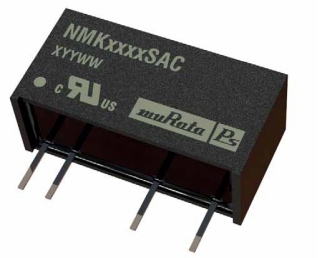
Murata Power Solutions

NMK Series

3kVDC Isolated 2W Single & Dual Output DC-DC Converters



FEATURES

- UL60950 recognised[4]
- RoHS compliant
- Efficiency from 77%
- Power density 1.31W/cm³
- Wide temperature performance at full 2 Watt load, –40°C up to 105°C
- UL 94V-0 package material
- No heatsink required
- Industry standard pinout
- 3kVDC isolation (1 minute) 'Hi Pot Test'
- 5V, 12V, 15V & 24V inputs
- 5V, 9V, 12V & 15V outputs
- Fully encapsulated with toroidal magnetics
- No electrolytic or tantalum capacitors
- Pin compatible with MEV1, MEV3 & NMV series

PRODUCT OVERVIEW

The NMK series of industrial temperature range DC-DC converters, available in industry standard SIP packaging offers a power upgrade path from the 1W NMV series. The un-regulated NMK series has superior output voltage set point accuracy in conjunction with excellent load regulation for this converter type.

Unbalanced loading capabilities on dual output variants, all of the rated output power may be drawn from a single output [3].

SELECTION GUIDE

Order Code[3]	Nominal Input Voltage	Output Voltage	Output Current	Input Current at Rated Load	Load Regulation (Typ)	Load Regulation (Max)	Ripple & Noise (Typ)[1]	Ripple & Noise (Max)[1]	Efficiency (Min.)	Efficiency (Typ.)	Isolation Capacitance	MTTF[2]		Recommended Alternative
	V	V	mA	mA	%		mVp-p		%	%	pF	MIL. kHrs	Tel. kHrs	
Recommended / In Production														
NMK0505SAC	5	5	400	470	5.7	7.3	24	40	80	83	28	3998		
NMK0505TSAC	5	5	400	470	5.8	8	25	50	77	83	30	2995	74887	
NMK0509SAC	5	9	222	455	4.2	5.9	20	25	83	86	36	3718		
NMK0512SAC	5	12	167	450	3.8	5.1	18	20	83	87	36	3328		
NMK0515SAC	5	15	133	450	3.4	4.5	17	20	84	87	34	2855		
NMK1205SAC	12	5	400	200	4.2	4.9	25	30	80	83	33	3532		
NMK1209SAC	12	9	222	190	2.6	3.1	19	20	83	87	53	2417		
NMK1212SAC	12	12	167	190	2.4	2.9	17	23	85	88	62	2246		
NMK1215SAC	12	15	133	185	2.0	2.4	14	25	84	89	56	2020		
NMK1505SAC	15	5	400	158	4.3	5.5	34	55	81	84	37	2202	9857	
NMK1512SAC	15	12	167	150	2.5	3.5	20	40	84	87	63	1825	10324	
NMK1515SAC	15	15	133	149	2.4	3.5	20	40	85	88	72	2220	13067	
NMK2405SAC	24	5	400	99	4.2	5.5	42	70	80	84	41	1618	9838	
NMK2409SAC	24	9	222	95	2.7	3.5	30	55	83	87	59	2032	12177	
NMK2412SAC	24	12	167	94	2.1	3	29	55	84	88	77	1879	12287	
NMK2415SAC	24	15	133	93	2.2	3	34	70	85	88	85	1558	11155	
NMK0505SC	5	±5	±200	470	5	6.2	24	40	81	83	28	2324		
NMK0509SC	5	±9	±111	455	3.9	5.3	18	30	83	86	33	2158		
NMK0512SC	5	±12	±83	450	3.7	4.8	14	20	84	87	35	1931		
NMK0515SC	5	±15	±67	450	3.5	5.2	12	20	84	87	31	1655		
NMK1205SC	12	±5	±200	200	3.4	3.9	21	30	80	84	35	1952		
NMK1209SC	12	±9	±111	190	2.4	2.8	16	20	83	87	50	2021		
NMK1212SC	12	±12	±83	190	2.2	2.7	13	20	84	87	53	1821		
NMK1215SC	12	±15	±67	190	1.9	2.4	13	20	83	87	57	1574		
NMK1505SC	15	±5	±200	156	3.7	5	27	50	81	84	43	1466	8190	
NMK1509SC	15	±9	±111	153	2.4	3.5	19	35	82	86	47	1957	11117	
NMK1512SC	15	±12	±83	151	2.2	3	18	35	84	88	65	1515	10279	
NMK1515SC	15	±15	±67	150	2.0	3	14	35	85	88	74	1404	11747	
NMK2409SC	24	±9	±111	94	2.3	3.5	26	45	84	87	65	2571	12903	
NMK2412SC	24	±12	±83	93	1.9	3	24	45	85	89	82	2134	12888	
NMK2415SC	24	±15	±67	93	1.7	3	17	35	85	89	86	1581	12750	
Discontinued														
NMK1509SAC	15	9	222	153	3	4	21	40	83	86	51	2478	11668	MEJ2S1509SC
NMK1512SAC	15	12	167	150	2.5	3.5	20	40	84	87	63	1825	10324	MEJ2S1512SC
NMK1505SC	15	±5	±200	156	3.7	5	27	50	81	84	43	1466	8190	MEJ2D1505SC
NMK2405SC	24	±5	±200	96	3.4	5	30	50	81	84	43	2268	12558	NMH2405SC

