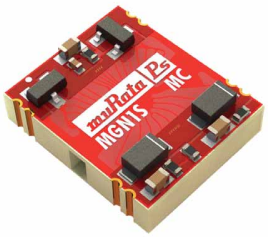
Murata Power Solutions

MGN1 Series

3kVAC Isolated 1W SM GaN Gate Drive DC-DC Converters



FEATURES

- Patent protected
- Optimised output voltages designed to meet leading GaN devices requirements
- Reinforced insulation to UL62368 recognition pending
- 3kVAC isolation test voltage 'Hi Pot Test'
- Ultra low isolation capacitance
- Surface mount package style
- 5V & 12V inputs
- +8V, +12V & +6V/-3V outputs
- Operation up to 105°C
- Short circuit protection
- Reverse polarity protection
- Characterised CMTI >200kV/µS
- Continuous barrier withstand voltage 1.1kV
- Characterised partial discharge performance

PRODUCT OVERVIEW

The MGN1 series of DC-DC converters is ideal for powering 'high side' and 'low side' gate drive circuits for GaN in bridge circuits. A choice of output voltages allows optimum drive levels for best system efficiency. The MGN1 series is characterised for high isolation requirements commonly seen in bridge circuits used in motor drives and inverters, while the MGN1 industrial grade temperature rating and construction gives long service life and reliability.

SELECTION GUIDE

Order Code[1]	Nominal Input Voltage	Output Voltage 1	Output Voltage 2	Output Current 1	Output Current 2	Input Current at Rated Load	Output 1 Load Regulation (Typ)	Output 1 Load Regulation (Max)	Output 2 Load Regulation (Typ)	Output 2 Load Regulation (Max)
	V	V	V	mA			%			
MGN1S0508MC	5	8	-	125	-	310	2.5	4	-	-
MGN1S0512MC	5	12	-	83.3	-	310	1.7	4	-	-
MGN1S1208MC	12	8	-	125	-	130	2.5	4	-	-
MGN1S1212MC	12	12	-	83.3	-	120	1.7	4	-	-
MGN1D050603MC	5	6	-3	111	111	320	0.3	1	7	10
MGN1D120603MC	12	6	-3	111	111	130	0.3	1	6	8

SELECTION GUIDE (Continued)

Order Code[1]	Ripple & Noise (Typ)[3]	Ripple & Noise (Max)[3]	Efficiency (Min)	Efficiency (Typ)	Isolation Capacitance	MTTF[2]	
	mVp-p		%		pF	MIL.	Tel.
						kHrs	
MGN1S0508MC	20	50	58	61	2.5	2542	32674
MGN1S0512MC	20	50	58	62.5	2.5	2263	30885
MGN1S1208MC	20	50	62	67.5	2.5	2128	34861
MGN1S1212MC	20	50	65	69	2.5	2484	38343
MGN1D050603MC	20	50	58	62	2.5	1503	24882
MGN1D120603MC	20	50	64	68.5	2.5	1696	31467

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	
Input short circuit current I_{SC}	MGN1S0508MC, MGN1D050603MC		120		mA
	MGN1S0512MC		130		
	MGN1S1208MC		70		
	MGN1S1212MC		60		
	MGN1D120603MC		65		
Input reflected ripple	MGN1S0508MC, MGN1S0512MC, MGN1S1208MC, MGN1D120603MC		35		mA p-p
	MGN1S1212MC		30		
	MGN1D050603MC		40		

GENERAL CHARACTERISTICS

Parameter	Conditions	Min.	Typ.	Max.	Units
Switching frequency	5V input type		150		kHz
	12V input type		160		

RoHS COMPLIANT

For full details go to https://www.murata.com/en-global/products/power/rohs

1. Components are supplied in tape and reel packaging, please refer to package specification section. Orderable part numbers are MGN1SXXXXMC-R7/MGN1DXXXXXXMC-R7 (155 pieces per reel), or MGN1SXXXXMC-R13/MGN1DXXXXXXMC-R13 (620 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°C, nominal input voltage and rated output current unless otherwise specified.

OUTPUT CHARACTERISTICS

Parameter	Conditions		Min.	Typ.	Max.	Units
Rated Power	T_A=-40ºC to 105ºC				1	W
Minimum load			1			mA
Maximum output voltage[1]	1mA external load	-3V output			-5	V
		6V output			6.25	
		8V output			10	
		12V output			15	
Voltage Set Point Accuracy[2]	MGN1S0508MC		-6		-1	%
	MGN1S0512MC		-2		2	
	MGN1S1208MC		3		7	
	MGN1S1212MC		1		5	
	MGN1D050603MC	OP1	-3		4	
		OP2	-6		5	
	MGN1D120603MC	OP1	-2		5	
		OP2	16		26	
Line regulation	MGN1S0508MC, MGN1S0512MC & MGN1S1212MC			1.1	1.2	%/%
	MGN1S1208MC			1.2	1.25	
	MGN1D050603MC	OP1		0.1	0.2	
		OP2		3.2	3.5	
	MGN1D120603MC	OP1		0.1	0.2	
		OP2		3.2	3.5	

ISOLATION CHARACTERISTICS

Parameter		Conditions		Min.	Typ.	Max.	Units
Isolation test voltage		Production tested for 1 second		3000			VAC
		Qualification tested for 1 minute		3000			VAC
Resistance		Viso= 1000VDC		10			GΩ
Continuous barrier withstand voltage		Non-safety barrier application				1100	VDC
Safety standard[3]	UL62368-1	Reinforced	Creepage and clearance 6.5mm			250	Vrms
		Basic				650	VDC

TEMPERATURE CHARACTERISTICS

Parameter	Conditions		Min.	Typ.	Max.	Units
Specification	see derating curves		-40		105	°C
Storage			-40		125	
Product Temperature above ambient	MGN1S0508MC	1 Layer PCB		31		
		4 Layer PCB		15		
	MGN1S0512MC	1 Layer PCB		34		
		4 Layer PCB		17		
	MGN1S1208MC	1 Layer PCB		27		
		4 Layer PCB		15		
	MGN1S1212MC	1 Layer PCB		23		
		4 Layer PCB		10		
	MGN1D050603MC	1 Layer PCB		29		
		4 Layer PCB		15		
	MGN1D120603MC	1 Layer PCB		22		
		4 Layer PCB		12		
Cooling	Free air convection					

ABSOLUTE MAXIMUM RATINGS

Short-circuit protection		See graphs
Input voltage V_{IN}, MGN1X05		7V
Input voltage V_{IN}, MGN1X12		15V
Reverse polarity	MGN1X05	5.5V
	MGN1X12	13.2V

1. Most gate drive circuits will have at least 1mA of standby current, if this is not the case an external bleed resistor may be necessary.
2. T_A=25°C, nominal input voltage and 75% load.
3. UL62368-1 recognition is currently pending.

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 MGN1 series of DC-DC converters are all 100% production tested at 3kVAC for 1 second and have been qualification tested at 3kVAC 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 MGN1 series is not used as a safety barrier, i.e. provides functional isolation only, continuous or switched voltages across the barrier up to 1.1kV are sustainable. Long term reliability testing at these voltages continues. Peak Inception voltages measured were in excess of 1.1kV when testing for partial discharge in accordance with IEC 60270. Please contact Murata for further information.

The MGN1 series is pending recognition by Underwriters Laboratory to 250VAC 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

UL62368-1

The MGN1 series is pending recognition by Underwriters Laboratory (UL) to UL62368-1 for reinforced insulation to a working voltage of 250Vrms and for basic insulation to a working voltage of 650Vrms.

Creepage and clearance 6.5mm.
Working altitude OVC II 5000m

FUSING

The MGN1 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 0.5A
Input Voltage, 12V 0.25A
All fuses should be Anti-Surge and UL rated.

RoHS COMPLIANCE AND MSL INFORMATION

RoHS COMPLIANT

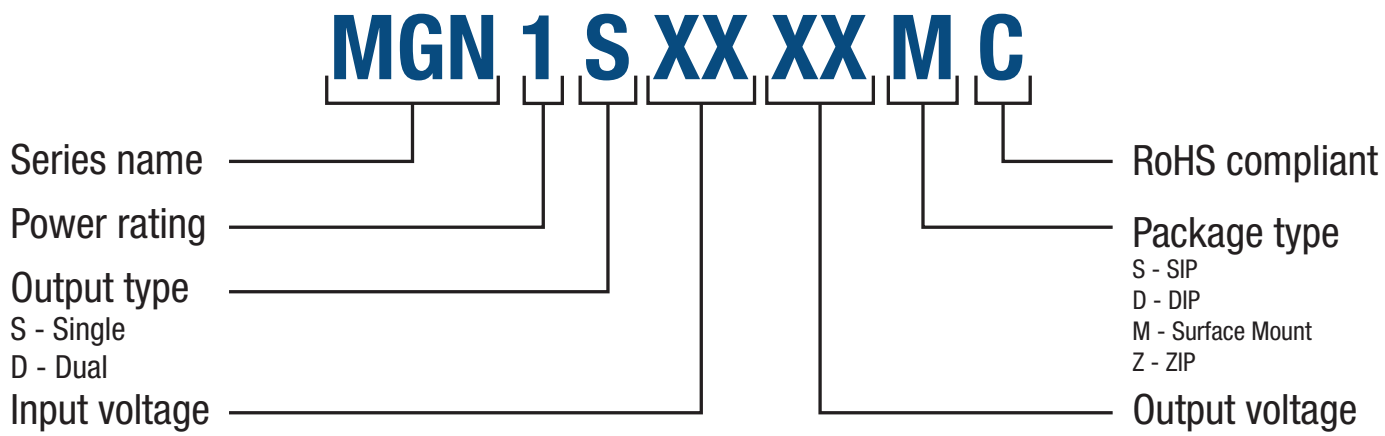
This series is compatible with Pb-Free soldering systems and is also backward compatible with Sn/Pb soldering systems. The series can be soldered in accordance with J-STD-020. Please refer to application notes for further information. This series have a classification temperature of 260°C and moisture sensitivity level 2. The termination finish on this product is Gold with plating thickness 0.12 microns.

