

**FEATURES**

- ▶ Industrial Standard 2"x1" Package
- ▶ Wide 2:1 Input Voltage Range
- ▶ Fully Regulated Output Voltage
- ▶ Ultra-high I/O Isolation 8000VDC with Reinforced Insulation, rated for 1000Vrms Working Voltage
- ▶ Common Mode Transient Immunity: 15KV/μS
- ▶ Qualified for IGBT and High Isolation Applications
- ▶ Operating Ambient Temp. Range -40°C to +80°C
- ▶ No Min. Load Requirement
- ▶ Overload/Voltage and Short Circuit Protection
- ▶ Designed-in Conducted EMI meets EN 55032 Class A & FCC Part15 Level A
- ▶ UL/cUL/IEC/EN 62368-1 (60950-1) Safety Approval & CE Marking



**PRODUCT OVERVIEW**

The MINMAX MKE20-HI series is a new range of high performance 20W dc-dc converter within encapsulated 2"x1" package which specifically design for high isolation applications where reinforced insulation and high working voltage are required. There are 21 models available for input voltage of 12, 24, 48VDC with wide 2:1 input range and tight output voltage. The I/O isolation is specified for 8000VDC with reinforced insulation, which rated for 1000Vrms working voltage. Further features include overload, short circuit protection, no min. load requirement, EMI mission meets EN 55032 Class A, low I/O capacitance 80pF max. and operating ambient temp. range by -40°C to 80°C by high efficiency up to 90%. MKE20-HI series conform to common mode transient immunity testing by 15KV/μS and UL/cUL/IEC/EN 62368-1 (60950-1) safety approvals.

The MKE20-HI series offer a economical solution for demanding application in requesting a certified supplementary and high I/O isolation with reinforced insulation system to comply with 1000VAC working voltage.

**Model Selection Guide**

Model Number	Input Voltage (Range) VDC	Output Voltage VDC	Output Current		Input Current		Reflected Ripple Current mA(typ.)	Over Voltage Protection VDC	Max. capacitive Load μF	Efficiency (typ.) %
			Max. mA	@Max. Load mA(typ.)	@No Load mA (typ.)	@Max. Load				
MKE20-12S05HI	12 (9 - 18)	5	4000	1961	20	100	6.2	6800	85	
MKE20-12S051HI		5.1	4000	2000			6.2		85	
MKE20-12S12HI		12	1670	1898			15		1160	88
MKE20-12S15HI		15	1333	1893			18		750	88
MKE20-12S24HI		24	840	1888			27		295	89
MKE20-12D12HI		±12	±840	1888			±15		590#	89
MKE20-12D15HI		±15	±670	1882			±18		380#	89
MKE20-24S05HI	24 (18 - 36)	5	4000	958	15	50	6.2	6800	87	
MKE20-24S051HI		5.1	4000	977			6.2		87	
MKE20-24S12HI		12	1670	949			15		1160	88
MKE20-24S15HI		15	1333	936			18		750	89
MKE20-24S24HI		24	840	933			27		295	90
MKE20-24D12HI		±12	±840	933			±15		590#	90
MKE20-24D15HI		±15	±670	931			±18		380#	90
MKE20-48S05HI	48 (36 - 75)	5	4000	479	10	30	6.2	6800	87	
MKE20-48S051HI		5.1	4000	489			6.2		87	
MKE20-48S12HI		12	1670	474			15		1160	88
MKE20-48S15HI		15	1333	463			18		750	90
MKE20-48S24HI		24	840	472			27		295	89
MKE20-48D12HI		±12	±840	472			±15		590#	89
MKE20-48D15HI		±15	±670	465			±18		380#	90

# For each output

Input Specifications							
Parameter	Conditions / Model	Min.	Typ.	Max.	Unit		
Input Surge Voltage (100 ms max.)	12V Input Models	-0.7	---	25	VDC		
	24V Input Models	-0.7	---	50			
	48V Input Models	-0.7	---	100			
Start-Up Threshold Voltage	12V Input Models	---	---	9			
	24V Input Models	---	---	18			
	48V Input Models	---	---	36			
Under Voltage Shutdown	12V Input Models	---	7.5	---			
	24V Input Models	---	15	---			
	48V Input Models	---	33	---			
Start Up Time (Power On)	Nominal Vin and Constant Resistive Load	---	---	30	ms		
Input Filter	All Models	Internal Pi Type					