RoHS COMPLIANT

25

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

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1. See Ripple & Noise characterisation method.
2. Calculated using MIL-HDBK-217 FN2 and Telcordia SR-332 calculation model with nominal input voltage at full load.
3. See application notes on page 4.
4. The NMK0505TSAC is pending recognition to UL62368-1.

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

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, 15V input types	13.5	15	16.5	
	Continuous operation, 24V input types	21.6	24	26.4	
Reflected ripple current	NMK0505TSAC		5		mA p-p
	NMK2405SAC, NMK2409SAC, NMK2405SC, NMK2409SC		14	25	
	All other variants		7.5	15	

OUTPUT CHARACTERISTICS

Parameter	Conditions		Min.	Typ.	Max.	Units
Rated Power	T_A=-40°C to 105°C				2	W
Voltage Set Point Accuracy	See tolerance envelope					
Line regulation	High V_{IN} to low V_{IN}	NMK0505TSAC		1.1	1.2	%/%
		All other variants		1.05	1.2	

ISOLATION CHARACTERISTICS

Parameter	Conditions	Min.	Typ.	Max.	Units
Isolation test voltage	Flash tested for 1 minute	3000			VDC
Resistance	Viso= 1000VDC	10			GΩ

GENERAL CHARACTERISTICS

Parameter	Conditions	Min.	Typ.	Max.	Units
Switching frequency	NMK0505TSAC		50		kHz
	All other variants		60		

TEMPERATURE CHARACTERISTICS

Parameter	Conditions	Min.	Typ.	Max.	Units
Specification	NMK0505TSAC	-40		105	°C
	All other output types, see safety approval section for UL temperature specification	-40		85	
Storage		-50		125	
Case Temperature above ambient	NMK0505TSAC		22		
	5V output types & NMK1509SAC (Except NMK1505S(A)C & NMK2405S(A)			28	
	NMK1505S(A)C & NMK2405S(A)C			32	
	All other output types			25	
Cooling	Free air convection				

ABSOLUTE MAXIMUM RATINGS

Lead temperature 1.5mm from case for 10 seconds	260°C
Wave Solder	Wave Solder profile not to exceed the profile recommended in IEC 61760-1 Section 6.1.3. Please refer to application notes for further information.
Input voltage V_{IN}, NMK05 types	7V
Input voltage V_{IN}, NMK12 types	15V
Input voltage V_{IN}, NMK15 types	18V
Input voltage V_{IN}, NMK24 types	28V

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 NMK series of DC-DC converters are all 100% production tested at their stated isolation voltage. This is 3kVDC for 1 minute.

A question commonly asked is, "What is the continuous voltage that can be applied across the part in normal operation?"

