

### 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 <sup>1</sup> | 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                    | 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 <sup>1</sup> | Input Voltage Range | Output 1 VH           |                       |                                   |                                   | Output 2 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                             |
| 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 <sup>1</sup> | Nominal Input Voltage | Input Current at Rated Load | Efficiency (Min) | Efficiency (Typ) | MTTF <sup>3</sup> |            |
|-------------------------|-----------------------|-----------------------------|------------------|------------------|-------------------|------------|
|                         |                       |                             |                  |                  | MIL 217           | Telecordia |
|                         |                       |                             |                  |                  | 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 MGJ6DXXH24MC-R7 ( 23 pieces per reel), or MGJ6DXXH24MC-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.



For full details go to  
[www.murata-ps.com/rohs](http://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<br>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 Vin, 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

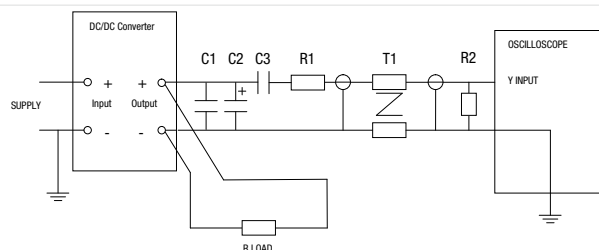
#### Ripple & Noise Characterisation Method

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



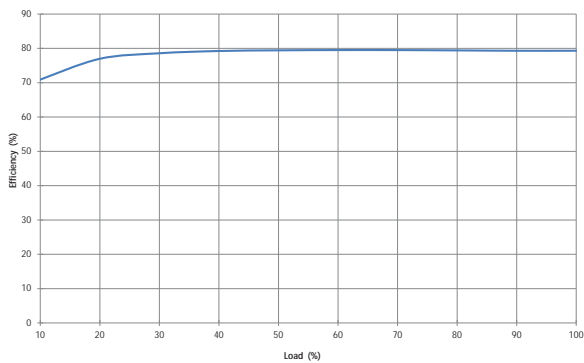
## RoHS COMPLIANCE, MSL AND PSL INFORMATION



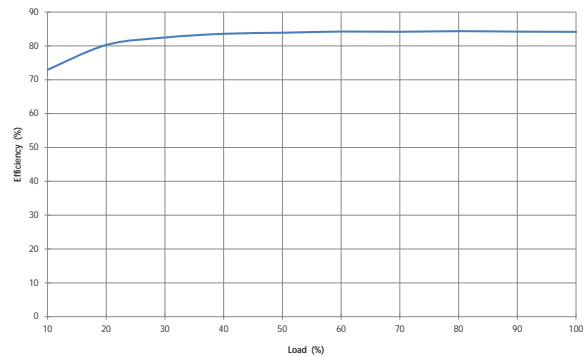
This series is compatible with Pb-Free soldering systems and is also backward compatible with Sn/Pb soldering systems. The MGJ6 half bridge series has a process, moisture, and reflow sensitivity classification of MSL2 PSL R7F as defined in J-STD-020 and J-STD-075. This translates to: MSL2 = 1 year floor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

