

## FEATURES

- Patent pending
- Optimised bipolar output voltages for IGBT/SiC & MOSFET gate drives
- Reinforced insulation to UL60950 recognition pending
- ANSI/AAMI ES60601-1 recognition pending
- 5.2kVDC isolation test voltage 'Hi Pot Test'
- Ultra low coupling capacitance
- Surface mount package style
- 5V, 12V & 24V inputs
- +15V/-9V, +15V/-5V & +19V/-5V outputs
- Operation to 105 °C
- Short circuit protection
- Thermal shutdown
- Characterised partial discharge performance
- DC link voltage 3kVDC

## PRODUCT OVERVIEW

The MGJ1 series of DC-DC converters is ideal for powering 'high side' and 'low side' gate drive circuits for IGBTs/SiC and MOSFETs in bridge circuits. A choice of asymmetric output voltages allows optimum drive levels for best system efficiency. The MGJ1 series is characterised for high isolation requirements commonly seen in bridge circuits used in motor drives and inverters, while the MGJ1 industrial grade temperature rating and construction gives long service life and reliability.



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

# MGJ1 Series

## 5.2kVDC Isolated 1W SM Gate Drive DC/DC Converters

### SELECTION GUIDE

| Order Code <sup>1</sup> | Nominal Input Voltage | Output Voltage 1 | Output Voltage 2 | Output Current 1 | Output Current 2 | Input Current at Rated Load | Output 1              |                       | Output 2              |                       |
|-------------------------|-----------------------|------------------|------------------|------------------|------------------|-----------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|                         | V                     | V                | V                |                  |                  |                             | Load Regulation (Typ) | Load Regulation (Max) | Load Regulation (Typ) | Load Regulation (Max) |
|                         | V                     | V                | V                | mA               |                  |                             | %                     |                       |                       |                       |
| MGJ1D051505MPC          | 5                     | 15               | -5               | 50               | 50               | 320                         | 7                     | 8.1                   | 0.3                   | 0.5                   |
| MGJ1D051510MPC          | 5                     | 15               | -10              | 40               | 40               | 310                         | 7.6                   | 8.8                   | 0                     | 0.1                   |
| MGJ1D051905MPC          | 5                     | 19               | -5               | 42               | 42               | 320                         | 6.2                   | 7.4                   | 0.2                   | 0.3                   |
| MGJ1D121505MPC          | 12                    | 15               | -5               | 50               | 50               | 115                         | 5.6                   | 6.6                   | 0.3                   | 0.4                   |
| MGJ1D121509MPC          | 12                    | 15               | -9               | 42               | 42               | 115                         | 6.6                   | 7.6                   | 0                     | 0.1                   |
| MGJ1D121905MPC          | 12                    | 19               | -5               | 42               | 42               | 115                         | 5.1                   | 6                     | 0.2                   | 0.3                   |
| MGJ1D241505MPC          | 24                    | 15               | -5               | 50               | 50               | 65                          | 3.8                   | 5.2                   | 0.2                   | 0.3                   |
| MGJ1D241509MPC          | 24                    | 15               | -9               | 42               | 42               | 65                          | 4.5                   | 6                     | 0                     | 0.1                   |
| MGJ1D241905MPC          | 24                    | 19               | -5               | 42               | 42               | 65                          | 3.4                   | 4.5                   | 0.2                   | 0.3                   |

### SELECTION GUIDE (Continued)

| Order Code <sup>1</sup> | Ripple & Noise (Typ) <sup>3</sup> | Ripple & Noise (Max) <sup>3</sup> | Efficiency (Min) | Efficiency (Typ) | Isolation Capacitance | MTTF <sup>2</sup> |       |
|-------------------------|-----------------------------------|-----------------------------------|------------------|------------------|-----------------------|-------------------|-------|
|                         | mVp-p                             |                                   | %                | %                | pF                    | MIL.              | Tel.  |
|                         |                                   |                                   |                  |                  |                       | kHrs              |       |
| MGJ1D051505MPC          | 15                                | 30                                | 60               | 63.5             | 5                     | 1964              | 70733 |
| MGJ1D051510MPC          | 14                                | 30                                | 60               | 64               | 5                     | 1872              | 65924 |
| MGJ1D051905MPC          | 14                                | 30                                | 61               | 64.5             | 5                     | 1816              | 55135 |
| MGJ1D121505MPC          | 10                                | 20                                | 67               | 71.5             | 5                     | 2214              | 39194 |
| MGJ1D121509MPC          | 10                                | 20                                | 68               | 73               | 5                     | 2069              | 37971 |
| MGJ1D121905MPC          | 10                                | 20                                | 67               | 72               | 5                     | 1908              | 37172 |
| MGJ1D241505MPC          | 15                                | 30                                | 57               | 64               | 5                     | 1500              | 33052 |
| MGJ1D241509MPC          | 15                                | 30                                | 60               | 64               | 5                     | 1378              | 31761 |
| MGJ1D241905MPC          | 15                                | 30                                | 58               | 64               | 5                     | 1356              | 29139 |

### INPUT CHARACTERISTICS

| Parameter                            | Conditions                            | Min. | Typ. | Max. | Units  |
|--------------------------------------|---------------------------------------|------|------|------|--------|
| Voltage range                        | Continuous operation, 5V input types  | 4.5  | 5    | 5.5  | V      |
|                                      | Continuous operation, 12V input types | 10.8 | 12   | 13.2 |        |
|                                      | Continuous operation, 24V input types | 21.6 | 24   | 26.4 |        |
| Input short circuit current $I_{sc}$ | 5V input types                        |      | 125  |      | mA     |
|                                      | 12V input types                       |      | 55   |      |        |
|                                      | 24V input types                       |      | 80   |      |        |
| Input reflected ripple               | 5V input types                        |      | 7.5  |      | mA p-p |
|                                      | 12V input types                       |      | 2    |      |        |
|                                      | 24V input types                       |      | 2.5  |      |        |

1. Components are supplied in tape and reel packaging, please refer to package specification section. Orderable part numbers are MGJ1D051505MPC-R7 (80 pieces per reel), or MGJ1D051505MPC-R13 (400 pieces per reel).

2. Calculated using MIL-HDBK-217 FN2 and Telcordia SR-332 calculation model with nominal input voltage at full load.

3. See ripple & noise test method.

All specifications typical at  $T_a=25^{\circ}\text{C}$ , nominal input voltage and rated output current unless otherwise specified

### OUTPUT CHARACTERISTICS

| Parameter                  | Conditions                     | Min.                                            | Typ. | Max. | Units |
|----------------------------|--------------------------------|-------------------------------------------------|------|------|-------|
| Rated Power                | T <sub>A</sub> =-40°C to 105°C |                                                 |      | 1.0  | W     |
| Voltage Set Point Accuracy | See tolerance envelopes        |                                                 |      |      |       |
| Line regulation            | 051505                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.38 | 1.45  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.06 | 0.08  |
|                            | 051510                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.68 | 1.75  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.01 | 0.01  |
|                            | 051905                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.32 | 1.40  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.05 | 0.06  |
|                            | 121505                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.56 | 1.62  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.05 | 0.06  |
|                            | 121509                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.64 | 1.70  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.01 | 0.01  |
|                            | 121905                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.29 | 1.32  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.06 | 0.07  |
|                            | 241505                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.34 | 1.40  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.07 | 0.10  |
|                            | 241509                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.61 | 1.70  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.01 | 0.01  |
|                            | 241905                         | High V <sub>IN</sub> to low V <sub>IN</sub> OP1 |      | 1.26 | 1.32  |
|                            |                                | High V <sub>IN</sub> to low V <sub>IN</sub> OP2 |      | 0.05 | 0.07  |

