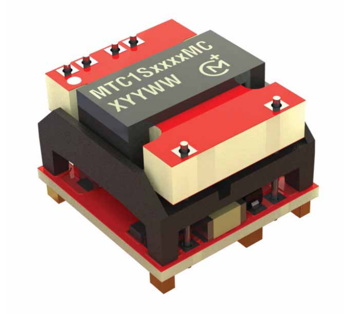
Murata Power Solutions

MTC1 Series

Isolated 1W SM 2:1 Input Single Output DC-DC Converters



FEATURES

- UL60950 recognised for reinforced insulation
- ANSI/AAMI ES60601-1, 1 MOPP/ 2 MOOPs recognised[4]
- 3kVAC isolation test voltage 'Hi Pot Test'
- Continuous short circuit protection
- Output voltage trim
- Remote on/off pin
- No electrolytic capacitors
- Operation up to 105°C (With derating)
- 2:1 input range

PRODUCT OVERVIEW

The MTC1 series of miniature surface mount DC-DC converters offers a single output voltage from input voltage ranges of 4.5-9V, 9-18V and 18-36V. The MTC1 series regulated output voltage is adjustable by ±10% and a remote on/off pin is also included for application power saving.

The MTC1 ideally suited to applications which include medical. Industrial, telecommunications, battery powered systems and process automation.

SELECTION GUIDE

Order Code[1]	Input Voltage	Output Voltage	Output Current	Rated Input Current	Efficiency		Ripple and Noise		MTTF[2]	
	Nom.				Min.	Typ.	Typ.	Max.	MIL.	Tel.
	V	V	mA	mA	%	%	mVp/p	mVp/p	kHrs	kHrs
MTC1S0503MC[3]	5	3.3	303	270	72	75	70	120	1938	4597
MTC1S0505MC[3]	5	5	200	270	72	76	70	120	1825	4658
MTC1S0512MC[3]	5	12	83	270	73	76.5	50	120	1841	5793
MTC1S1203MC	12	3.3	303	110	72	75	25	50	1463	4635
MTC1S1205MC	12	5	200	110	77	78.5	25	50	1735	5751
MTC1S1212MC	12	12	83	100	77	79	20	40	1559	6056
MTC1S2403MC	24	3.3	303	55	73	75.5	30	55	1508	5085
MTC1S2405MC	24	5	200	55	74	76.5	25	50	1499	5458
MTC1S2412MC	24	12	83	55	75	77	25	50	1435	5234

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	
Input reflected ripple current	0503		10		mA p-p
	0505		15		
	0512		25		
	All other variants		2		

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
Isolation capacitance		5V input types			20		pF
		All other variants			7		
Resistance		Viso = 1kVDC		1			GΩ
Safety Standard	UL60950-1	Reinforced	Creepage and clearance 5mm			250	VAC
	ANSI/AAMI ES60601-1	1 MOPP/2 MOOP				250	

OUTPUT CHARACTERISTICS

Parameter	Conditions	Min.	Typ.	Max.	Units
Rated power	All output types			1	W
Minimal load to meet datasheet specification		10			%
Voltage set point accuracy	3V, 5V output & 5V input types	-2.5		2	%
	1212 & 2412	-3		2	
Line regulation	Low line to high line		±0.05	±0.2	%
Load regulation	All output types		±0.05	±0.2	%

1. Components are supplied in tape and reel packaging, please refer to package specification section. Orderable part numbers are MTC1SXXXXMC-R7 (30 pieces per reel), or MTC1SXXXXMC-R13 (150 pieces per reel).
2. Calculated using MIL-HDBK-217 FN2 and Telecordia SR-332 calculation model with nominal input voltage at full load.
3. MTC1S05xxMC variants are currently pending recognition to UL62368-1 as UL60950 is superseded by UL62638.
4. ANSI/AAMI ES60601-1 recognition is currently pending for MTC1S05xxMC.

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

RoHS COMPLIANT

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

OUTPUT CHARACTERISTICS (Continued)						
Parameter	Conditions		Min.	Typ.	Max.	Units
Transient response	Peak deviation (25-75% & 75-25% swing)	0512			±1	$\%V_{out}$
		2403			±4	
		2405			±3	
		All other variants			±2	
	Settling time (within 5% V_{out} Nom.)	0503		350		µs
		0505		400		
		0512		100		
		1203		220		
		1205		260		
		1212, 2403 & 2405		100		
		2412		70		

GENERAL CHARACTERISTICS					
Parameter	Conditions	Min.	Typ.	Max.	Units
Switching frequency	0503		125		kHz
	0505		85		
	0512		110		
	1203, 2405, 2403 variants		240		
	1205, 2412 variants		260		
	1212		300		
Remote on/off pin	Module on, pin unconnected or open collector floating				
	Module off (refer to application notes)		2		V
	5V input types		0.25		mW
	12V input types		1.5		
	24V input types		3.9		

TEMPERATURE CHARACTERISTICS					
Parameter	Conditions	Min.	Typ.	Max.	Units
Operation	See derating curves	-40		105	°C
Storage		-50		125	
Case temperature above ambient	100% Load, Nom V_{IN}, Still Air		15		

ABSOLUTE MAXIMUM RATINGS	
Short-circuit protection (for SELV input voltages)	Continuous
Remote on/off pin input voltage	6V
Input voltage, MTC1 5V input types	15V
Input voltage, MTC1 12V input types	25V
Input voltage, MTC1 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 MTC1 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?"

The MTC1 series has been recognised 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 MTC1 series has been recognised by Underwriters Laboratory (UL) to ANSI/AAMI ES60601-1 and provides 1 MOPP (Means Of Patient Protection) and 2 MOOP (Means Of Operator Protection) based upon a working voltage of 250 Vrms max., between Primary and Secondary. The MTC1S05xxMC variants are currently pending recognition.

File number E202895 applies.

UL60950

The MTC1 series has been recognised by Underwriters Laboratory (UL) to UL 60950 for reinforced insulation to a working voltage of 250 Vrms. File number E151252 applies.

Creepage and clearance is 5mm.

FUSING

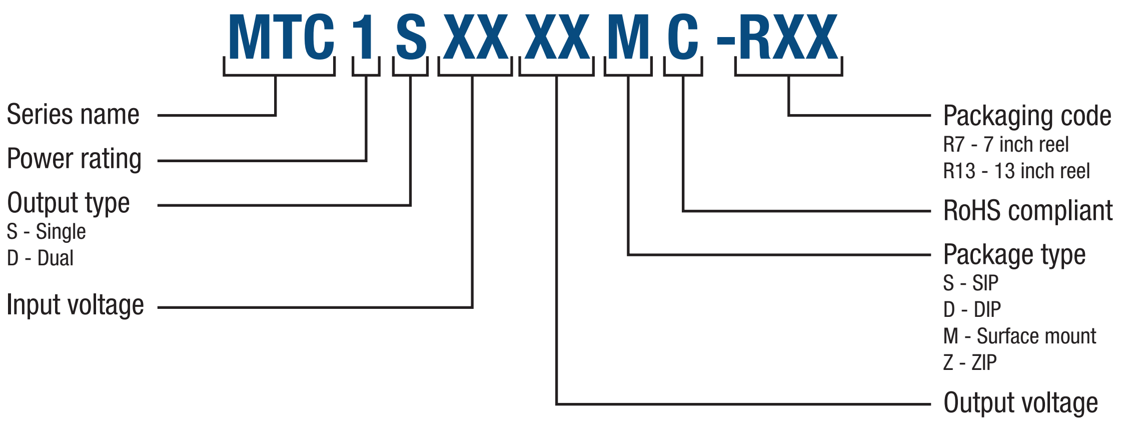
The MTC1 Series of converters are not internally fused so to meet the requirements of UL an anti-surge input line fuse should always be used with ratings as defined below.
Input Voltage, 5V: 0.5A (Fuse value is pending Underwriters Laboratory (UL) confirmation.)
Input Voltage, 12V: 0.5A
Input Voltage, 24V: 0.25A
All fuses should be UL recognised and rated to 125V.