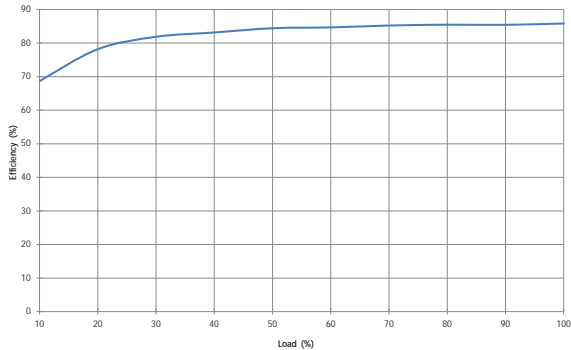
**MGJ6D05H24MC**



**MGJ6D12H24MC**

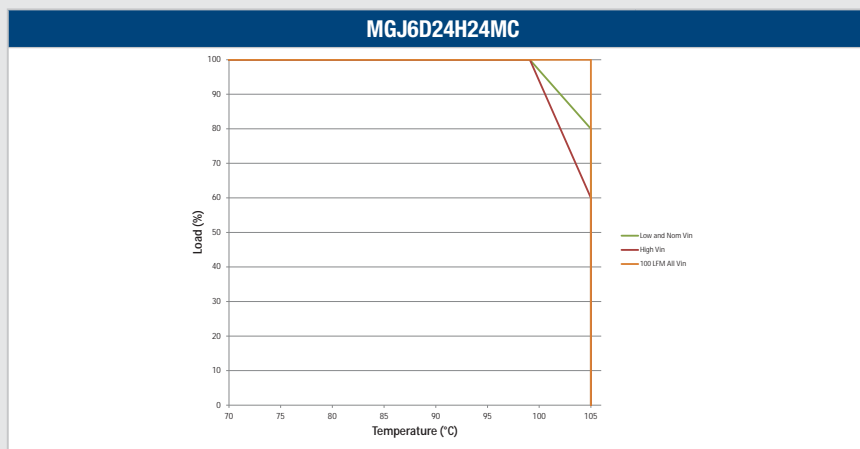
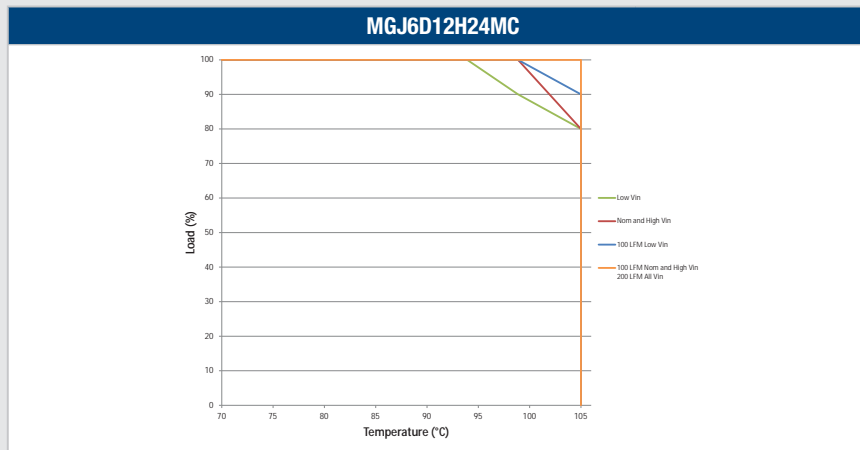
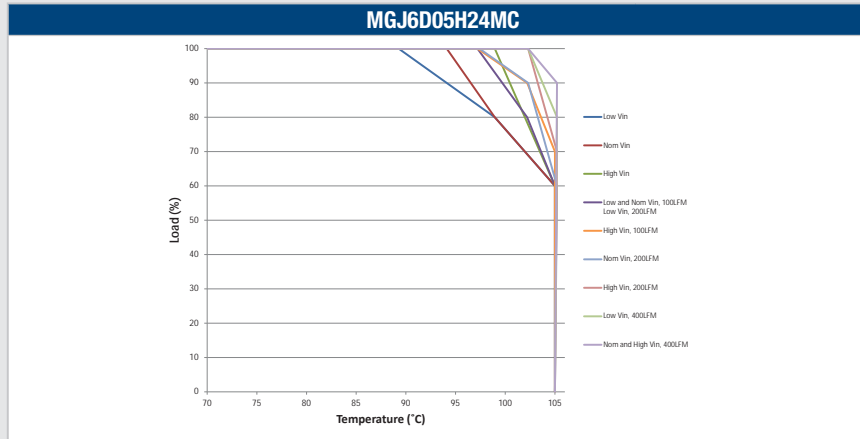