### ABSOLUTE MAXIMUM RATINGS

|                                         |            |
|-----------------------------------------|------------|
| Short-circuit protection                | Continuous |
| Input voltage V <sub>IN</sub> , MGJ1D05 | 6V         |
| Input voltage V <sub>IN</sub> , MGJ1D12 | 15V        |
| Input voltage V <sub>IN</sub> , MGJ1D24 | 28V        |

### ISOLATION CHARACTERISTICS

| Parameter              | Conditions                        | Min. | Typ. | Max. | Units |
|------------------------|-----------------------------------|------|------|------|-------|
| Isolation test voltage | Production tested for 1 second    | 5200 |      |      | VDC   |
|                        | Qualification tested for 1 minute | 5200 |      |      | VDC   |
| Resistance             | Viso= 500VDC                      | 1    |      |      | GΩ    |

### GENERAL CHARACTERISTICS

| Parameter           | Conditions      | Min. | Typ. | Max. | Units |
|---------------------|-----------------|------|------|------|-------|
| Switching frequency | 5V input types  |      | 90   |      | kHz   |
|                     | 12V input types |      | 95   |      |       |
|                     | 24V input types |      | 115  |      |       |

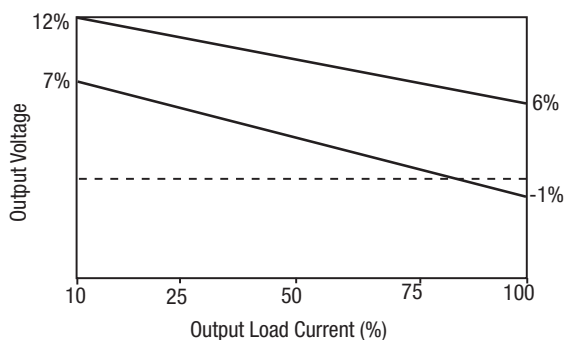
### TEMPERATURE CHARACTERISTICS

| Parameter                         | Conditions                             | Min. | Typ. | Max. | Units |
|-----------------------------------|----------------------------------------|------|------|------|-------|
| Specification                     | All output types (see derating curves) | -40  |      | 105  | °C    |
| Storage                           |                                        | -55  |      | 125  |       |
| Product Temperature above ambient | 5V input types                         |      | 23   |      |       |
|                                   | 12V input types                        |      | 17   |      |       |
|                                   | 24V input types                        |      | 26   |      |       |
| Cooling                           | Free air convection                    |      |      |      |       |

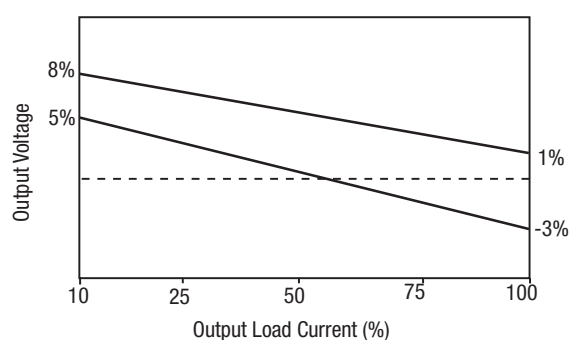
### POSITIVE OUTPUT VOLTAGE TOLERANCE ENVELOPES

The voltage tolerance envelopes show typical load regulation characteristics for this product series. The tolerance envelope is the maximum output voltage variation due to changes in output loading and set point accuracy.