Output Specifications							
Parameter	Conditions / Model	Min.	Typ.	Max.	Unit		
Output Voltage Setting Accuracy		---	---	±1.0	%Vnom.		
Output Voltage Balance	Dual Output, Balanced Loads	---	---	±2.0	%		
Line Regulation	Vin=Min. to Max. @Full Load	---	---	±0.5	%		
Load Regulation	Io=0% to 100%	Single Output	---	---	±0.5	%	
		Dual Output	---	---	±1.0	%	
Minimum Load	No minimum Load Requirement						
Ripple & Noise	0-20 MHz Bandwidth	5V & 5.1Vo	Measured with a MLCC : 4.7µF	---	50	---	mV <sub>P-P</sub>
		12V,15V, ±12V, ±15Vo		---	100	---	mV <sub>P-P</sub>
		24Vo		---	150	---	mV <sub>P-P</sub>
Transient Recovery Time	25% Load Step Change <sup>(2)</sup>		---	---	300	µsec	
Transient Response Deviation			---	±3	±5	%	
Temperature Coefficient			---	---	±0.02	%/°C	
Over Load Protection	Hiccup		---	---	150	---	%
Short Circuit Protection	Hiccup Mode 0.7 Hz typ., Automatic Recovery						

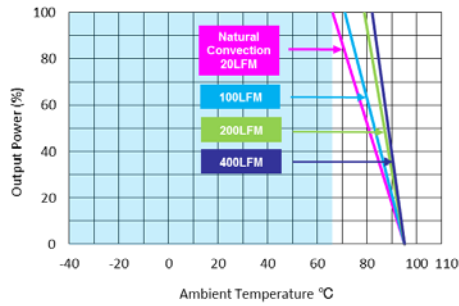
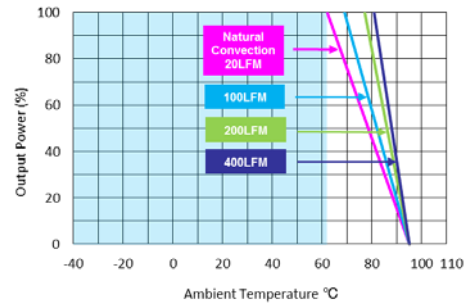
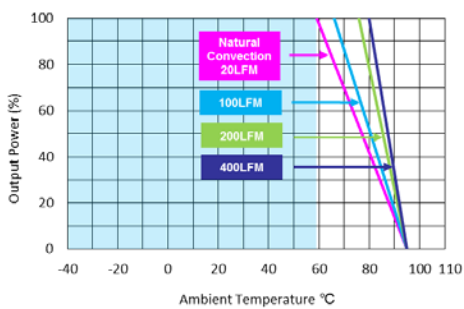
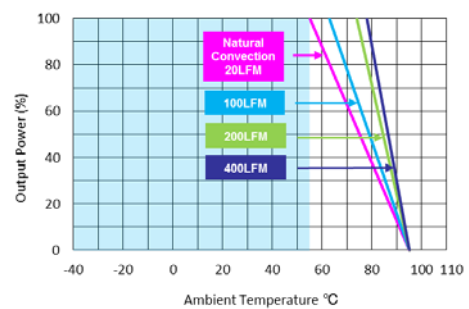
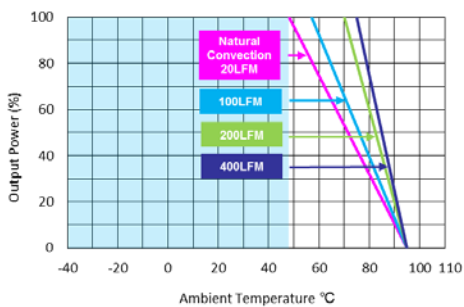
Isolation, Safety Standards						
Parameter	Conditions	Min.	Typ.	Max.	Unit	
I/O Isolation Voltage	60 Seconds	4200	---	---	VACrms	
	Reinforced insulation, rated for 1000Vrms working voltage	8000	---	---	VDC	
I/O Isolation Resistance	Tested for 1 second	10	---	---	GΩ	
I/O Isolation Capacitance	500 VDC	---	---	80	pF	
Common Mode Transient Immunity	100KHz, 1V	15	---	---	KV/µs	
Safety Approvals	UL/cUL 60950-1 recognition (UL certificate), IEC/EN 60950-1 (CB-report) UL/cUL 62368-1 recognition (UL certificate), IEC/EN 62368-1 (CB-report)					

General Specifications						
Parameter	Conditions	Min.	Typ.	Max.	Unit	
Switching Frequency		---	285	---	KHz	
MTBF(calculated)	MIL-HDBK-217F@25°C, Ground Benign	1,087,344	---	---	Hours	