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 MTC1 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 90 sec max. Please refer to application notes for further information. The pin termination finish on this product series is Gold with Nickel Pre-plate.

PART NUMBER STRUCTURE



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	MIL-STD-883 1010, Condition B	10 cycles between two chambers set to achieve -55°C and +125°C.The dwell time shall not be less than 10min and the load shall reach the specified temperature in 15min.
HAST (biased)	JEDEC JESD22-A110	96Hrs +2/-0Hrs at 130°C ± 2°C, 85% ± 5% R.H.
High temperature storage life	JEDEC JESD22-A103, Condition A	125°C +10/-0°C for ≥1000 hours
Vibration	BS EN 61373 with respect to BS EN 60068-2-64, Test Fh Category 1 Class B	5 – 150Hz. Level at each axis – Vertical, Traverse and Longitudinal: 5.72m/s^2 rms. 5 hours in each axis. Crest factor: 3 Sigma. Device is secured via pins.
Shock	BS EN 61373: Category 1 Class B	Test is 30ms duration, 3 shocks in each sense of 3 mutually perpendicular axes (18 shocks total). Level at each axis as follows: Vertical, Traverse and Longitudinal: 50m/s^2. Device is secured via pins.
Solderability	IPC/ECA J-STD-002, Test A and A1	SnPb (Test A): For lead free solderability, 5 off Parts conditioned to a 48hour dry bake at 125°C followed by 4 hours at 155°C and 5 off Parts conditioned to 96hours at 125°C. All 10 Dipped in solder at 245°C ±5°C for 5 +0/-0.5 seconds. Pb-free (Test A1): For leaded solderability, 5 off Parts conditioned to a 48hour dry bake at 125°C followed by 4 hours at 155°C and 5 off Parts conditioned to 96hours at 125°C. All 10 Dipped in solder at 255°C ±5°C for 5 +0/-0.5 seconds.
Solvent cleaning	Resistance to cleaning agents	Solvent – Novec 71IPA & Topklean EL-20A. Pulsed ultrasonic immersion 45°C- 65°C
Solvent resistance	MIL-STD-883, Method 2015	The parts and the bristle portion of the brush are immersed in Isopropanol for a minimum of 1 minute. The parts are brushed 3 times, after the third time the parts are blown dry and inspected.

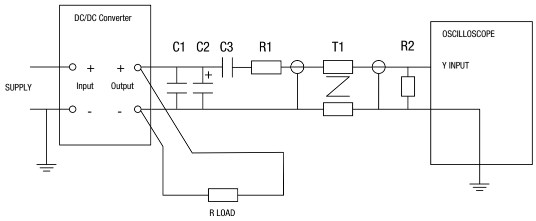
CHARACTERISATION TEST METHODS

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

Maximum Output Capacitance

Maximum output capacitance should not exceed:

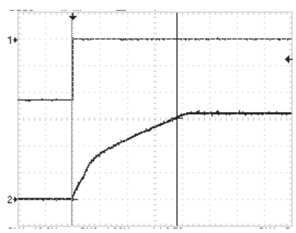
Output Voltage	Maximum Load Capacitance
V	µF
3.3	470
5	470
12	220

Start-up times

Typical start up times for this series, with a typical input voltage rise time of 2.2µs and output capacitance of 10µF, are shown in the table below. The product series will start into the maximum output capacitance with increased start times.

Part No.	Start-up times
	ms
MTC1S0503MC	6
MTC1S0505MC	12
MTC1S0512MC	30
MTC1S1203MC	5
MTC1S1205MC	14
MTC1S1212MC	25
MTC1S2403MC	9
MTC1S2405MC	14
MTC1S2412MC	25

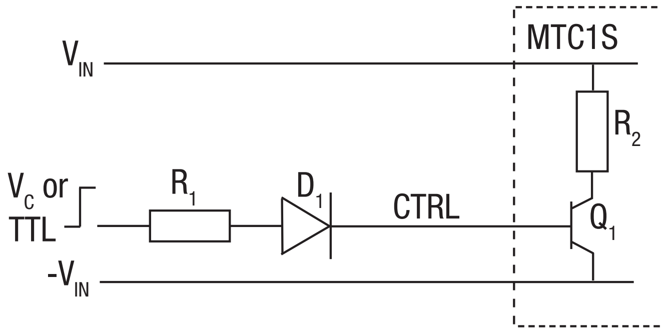
Typical Wave Form:



APPLICATION NOTES (Continued)

Control Pin

The MTC1 converters have a shutdown feature which enables the user to disable the converter into a low power state. The control pin connects to the base of an internal NPN transistor with the converter shut down when the transistor is turned on by an external applied voltage. The converter can also be shut down using a 5V TTL signal (the unit is OFF for logic High and ON for logic LOW). If the control pin is left open (high impedance), the converter will run normally. A suitable application circuit is shown below.



D_1 (e.g. 1N4001) is necessary for correct operation of the MTC1 when the control signal is LOW. The recommended drive current I_B to shut down the MTC1 is 6mA to 15mA. The value of R_1 can be derived as follows:

$$R_1 = \frac{V_C - V_D - 0.6}{I_B}$$

For a switch input:
Calculate the value of R_1 from the above equation given switch voltage V_c and chosen current between 6 and 15mA.

For 5V TTL Signal:
Set R_1 to be between 320Ω to 800Ω.

Output Voltage Adjustment

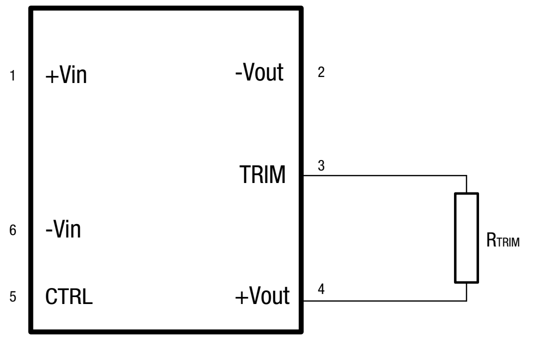
The MTC1S series has a trim capability which is located at pin 3, this allows the user to independently adjust the output voltages by ±10%. Adjustments to the output voltages can be accomplished via a single fixed resistor as shown in Figures 1 and 2. A single fixed resistor can increase or decrease the output voltage depending on its connection. Fixed resistors should have low temperature coefficient to minimize sensitivity to changes in temperature.

A single resistor connected from the TRIM pin (pin 3) to the +Vout (pin 4), will decrease the output voltage which is shown in figure 1.

A single resistor connected from the TRIM pin (pin 3) to the -Vout (pin 2) will increase the output voltage which is shown in figure 2.

TRIM DOWN

Figure 1. Trim connections to decrease the output voltage



$$3.3V_{out} R_{TRIM} = \frac{18.64k \times V_{out} - 52.3k}{3.32 - V_{out}}$$

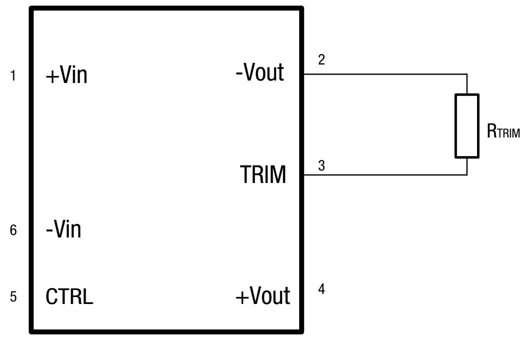
$$5V_{in} 12V_{out} R_{TRIM} = \frac{30.4k \times V_{out} - 194.723k}{12.0744 - V_{out}}$$

$$5V_{out} R_{TRIM} = \frac{33.2k \times V_{out} - 141k}{5 - V_{out}}$$

$$12V_{out} R_{TRIM} = \frac{21.5k \times V_{out} - 171.29k}{11.979 - V_{out}}$$

TRIM UP

Figure 2. Trim connections to increase the output voltage



$$3.3V_{out} R_{TRIM} = \frac{14k \times V_{out} - 52.3k}{3.32 - V_{out}}$$

$$5V_{in} 12V_{out} R_{TRIM} = \frac{12.4k \times V_{out} - 194.723k}{12.0744 - V_{out}}$$