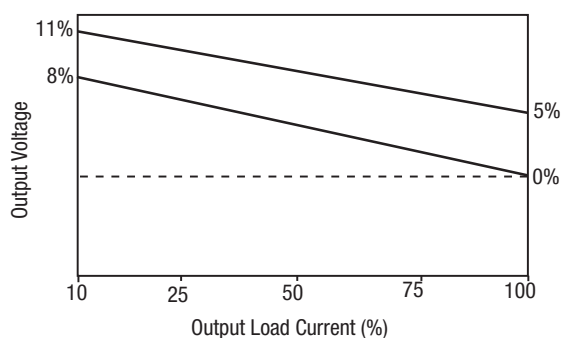
**051505**



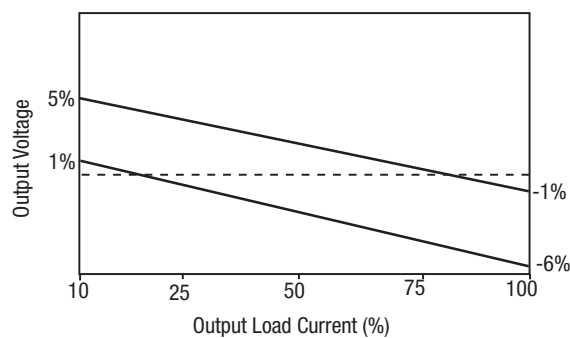
**051510**



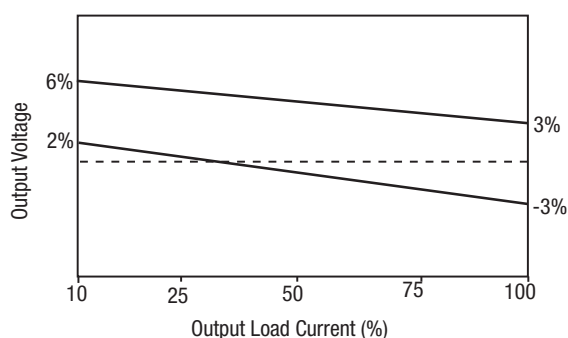
**051905**



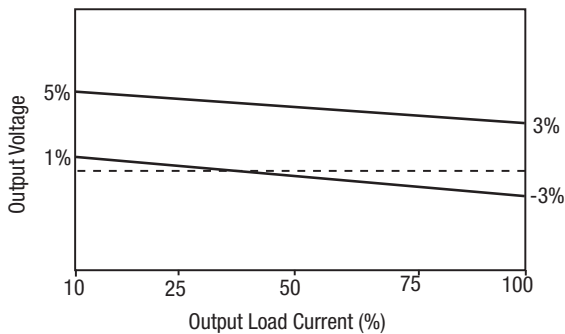
**121505, 121509, 121905**



**241505, 241509**

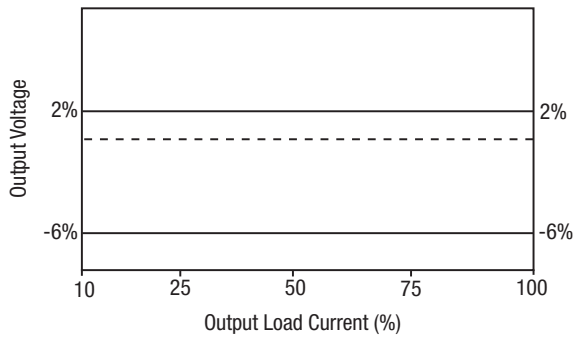


**241905**

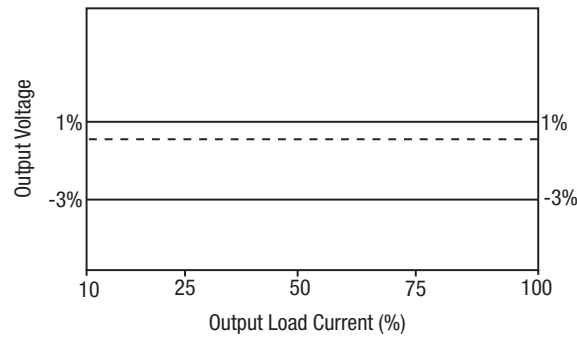


**NEGATIVE OUTPUT VOLTAGE TOLERANCE ENVELOPES**

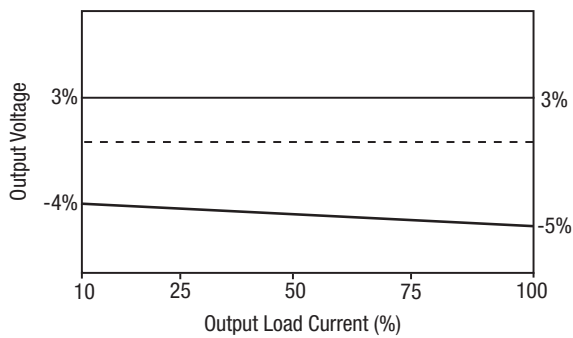
**051505, 121905, 241905**



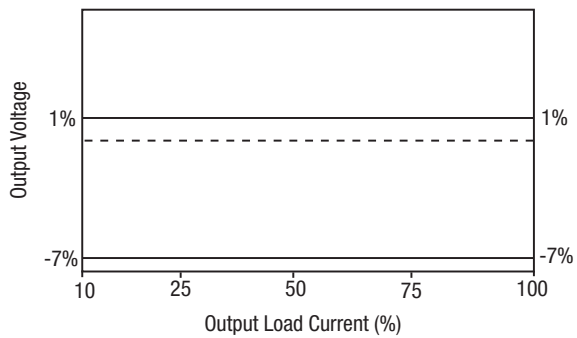
**051510, 121509, 241509**



**051905**



**121505, 241505**



### 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 MGJ1 series of DC/DC converters are all 100% production tested at 5.2kVDC for 1 second and have been qualification tested at 5.2kVDC for 1 minute.

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 MGJ1 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 3kV when testing for partial discharge in accordance with IEC 60270. Please contact Murata for further information.

The MGJ1 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 MGJ1 series is pending recognition ANSI/AAMI ES60601-1.

#### UL 60950

The MGJ1 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 9.3mm.

#### FUSING

The MGJ1 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 600mA

Input Voltage, 12V 250mA

Input Voltage, 24V 125mA

All fuses should be Anti-Surge and UL rated.

### 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 MGJ1 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 a plating thickness of 0.12 microns.

### APPLICATION NOTES

#### Minimum load

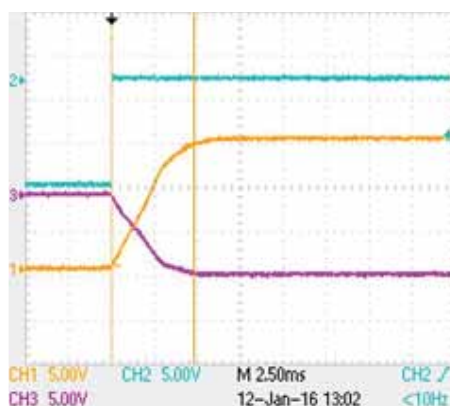
The minimum load to meet datasheet specification is 10% of the full rated load across the specified input voltage range. Lower than 10% minimum loading will result in an increase in output voltage, which may rise to typically 1.25 times the specified output voltage if the output load falls to less than 5%.

#### Capacitive loading and start up

Typical start up times for this series, with a typical input voltage rise time of 2.2 $\mu$ s and output capacitance of 10 $\mu$ F, are shown in the table below. The product series will start into capacitance ranging up to 47 $\mu$ F (Capacitor across +V to -V or 100 $\mu$ F across each output) with increased start times.

|                | Start-up time<br>ms |
|----------------|---------------------|
| MGJ1D051505MPC | 4.2                 |
| MGJ1D051509MPC | 5                   |
| MGJ1D051905MPC | 5.2                 |
| MGJ1D121505MPC | 2.8                 |
| MGJ1D121509MPC | 3.9                 |
| MGJ1D121905MPC | 4                   |
| MGJ1D241505MPC | 1                   |
| MGJ1D241509MPC | 1.3                 |
| MGJ1D241905MPC | 1.3                 |

Typical Start-Up Wave Form



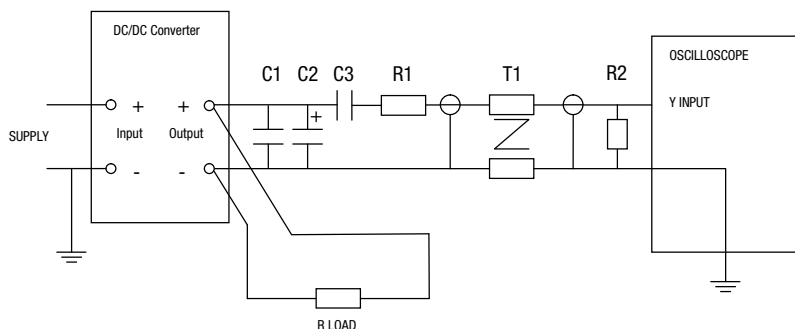
#### Ripple & Noise Characterisation Method

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

|       |                                                                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C1    | 1 $\mu$ F X7R multilayer ceramic capacitor, voltage rating to be a minimum of 3 times the output voltage of the DC/DC converter                                        |
| C2    | 10 $\mu$ F 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 100m $\Omega$ at 100 kHz |
| C3    | 100nF multilayer ceramic capacitor, general purpose                                                                                                                    |
| R1    | 450 $\Omega$ resistor, carbon film, $\pm$ 1% tolerance                                                                                                                 |
| R2    | 50 $\Omega$ 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.

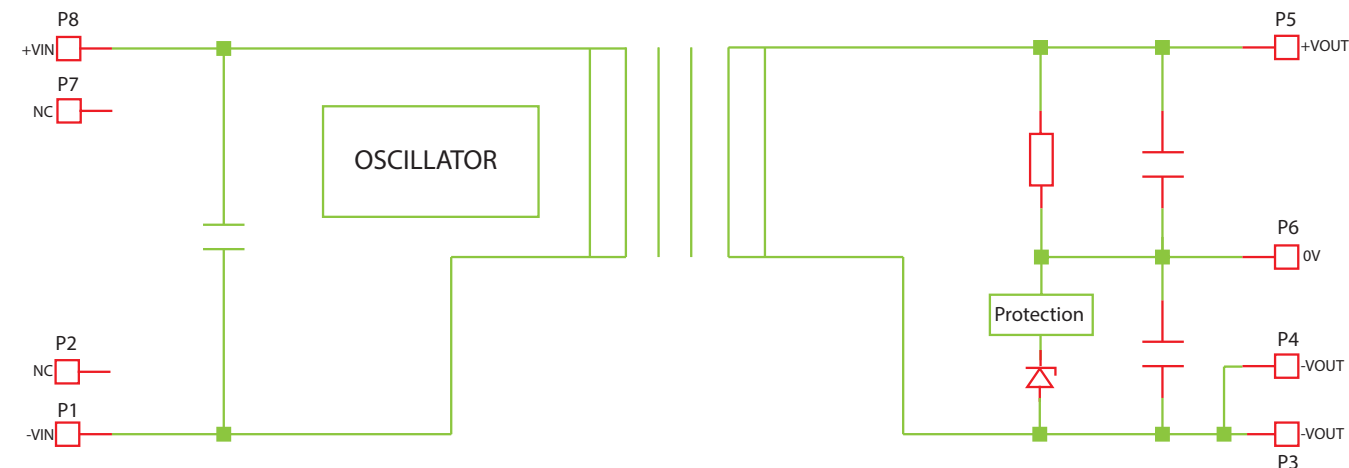
#### Differential Mode Noise Test Schematic



## APPLICATION NOTES (Continued)

The MGJ1 series is a dual output DC/DC specifically designed for gate drive applications and its output configuration is not suitable for application usage as a general dual output DC/DC converter. However the MGJ1 series can be used as a general purpose single output converter, by loading from +Vout to -Vout.

