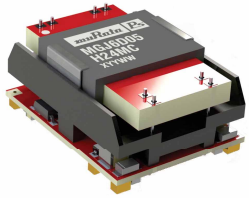
Murata Power Solutions

MGJ6 Half Bridge Series

5.7kVDC Isolated 6W Dual Output Gate Drive SM DC/DC Converters



FEATURES

- No opto feedback
- Patent protected
- Two isolated output voltages for IGBT/SiC & Mosfet gate drives in half 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 two configurable 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 half 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.

SELECTION GUIDE

Order Code[1]	Input Voltage Range	Output 1 VH			Output 2 VL		
		Rated Output Voltage	Rated Output Current	Output Power	Rated Output Voltage	Rated Output Current	Output Power
	V	V	mA	W	V	mA	W
MGJ6D05H24MC	4.5 - 9	24	125	3	24	125	3
MGJ6D12H24MC	9 - 18	24	125	3	24	125	3
MGJ6D24H24MC	18 - 36	24	125	3	24	125	3

SELECTION GUIDE (Continued)

Order Code[1]	Input Voltage Range	Output 1 VH				Output 2 VL			
		Load Regulation (Typ)	Load Regulation (Max)	Ripple & Noise (Typ)[2]	Ripple & Noise (Max)[2]	Load Regulation (Typ)	Load Regulation (Max)	Ripple & Noise (Typ)[2]	Ripple & Noise (Max)[2]
	V	%		mVp-p		%		mVp-p	
MGJ6D05H24MC	4.5 - 9	2	3	100	150	2	3	100	150
MGJ6D12H24MC	9 - 18	2	3	100	150	2	3	100	150
MGJ6D24H24MC	18 - 36	2	3	100	150	2	3	100	150

SELECTION GUIDE (Continued)

Order Code[1]	Nominal Input Voltage	Input Current at Rated Load	Efficiency (Min)	Efficiency (Typ)	MTTF[3]	
					MIL 217	Telecordia
	V	mA	%		kHrs	
MGJ6D05H24MC	5	1500	76	79.5		
MGJ6D12H24MC	12	600	81	84		
MGJ6D24H24MC	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 MGJ6D05H24MC-R7 (23 pieces per reel), or MGJ6D05H24MC-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_A=25°C with nominal input voltage at full load.

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

RoHS COMPLIANT

For full details go to www.murata-ps.com/rohs

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 MGJ6D05		3.8		V
	Turn off threshold MGJ6D05		3.2		
	Turn on threshold MGJ6D12		8.1		
	Turn off threshold MGJ6D12		7.5		
	Turn on threshold MGJ6D24		16.7		
	Turn off threshold MGJ6D24		16.3		
Input ripple current	5V input types		30		mA p-p
	12V input types		40		
	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			
	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 VH		15		pF
	Primary to Output 2 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 V_{IN}, Still Air	5V input types		30		
		All other input types		20		

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.