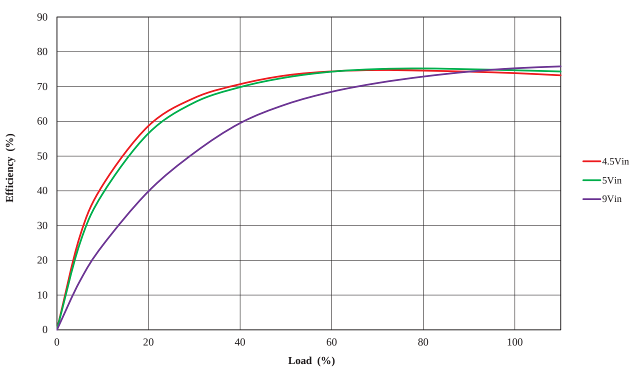
$$5V_{out} R_{TRIM} = \frac{23.2k \times V_{out} - 141k}{5 - V_{out}}$$

$$12V_{out} R_{TRIM} = \frac{12.4k \times V_{out} - 171.29k}{11.979 - V_{out}}$$

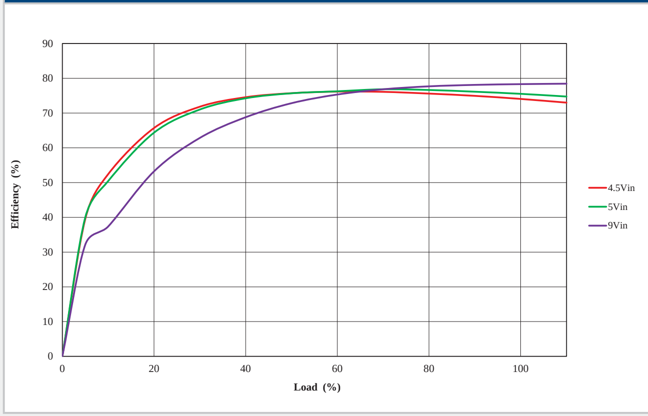
Accuracy of adjustment is subject to tolerances of resistors and factory adjusted output accuracy. Vout is equal to the desired output voltage.