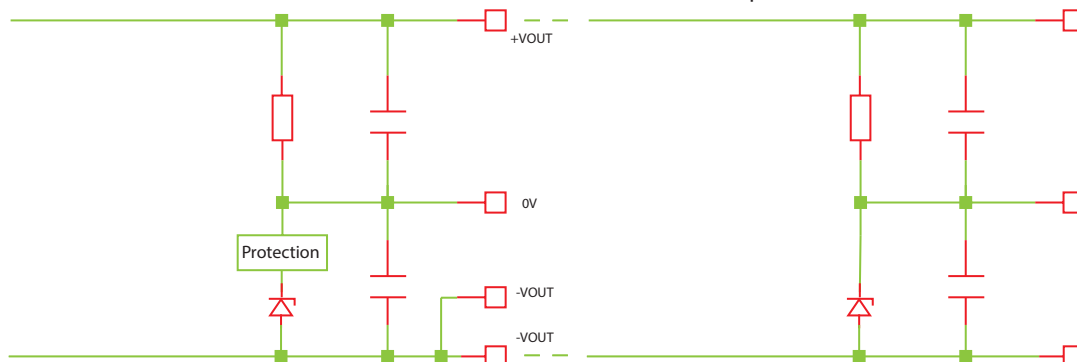
The MGJ1 series provides a dual output by using a zener voltage divider network, the negative output is obtained by using a zener diode as a voltage regulator. If a short circuit occurs, the zener diode is protected. A 5V1 zener diode is used to set the -5 Vout, a 9V1 zener diode to set the -9Vout and a 10V zener diode to set the -10Vout. A tolerance of 2% should be taken into consideration for the zener diodes. The 5V1 zener diode is rated at 300mW, the 9V1 and 10V zener diodes are rated at 400mW.



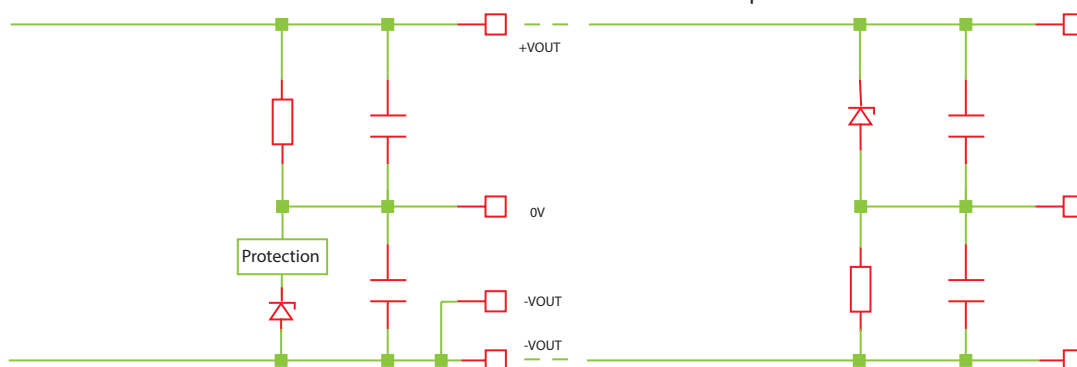
### Optional Configuration:

For optional configuration where alternative negative output voltages are required, an external zener diode network can be connected across the main 20V or 24V output. However this zener diode will no longer be protected from short circuits as the internal short circuit protection is bypassed.

External Zener Diode Network Circuit Option 1



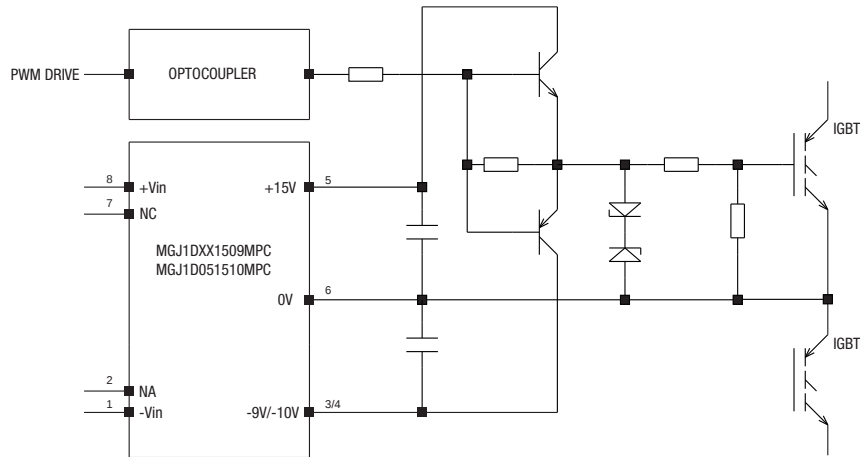
External Zener Diode Network Circuit Option 2



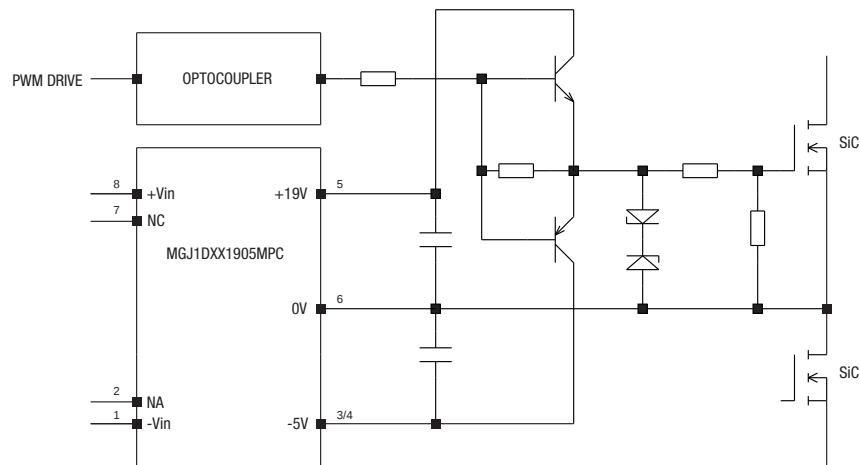
APPLICATION NOTES (Continued)