**MGJ6D24H24MC**



### DERATING GRAPHS

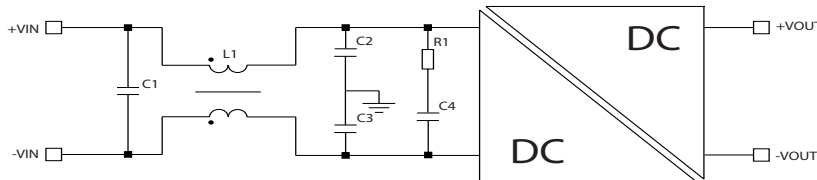
Derating curves are based on IPC-9592. With no derating some components may be operating at the manufacturers maximum temperature ratings.



### 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. If a high dv/dt above 80kV/us is expected from output to input it is advised that a common mode filter is used on each output as this will reduce the common mode current circulating between outputs and input and causing interference.

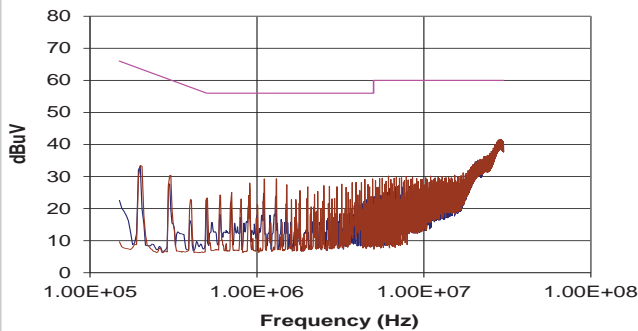


**C1, C2 & C3** Polyester or ceramic capacitor

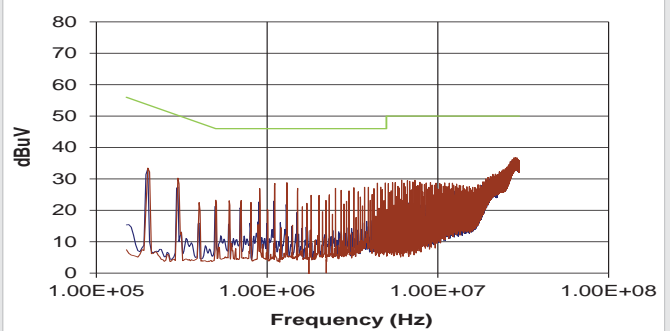
**C4** Electrolytic capacitor (note R1 could be omitted if C4 has ESR  $\geq$  R1)

| TO MEET CURVE B |            |     |             |     |     |            |             |
|-----------------|------------|-----|-------------|-----|-----|------------|-------------|
| Part Number     | C1         | L1  | Part Number | C2  | C3  | R1         | C4          |
| MGJ6D05H24MC    | 10 $\mu$ F | 1mH | 51105C      | 1nF | 1nF | 1 $\Omega$ | 470 $\mu$ F |
| MGJ6D12H24MC    | 10 $\mu$ F | 1mH | 51105C      | 1nF | 1nF | 1 $\Omega$ | 470 $\mu$ F |
| MGJ6D24H24MC    | 10 $\mu$ F | 1mH | 51105C      | 1nF | 1nF | 1 $\Omega$ | 470 $\mu$ F |