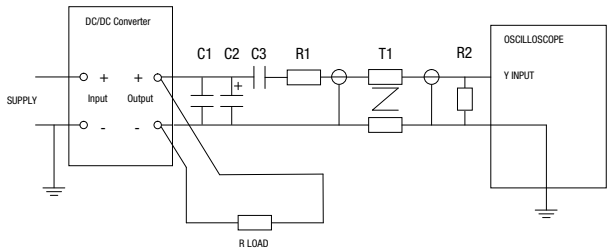
CHARACTERISATION TEST METHODS

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

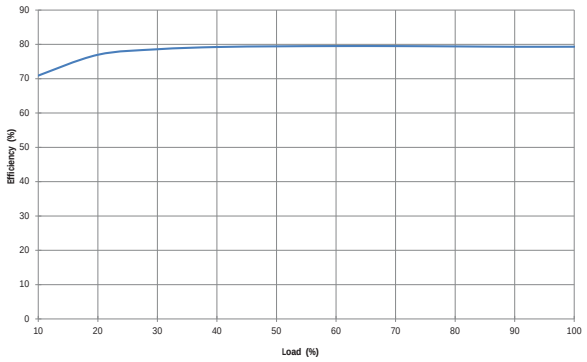


RoHS COMPLIANCE, MSL AND PSL INFORMATION

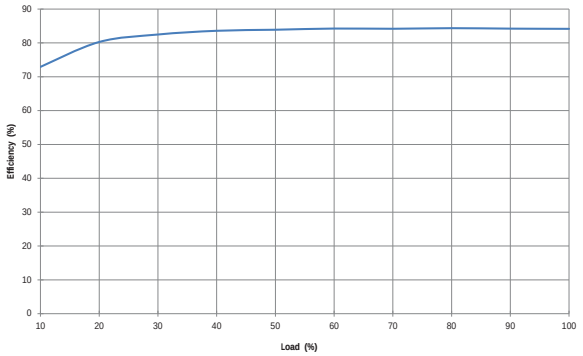
This series is compatible with Pb-Free soldering systems and is also backward compatible with Sn/Pb soldering systems. The MGJ6 half bridge series has a process, moisture, and reflow sensitivity classification of MSL2 PSL R7F as defined in J-STD-020 and J-STD-075. This translates to: MSL2 = 1 year floor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

