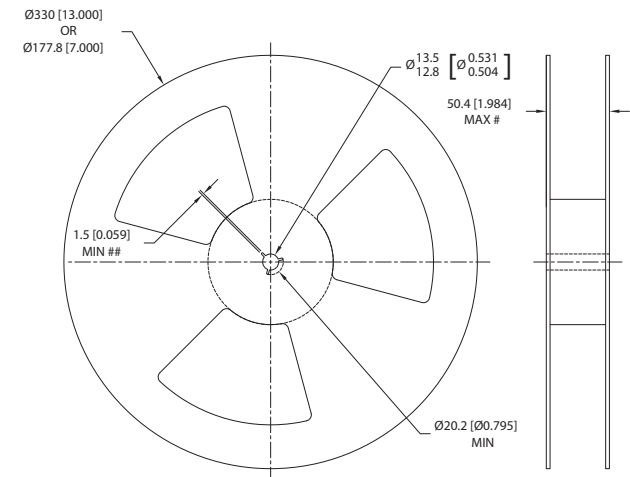
Pin	Function
1	Dis/Sync
2	VHA RTN
3	VHA +24V
4	VHB RTN
5	VHB +24V
6	VL +24V
7	VL RTN
8	-Vin
9	+Vin

#### RECOMMENDED FOOTPRINT DETAILS



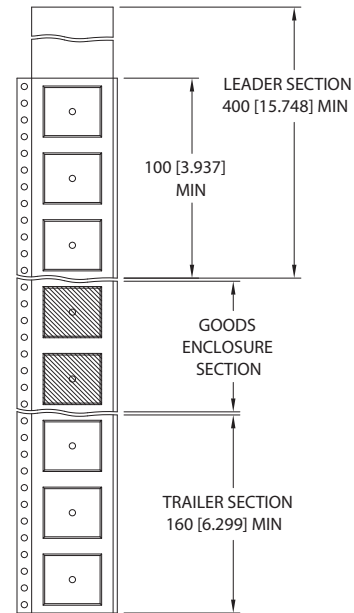
### TAPE & REEL SPECIFICATIONS

#### REEL OUTLINE DIMENSIONS



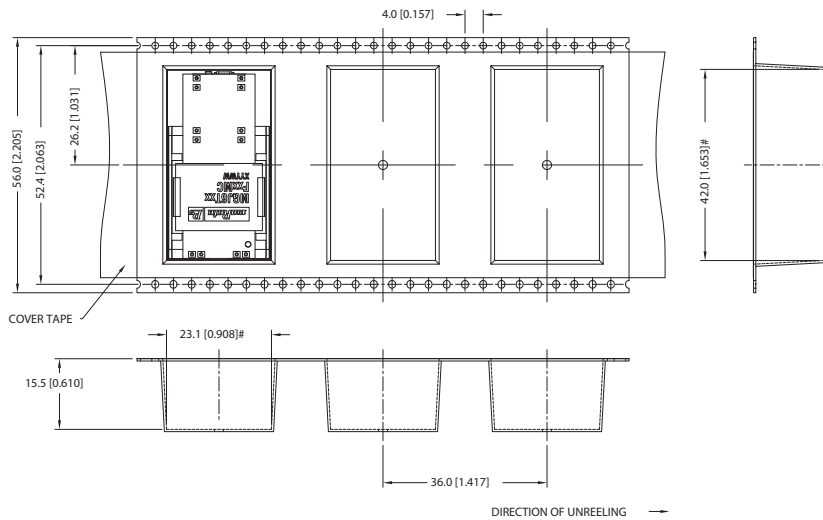
Tape & Reel specifications shall conform with current EIA-481 standard  
 Unless otherwise stated all dimensions in mm(inches)  
 Controlling dimension is mm  
 # Measured at hub  
 ## Six equi-spaced slots on 180mm/7" reel

#### 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.  
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 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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