ENVIRONMENTAL VALIDATION TESTING

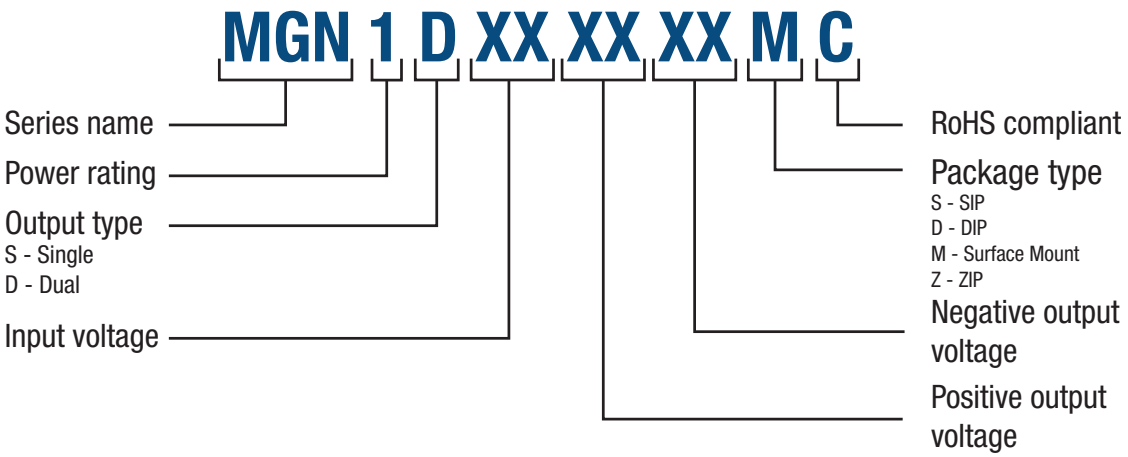
The following tests have been conducted on this product series, please contact Murata if further information about the tests is required.

Test	Standard	Condition
Temperature cycling	JEDEC JESD22-A104	500 cycles in a dual zone chamber from -40 (+5/-10)°C to 105 (+10/-5)°C. 15mins dwell at each (inclusive of ramps). 2 cycles per hour
HAST (unbiased)	JEDEC JESD22-A118	130±2°C, 85±5% R.H. for 96 (+2/-0) hours
Storage life (high temperature)	JEDEC JESD22-A103, Condition A	125°C +10/-0°C for ≥1000 hours
Storage life (low temperature)	JEDEC JESD22-A119	-40°C -10/+0°C for ≥1000 hours
MSL	IPC/JEDEC J-STD-020	Bake samples at 125 +5/-0°C for 24hours minimum before conditioning in the temperature/humidity chamber for 168 hours at 85°C/60%RH and Pb Free JEDEC Max profile conditioning with electrical testing, co-planarity, visual inspection before and after.
Vibration	JEDEC JESD22-B103	20Hz to 2 kHz to 20Hz (logarithmic variation) in >4 minutes, 4 times in each orientation (i.e. 12times), 50G (±10%) peak acceleration. Sinusoidal Vibration.
Shock	JEDEC JESD22 B110	5 pulses half sine pulses of 0.5msec (±15%)duration, 1500g (±10%) peak acceleration. This equates to free state test level B in JESD22-B110 which states an Equivalent drop height of 112cm and a Velocity change 468cm/s (±10%).
Solvent cleaning	Resistance to cleaning agents.	Solvent – Novec 71IPA & Topklean EL-20A. Pulsed ultrasonic immersion 45°C - 65°C

PART NUMBER STRUCTURE - SINGLE



PART NUMBER STRUCTURE - DUAL



GaN MANUFACTURES GATE DRIVE VOLTAGE

GaN manufactures	Gate voltage	MGN1 part number
GaN Systems	+6V/-3V	MGN1D050603MC & MGN1D120603MC
Infineon	8V	MGN1D0508MC & MGN1D1208MC
Texas Instruments	12V	MGN1D0512MC & MGN1D1212MC
GanPower international	+6V/-3V	MGN1D050603MC & MGN1D120603MC
Nexperia	12V	MGN1D0512MC & MGN1D1212MC
Navitas	12V	MGN1D0512MC & MGN1D1212MC
Transphorm	12V	MGN1D0512MC & MGN1D1212MC

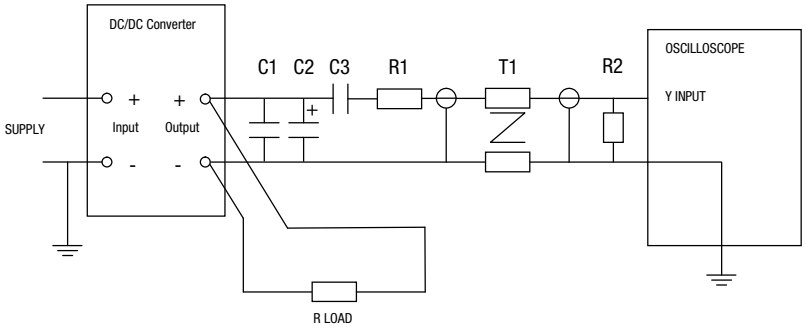
CHARACTERISATION TEST METHODS

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



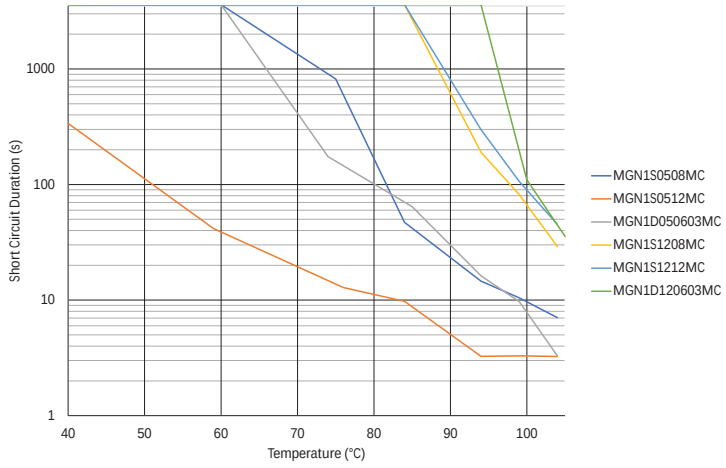
APPLICATION NOTES

Gate Drive Applications Advisory Note

For general guidance for product usage in gate drive applications please refer to "gate drive application notes".

Short Circuit Performance

Below an ambient temperature of 40°C, the MGN1 short circuit protection is continuous. Above 40°C, short circuit duration time is reduced as shown in the following graph:

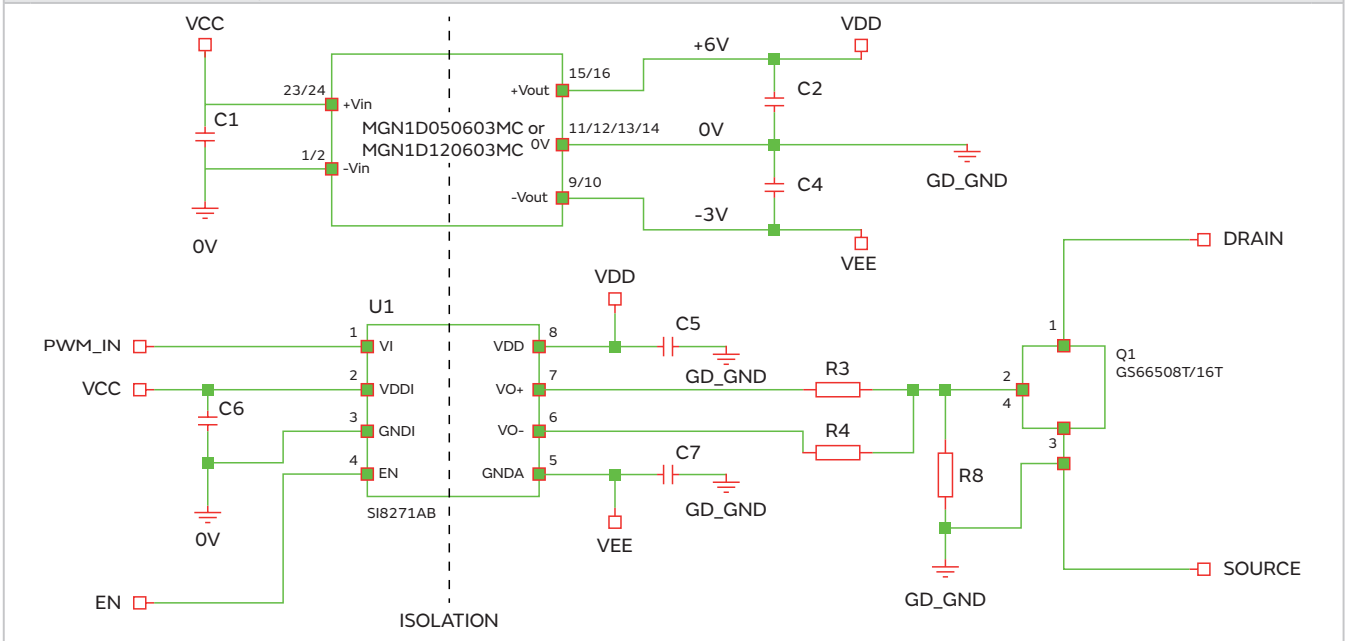


Typical Application Circuit Diagrams

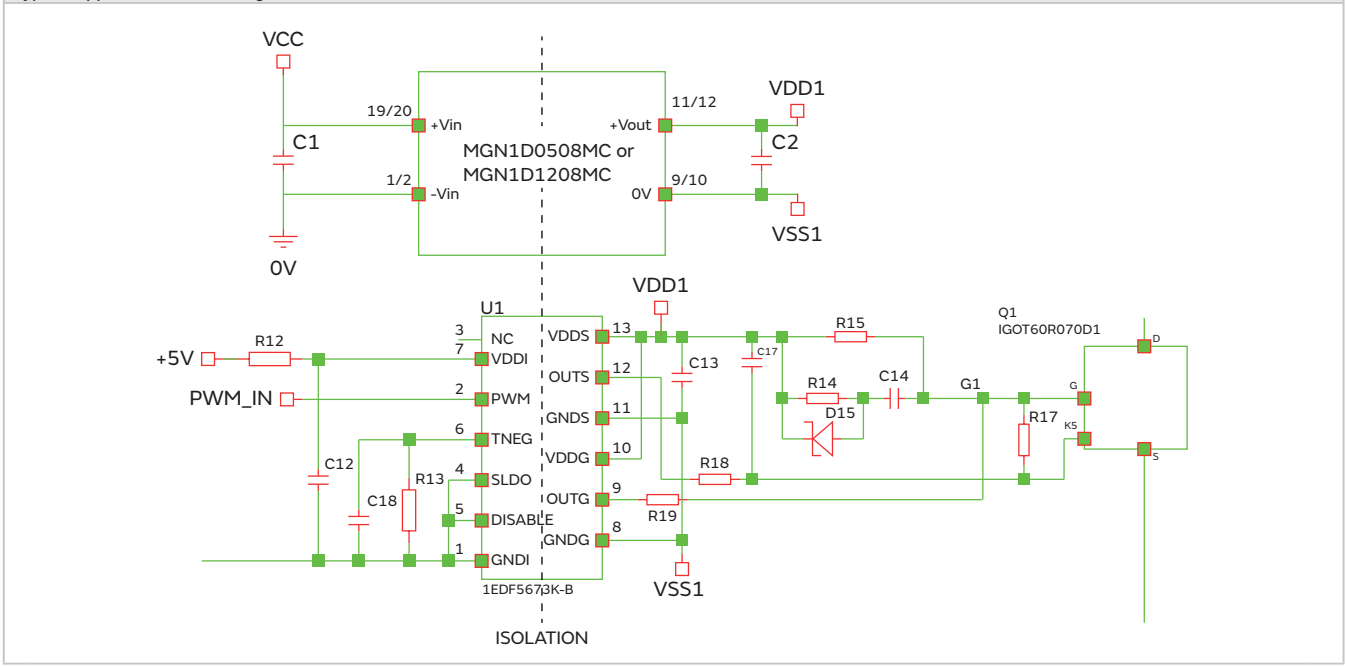
The following circuit diagrams are intended to provide guidance on how to connect the MGN1 series to GaN drivers for GaN devices. Please refer to GaN manufactures datasheets for full application circuits.

APPLICATION NOTES (Continued)

Typical Application Circuit Diagrams - GaN Systems

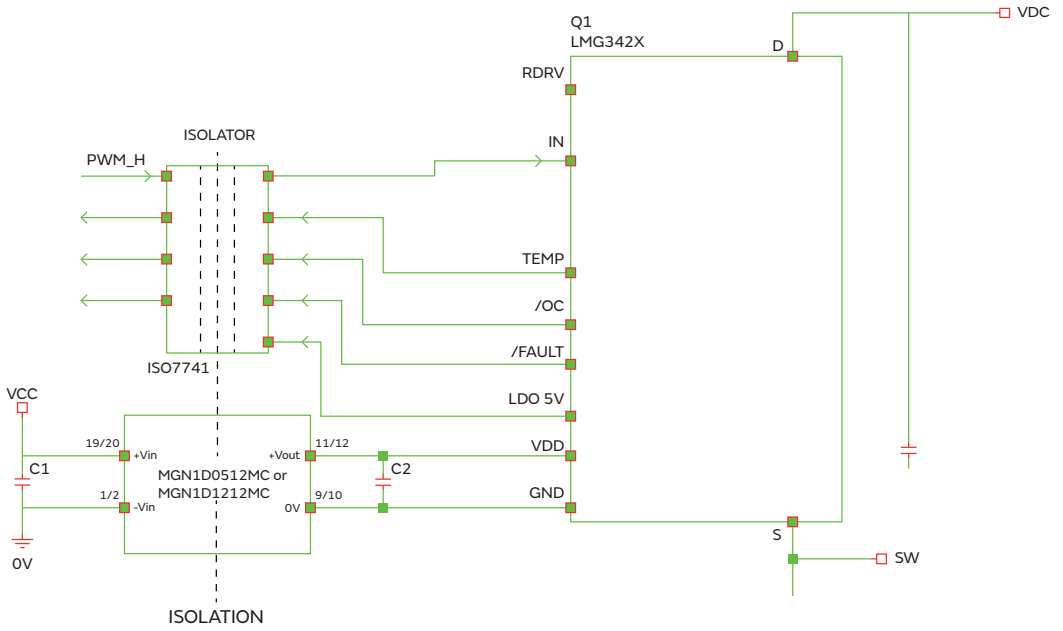


Typical Application Circuit Diagrams - Infineon

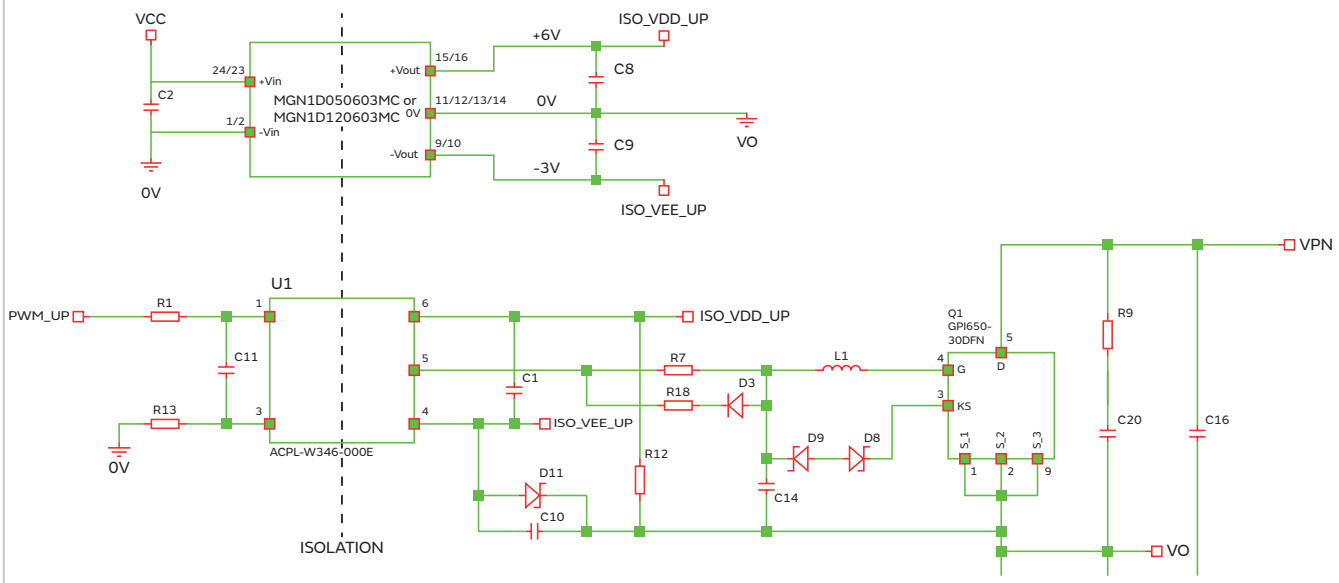


APPLICATION NOTES (Continued)