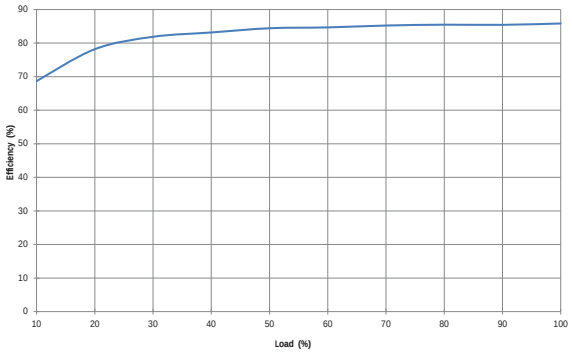
MGJ6D05H24MC



MGJ6D12H24MC



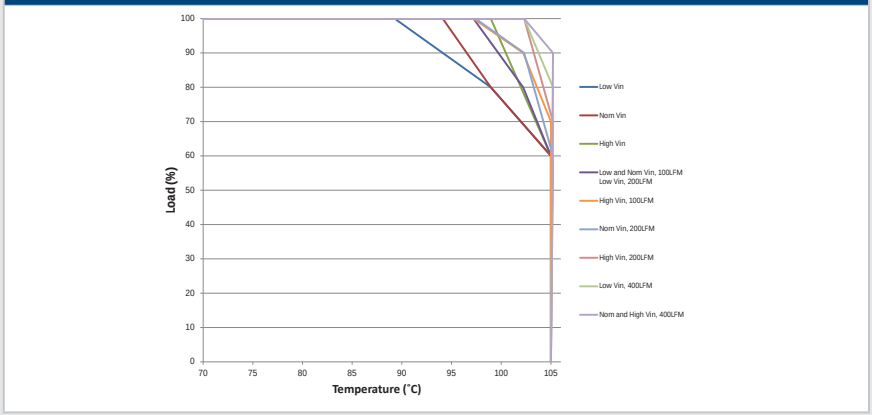
MGJ6D24H24MC



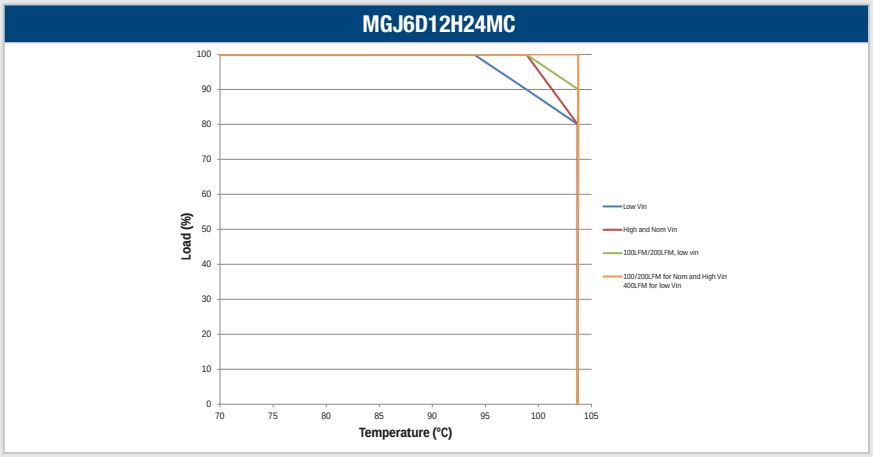
DERATING GRAPHS

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

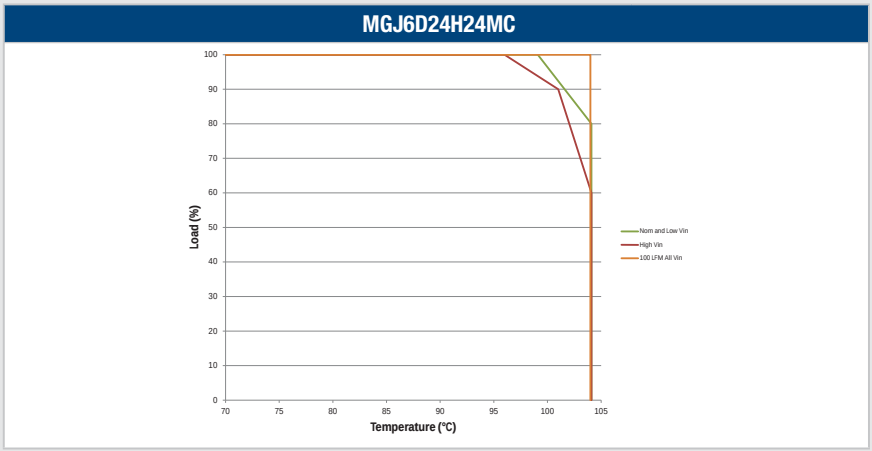
MGJ6D05H24MC



MGJ6D12H24MC



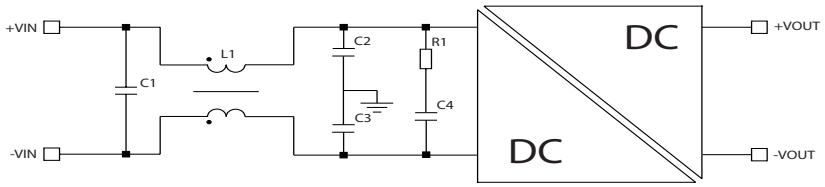
MGJ6D24H24MC



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.

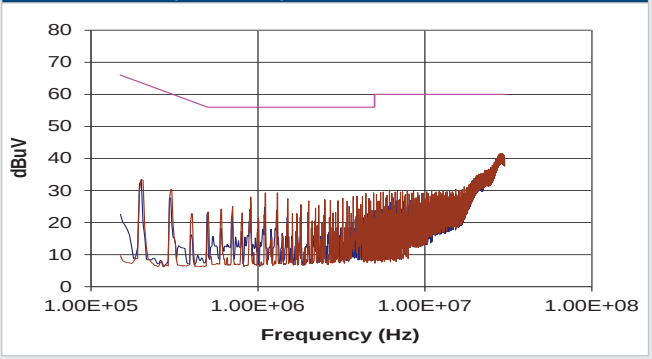


C1, C2 & C3 Polyester or ceramic capacitor

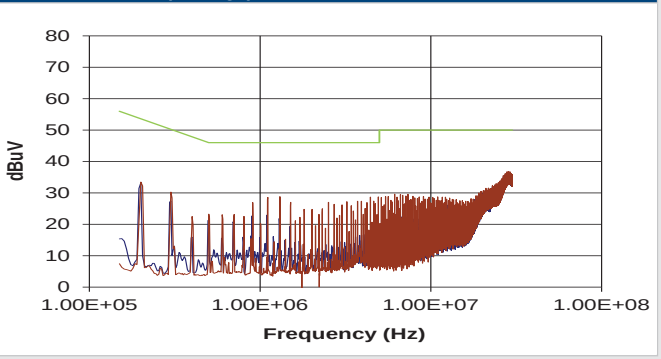
C4 Electrolytic capacitor (note R1 could be omitted if C4 has ESR >= R1)