Schematic for driving IGBT, SiC & MOSFET

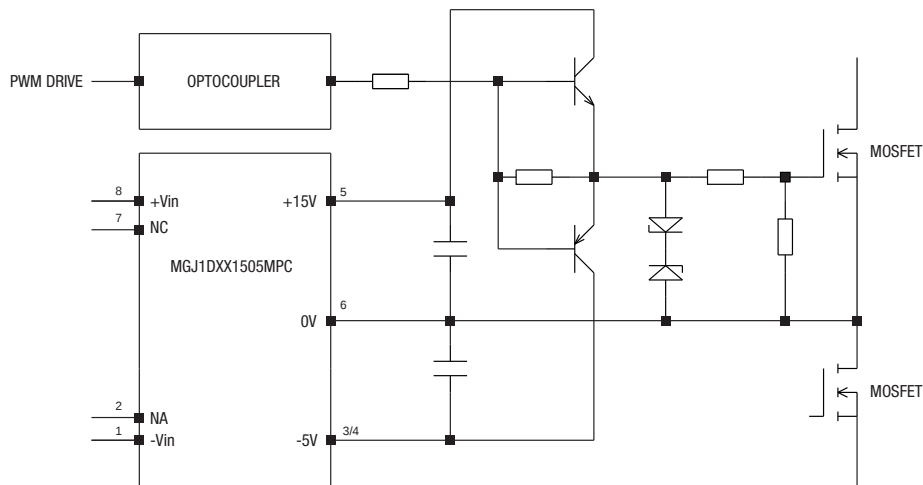
MGJ1 DC-DC CONNECTIONS FOR DRIVING IGBT DEVICES



MGJ1 DC-DC CONNECTIONS FOR DRIVING SiC DEVICES

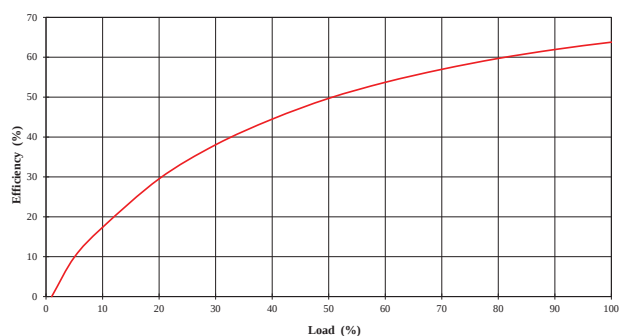


MGJ1 DC-DC CONNECTIONS FOR DRIVING MOSFET DEVICES

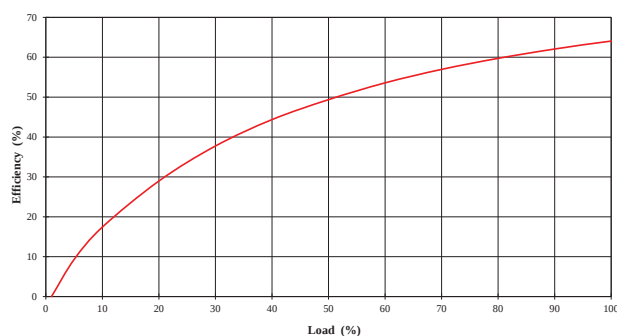


## EFFICIENCY VS LOAD

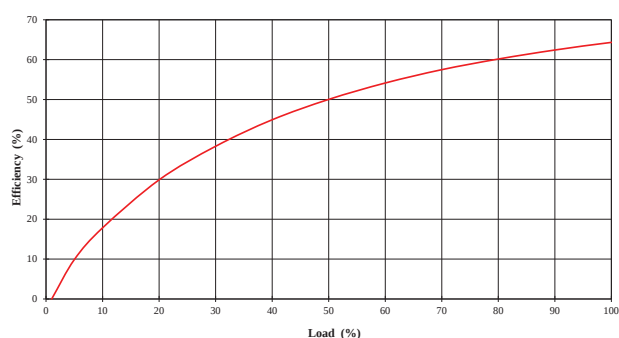
**MGJ1D051505MPC**



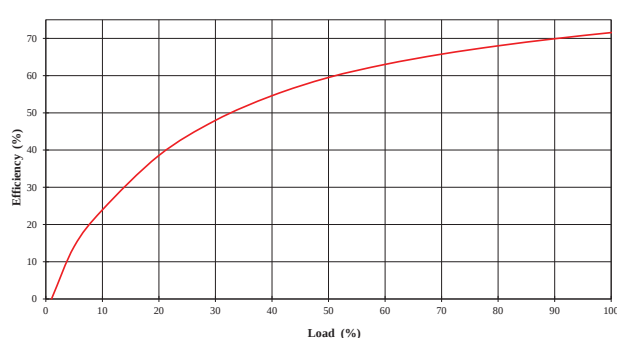
**MGJ1D051510MPC**



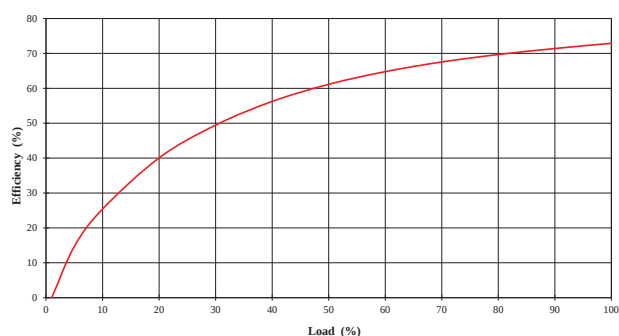
**MGJ1D051905MPC**



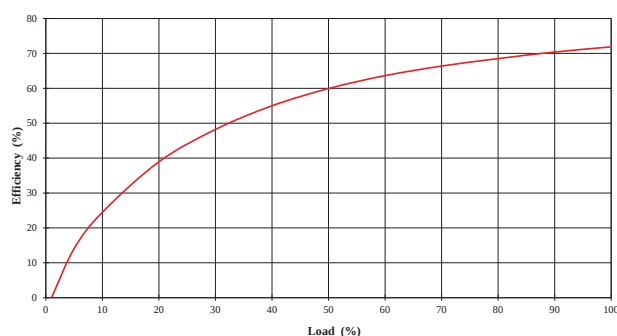
**MGJ1D121505MPC**



**MGJ1D121509MPC**

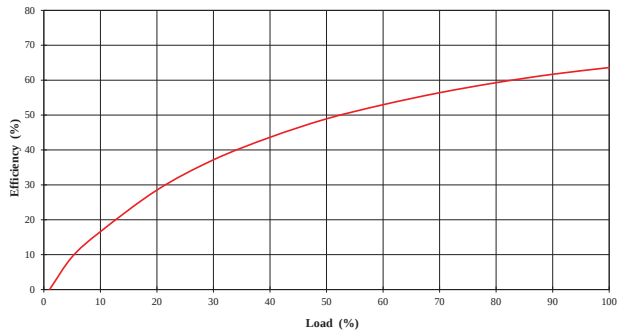


**MGJ1D121905MPC**

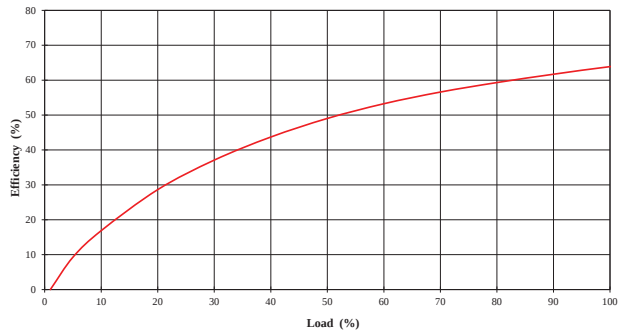


**EFFICIENCY VS LOAD**

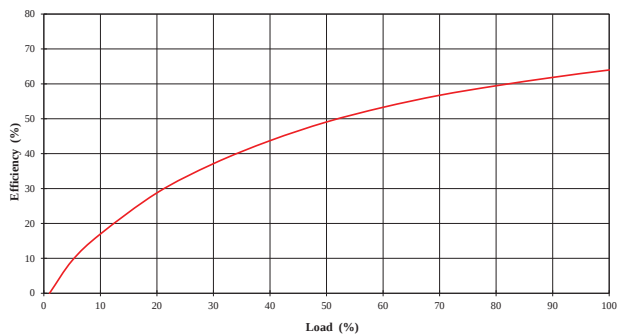
**MGJ1D241505MPC**



**MGJ1D241509MPC**

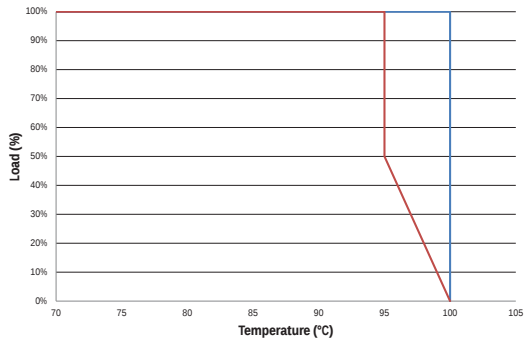


**MGJ1D241905MPC**

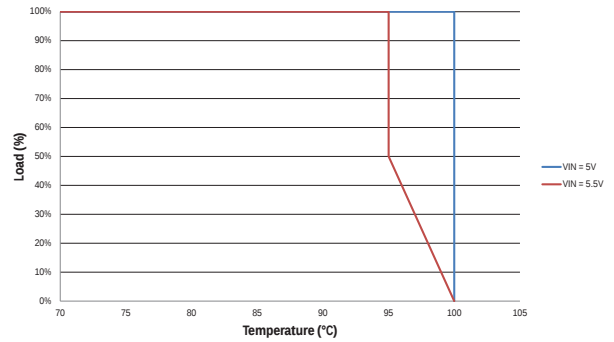