Environmental Specifications						
Parameter	Conditions / Model	Min.	Max.	Unit		
Operating Ambient Temperature Range Natural Convection <sup>(6)</sup> Nominal Vin, Load 100% Inom. (for Power Derating see relative Derating Curves)	MKE20-24S24HI, MKE20-24D12HI, MKE20-24D15HI MKE20-48S15HI, MKE20-48D15HI	-40	66	°C		
	MKE20-12S24HI, MKE20-12D12HI, MKE20-12D15HI MKE20-24S15HI, MKE20-48S24HI, MKE20-48D12HI		62			
	MKE20-12S12HI, MKE20-12S15HI, MKE20-24S12HI MKE20-48S12HI		59			
	MKE20-24S05HI, MKE20-24S051HI, MKE20-48S05HI MKE20-48S051HI		55			
	MKE20-12S05HI, MKE20-12S051HI		48			
	Thermal Impedance		Natural Convection			
Case Temperature		---	+95	°C		
Storage Temperature Range		-50	+125	°C		
Humidity (non condensing)		---	95	% rel. H		
Altitude		---	4000	m		
Cooling	Natural Convection					
Lead Temperature (1.5mm from case for 10Sec.)		---	260	°C		

**EMC Specifications**

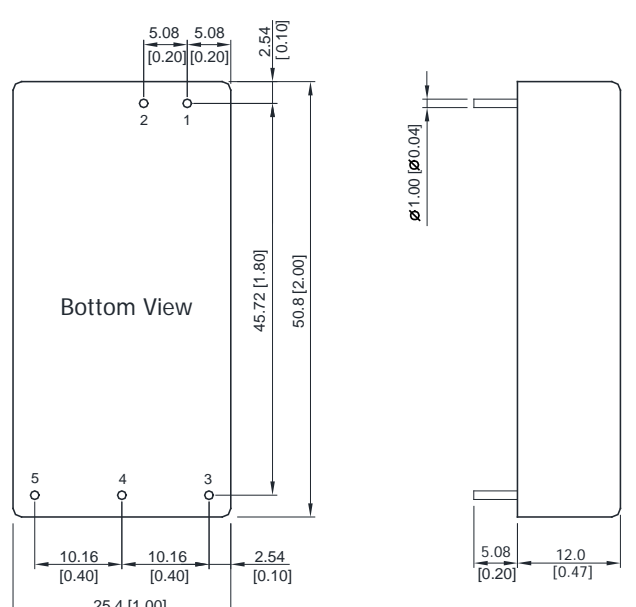
Parameter	Standards & Level		Performance
EMI	Conduction	EN 55032, FCC part 15	Class A
EMS	EN 55024		
	ESD	EN 61000-4-2 Air ± 8kV, Contact ± 6kV	A
	Radiated immunity	EN 61000-4-3 10V/m	A
	Fast transient (5)	EN 61000-4-4 ±2kV	A
	Surge (5)	EN 61000-4-5 ±1kV	A
	Conducted immunity	EN 61000-4-6 10Vrms	A
	PFMF	EN 61000-4-8 3A/m	A

**Power Derating Curve**

 MKE20-24S24HI, MKE20-24D12HI, MKE20-24D15HI  
 MKE20-48S15HI, MKE20-48D15HI

 MKE20-12S24HI, MKE20-12D12HI, MKE20-12D15HI  
 MKE20-24S15HI, MKE20-48S24HI, MKE20-48D12HI

 MKE20-12S12HI, MKE20-12S15HI, MKE20-24S12HI  
 MKE20-48S12HI

 MKE20-24S05HI, MKE20-24S051HI, MKE20-48S05HI  
 MKE20-48S051HI


MKE20-12S05HI, MKE20-12S051HI

**Notes**

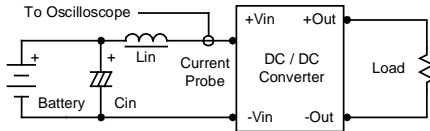
- Specifications typical at  $T_a = +25^\circ\text{C}$ , resistive load, nominal input voltage and rated output current unless otherwise noted.
- Transient recovery time is measured to within 1% error band for a step change in output load of 75% to 100%.
- We recommend to protect the converter by a slow blow fuse in the input supply line.
- Other input and output voltage may be available, please contact factory.
- To meet EN 61000-4-4 & EN 61000-4-5 an external capacitor across the input pins is required. Suggested capacitor : 330 $\mu\text{F}/100\text{V}$ .
- That "natural convection" is about 20LFM but is not equal to still air (0 LFM).
- Specifications are subject to change without notice.