TO MEET CURVE B							
Part Number	C1	L1	Part Number	C2	C3	R1	C4
MGJ6D05H24MC	10µF	1mH	51105C	1nF	1nF	1Ω	470µF
MGJ6D12H24MC	10µF	1mH	51105C	1nF	1nF	1Ω	470µF
MGJ6D24H24MC	10µF	1mH	51105C	1nF	1nF	1Ω	470µF

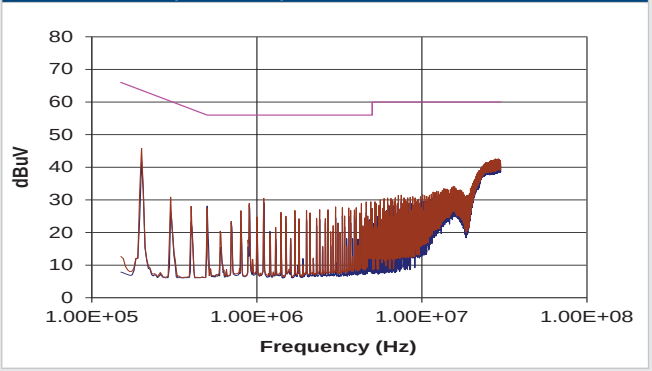
MGJ6D05H24MC (Quasi Peak)



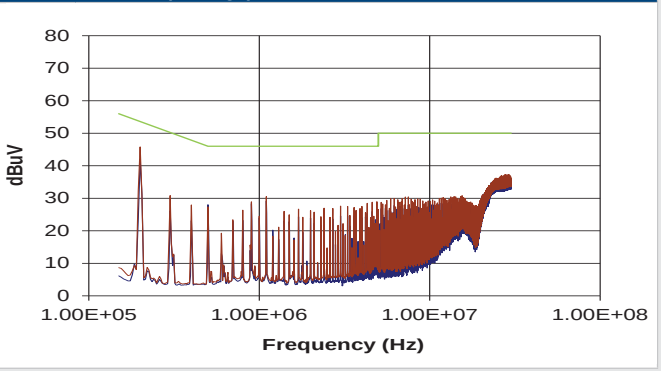
MGJ6D05H24MC (Average)



MGJ6D12H24MC (Quasi Peak)

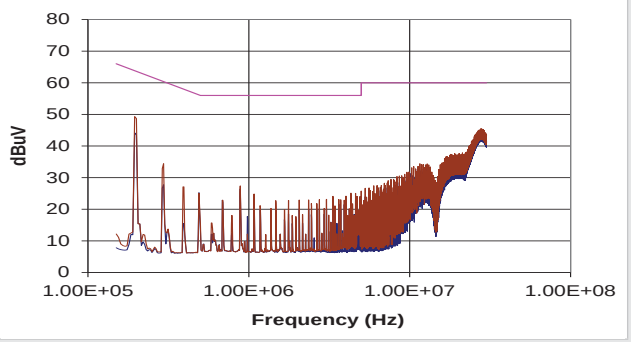


MGJ6D12H24MC (Average)

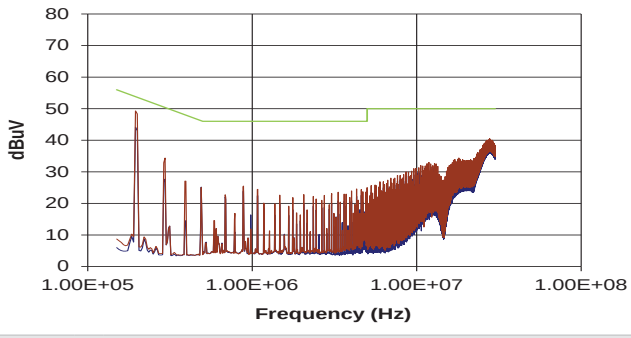


EMC FILTERING AND SPECTRA

MGJ6D24H24MC (Quasi Peak)



MGJ6D24H24MC (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
MGJ6D05H24MC	30
MGJ6D12H24MC	30
MGJ6D24H24MC	30

Output capacitance must not exceed:

Output Voltage	Maximum output capacitance
V	µF
24 VH	56
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:

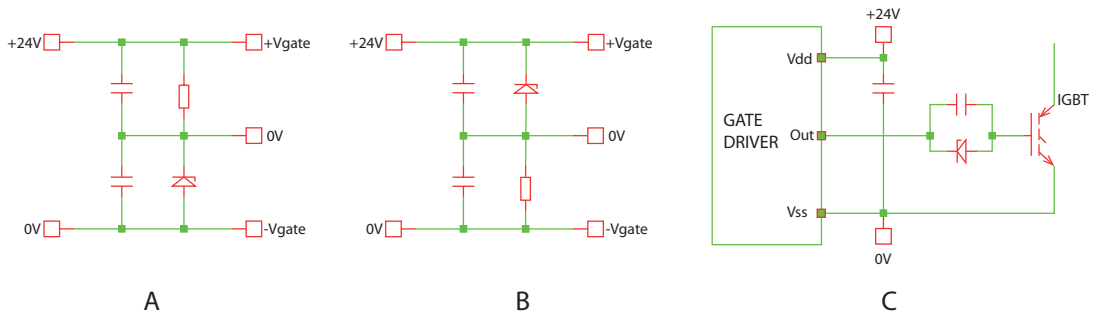
1. When a dc logic low voltage is applied to this pin the MGJ6 is disabled and enters a low quiescent current sleep mode.
2. When this pin is left floating or a dc logic high (CMOS/TTL compatible) voltage is applied the MGJ6 is enabled and operates at the programmed frequency of 100kHz.
3. When a square 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[1]	9V1	5V1	9V1
Resistor	15K	18K	15K

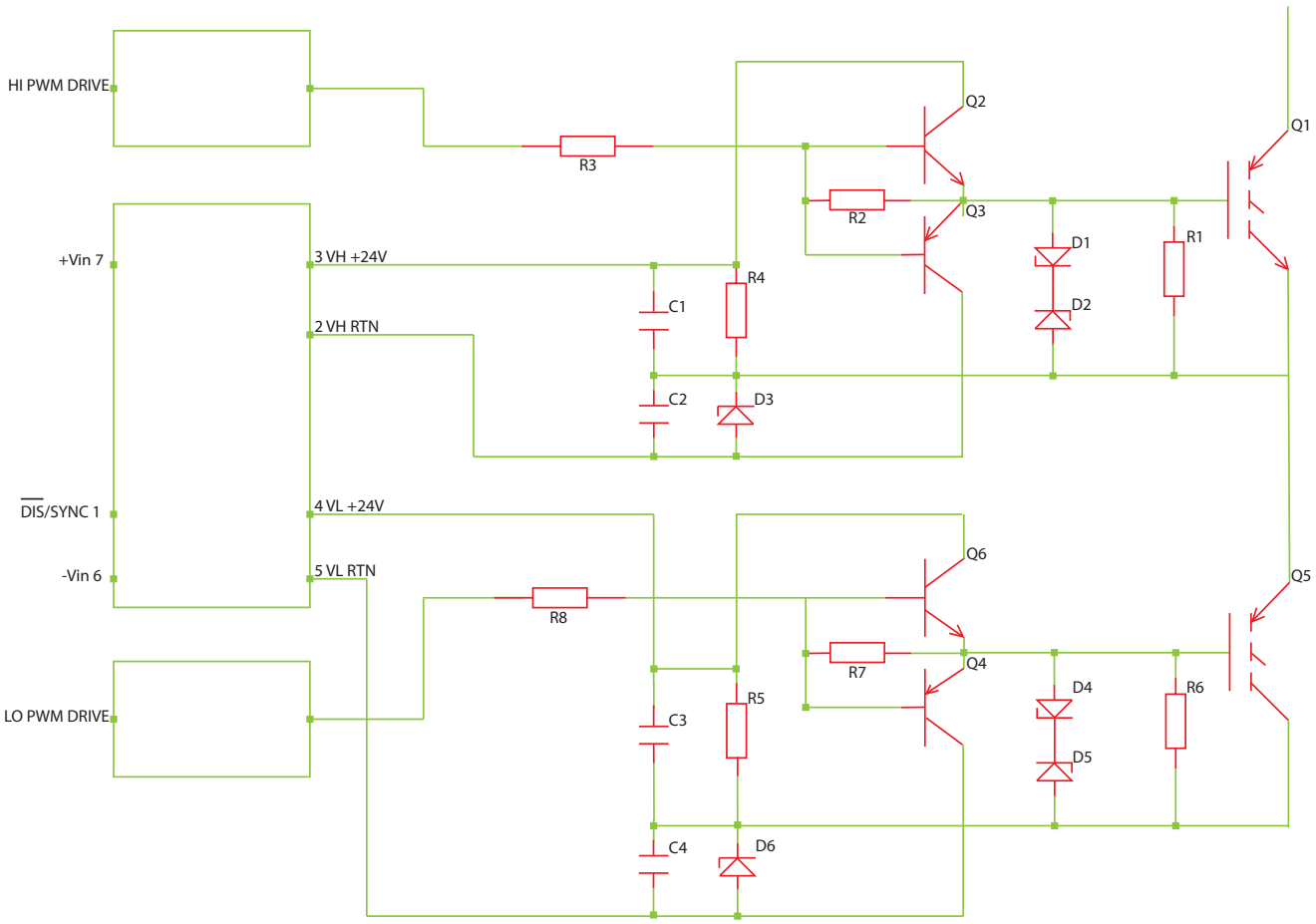
1. Suggested zener diode is BZX84C.