## TEMPERATURE DERATING

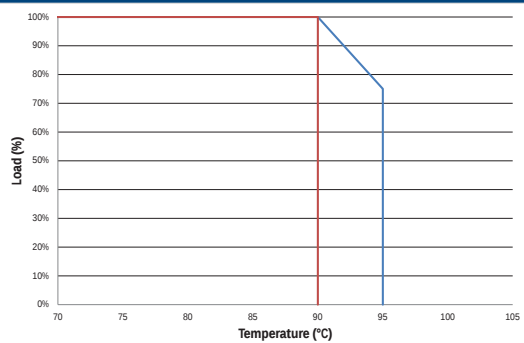
**MGJ1D051505MPC**



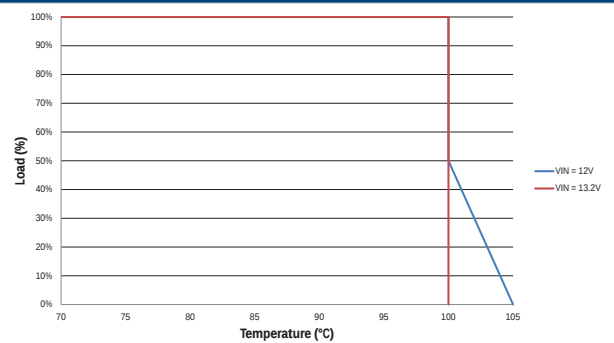
**MGJ1D051510MPC**



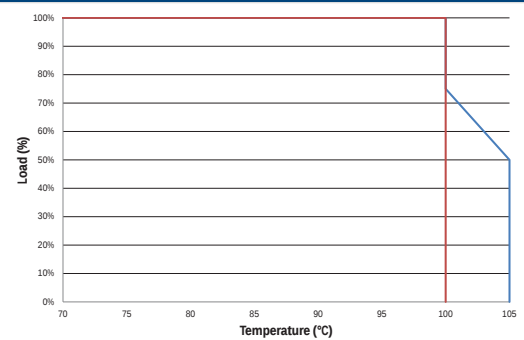
**MGJ1D051905MPC**



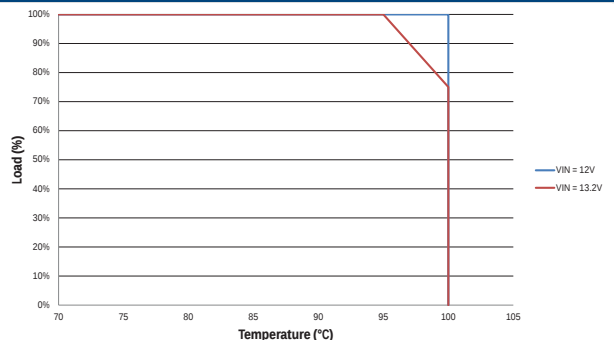
**MGJ1D121505MPC**



**MGJ1D121509MPC**

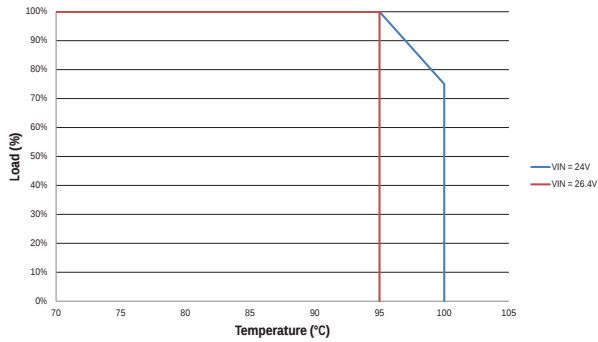


**MGJ1D121905MPC**

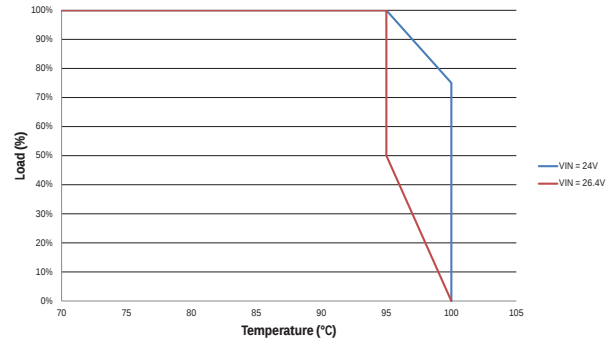


TEMPERATURE DERATING

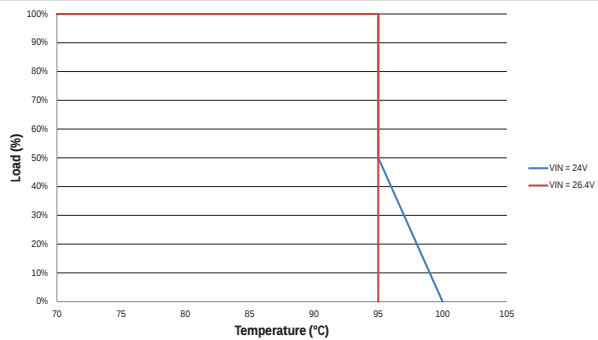
MGJ1D241505MPC



MGJ1D241509MPC



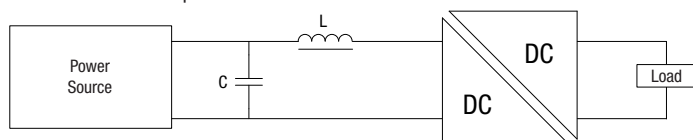
MGJ1D241905MPC



### EMC FILTERING AND SPECTRA

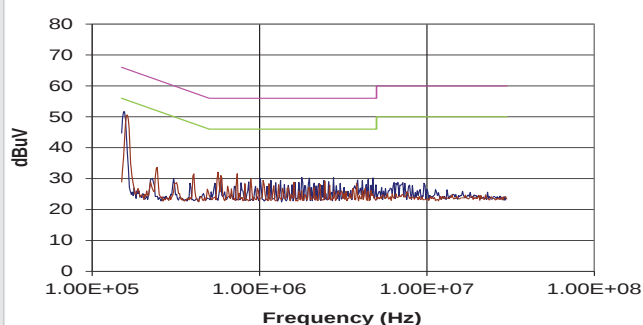
#### FILTERING

An input capacitor and inductor is 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 (green line) and Quasi Peak Limit B (pink line) adherence limits. The recommended input capacitor to use for this circuit is 10 $\mu$ F/50V. The recommended Murata part is GRM32ER71H106KA1Z.