Typical Application Circuit Diagrams - Texas instruments

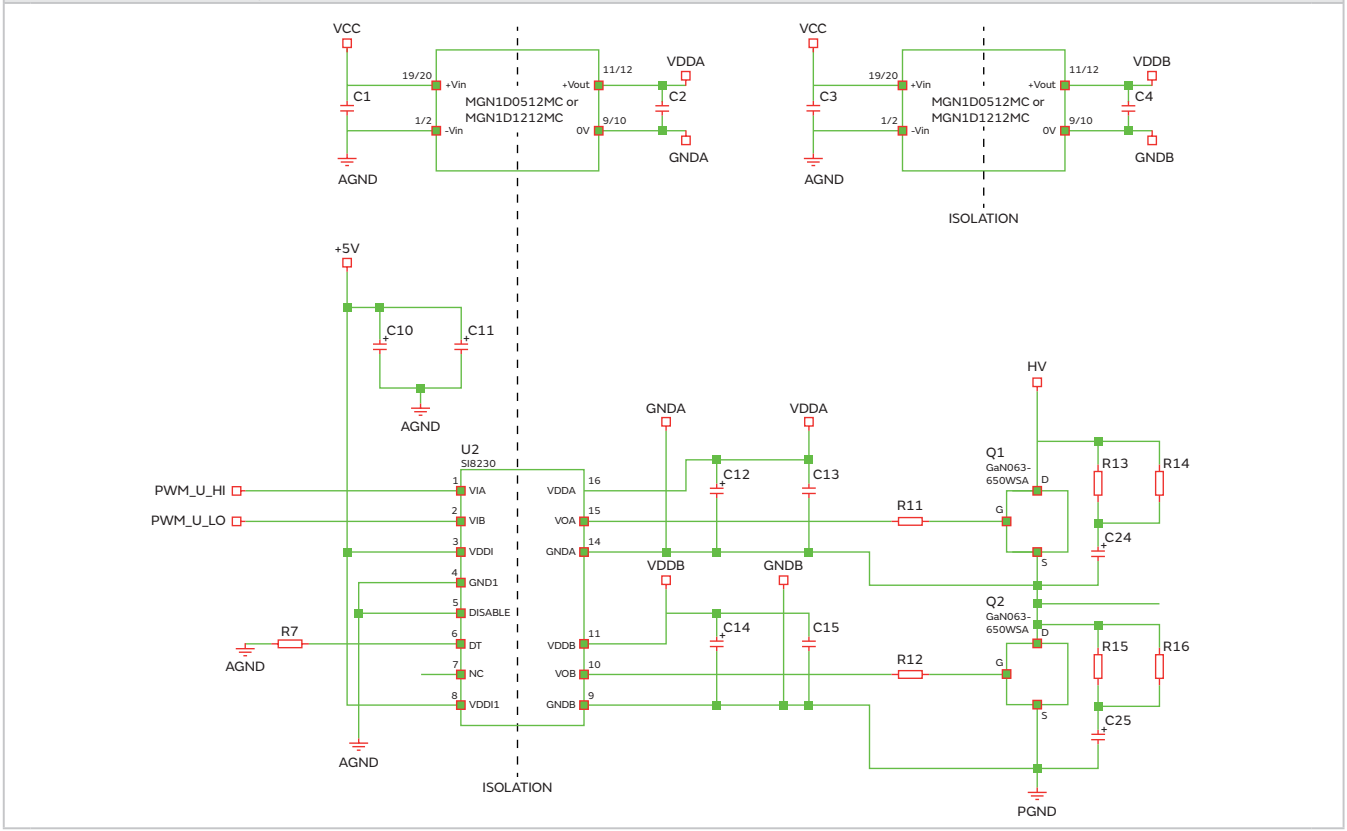


Typical Application Circuit Diagrams - Ganpower International

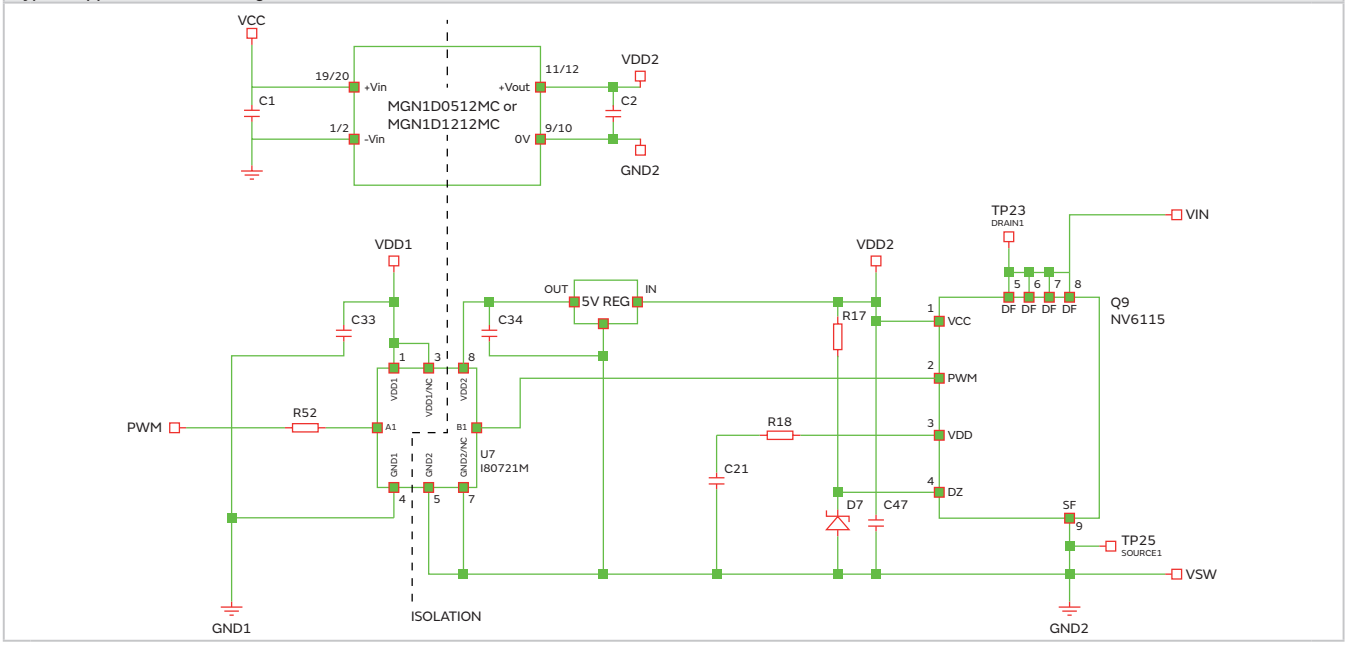


APPLICATION NOTES (Continued)

Typical Application Circuit Diagrams - Nexperia

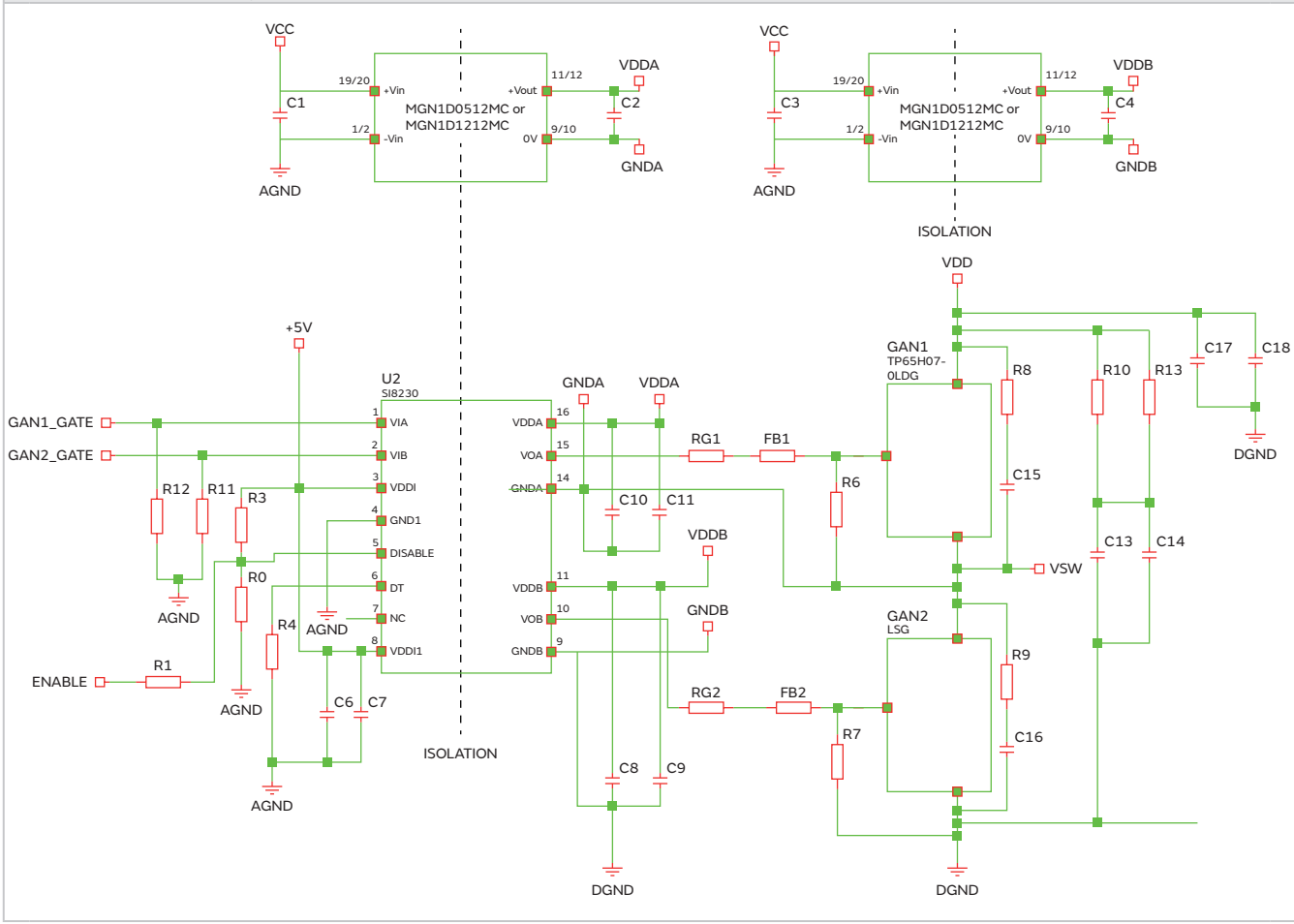


Typical Application Circuit Diagrams - Navitas



APPLICATION NOTES (Continued)

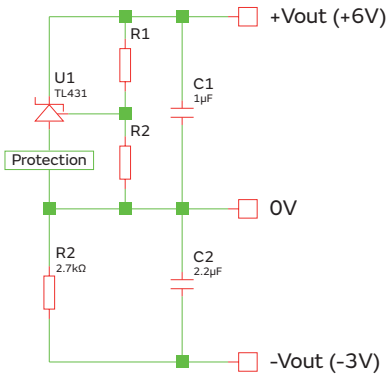
Typical Application Circuit Diagrams - Transphorm



Dual Output Configuration

The MGN1D050603MC and MGN1D120603MC are dual output DC-DC converters specifically designed for gate drive applications and are not suitable for general purpose dual output use. However, each can be used as a general purpose single 9V output converter, by loading from +Vout to -Vout.

The MGN1D050603MC and MGN1D120603MC provide a dual output by using a reference IC and resistor divider network circuit with patented short circuit protection. This is important to maintain an accurate 6V to the gate of the GaN device over the temperature range and operating conditions, something a Zener diode cannot guarantee.



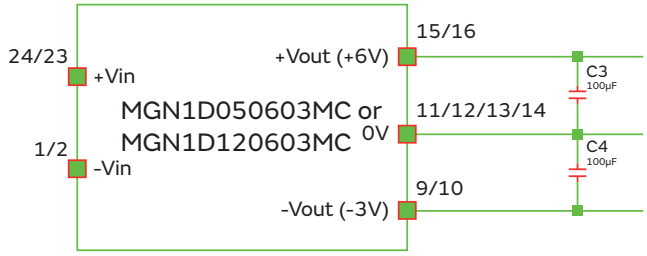
APPLICATION NOTES (Continued)

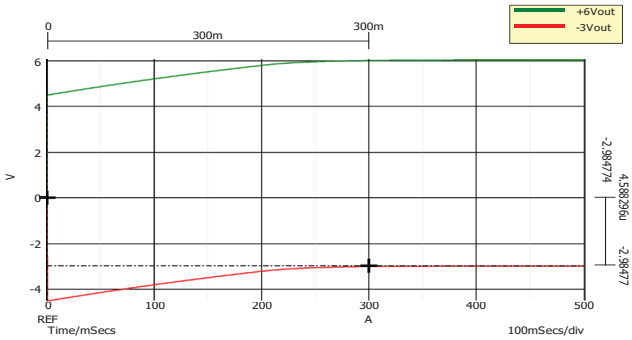
Capacitive loading and start up

The typical start up for single output variants, using a 56uF capacitor is 10mS. The start up behaviour of the +Vout and -Vout rails of a dual output DC-DC using a divider network depends significantly on the additional capacitance added to the outputs. This is because the two capacitors behave as a capacitive divider. If the two capacitors are equal and 9V is applied across them the outputs will initially start as +/-4.5V.
There will be a settling time while the divider circuit adjusts to the correct voltages, to calulcate the approixmate value please refer to the following formula.

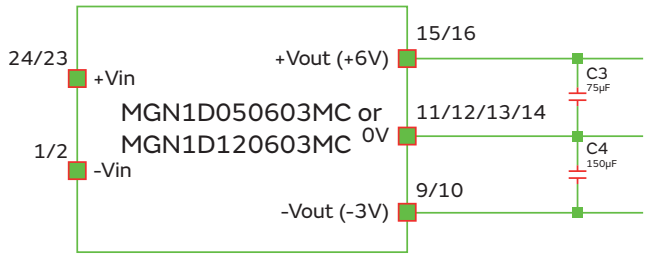
Settling time ≈ 3000 x C (s)

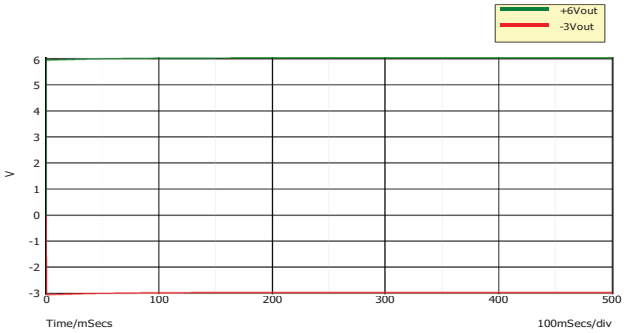
So, for instance if a maximum capacitance of 100uF is applied to each output the settling time will be about 300ms.