APPLICATION NOTES (Continued)

Schematic for driving IGBT

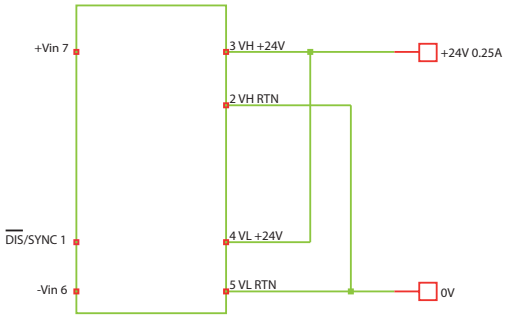
The following circuit shows an example of a complete half bridge and how the DC-DC would be connected using the zener divider in circuit A (page 7).

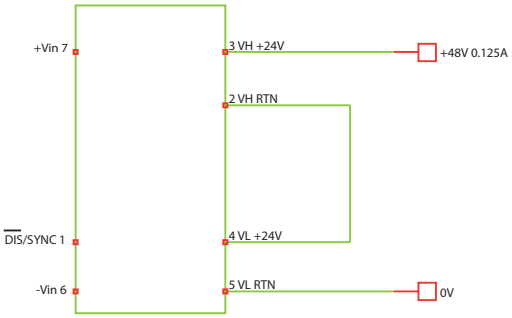


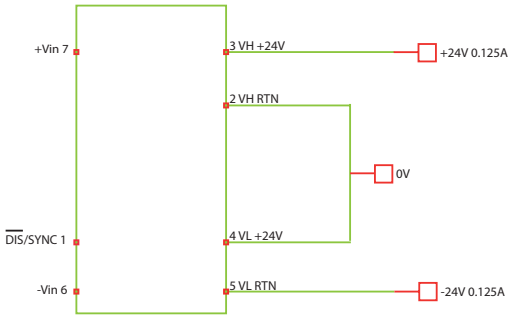
APPLICATION NOTES (Continued)