EFFICIENCY VS LOAD

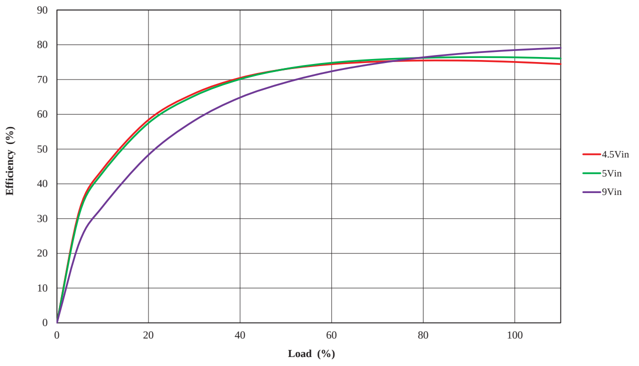
MTC1S0503MC



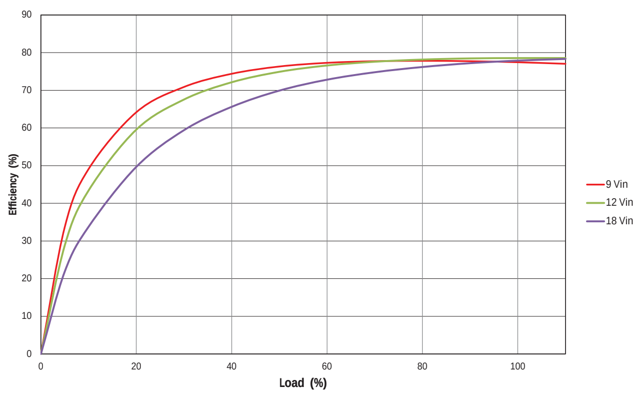
MTC1S0505MC



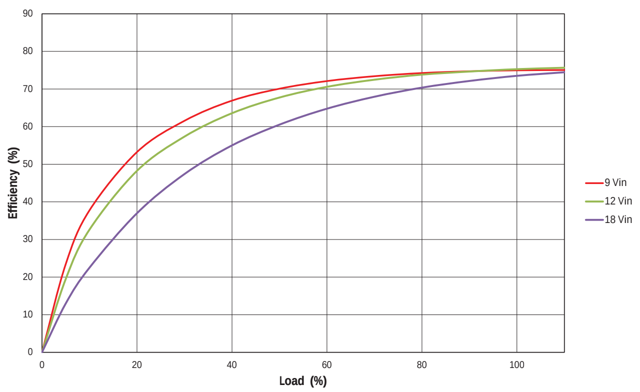
MTC1S0512MC



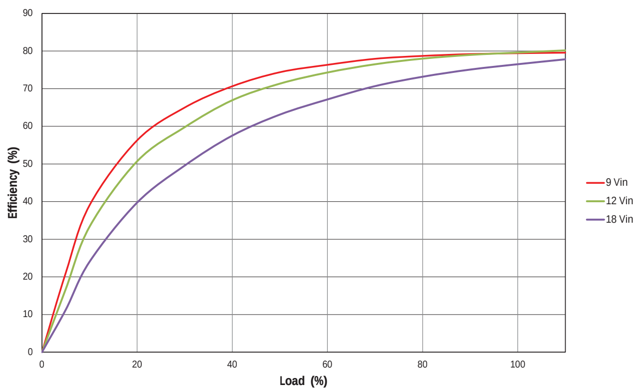
MTC1S1203MC



MTC1S1205MC

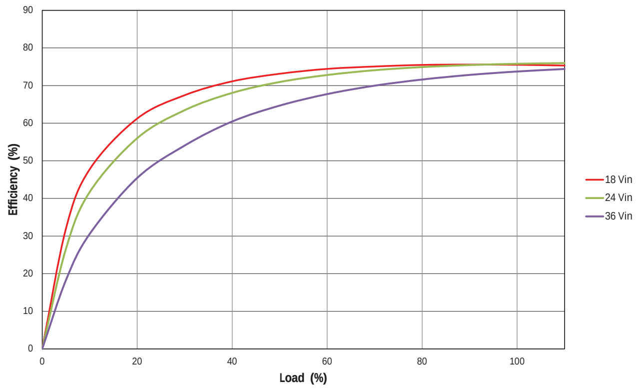


MTC1S1212MC

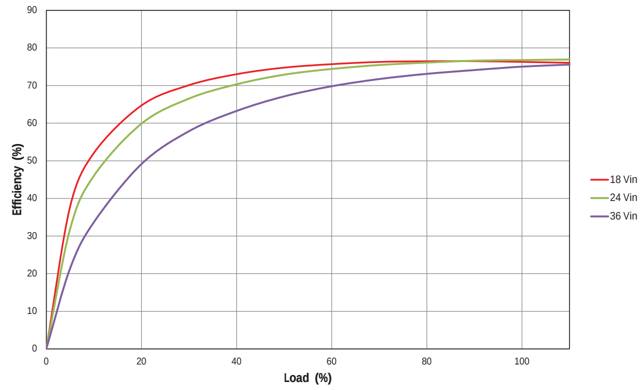


EFFICIENCY VS LOAD

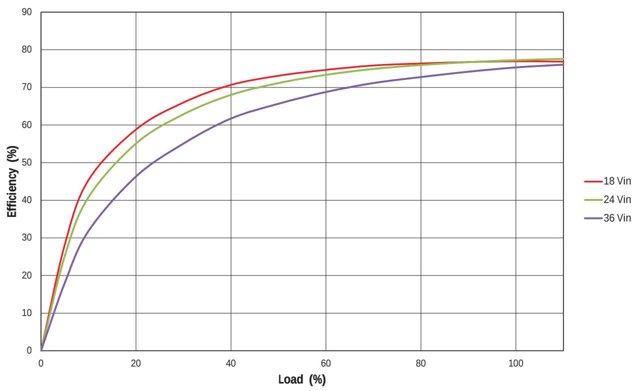
MTC1S2403MC



MTC1S2405MC

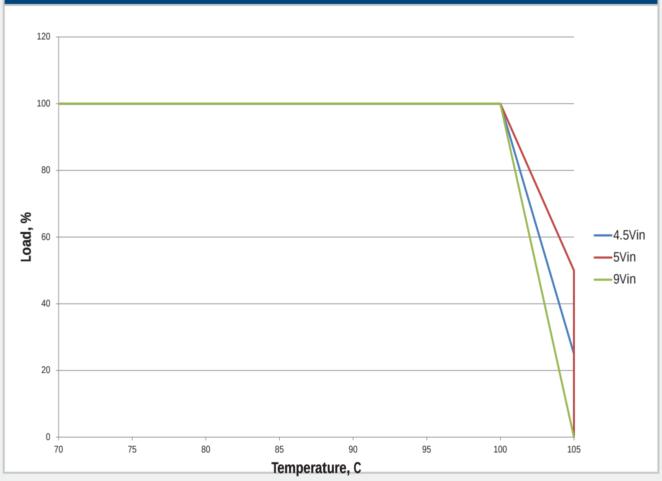


MTC1S2412MC

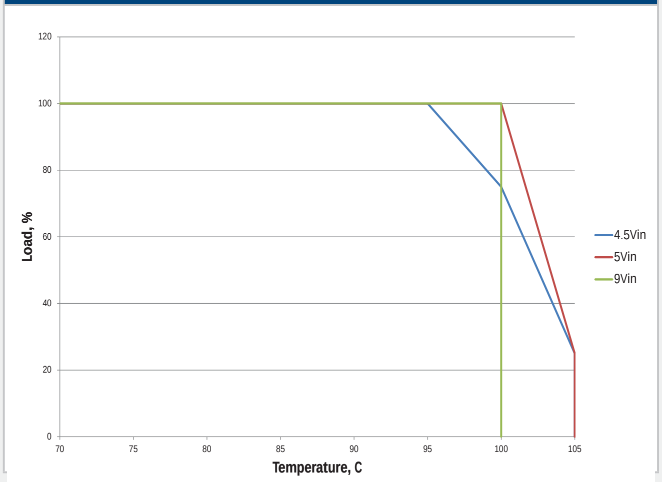


TEMPERATURE DERATING (Continued)