To avoid spurious gate pulses it is recommended that the PWM gate signal is not applied until after the settling time has ended.
An alternative method to reduce the settling time is to adjust the values of the additional capacitance so that the CV products are equal. i.e. C3 x 6V = C4 x 3V.
So, for instance if a maximum capacitance of 75uF is applied to the +6V output and 150uF is applied to the -3V output the settling time is greatly reduced.

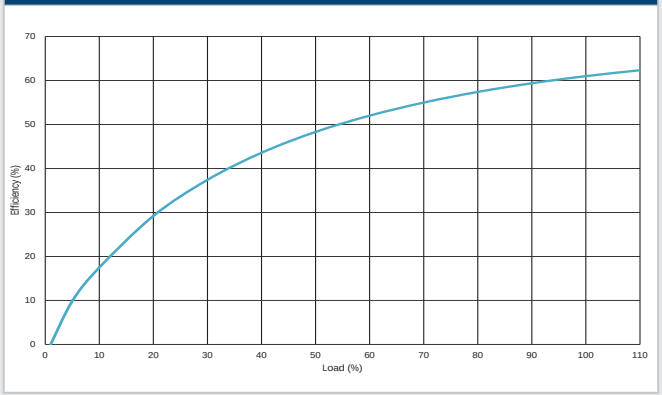




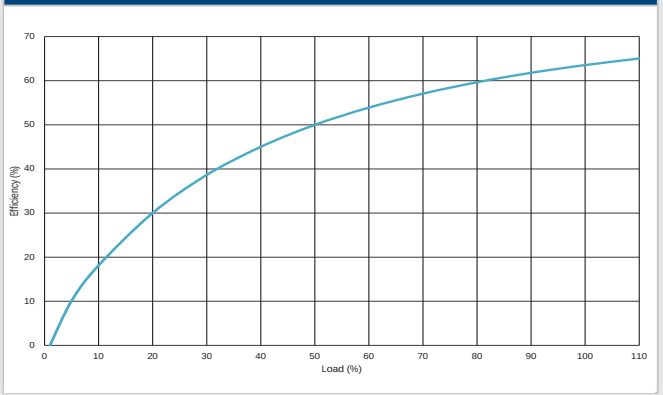
NB: The total maximum series capacitance across 9V = 50uF.