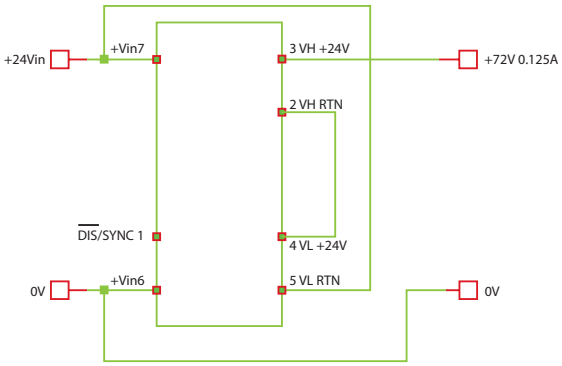
Alternative configuration options

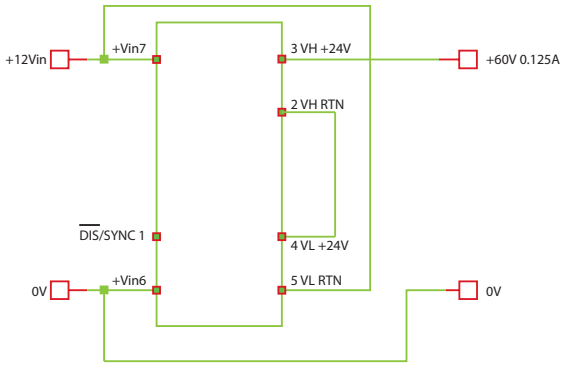
For convenience the two isolated 24V outputs have been labelled VH (Voltage for high side) and VL (Voltage for low side) however both outputs are identical and they can be swapped if this helps to improve system layout.
Both outputs can be connected in parallel to produce a single 24V @ 0.25A output
Both outputs can also be connected in series to produce a single 48V @ 0.125A output or dual +/-24V @ 0.125A
Other configurations include a non-isolated +24V to +72V or +12V to +60V boost converter @ 0.125A as shown below:





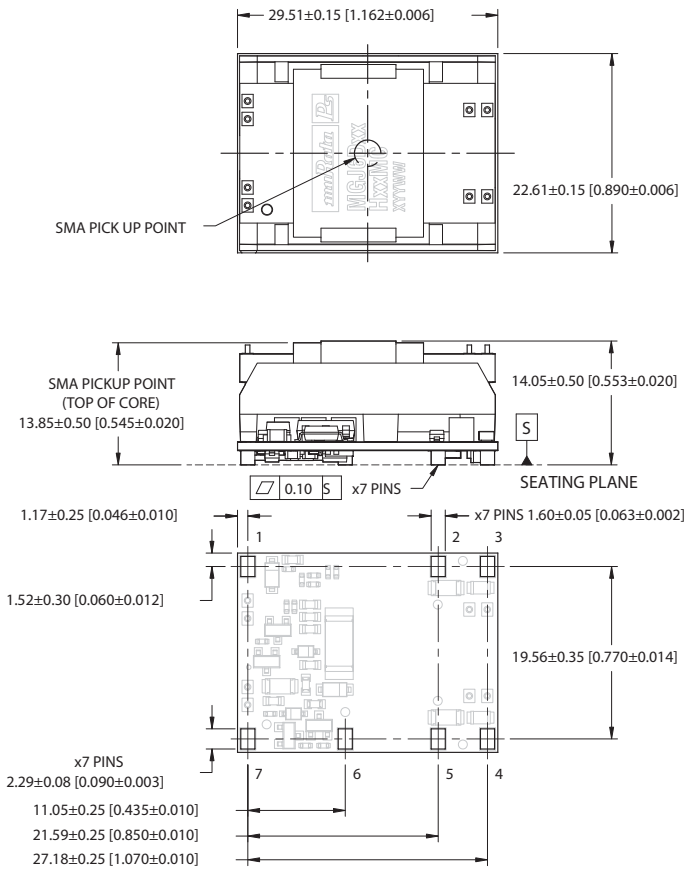






PACKAGE SPECIFICATIONS

MECHANICAL DIMENSIONS



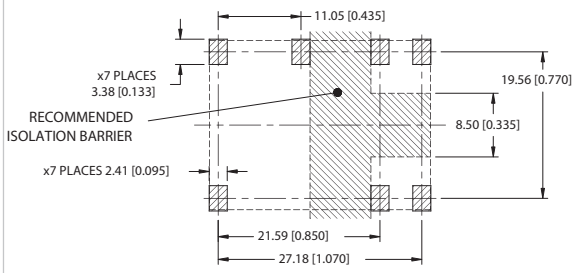
All dimensions in mm (inches), Controlling dimensions is mm.
Tolerance (unless otherwise stated) ±0.25 (0.010).
Component layout is shown for reference only.