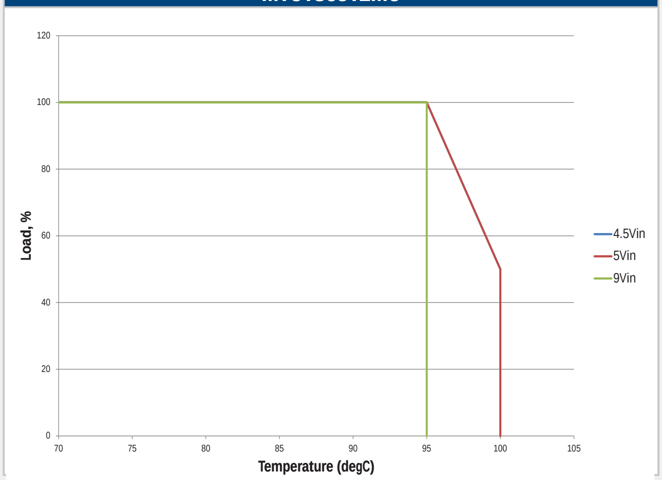
MTC1S0503MC



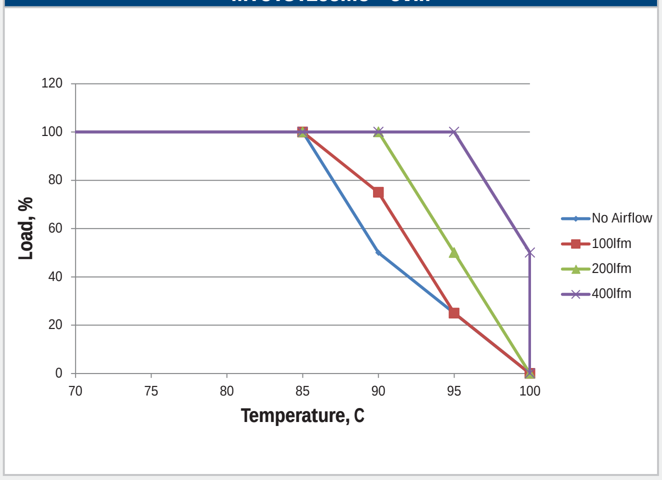
MTC1S0505MC



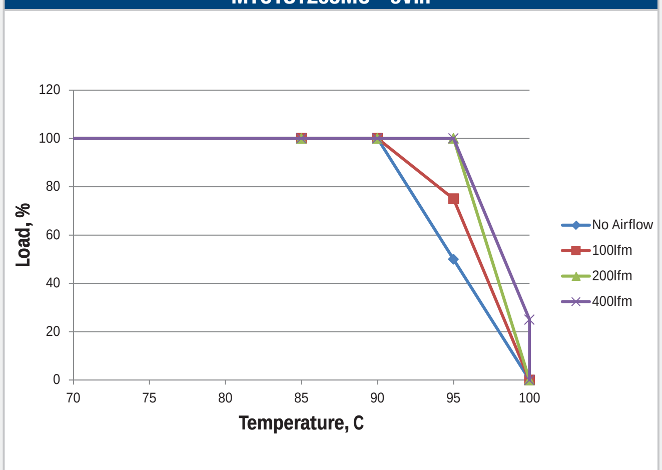
MTC1S0512MC



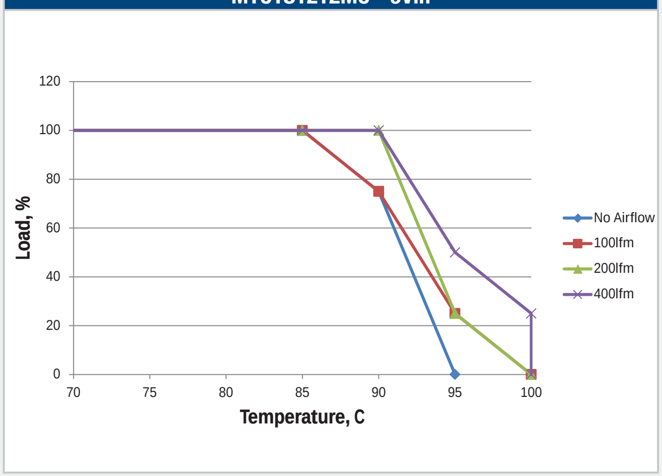
MTC1S1203MC - 9Vin



MTC1S1205MC - 9Vin

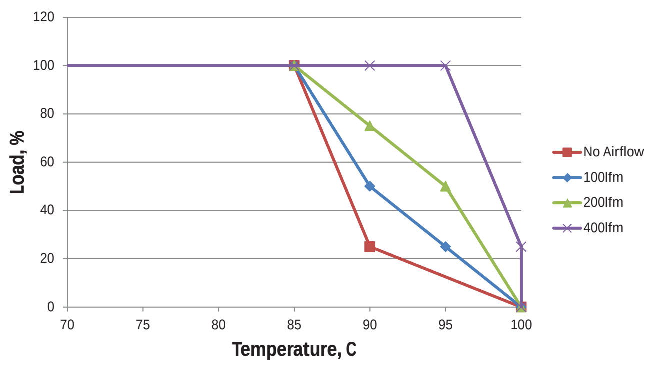


MTC1S1212MC - 9Vin

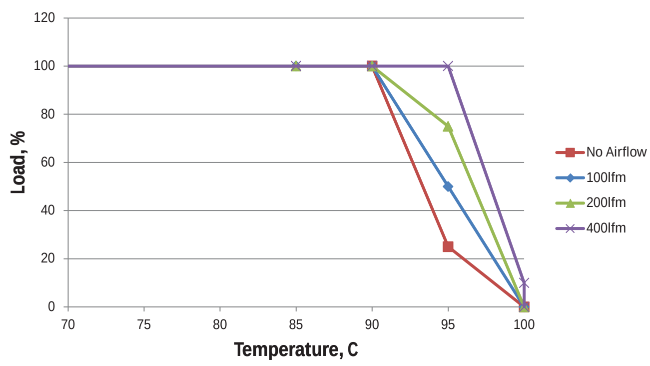


TEMPERATURE DERATING

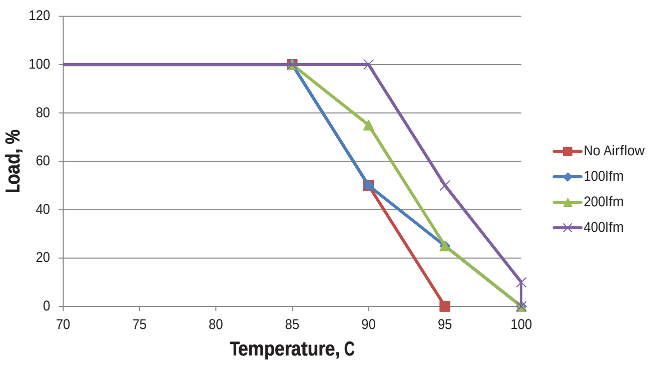
MTC1S1203MC - 12Vin



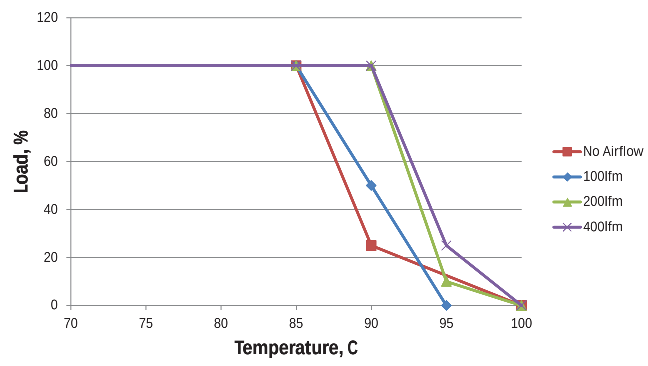
MTC1S1205MC- 12Vin



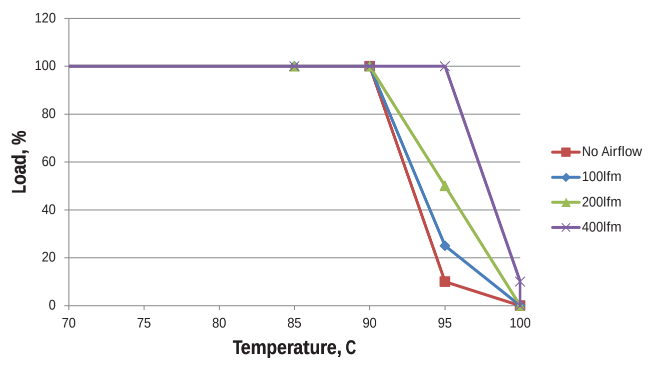
MTC1S1212MC- 12Vin



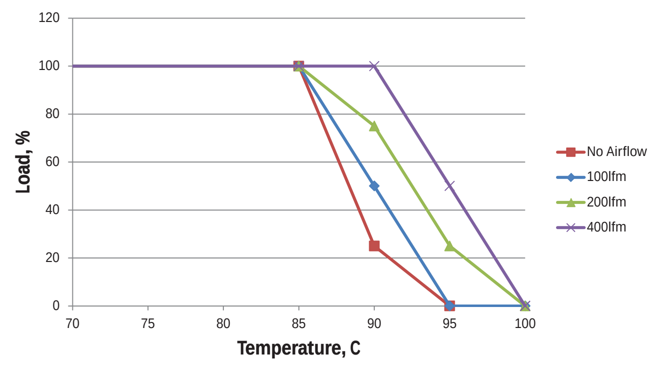
MTC1S2403MC- 24Vin



MTC1S2405MC- 24Vin

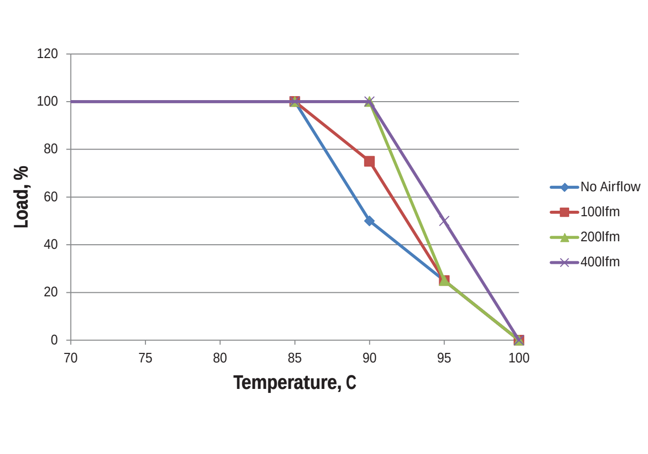


MTC1S2412MC- 24Vin

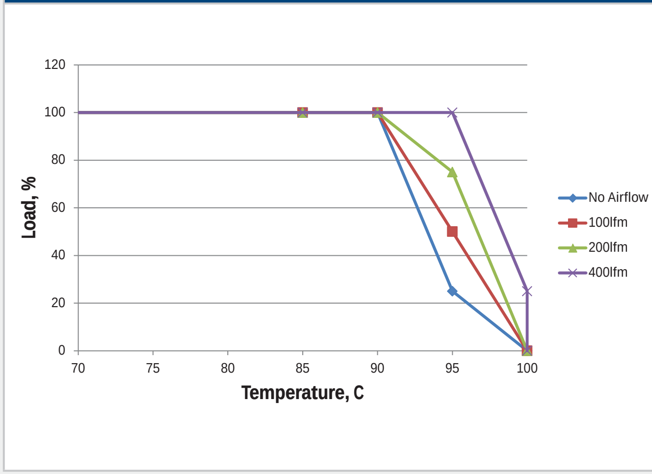


TEMPERATURE DERATING (Continued)