EFFICIENCY VS LOAD

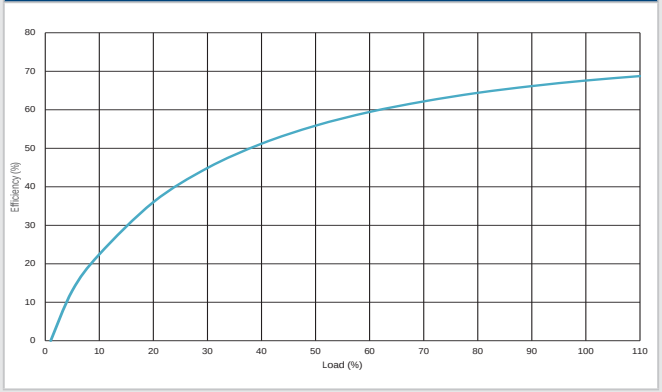
MGN1S0508MC



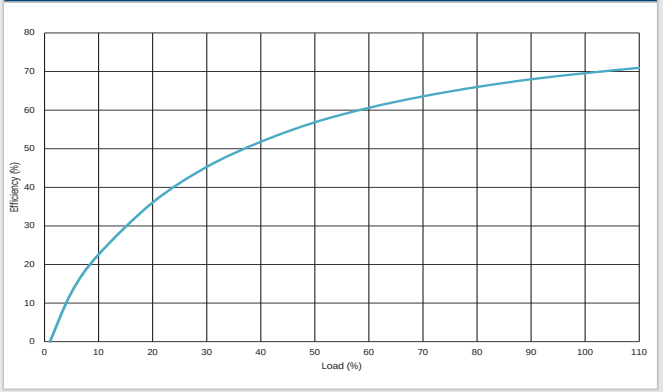
MGN1S0512MC



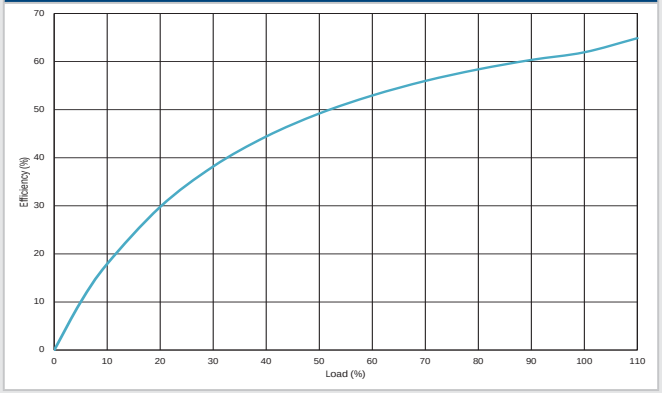
MGN1S1208MC



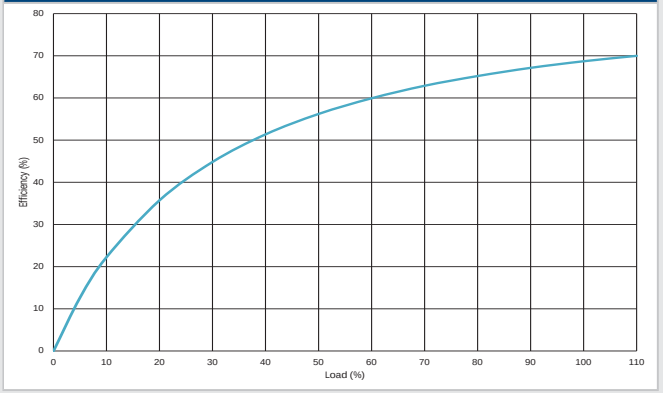
MGN1S1212MC



MGN1D050603MC

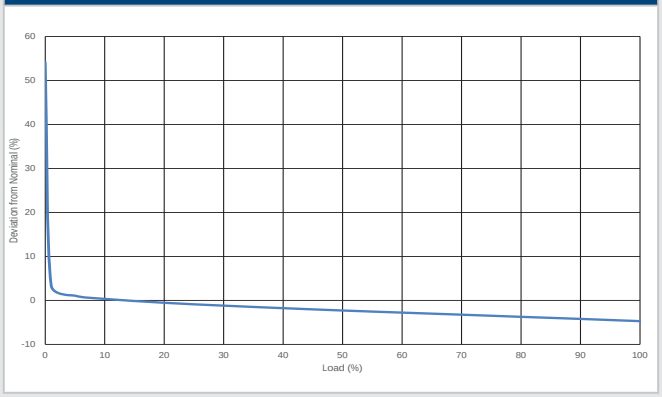


MGN1D120603MC

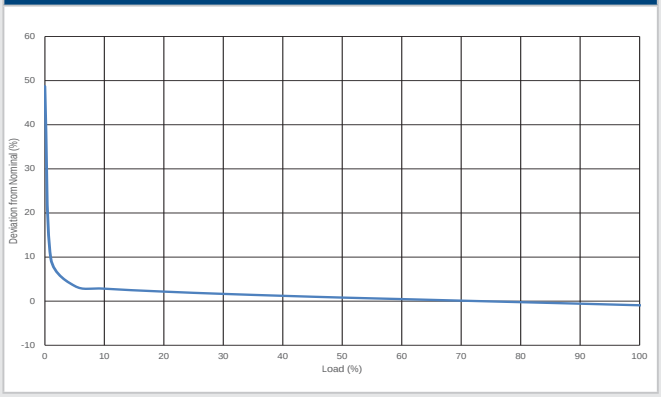


OUTPUT VOLTAGE DEVIATION FROM NOMINAL VS LOAD

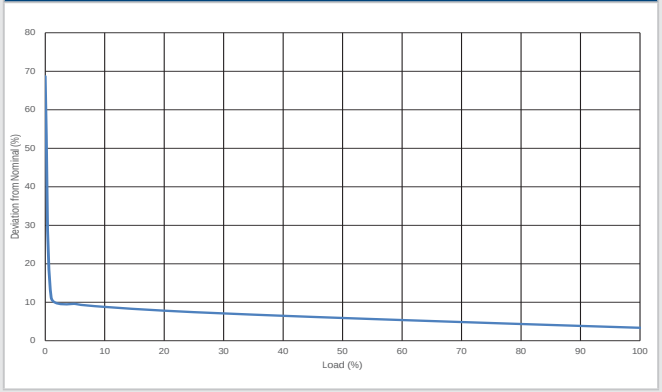
MGN1S0508MC



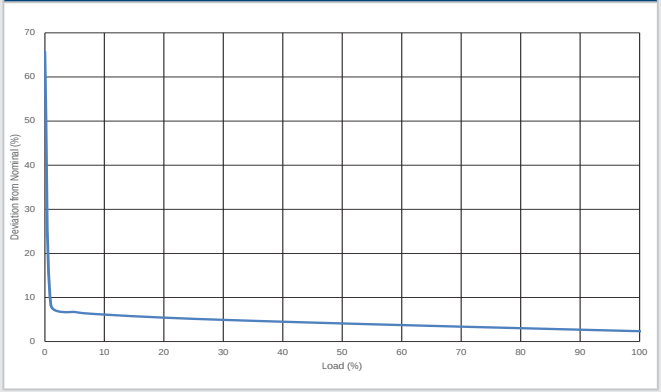
MGN1S0512MC



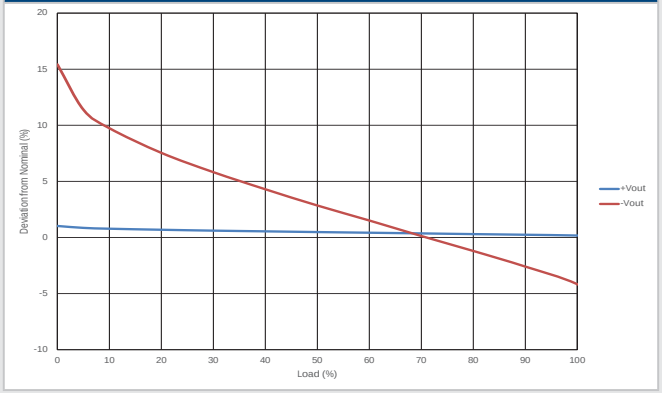
MGN1S1208MC



MGN1S1212MC



MGN1D050603MC



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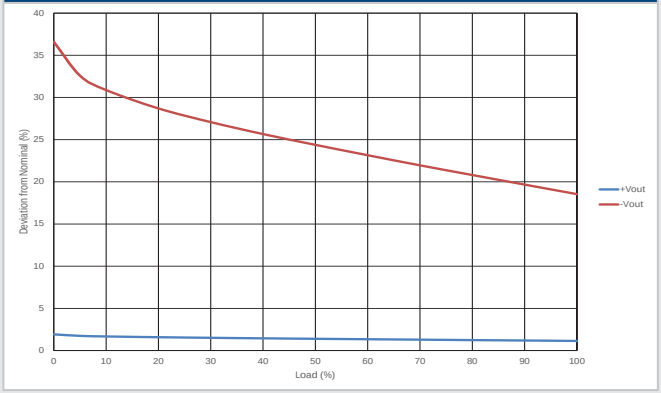
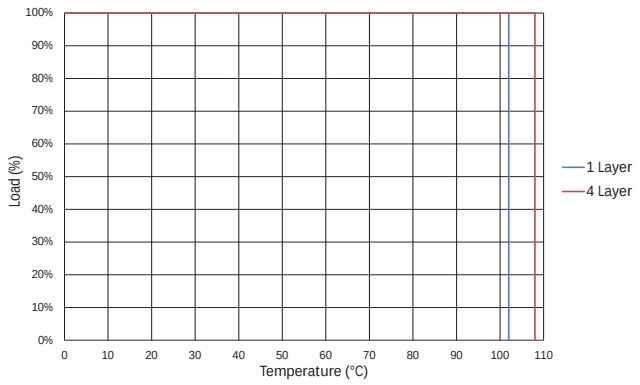


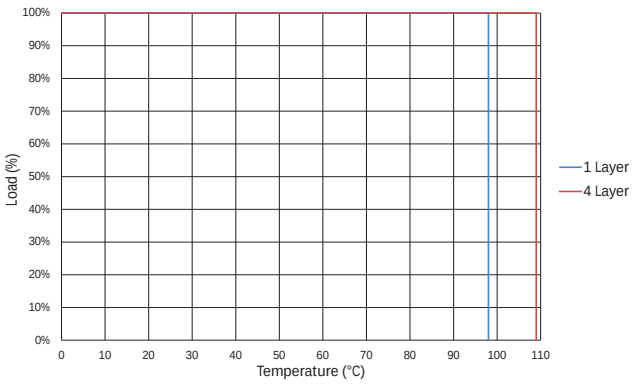
TEMPERATURE DERATING

The MGN1 series has been designed to minimise the thermal impedance when mounted onto a customers application PCB by using multiple surface mount pads for each connection. All thermal measurements were carried out in still air using a test pcb designed in accordance with standard JESD51-9 (Test Boards for Area Array Surface Mount Package Thermal Measurements). A single layer and a 4 layer have been used and this demonstrates that a higher operating temperature can be achieved when the customers application pcb is designed to incorporate multiple layers and large copper planes. Please contact Murata for further information.

MGN1S0508MC



MGN1S0512MC



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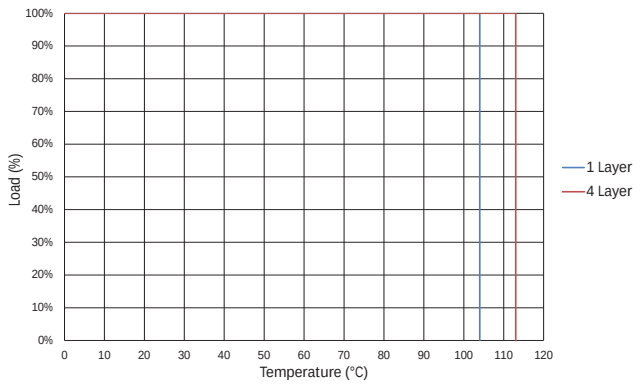

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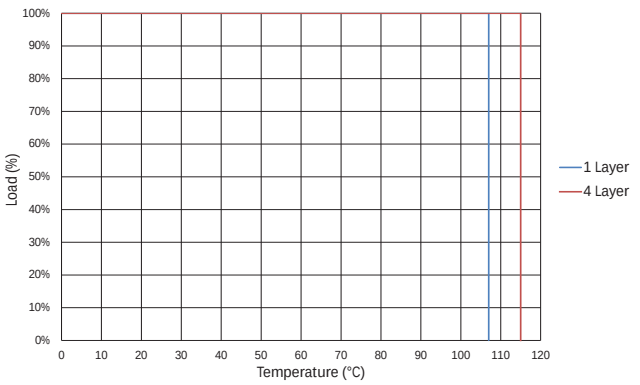

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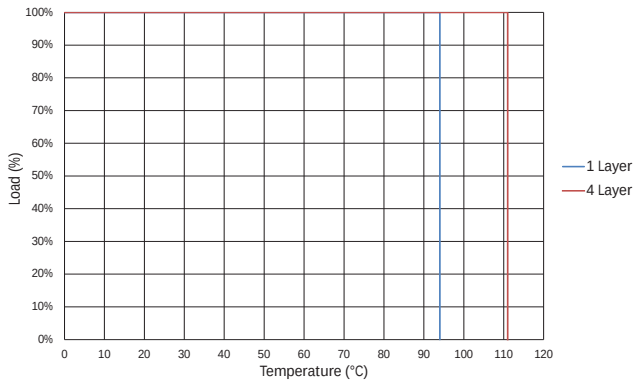

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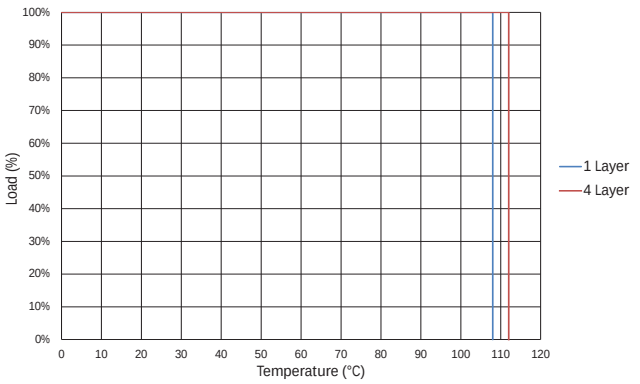
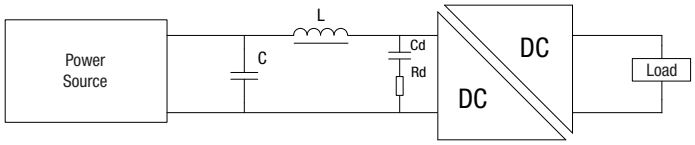


EMC FILTERING AND SPECTRA

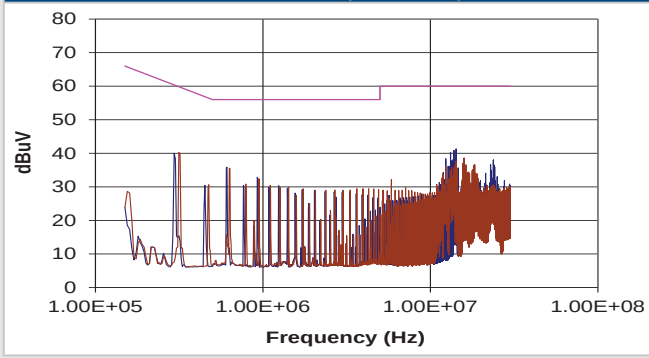
FILTERING

The following filter circuit and filter table shows the input filters typically required to meet EN55022 Quasi-PeakCurve A or B.

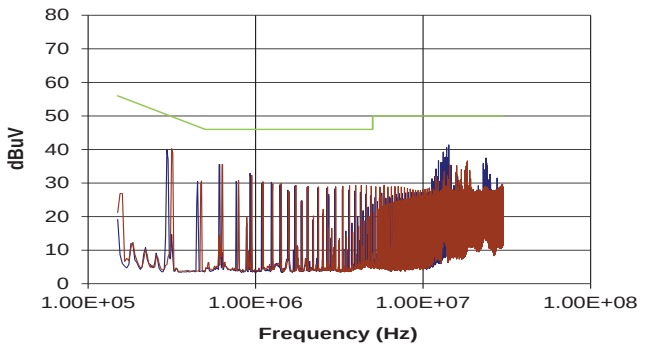


	Inductor		Capacitor		Resistor	Capacitor
	L, µH	SMD	C, µF	SMD	Rd, Ω	Cd, µF
MGN1S0508MC	22	29223C	10	GRM31CR61E106KA12L	3	10
MGN1S0512MC	22	29223C	10	GRM31CR61E106KA12L	3	10
MGN1S1208MC	10	34103C	10	GRM31CR61E106KA12L	3	10
MGN1S1212MC	10	34103C	10	GRM31CR61E106KA12L	3	10
MGN1S050603MC	22	29223C	10	GRM31CR61E106KA12L	3	10
MGN1S120603MC	10	34103C	10	GRM31CR61E106KA12L	3	10

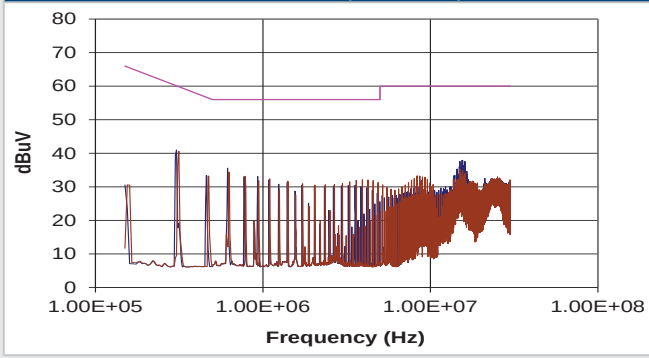
MGN1S0508MC (Quasi-Peak)