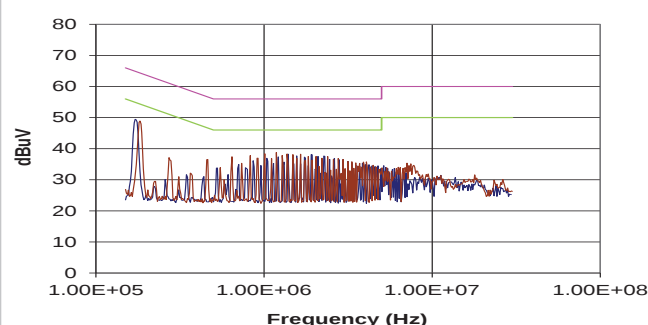


|                | Inductor   |        |              | Capacitor  |
|----------------|------------|--------|--------------|------------|
|                | L, $\mu$ H | SMD    | Through Hole | C, $\mu$ F |
| MGJ1D051505MPC | 15         | 46153C | 13R153C      | 10         |
| MGJ1D051510MPC | 15         | 46153C | 13R153C      | 10         |
| MGJ1D051905MPC | 15         | 46153C | 13R153C      | 10         |
| MGJ1D121505MPC | 10         | 46103C | 13R103C      | 10         |
| MGJ1D121509MPC | 10         | 46103C | 13R103C      | 10         |
| MGJ1D121905MPC | 10         | 46103C | 13R103C      | 10         |
| MGJ1D241505MPC | 10         | 46103C | 13R103C      | 10         |
| MGJ1D241509MPC | 10         | 46103C | 13R103C      | 10         |
| MGJ1D241905MPC | 10         | 46103C | 13R103C      | 10         |