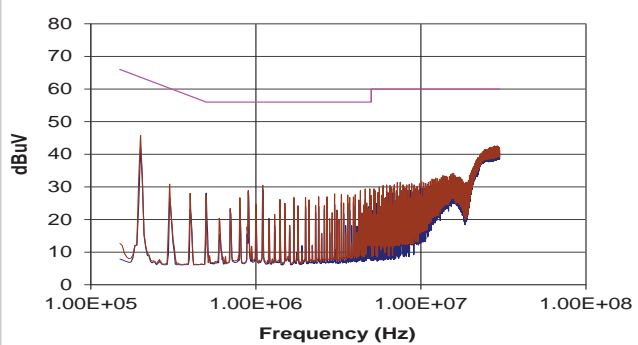
**MGJ6D05H24MC (Quasi Peak)**



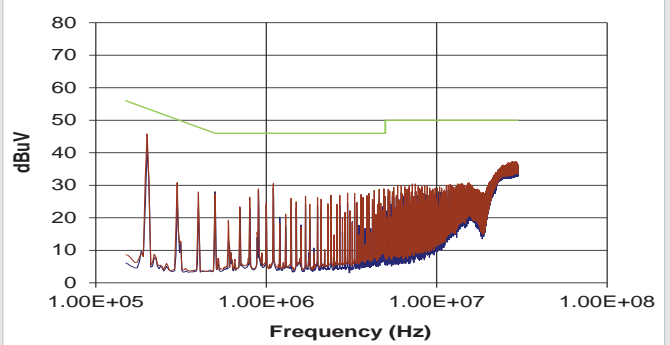
**MGJ6D05H24MC (Average)**



**MGJ6D12H24MC (Quasi Peak)**

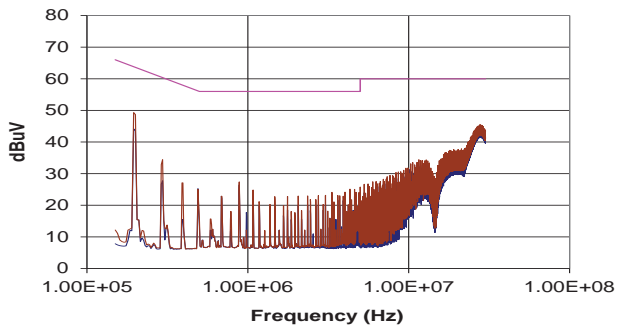


**MGJ6D12H24MC (Average)**

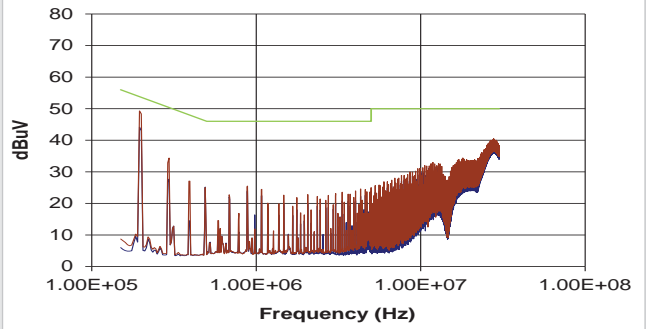


## EMC FILTERING AND SPECTRA

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             |
| <b>MGJ6D05H24MC</b> | 30             |
| <b>MGJ6D12H24MC</b> | 30             |
| <b>MGJ6D24H24MC</b> | 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<br>(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:

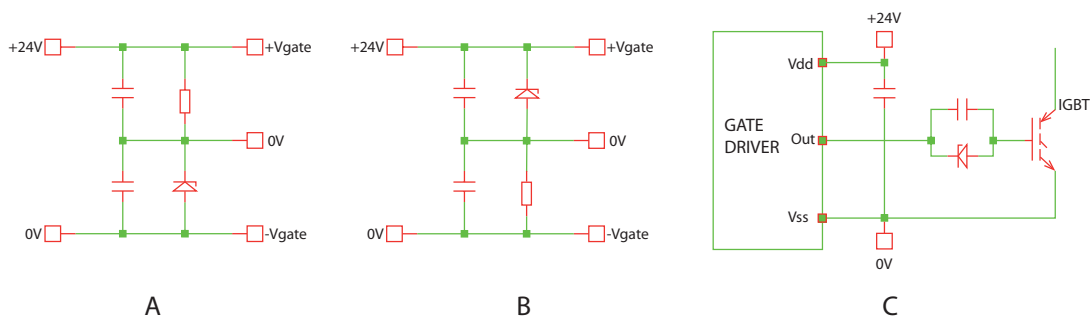
1. When a dc logic low voltage is applied to this pin the MGJ6 is disabled and enters a low quiescent current sleep mode.
2. When this pin is left floating or a dc logic high (CMOS/TTL compatible) voltage is applied the MGJ6 is enabled and operates at the programmed frequency of 100kHz.
3. When a square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

The DIS/Synch pin is a high impedance TTL input and can be triggered by noise from external circuits if not treated carefully. It is advised that any pcb traces connected to the DIS/Synch pin are kept as short as possible and away from other noisy pcb traces. The track should follow a similar route to the return path to avoid differential noise pick up. If the pin is not used for synchronisation then a 22nF capacitor can be added from DIS/Synch pin to -Vin to suppress noise.