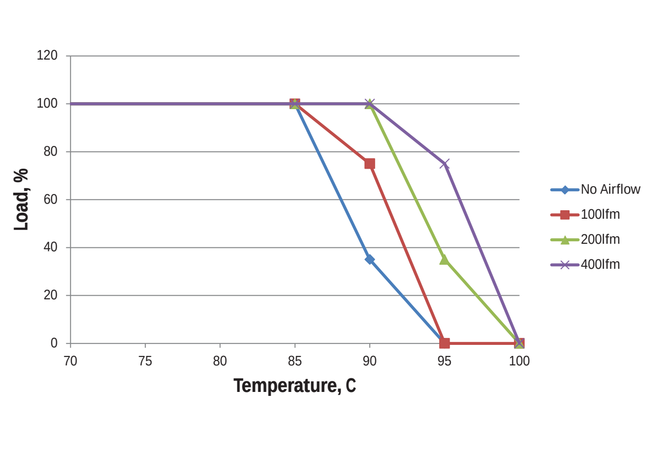
MTC1S2403MC - 18Vin



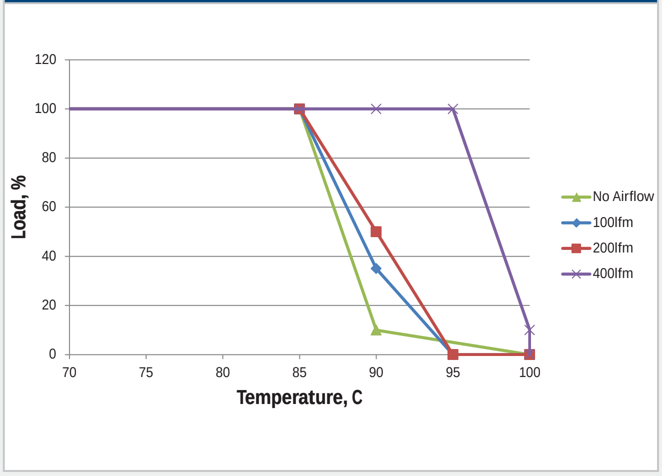
MTC1S2405MC - 18Vin



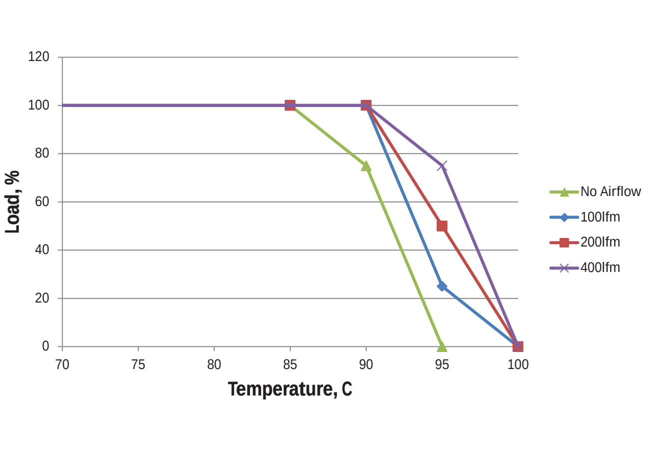
MTC1S2412MC - 18Vin



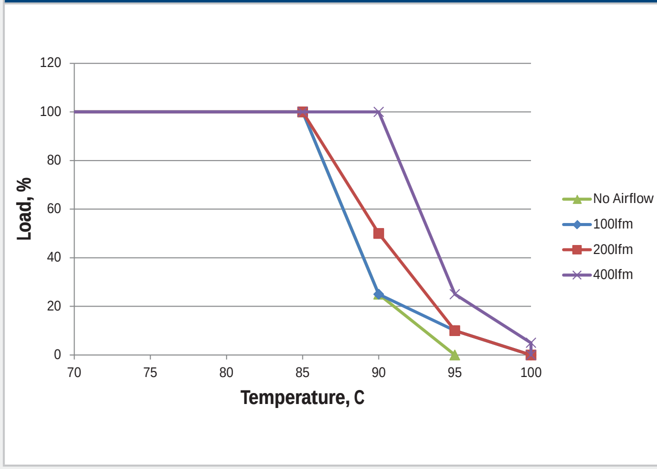
MTC1S1203MC - 18Vin



MTC1S1205MC - 18Vin

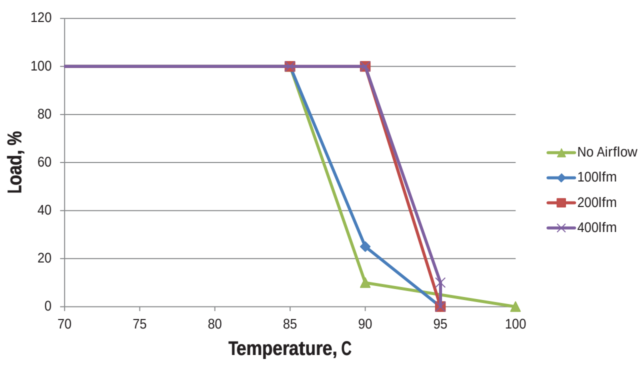


MTC1S1212MC - 18Vin

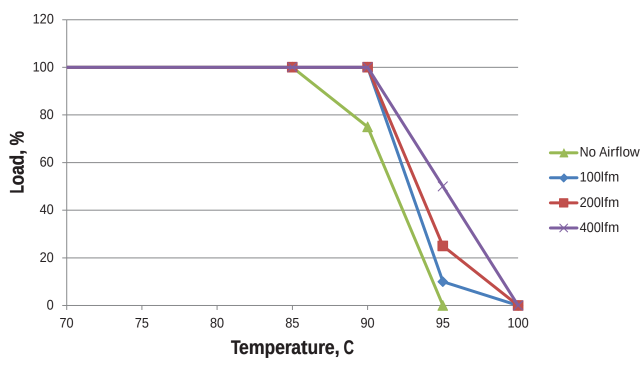


TEMPERATURE DERATING (Continued)

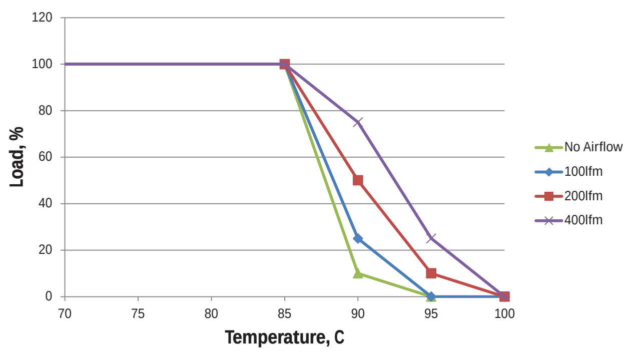
MTC1S2403MC- 36Vin



MTC1S2405MC- 36Vin



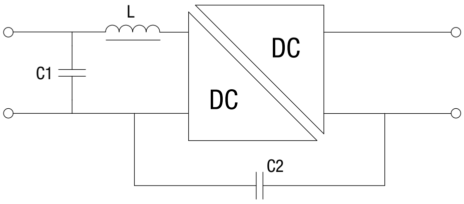
MTC1S2412MC- 36Vin



EMC FILTERING AND SPECTRA

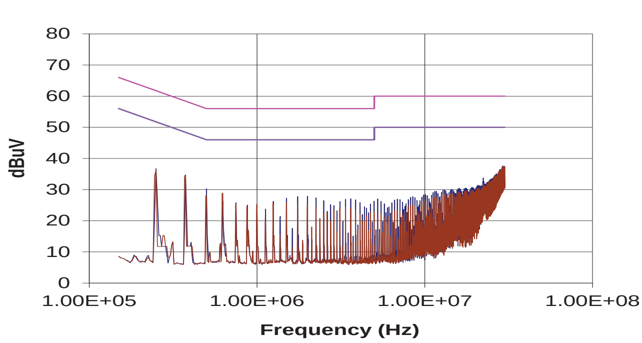
FILTERING

The following table shows the additional input capacitor and input inductor typically 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 (pink line) and Quasi Peak Limit B (purple line) adherence limits.The below values are for guidance only and should be evaluated in the application circuit.