The NMK series has been recognised by Underwriters Laboratory for functional insulation. Both input and output should normally be maintained within SELV limits i.e. less than 42.4V peak, or 60VDC. The isolation test voltage represents a measure of immunity to transient voltages and the part should never be used as an element of a safety isolation system. The part could be expected to function correctly with several hundred volts offset applied continuously across the isolation barrier; but then the circuitry on both sides of the barrier must be regarded as operating at an unsafe voltage and further isolation/insulation systems must form a barrier between these circuits and any user-accessible circuitry according to safety standard requirements.

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. The NMK series has toroidal isolation transformers, with no additional insulation between primary and secondary windings of enamelled wire. While parts can be expected to withstand several times the stated test voltage, the isolation capability does depend on the wire insulation. Any material, including this enamel (typically polyurethane) is susceptible to eventual chemical degradation when subject to very high applied voltages thus implying that the number of tests should be strictly limited. 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.

This consideration equally applies to agency recognised parts rated for better than functional isolation where the wire enamel insulation is always supplemented by a further insulation system of physical spacing or barriers.

SAFETY APPROVAL

The NMK series has been recognised by Underwriters Laboratory (UL) to UL 60950 for functional insulation in a maximum ambient temperature of 85ºC and/or case temperature limit of 130ºC. Case temperature measured on the face opposite the pins. File number E151252 applies. The NMK0505TSAC is pending recognition to UL62368-1.

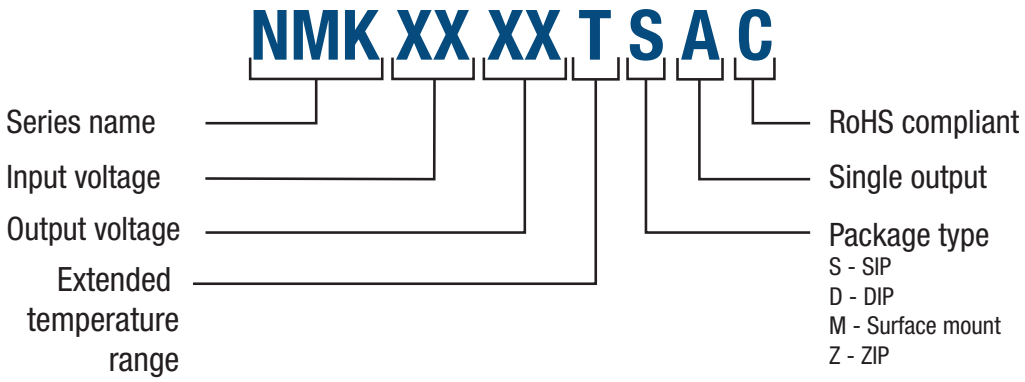
The NMK Series of converters are not internally fused so to meet the requirements of UL 60950 an anti-surge input line fuse should always be used as below:
NMK05xxSC/SAC: 2A
NMK12xxSC/SAC: 0.75A
NMK15xxSC/SAC: 0.75A
NMK24xxSC/SAC: 0.375A

RoHS COMPLIANT INFORMATION

RoHS COMPLIANT

This series is compatible with RoHS soldering systems with a peak wave solder temperature of 260°C for 10 seconds. Please refer to application notes for further information. The pin termination finish on the SIP package type is Tin Plate, Hot Dipped over Matte Tin with Nickel Preplate. The DIP types are Matte Tin over Nickel Preplate. Both types in this series are backward compatible with Sn/Pb soldering systems. For further information, please visit www.murata-ps.com/rohs

PART NUMBER STRUCTURE



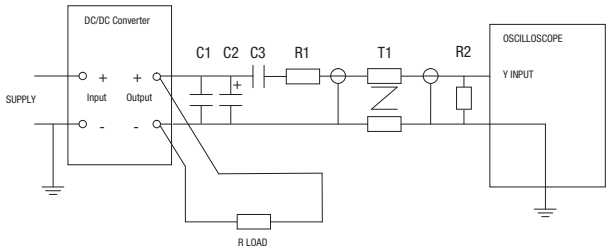
CHARACTERISATION TEST METHODS

Ripple & Noise Characterisation Method

All measurement to be taken with the following components connected to the UUT as detailed below. 50 Ohm coax cable, solder connections one end, BNC plug at the other end.