#### 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    |
| 1. Suggested zener diode is BZX84C.<br>Resistor | 15K  | 18K | 15K    |

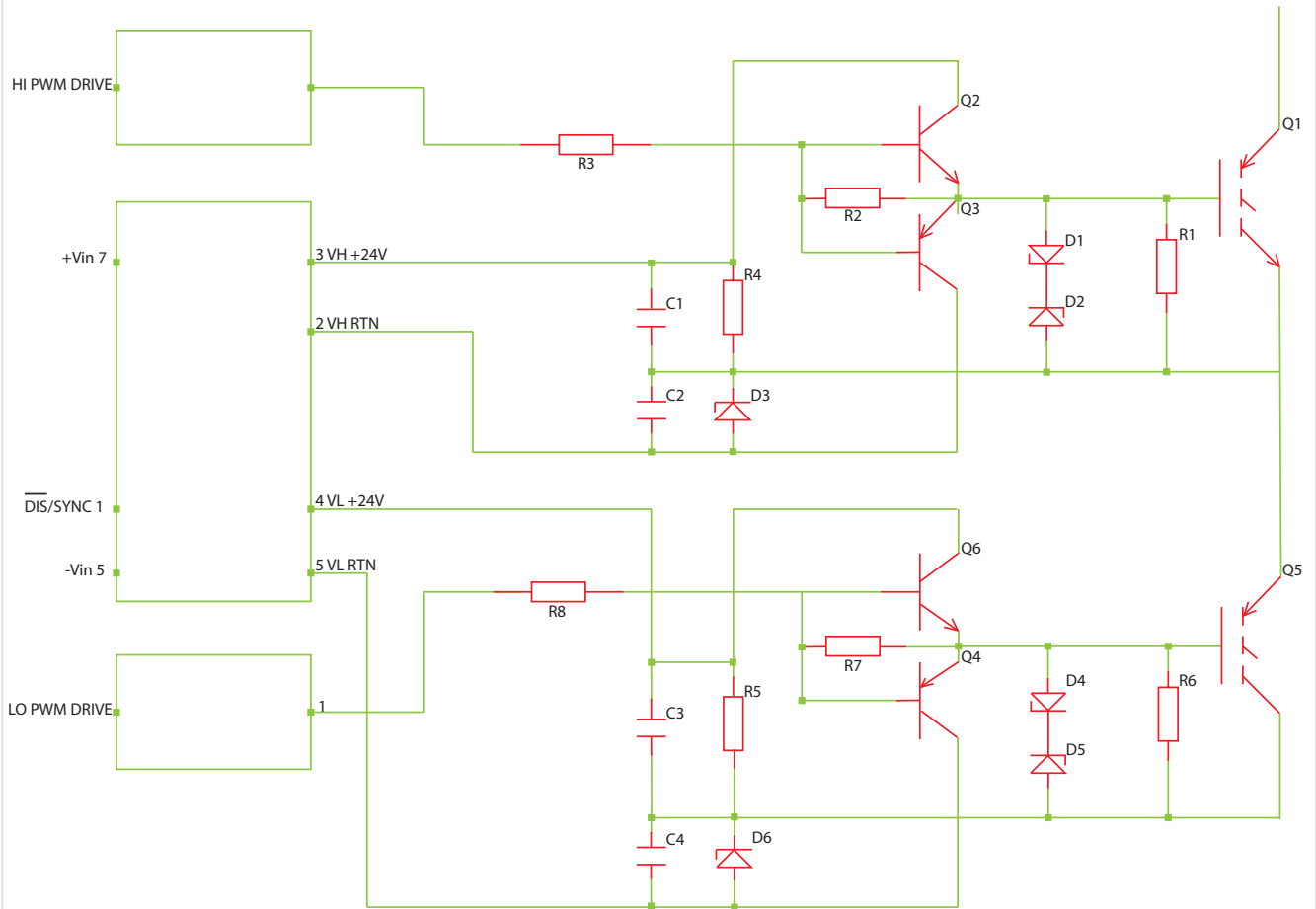




**APPLICATION NOTES (Continued)**

**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)

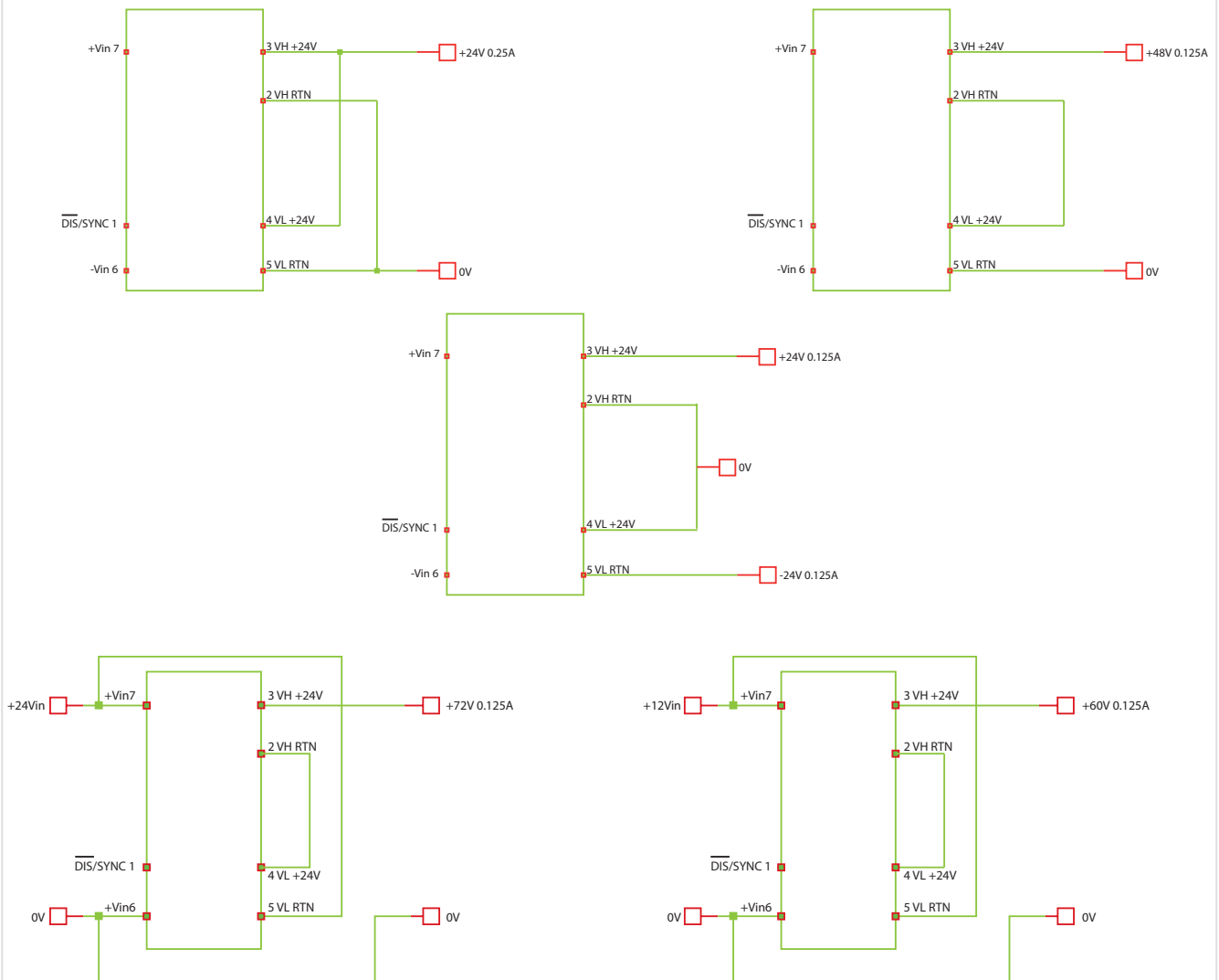