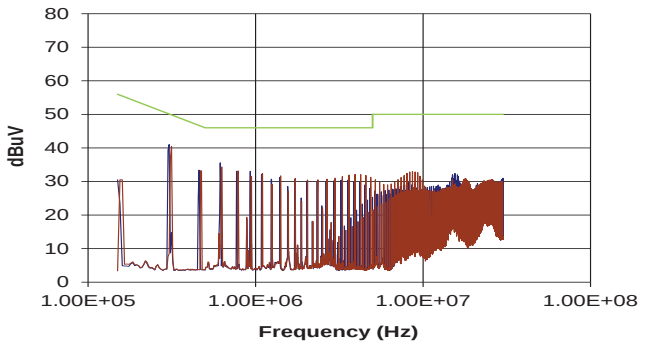
MGN1S0508MC (Average)



MGN1S0512MC (Quasi-Peak)

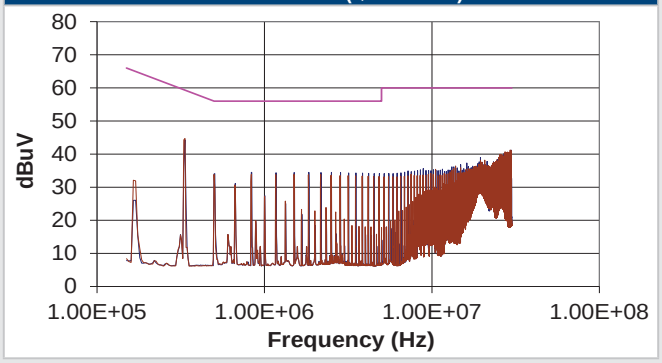


MGN1S0512MC (Average)

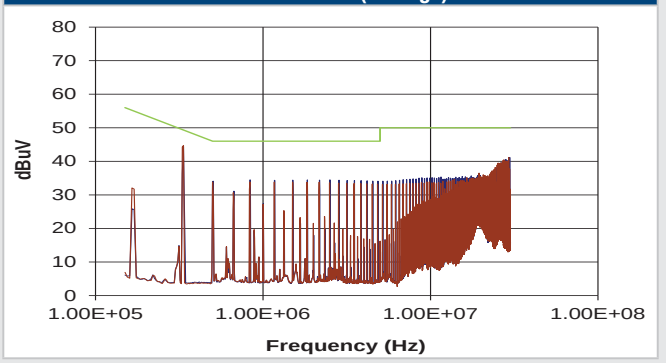


EMC FILTERING AND SPECTRA

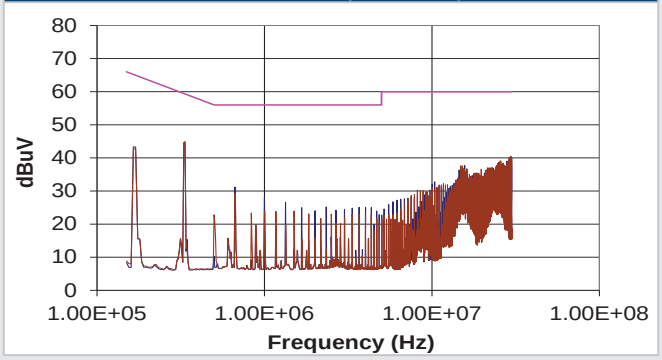
MGN1S1208MC (Quasi-Peak)



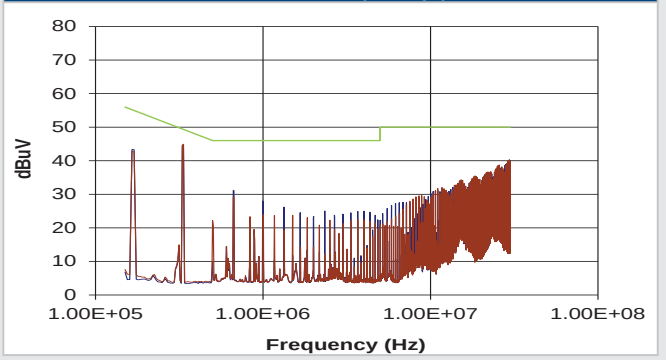
MGN1S1208MC (Average)



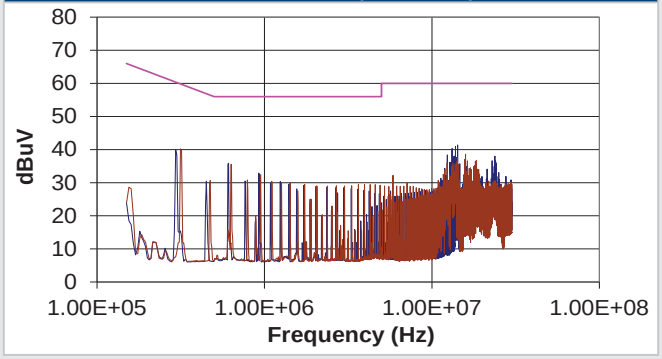
MGN1S1212MC (Quasi-Peak)



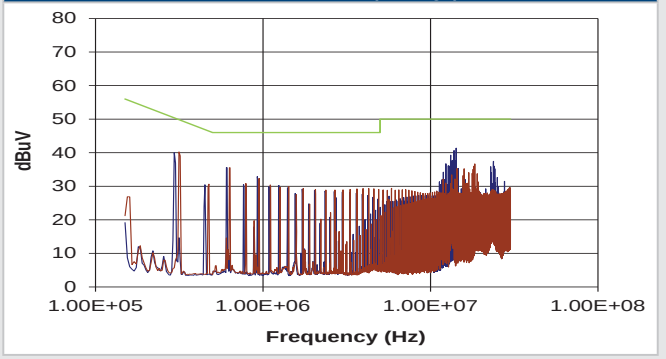
MGN1S1212MC (Average)



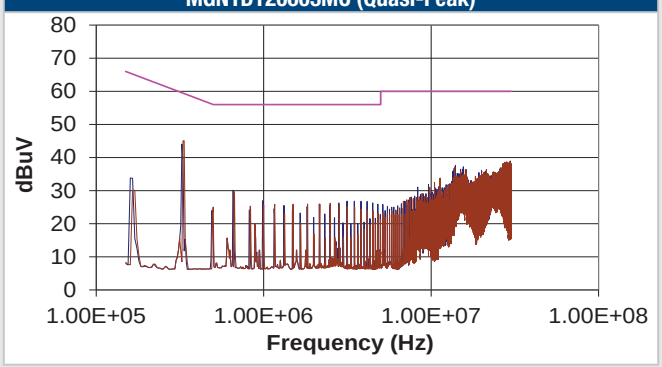
MGN1D050603MC (Quasi-Peak)



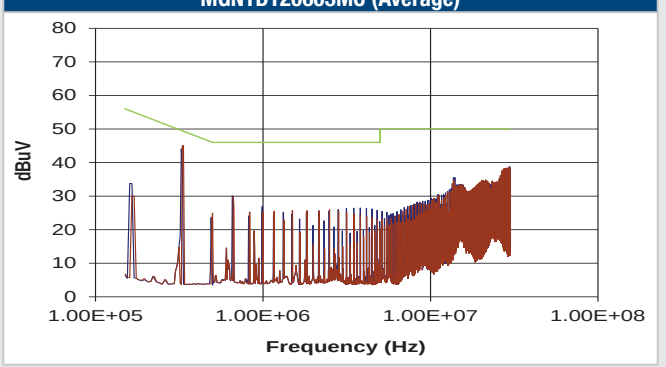
MGN1D050603MC (Average)



MGN1D120603MC (Quasi-Peak)

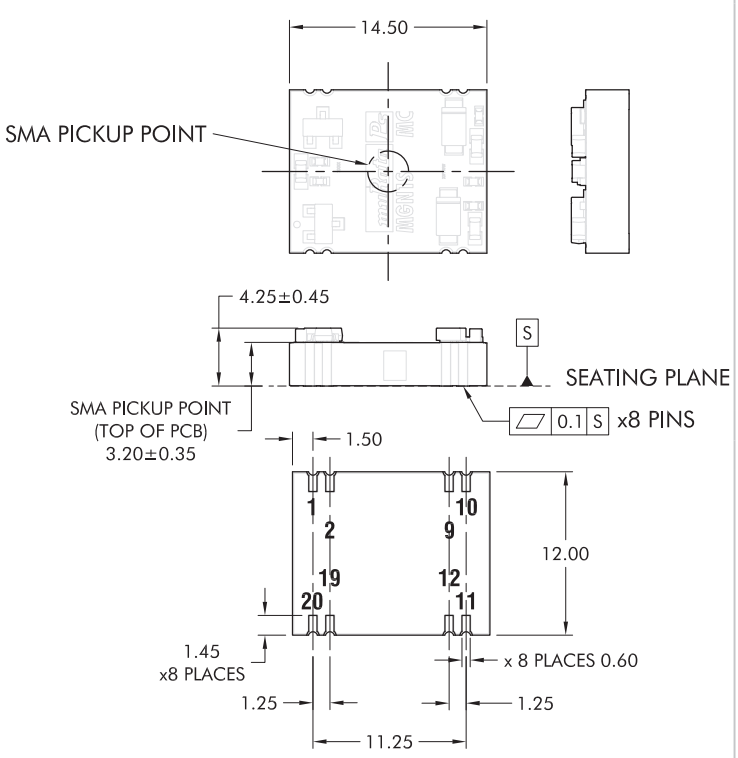


MGN1D120603MC (Average)



PACKAGE SPECIFICATIONS

MECHANICAL DIMENSIONS (SINGLE)



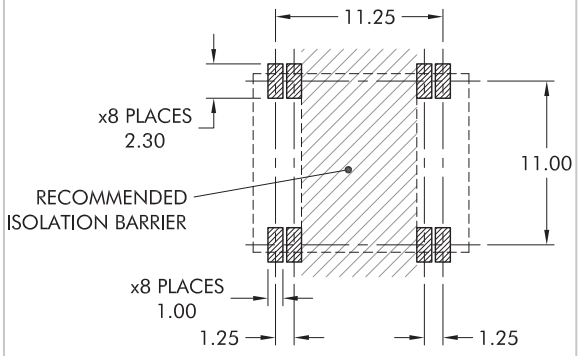
All dimensions in mm.
Tolerances (unless otherwise stated) ±0.2.
Components shown for reference only