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 rated at minimum 1.5 x the output voltage of the UUT with ESR of less than 100 milliohms at 100 kHz e.g. AVX TPS series.
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

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 double the specified output voltage if the output load falls to less than 5%.

Unbalanced Load

The NMK series offers unbalanced loading capabilities with up to the full 2W available from a single output. However, when operated in this mode there may be a slight performance decrease in efficiency and load regulation.

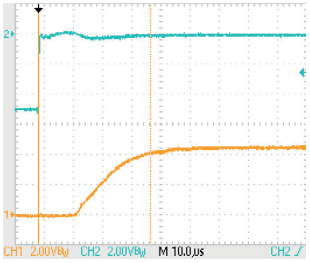
Capacitive loading and start up

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 a capacitance of 47µF with an increased start time, however, the maximum recommended output capacitance is 10µF.

	Start-up time
	µs
NMK0505TSAC	110
NMK05XXSAC	
NMK12XXSAC	
NMK15XXSAC	
NMK24XXSAC	
NMK05XXSC	
NMK12XXSC	

	Start-up time
	µs
NMK15XXSC	
NMK24XXSC	

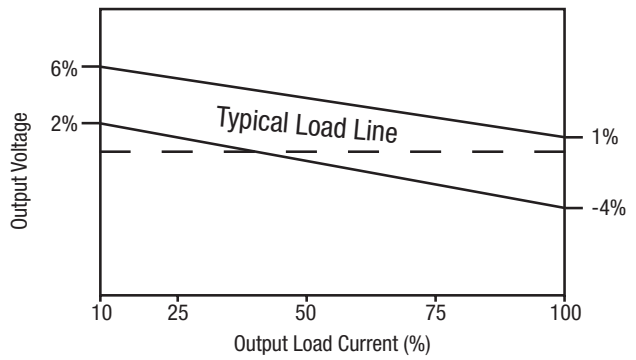
Typical Start-Up Wave Form



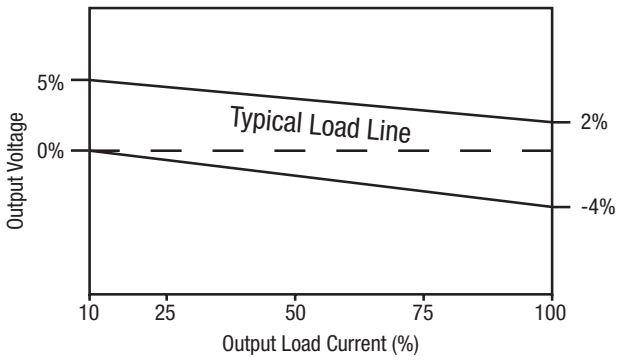
TOLERANCE ENVELOPES

The voltage tolerance envelope shows typical load regulation characteristics for this product series. The tolerance envelope is the maximum output voltage variation due to changes in output loading.