Package Specifications																			
<div style="border: 1px solid #ccc; padding: 5px;"> <p><b>Mechanical Dimensions</b></p>  <p style="text-align: center;">Bottom View</p> </div>	<div style="border: 1px solid #ccc; padding: 5px;"> <p><b>Pin Connections</b></p> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 10%;">Pin</th> <th style="width: 45%;">Single Output</th> <th style="width: 45%;">Dual Output</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>+Vin</td> <td>+Vin</td> </tr> <tr> <td>2</td> <td>-Vin</td> <td>-Vin</td> </tr> <tr> <td>3</td> <td>+Vout</td> <td>+Vout</td> </tr> <tr> <td>4</td> <td>No Pin</td> <td>Common</td> </tr> <tr> <td>5</td> <td>-Vout</td> <td>-Vout</td> </tr> </tbody> </table> </div>	Pin	Single Output	Dual Output	1	+Vin	+Vin	2	-Vin	-Vin	3	+Vout	+Vout	4	No Pin	Common	5	-Vout	-Vout
Pin	Single Output	Dual Output																	
1	+Vin	+Vin																	
2	-Vin	-Vin																	
3	+Vout	+Vout																	
4	No Pin	Common																	
5	-Vout	-Vout																	
<ul style="list-style-type: none"> <li>▶ All dimensions in mm (inches)</li> <li>▶ Tolerance: X.X±0.5 (X.XX±0.02) X.XX±0.25 (X.XXX±0.01)</li> <li>▶ Pin diameter <math>\varnothing 1.0 \pm 0.05</math> (0.04±0.002)</li> </ul>																			

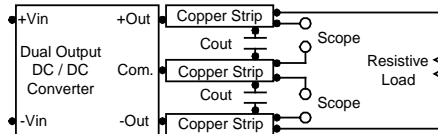
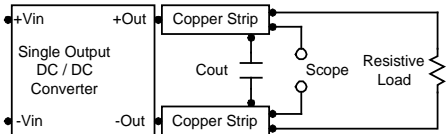
Physical Characteristics	
Case Size	: 50.8x25.4x12.0mm (2.0x1.0x0.47 inches)
Case Material	: Non-Conductive Black Plastic (flammability to UL 94V-0 rated)
Pin Material	: Tinned Copper
Weight	: 30g

**Test Setup**
**Input Reflected-Ripple Current Test Setup**

Input reflected-ripple current is measured with an inductor  $L_{in}$  (4.7 $\mu$ H) and  $C_{in}$  (220 $\mu$ F, ESR < 1.0 $\Omega$  at 100 KHz) to simulate source impedance. Capacitor  $C_{in}$  offsets possible battery impedance. Current ripple is measured at the input terminals of the module, measurement bandwidth is 0-500 KHz.


**Peak-to-Peak Output Noise Measurement Test**

Use a  $C_{out}$  4.7 $\mu$ F ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is 0-20 MHz. Position the load between 50 mm and 75 mm from the DC/DC Converter.


**Technical Notes**
**Overload Protection**

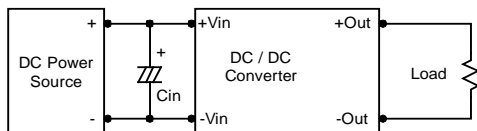
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

**Overvoltage Protection**

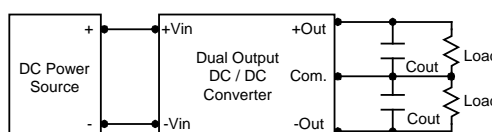
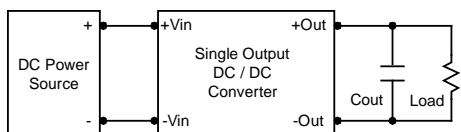
The output overvoltage clamp consists of control circuitry, which is independent of the primary regulation loop, that monitors the voltage on the output terminals. The control loop of the clamp has a higher voltage set point than the primary loop. This provides a redundant voltage control that reduces the risk of output overvoltage. The OVP level can be found in the output data.

**Input Source Impedance**

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor on the input to insure startup. By using a good quality low Equivalent Series Resistance (ESR < 1.0 $\Omega$  at 100 kHz) capacitor of a 10 $\mu$ F for the 12V input devices and a 4.7 $\mu$ F for the 24V input devices and a 2.2 $\mu$ F for the 48V devices, capacitor mounted close to the power module helps ensure stability of the unit.


**Output Ripple Reduction**

A good quality low ESR capacitor placed as close as practicable across the load will give the best ripple and noise performance. To reduce output ripple, it is recommended to use 4.7 $\mu$ F capacitors at the output.


**Maximum Capacitive Load**

The MKE20-HI series has limitation of maximum connected capacitance on the output. The power module may operate in current limiting mode during start-up, affecting the ramp-up and the startup time. Connect capacitors at the point of load for best performance. The maximum capacitance can be found in the data sheet.

**Thermal Considerations**

Many conditions affect the thermal performance of the power module, such as orientation, airflow over the module and board spacing. To avoid exceeding the maximum temperature rating of the components inside the power module, the case temperature must be kept below 95°C. The derating curves are determined from measurements obtained in a test setup.