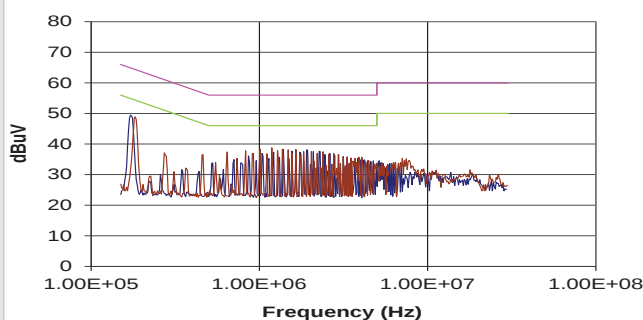
#### MGJ1D051505MPC



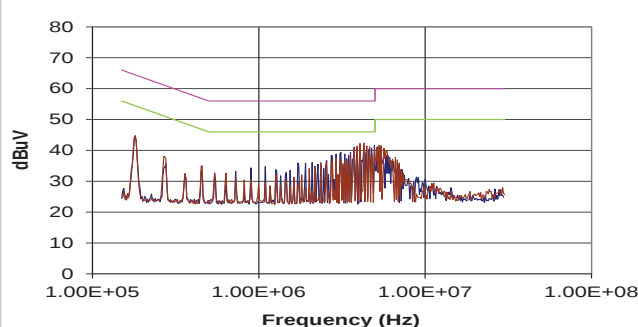
#### MGJ1D051510MPC



#### MGJ1D051905MPC

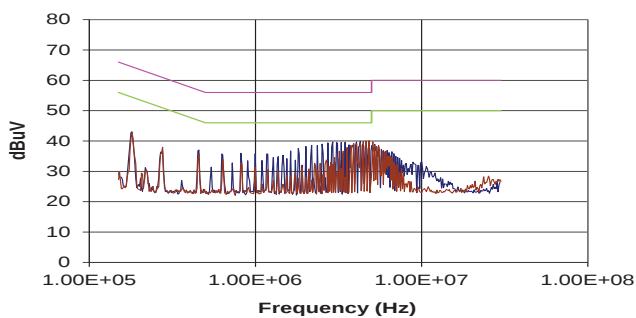


#### MGJ1D121505MPC

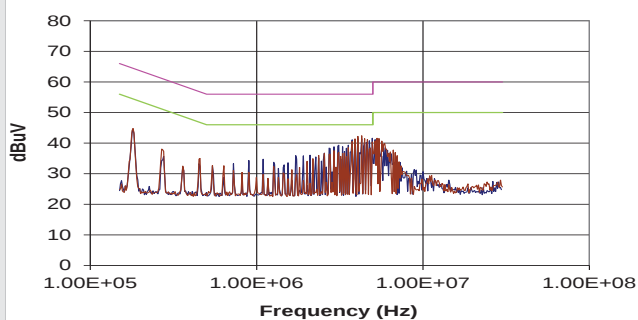


## EMC FILTERING AND SPECTRA

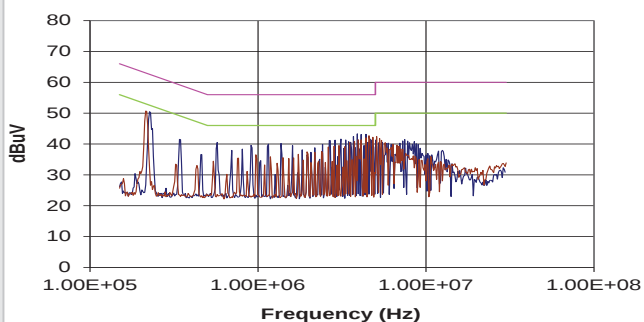
**MGJ1D121509MPC**



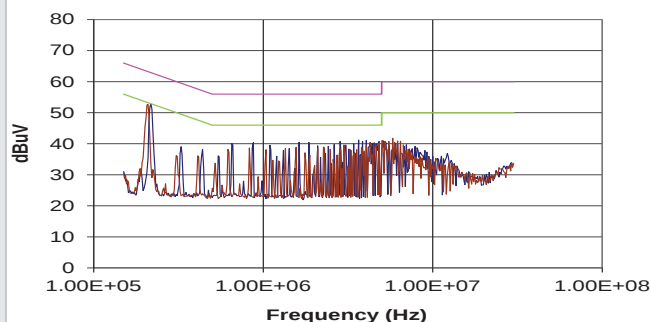
**MGJ1D121905MPC**



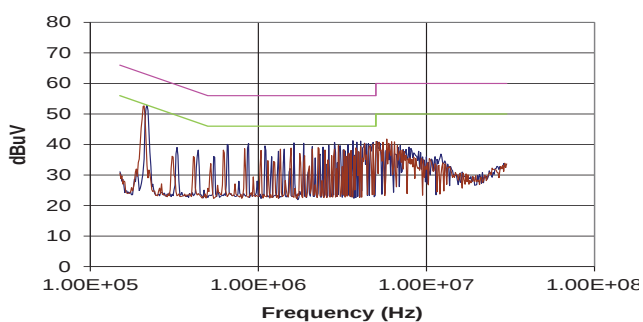
**MGJ1D241505MPC**



**MGJ1D241509MPC**

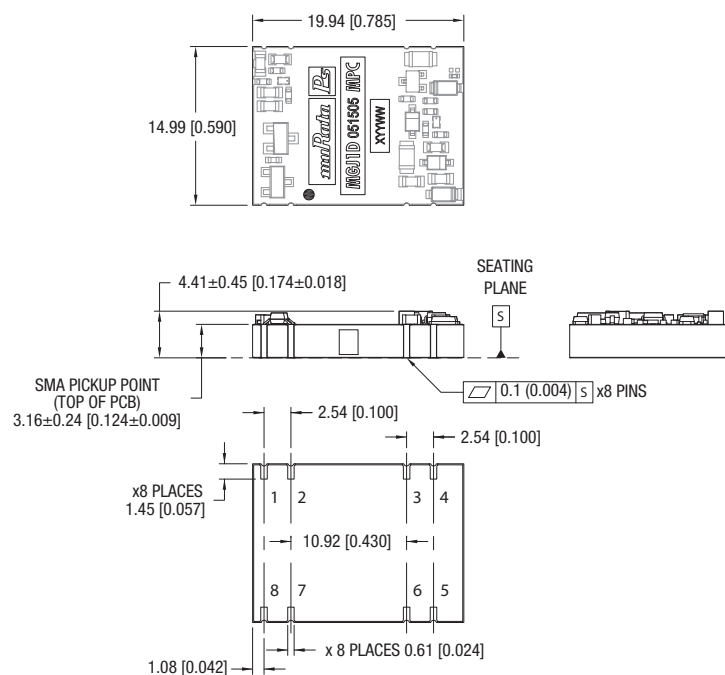


**MGJ1D241905MPC**



## PACKAGE SPECIFICATIONS

### MECHANICAL DIMENSIONS



All dimensions in mm (inches). Controlling dimensions in mm.  
Tolerance (unless otherwise stated) ±0.25 (0.010).

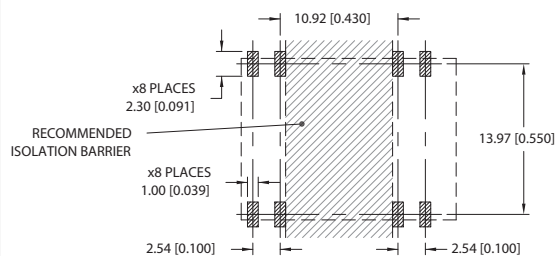
Weight: 2.3g

### PIN CONNECTIONS

| Pin | Function |
|-----|----------|
| 1   | -Vin     |
| 2   | NA       |
| 3   | -Vout    |
| 4   | -Vout    |
| 5   | +Vout    |
| 6   | 0V       |
| 7   | NC       |
| 8   | +Vin     |

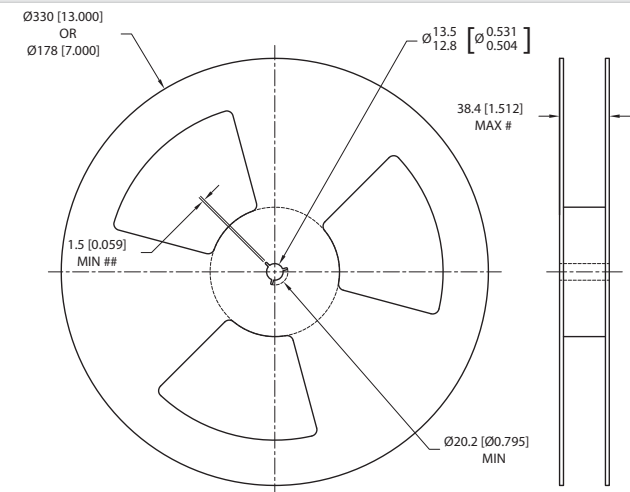
NA - Not Available for electrical connection.

### RECOMMENDED FOOTPRINT DETAILS



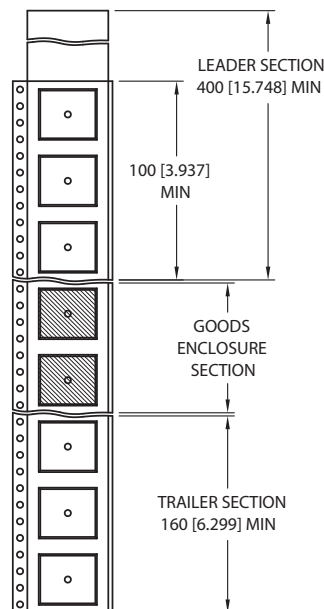
## TAPE & REEL SPECIFICATIONS

### REEL OUTLINE DIMENSIONS



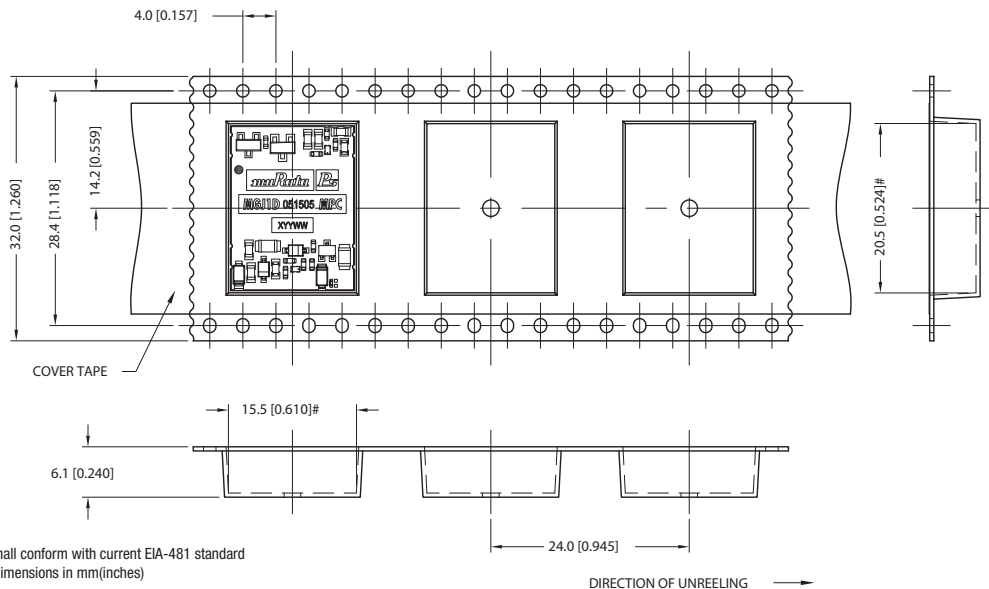
Tape & Reel specifications shall conform with current EIA-481 standard  
Unless otherwise stated all dimensions in mm(inches)  
Controlling dimension is mm  
# Measured at hub  
## Six equi-spaced slots on 180mm/7" reel

### REEL PACKAGING DETAILS



Reel Quantity: 7" - 80 or 13" - 400

### TAPE OUTLINE DIMENSIONS



Tape & Reel specifications shall conform with current EIA-481 standard  
Unless otherwise stated all dimensions in mm(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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