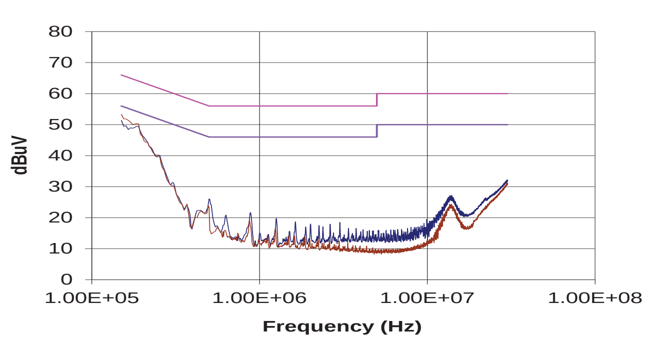


	Inductor			Capacitor			
Part Number	L, µH	SMD	Through Hole	C1, µF	Recommended Part Number	C2, pF	Recommended Part Number
MTC1S0503MC	2.2	84222C	13R222C	10 & 4.7	GRM31CR71E106KA12L & GCM21BR71C475KA73L	Not required	
MTC1S0505MC	2.2	84222C	13R222C	10	GRM31CR71E106KA12L	Not required	
MTC1S0505MC	4.7	84472C	13R472C	10	GRM31CR71E106KA12L	Not required	
MTC1S1203MC	6.8	84682C	13R682C	4.7	GRM21BC71E475KE11L	Not required	
MTC1S1205MC	4.7	84472C	13R472C	4.7	GRM21BC71E475KE11L	Not required	
MTC1S1205MC	4.7	84472C	13R472C	4.7	GRM21BC71E475KE11L	22	DK11XEA220K86RBH0
MTC1S2403MC	4.7	84472C	13R472C	10	GCM32EC71H106KA03L	47	DK11XEA470K86RBH01
MTC1S2405MC	4.7	84472C	13R472C	10	GCM32EC71H106KA03L	47	DK11XEA470K86RBH01
MTC1S2405MC	4.7	84472C	13R472C	10	GCM32EC71H106KA03L	Not required	

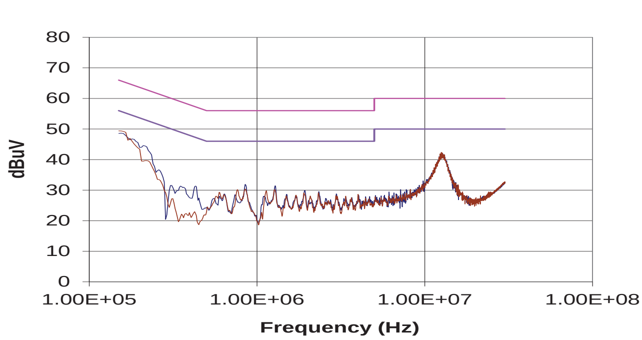
MTC1S0503MC



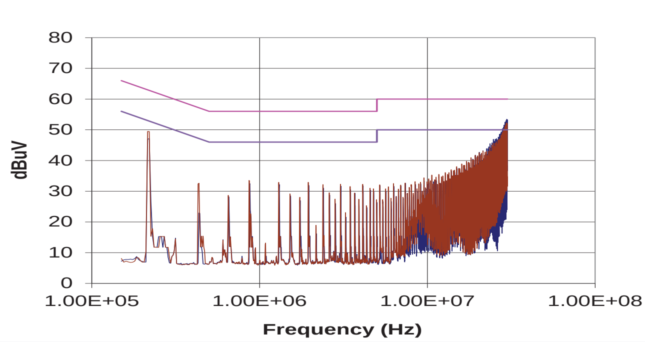
MTC1S0505MC



MTC1S0512MC

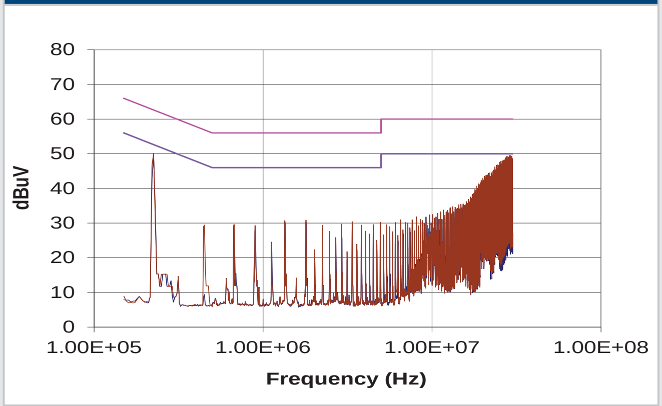


MTC1S1203MC

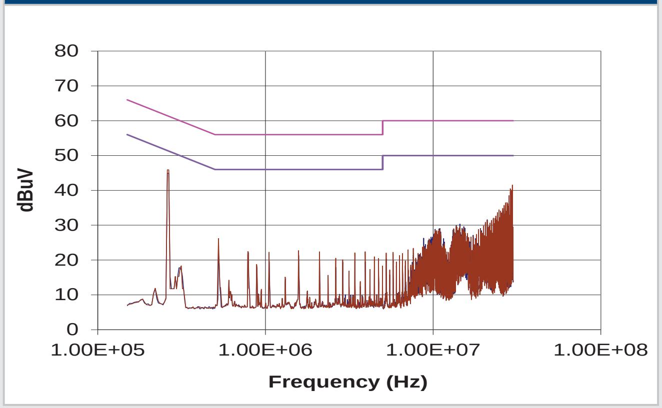


EMC FILTERING AND SPECTRA (Continued)