Weight: 14.4g

PIN CONNECTIONS

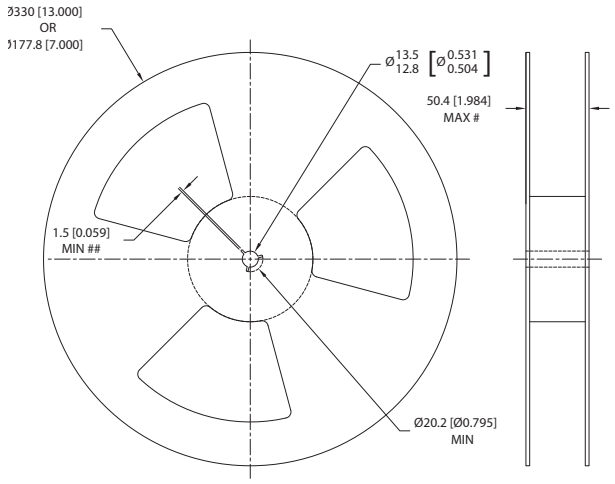
Pin	Function
1	$\overline{\text{Dis}}$/Sync
2	VH RTN
3	VH +24V
4	VL +24V
5	VL RTN
6	-Vin
7	+Vin

RECOMMENDED FOOTPRINT DETAILS



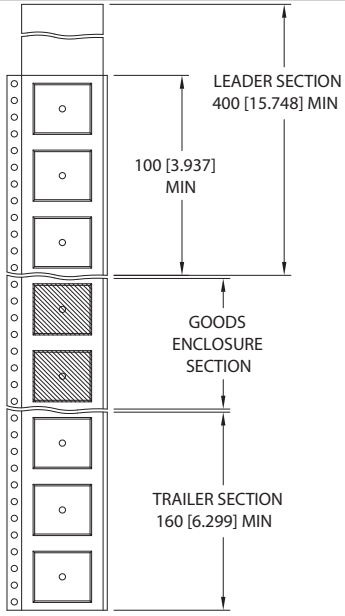
TAPE & REEL SPECIFICATIONS

REEL OUTLINE DIMENSIONS



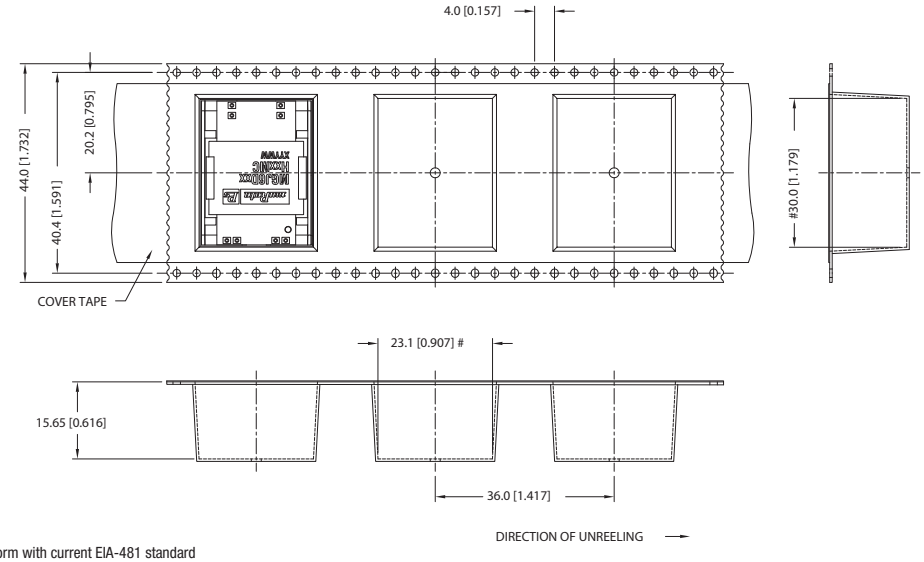
Tape & Reel specifications shall conform with current EIA-481 standard
Unless otherwise stated all dimensions in mm(inches)
Controlling dimension is mm
Measured at hub
Six equi-spaced slots on 180mm/7" reel

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) ±0.1mm (±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/