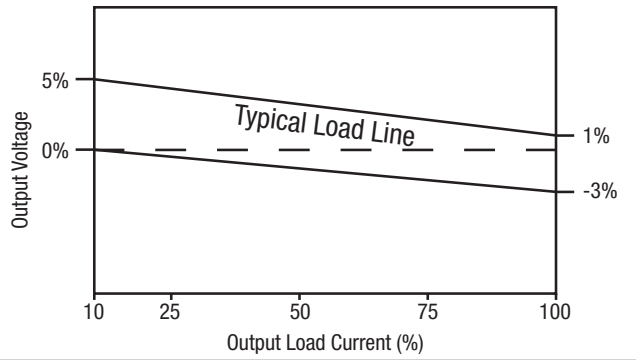
NMK0505TSAC



NMKXXXXSAC

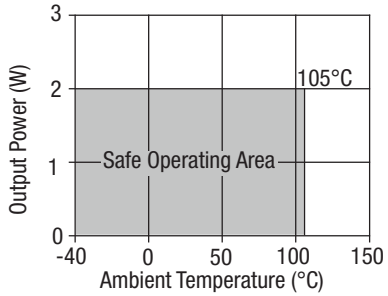


NMKXXXXSC

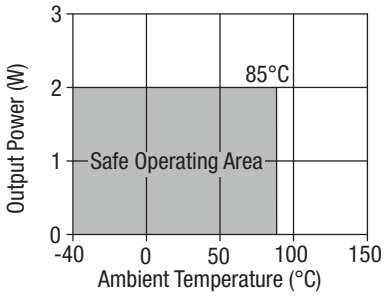


TEMPERATURE DERATING GRAPH

NMK0505TSAC:

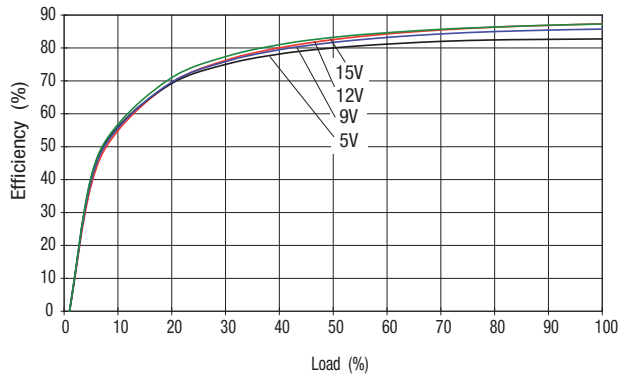


All other variants:

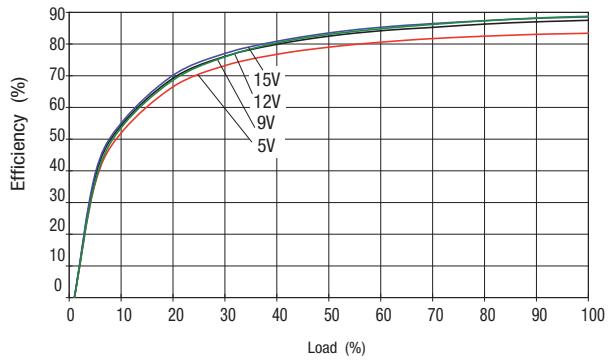


EFFICIENCY VS LOAD

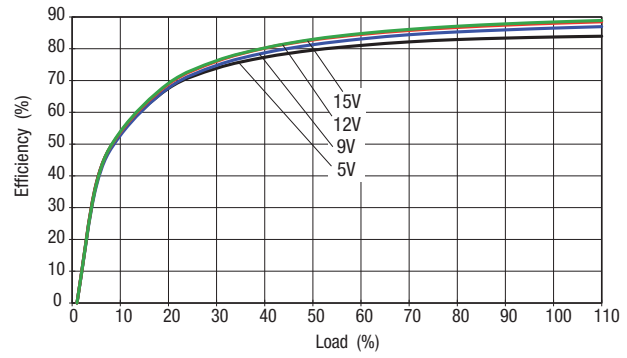
NMK05XXSAC



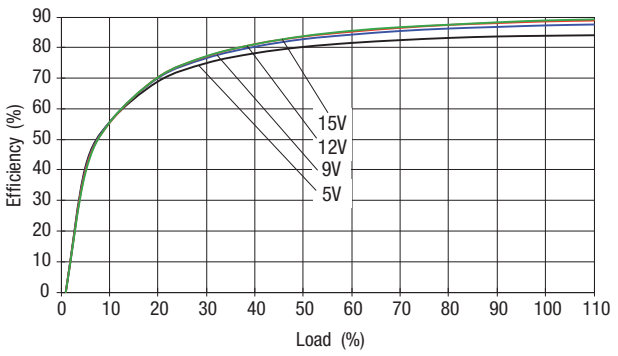
NMK12XXSAC



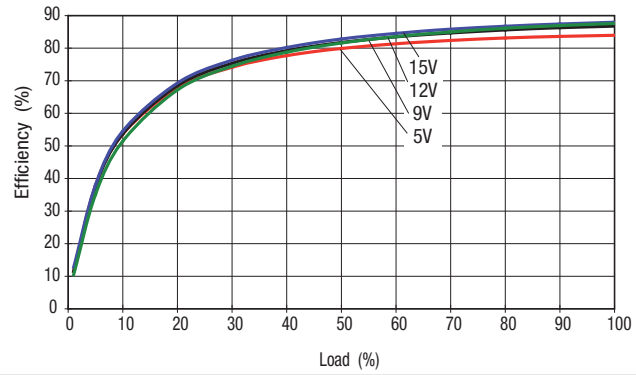
NMK15XXSAC



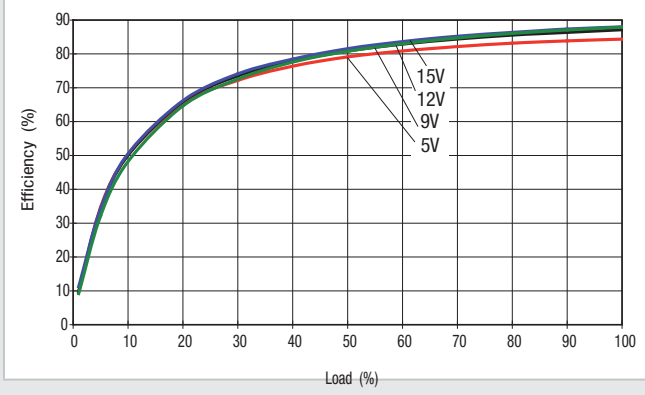
NMK24XXSAC



NMK05XXSC

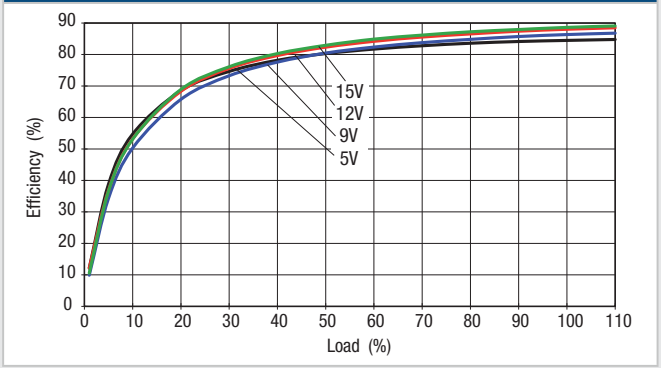


NMK12XXSC

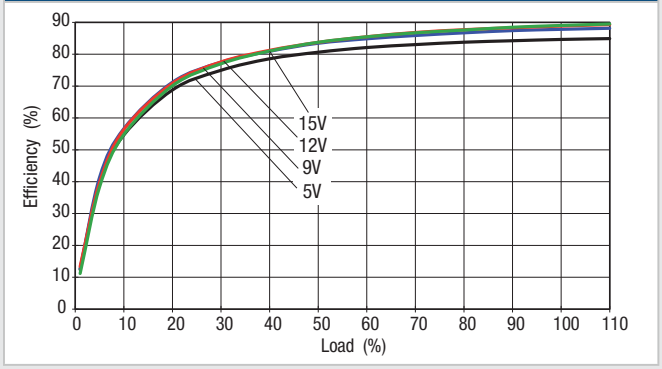


EFFICIENCY VS LOAD (Continued)