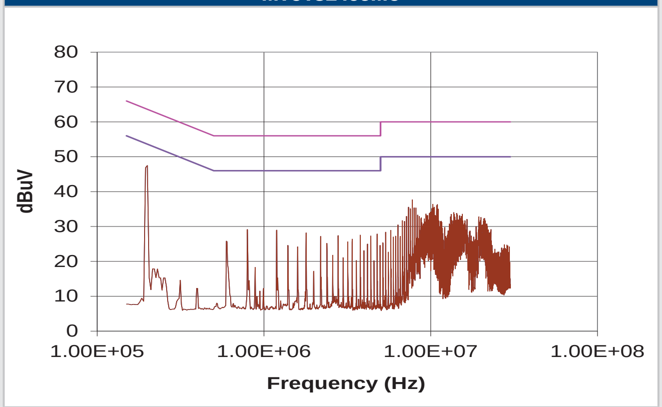
MTC1S1205MC



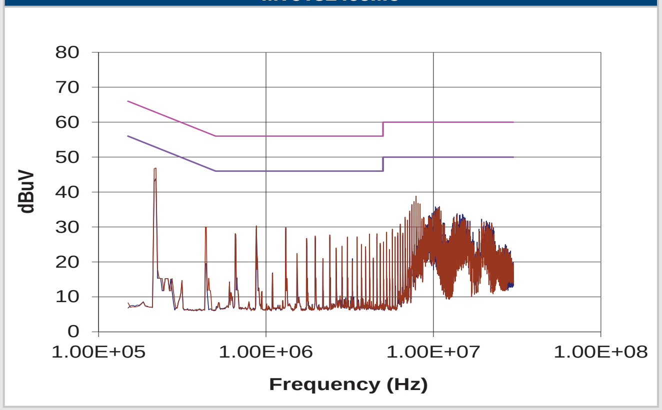
MTC1S1212MC



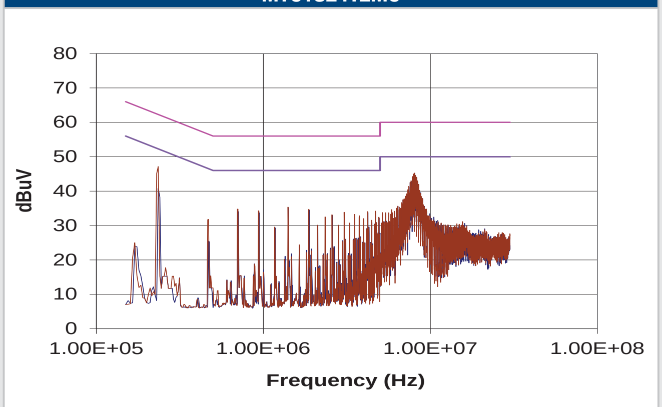
MTC1S2403MC



MTC1S2405MC

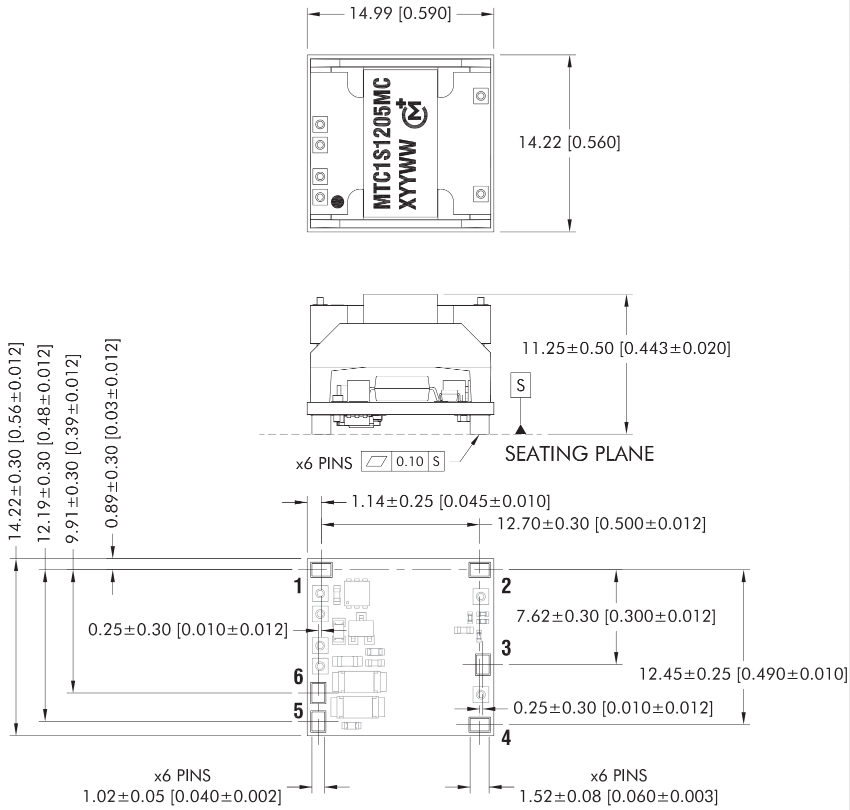


MTC1S2412MC



PACKAGE SPECIFICATIONS

Mechanical Dimensions



All dimensions in mm(inches), Controlling dimension is mm. Tolerances (unless otherwise stated) ±0.10(0.004).

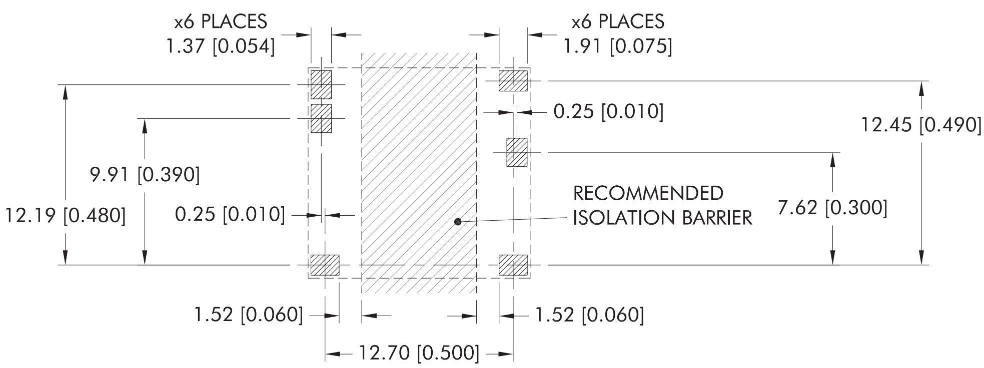
Components shown for reference only

Weight: 3.6g (5Vin) 3.4g (all others)

Pin Connections

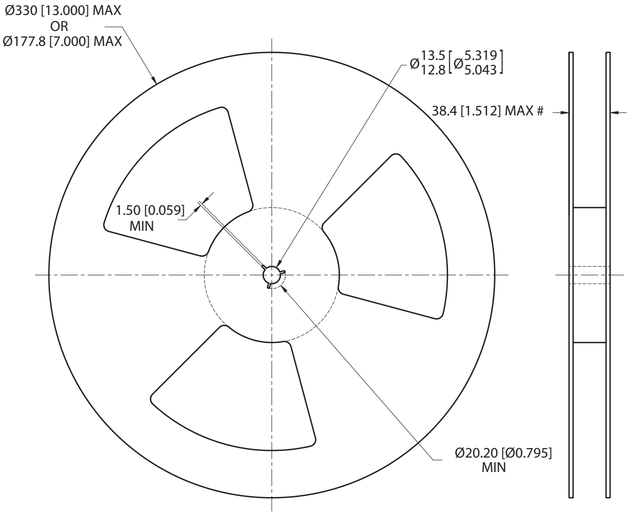
Pin	Function
1	+Vin
2	-Vout
3	Trim
4	+Vout
5	Ctrl
6	-Vin

Recommended Footprint Details



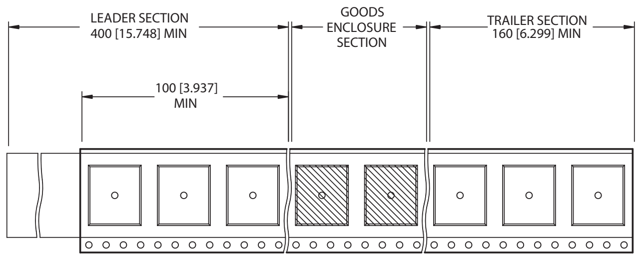
TAPE & REEL SPECIFICATIONS

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

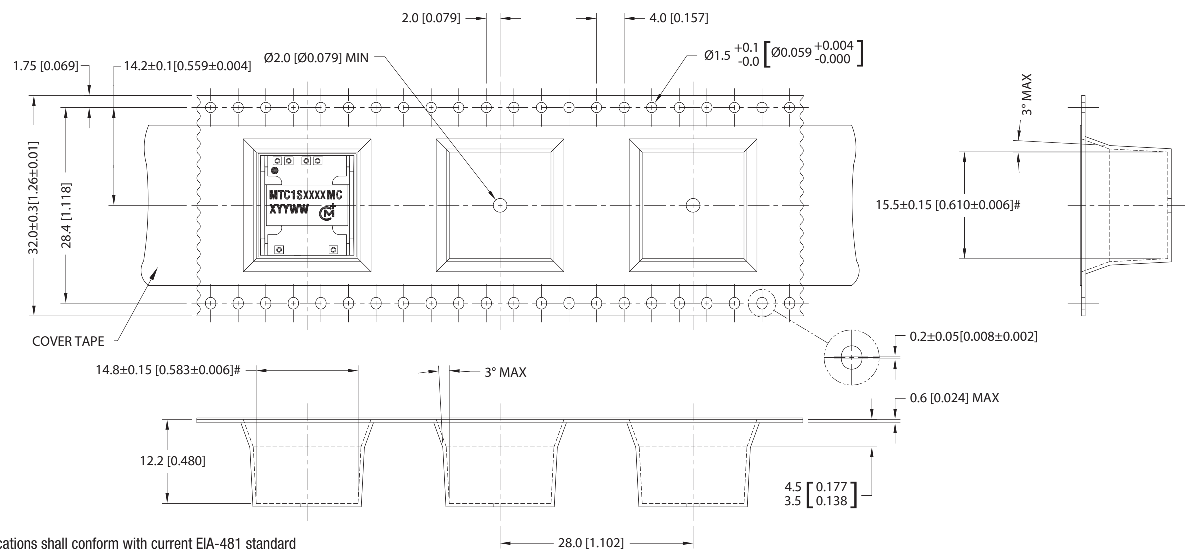
REEL PACKAGING DETAILS



Carrier tape pockets shown are illustrative only - Refer to carrier tape diagram for actual pocket details.

Reel Quantity: 7" - 30 or 13" - 150

TAPE OUTLINE DIMENSIONS



Tape & Reel specifications shall conform with current EIA-481 standard
Unless otherwise stated all dimensions in mm(inches) ±0.1mm (±0.004 Inches)
Controlling dimension is mm
Components shall be orientated within the carrier tape as indicated
Measured on a plane 0.3mm above the bottom pocket

DIRECTION OF UNREELING →

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- Disaster prevention / crime prevention equipment
- Data Processing equipment

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