Weight: 1.3g

PIN CONNECTIONS

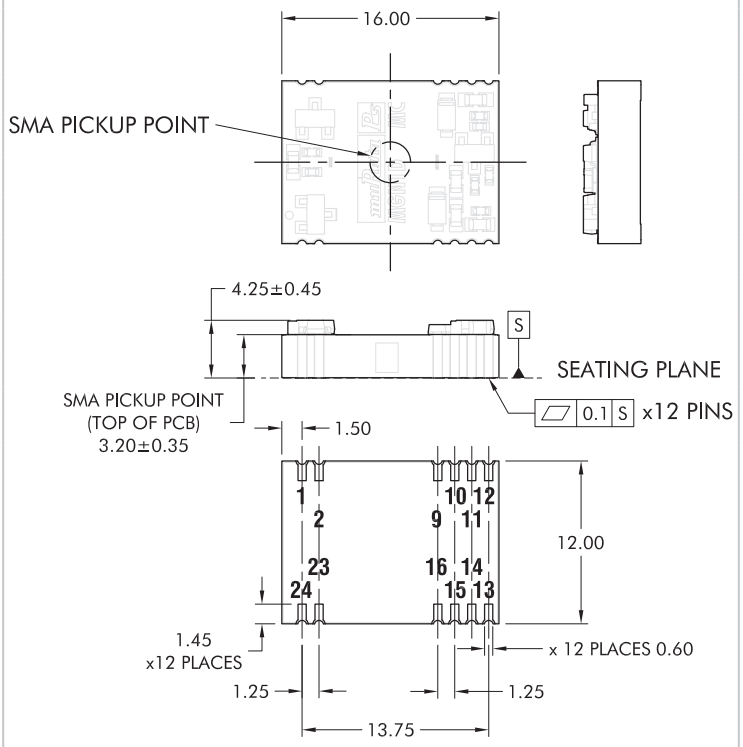
Pin	Function
1	-Vin
2	-Vin
9	0V
10	0V
11	+Vout
12	+Vout
19	+Vin
20	+Vin

RECOMMENDED FOOTPRINT DETAILS



PACKAGE SPECIFICATIONS

MECHANICAL DIMENSIONS (DUAL)



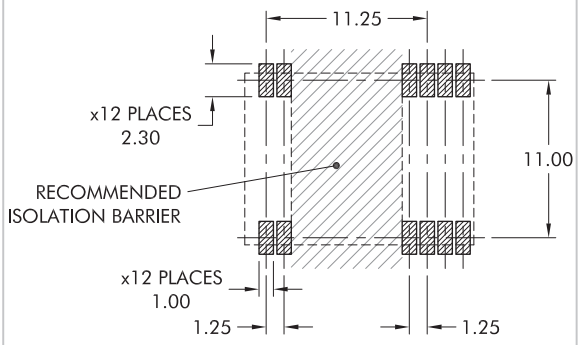
All dimensions in mm.
Tolerances (unless otherwise stated) ±0.2.
Components shown for reference only

Weight: 1.5g

PIN CONNECTIONS

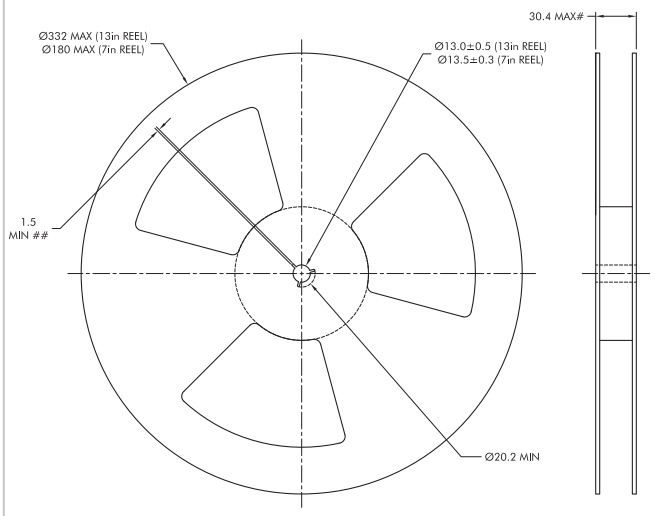
Pin	Function	Pin	Function
1	-Vin	13	0V
2	-Vin	14	0V
9	-Vout	15	+Vout
10	-Vout	16	+Vout
11	0V	23	+Vin
12	0V	24	+Vin

RECOMMENDED FOOTPRINT DETAILS



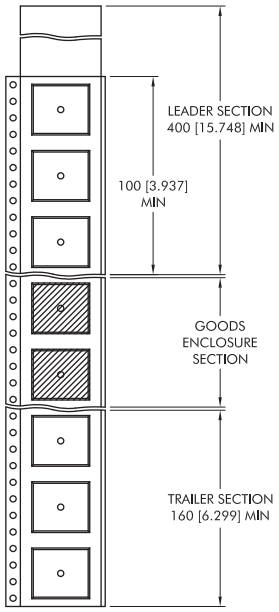
TAPE & REEL SPECIFICATIONS

Reel Outline Dimensions



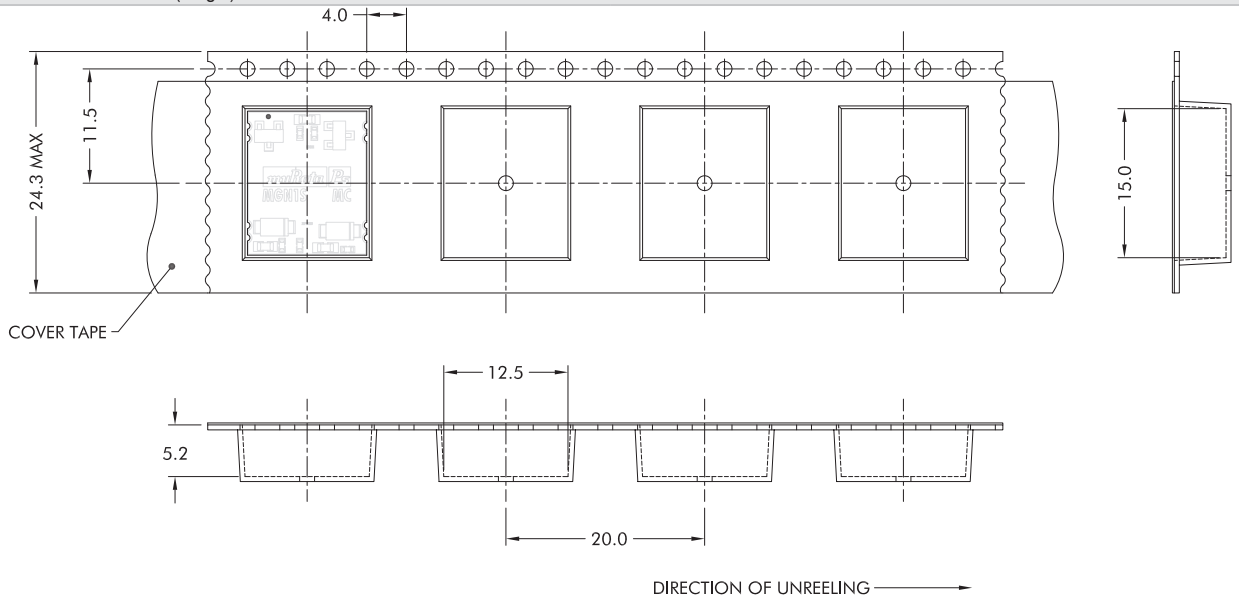
All dimension in mm
Measured at hub
Six equi-spaced slots on 180mm/7" reel

Reel Packaging Details



Reel Quantity: 7" - 155 or 13" - 620

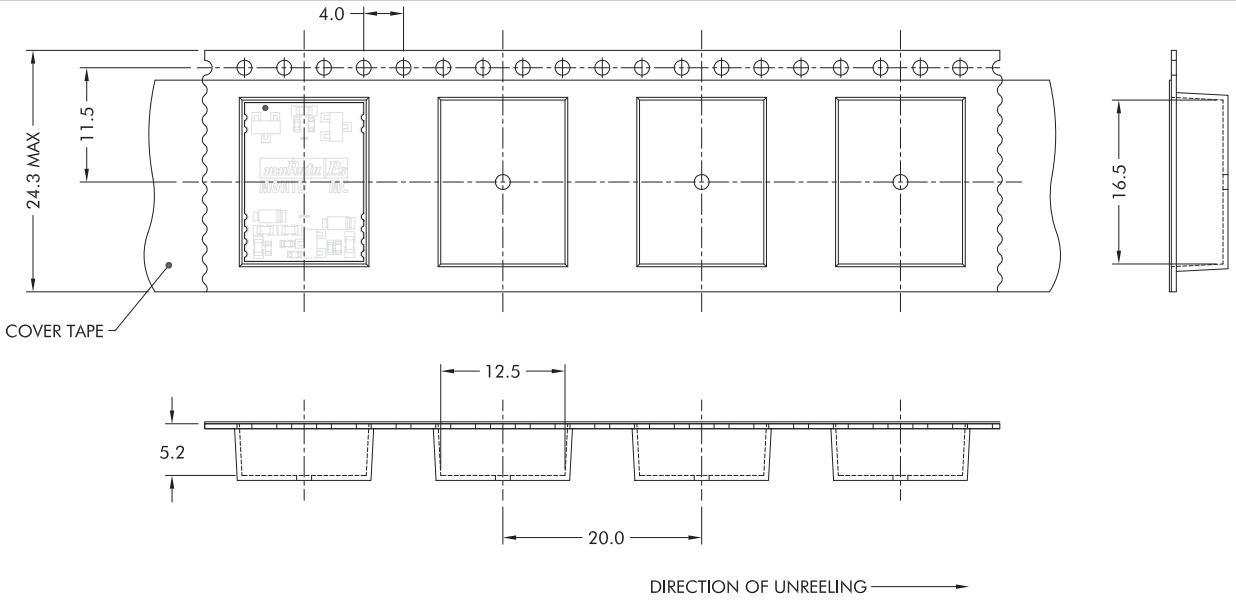
Tape Outline Dimensions (Single)



All dimensions in mm
Components shall be orientated within the carrier tape as indicated

TAPE & REEL SPECIFICATIONS

Tape Outline Dimensions (Single)



All dimensions in mm
Components shall be orientated within the carrier tape as indicated

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- Undersea equipment
- Power plant control equipment
- Medical equipment
- Transportation equipment (automobiles, trains, ships, etc.)
- Traffic signal equipment
- Disaster prevention / crime prevention equipment
- Data Processing equipment

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