#### Alternative configuration options

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

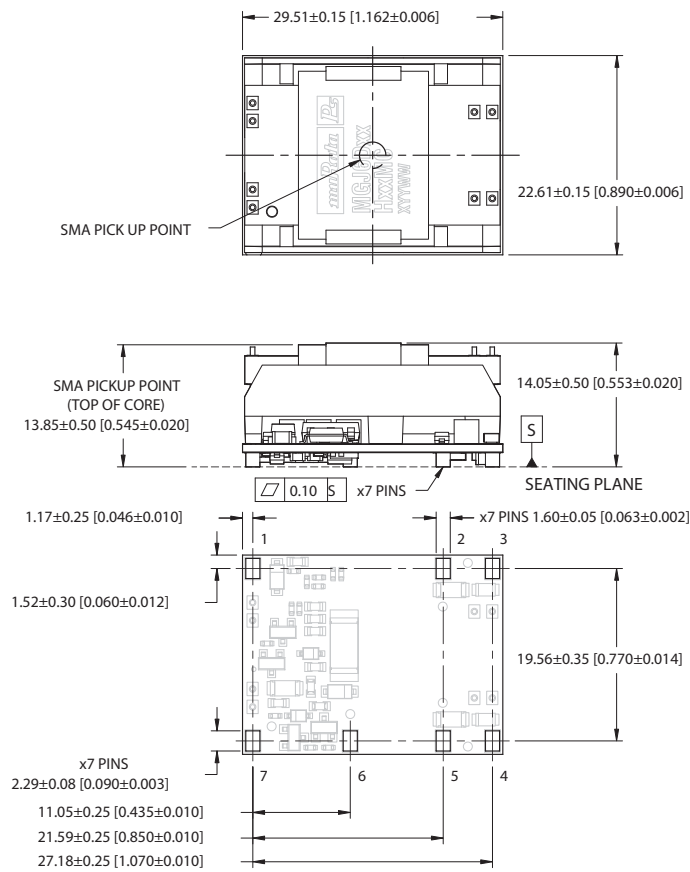
Both outputs can also be connected in series to produce a single 48V @ 0.125A output or dual +/-24V @ 0.125A

Other configurations include a non-isolated +24V to +72V or +12V to +60V boost converter @ 0.125A as shown below:



### PACKAGE SPECIFICATIONS

#### MECHANICAL DIMENSIONS



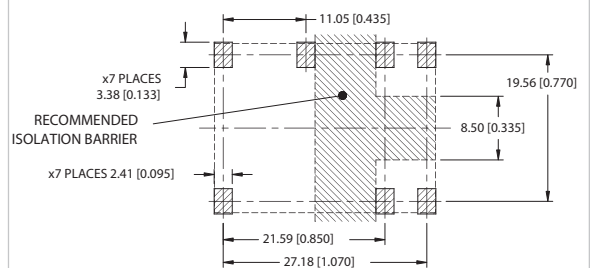
All dimensions in mm (inches), Controlling dimensions is mm.  
Tolerance (unless otherwise stated)  $\pm 0.25$  (0.010).  
Component layout is shown for reference only.