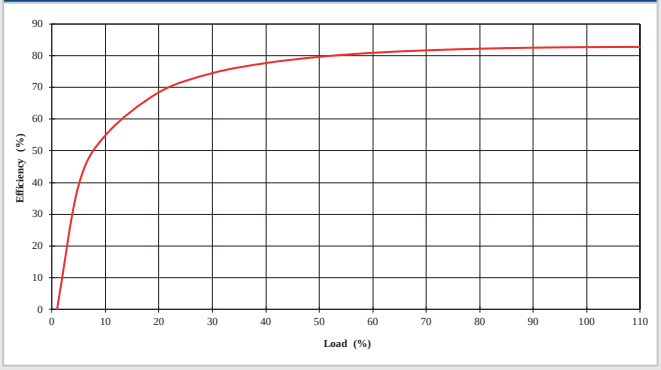
NMK15XXSC



NMK24XXSC



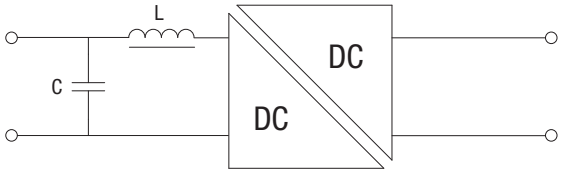
NMK0505TSAC



EMC FILTERING AND SPECTRA

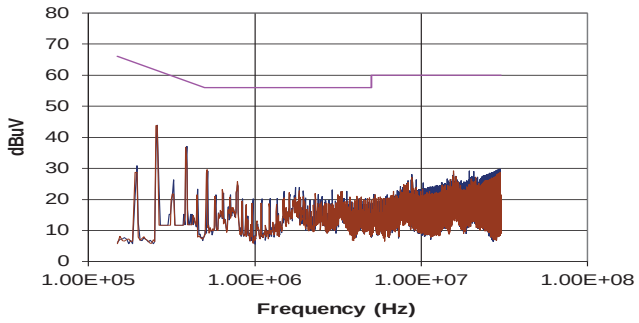
FILTERING

The following filter circuit and filter table shows the input filters typically required to meet conducted emissions limits for EN 55022 curve B using Quasi-Peak and average detectors according to CISPR 22.

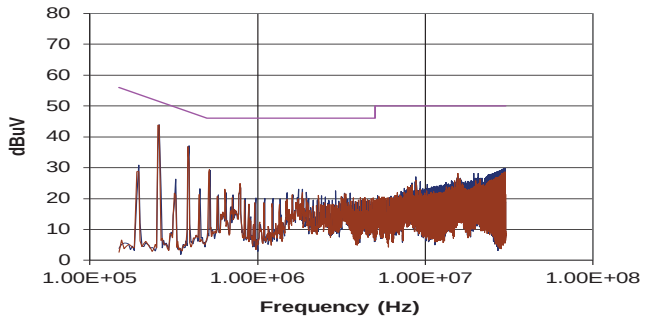


	Inductor		Capacitor	
Part Number	L, µH	SMD	C, µF	SMD
NMK0505TSAC	10µH	23100C	2.2µF	GRM188C71E225KE11D

NMK0505TSAC (Quasi-Peak)

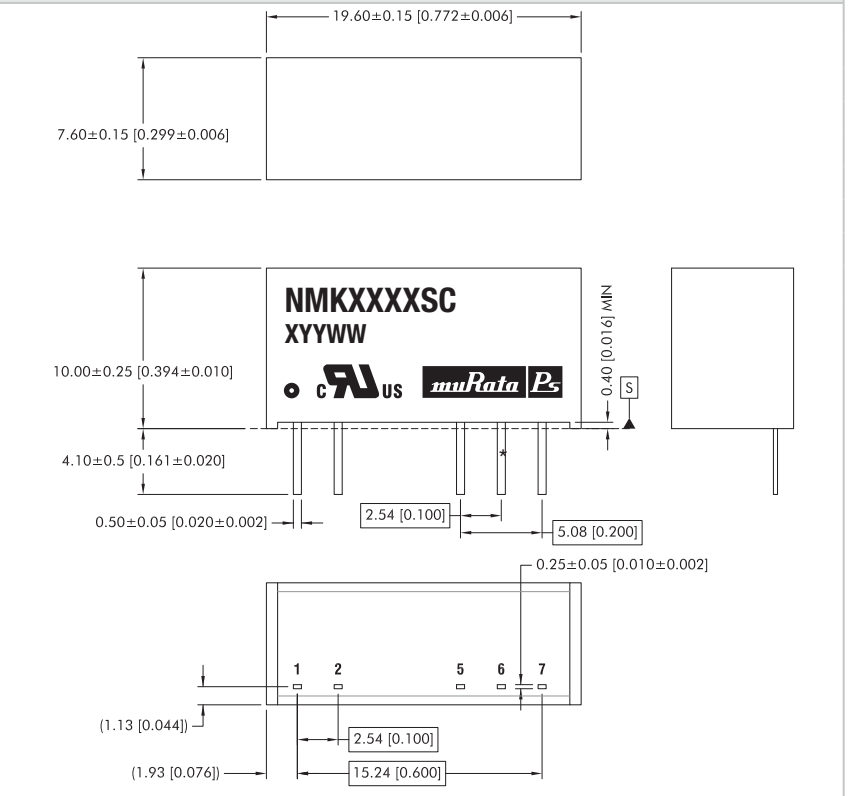


NMK0505TSAC (Average)