Weight: 14.4g

#### PIN CONNECTIONS

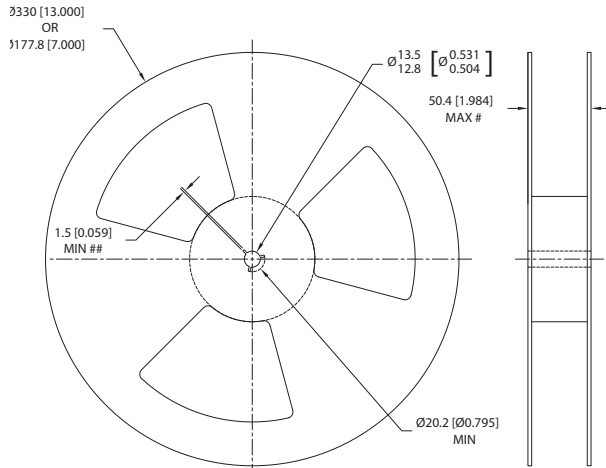
| Pin | Function |
|-----|----------|
| 1   | Dis/Sync |
| 2   | VH RTN   |
| 3   | VH +24V  |
| 4   | VL +24V  |
| 5   | VL RTN   |
| 6   | -Vin     |
| 7   | +Vin     |

#### RECOMMENDED FOOTPRINT DETAILS



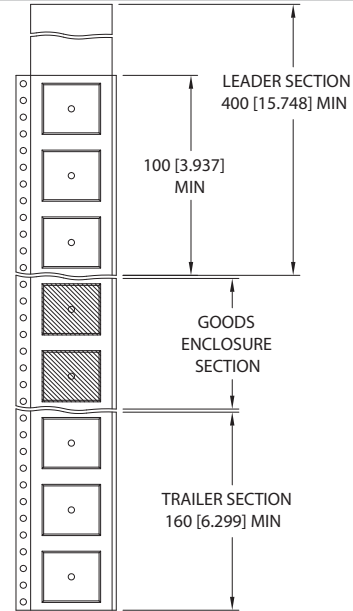
### TAPE & REEL SPECIFICATIONS

#### REEL OUTLINE DIMENSIONS



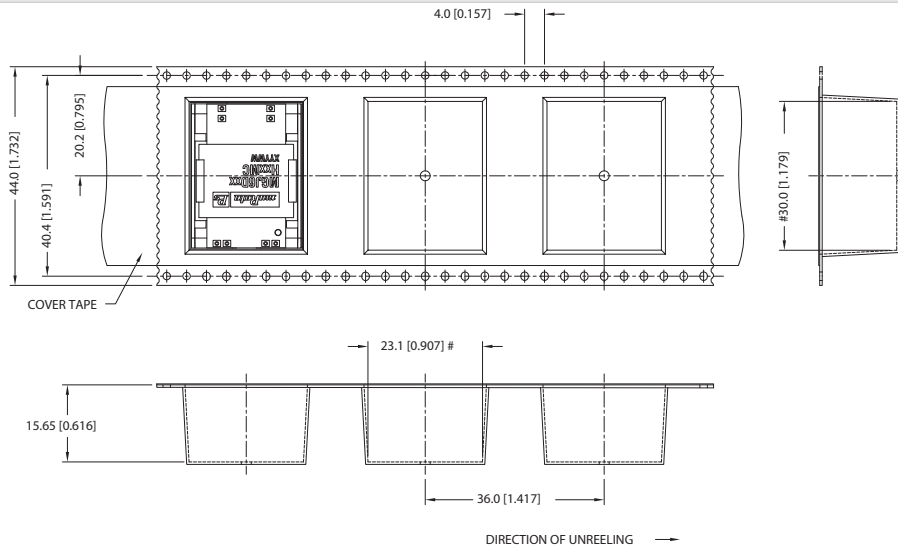
Tape & Reel specifications shall conform with current EIA-481 standard  
 Unless otherwise stated all dimensions in mm(inches)  
 Controlling dimension is mm  
 # Measured at hub  
 ## Six equi-spaced slots on 180mm/7" reel

#### 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)  $\pm 0.1\text{mm}$  ( $\pm 0.004$  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



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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