PACKAGE SPECIFICATIONS

MECHANICAL DIMENSIONS



* Pin not fitted on single output variants.

All dimensions in mm (inches) Controlling dimension is mm.

All pins on a 2.54 (0.100) pitch and within ±0. I (0.004) of true position from pin I at seating plane 'S'

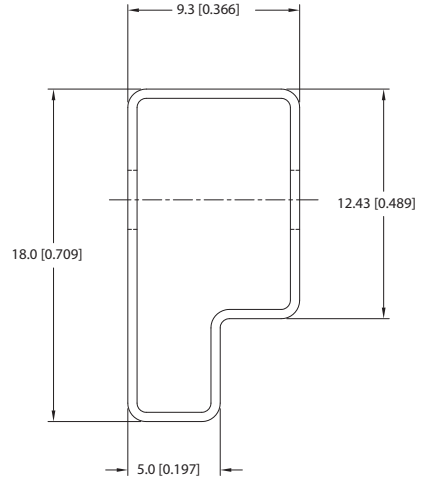
Weight: 2.8g

PIN CONNECTIONS

Single output variants	
Pin	Function
1	+V_{IN}
2	-V_{IN}
5	-V_{OUT}
7	+V_{OUT}

Dual output variants	
Pin	Function
1	+V_{IN}
2	-V_{IN}
5	-V_{OUT}
6	0V
7	+V_{OUT}

TUBE OUTLINE DIMENSIONS

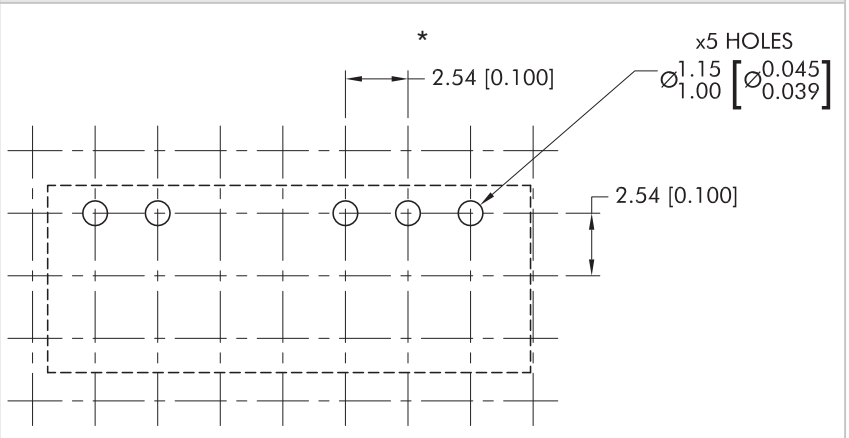


Unless otherwise stated all dimensions in mm (inches) ±0.5mm.

Tube length : 520mm ±2mm (20.47).

Tube Quantity : 25

RECOMMENDED FOOTPRINT DETAILS



* Hole not required for single output variants.

DISCLAIMER

Unless otherwise stated in the datasheet, all products are designed for standard commercial and industrial applications and NOT for safety-critical and/or life-critical applications.

Particularly for safety-critical and/or life-critical applications, i.e. applications that may directly endanger or cause the loss of life, inflict bodily harm and/or loss or severe damage to equipment/property, and severely harm the environment, a prior explicit written approval from Murata is strictly required. Any use of Murata standard products for any safety-critical, life-critical or any related applications without any prior explicit written approval from Murata shall be deemed unauthorised use.

These applications include but are not limited to:

- Aircraft equipment
- Aerospace equipment
- 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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