FEATURES

- ► **Industrial Standard 2"x1" Package**
- ► **Ultra-wide Input Range 9-36VDC, 18-75VDC, 40-160VDC**
- ► **I/O Isolation 3000VAC with Reinforced Insulation**
- ► **Operating Ambient Temp. Range -40°C to +88°C**
- ► **No Min. Load Requirement**
- ► **Overload/Voltage and Short Circuit Protection**
- ► **Remote On/Off, Output Voltage Trim**
- ► **Designed-in Conducted EMI meets EN55032/22 Class A & FCC Level A**
- ► **Vibration and Shock meets EN61373**
- ► **Cooling, Dry & Damp Heat Test meet IEC/EN60068-2-1,2,30**
- ► **Fire Protection Test meets EN45545-2**
- ► **Railway EMC Standard meets EN50121-3-2**
- ► **Railway Certified meets EN50155 (IEC60571)**
- ► **UL/cUL/IEC/EN 62368-1 (60950-1) Safety Approval & CE Marking**

NEW

UL 62368-1
UL 60950-1
CB Scheme

RAILWAY EN50155 · CONFLICT FREE Minerals Policy · REACH COMPLIANT · 3 YEAR WARRANTY · RoHS Compliant

PRODUCT OVERVIEW

The MINMAX MKZI20 series is a new range of high performance 20W isolated dc-dc converter within encapsulated 2"x1" package which specifically design for railway applications. There are 18 models available for railway input voltage of either 24(9~36)VDC or 48(18~75)VDC or 72/110(40~160)VDC and tight output voltage regulation. Further features include over current, over voltage, short circuit protection, remote ON/OFF, output trim and EMI filter meets EN55032/22 & FCC Part15 Class A as well. MKZI20 series conform to vibration and thermal shock test meets EN61373, cooling, dry and damp heat test meets IEC/EN 60068-2-1,2,30 and railway EMC standard EN50121-3-2 and complies also with Railway Certification EN50155 (IEC60571). MKZI20 series offer an highly reliable solution for critical applications in railway systems, battery-powered equipment, measure instrumentation and many critical applications.

Model Selection Guide

Model Number	Input Voltage (Range)	Output Voltage	Output Current	Input Current		Over Voltage Protection	Max. capacitive Load	Efficiency (typ.)
			Max.	@Max. Load	@No Load			@Max. Load
	VDC	VDC	mA	mA(typ.)	mA(typ.)	VDC	μF	%
MKZI20-24S05	24 (9 ~ 36)	5	4000	958	25	6.2	6800	87
MKZI20-24S12		12	1670	960		15	1200	87
MKZI20-24S15		15	1330	955		18	750	87
MKZI20-24S24		24	833	957		30	300	87
MKZI20-24D12		±12	±833	969		±15	600#	86
MKZI20-24D15		±15	±667	969		±18	380#	86
MKZI20-48S05	48 (18 ~ 75)	5	4000	479	15	6.2	6800	87
MKZI20-48S12		12	1670	474		15	1200	88
MKZI20-48S15		15	1330	472		18	750	88
MKZI20-48S24		24	833	473		30	300	88
MKZI20-48D12		±12	±833	479		±15	600#	87
MKZI20-48D15		±15	±667	479		±18	380#	87
MKZI20-110S05	110 (40 ~ 160)	5	4000	216	10	6.2	6800	84
MKZI20-110S12		12	1670	212		15	1200	86
MKZI20-110S15		15	1330	211		18	750	86
MKZI20-110S24		24	833	211		30	300	86
MKZI20-110D12		±12	±833	211		±15	600#	86
MKZI20-110D15		±15	±667	212		±18	380#	86

For each output

Input Specifications

Parameter	Model	Min.	Typ.	Max.	Unit
Input Surge Voltage (100ms. max)	24V Input Models	-0.7	---	50	VDC
	48V Input Models	-0.7	---	100	
	110V Input Models	-0.7	---	170	
Start-Up Threshold Voltage	24V Input Models	---	---	9	
	48V Input Models	---	---	18	
	110V Input Models	---	---	40	
Under Voltage Shutdown	24V Input Models	---	7.5	---	
	48V Input Models	---	16	---	
	110V Input Models	---	37	---	
Start Up Time	All Models	---	50	--	mS
Input Filter		Internal Pi Type			

Remote On/Off Control

Parameter	Conditions	Min.	Typ.	Max.	Unit
Converter On	3.5V ~ 12V or Open Circuit				
Converter Off	0V ~ 1.2V or Short Circuit				
Control Input Current (on)	Vctrl = 5.0V	---	0.5	---	mA
Control Input Current (off)	Vctrl = 0V	---	-0.5	---	mA
Control Common	Referenced to Negative Input				
Standby Input Current	Nominal Vin	---	2.5	---	mA

Output Specifications

Parameter	Conditions			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			---	---	±0.2	%
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	5Vo	Measured with a 10μF/25V MLCC	---	50	---	mV P-P
		12Vo,15Vo, ±12Vo, ±15Vo		---	100	---	mV P-P
		24Vo	Measured with a 4.7μF/50V MLCC	---	150	---	mV P-P
Transient Recovery Time	25% Load Step Change (2)			---	---	300	μsec
Transient Response Deviation				---	±3	±5	%
Temperature Coefficient				---	---	±0.02	%/°C
Trim Up / Down Range (See Page 8)	% of Nominal Output Voltage			---	---	±10	%
Over Load Protection	Hiccup			---	150	---	%
Short Circuit Protection	Hiccup Mode 0.7Hz typ., Automatic Recovery						

General Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	Reinforced Insulation, Rated For 60 Seconds	3000	---	---	VACrms
Isolation Voltage Input/Output to case	Rated For 60 Seconds	1500	---	---	VACrms
I/O Isolation Resistance	500 VDC	1000	---	---	MΩ
I/O Isolation Capacitance	100KHz, 1V	---	1500	---	pF
Switching Frequency		---	320	---	KHz
MTBF(calculated)	MIL-HDBK-217F@25°C Full Load, Ground Benign	665,100	---	---	Hours
Safety Approval	UL/cUL 60950-1 recognition (UL certificate), IEC/EN 60950-1(CB-report), EN 50155, IEC 60571				
	UL/cUL 62368-1 recognition (UL certificate), IEC/EN 62368-1 (CB-report)				

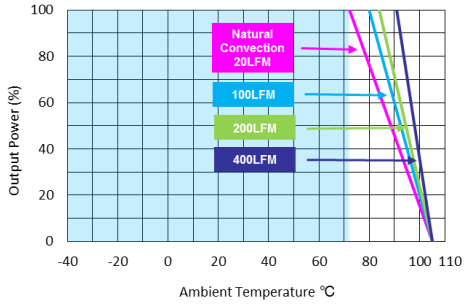
Environmental Specifications

Parameter	Model	Min.	Max. without Heatsink	Max. with Heatsink	Unit
Operating Temperature Range Natural Convection (6) Nominal Vin, Load 100% Inom. (for Power Derating see relative Derating Curves)	MKZI20-48S12, MKZI20-48S15, MKZI20-48S24	-40	72	78	℃
	MKZI20-24S05, MKZI20-24S12, MKZI20-24S15 MKZI20-24S24, MKZI20-48S05, MKZI20-48D12 MKZI20-48D15		69	76	
	MKZI20-24D12, MKZI20-24D15, MKZI20-110S12 MKZI20-110S15, MKZI20-110S24,MKZI20-110D12 MKZI20-110D15		66	73	
	MKZI20-110S05		59	68	
Thermal Impedance	Natural Convection without Heatsink	12.1	---		℃/W
	Natural Convection with Heatsink	9.8	---		℃/W
	100LFM Convection without Heatsink	9.2	---		℃/W
	100LFM Convection with Heatsink	5.4	---		℃/W
	200LFM Convection without Heatsink	7.8	---		℃/W
	200LFM Convection with Heatsink	4.5	---		℃/W
	400LFM Convection without Heatsink	5.2	---		℃/W
	400LFM Convection with Heatsink	3.0	---		℃/W
Case Temperature		---	+105		℃
Storage Temperature Range		-50	+125		℃
Cooling Test	Compliance to IEC/EN60068-2-1				
Dry Heat	Compliance to IEC/EN60068-2-2				
Damp Heat	Compliance to IEC/EN60068-2-30				
Shock & Vibration Test	Compliance to IEC/EN 61373				
Operating Humidity (non condensing)		---	95		% rel. H
RFI	Six-Sided Shielded, Metal Case				
Lead Temperature (1.5mm from case for 10Sec.)		---	260		℃

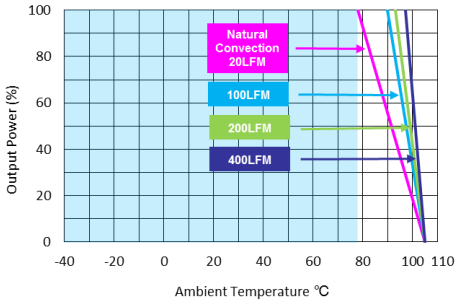
EMC Specifications

Parameter	Standards & Level		Performance
General	Compliance with EN 50121-3-2 Railway Applications		
EMI	Conduction	EN55032,EN55022, FCC part 15	Class A
EMS	EN55024		
	ESD	EN61000-4-2 Air ± 8kV , Contact ± 6kV	A
	Radiated immunity	EN61000-4-3 10V/m	A
	Fast transient(5)	EN61000-4-4 ±2kV	A
	Surge(5)	EN61000-4-5 ±2kV	A
	Conducted immunity	EN61000-4-6 10Vrms	A
	PFMF	EN61000-4-8 3A/M	A

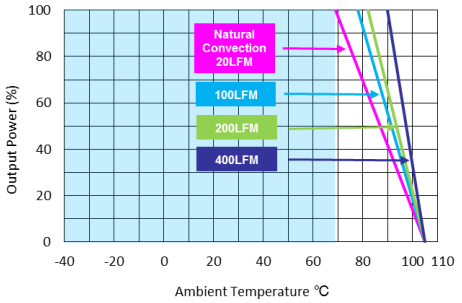
Power Derating Curve



MKZI20-48S12, MKZI20-48S15, MKZI20-48S24
Derating Curve without Heatsink



MKZI20-48S12, MKZI20-48S15, MKZI20-48S24
Derating Curve with Heatsink



MKZI20-24S05, MKZI20-24S12, MKZI20-24S15, MKZI20-24S24
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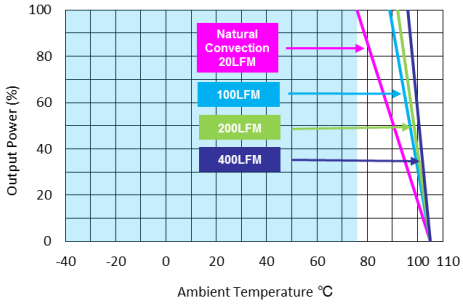
Derating Curve without Heatsink



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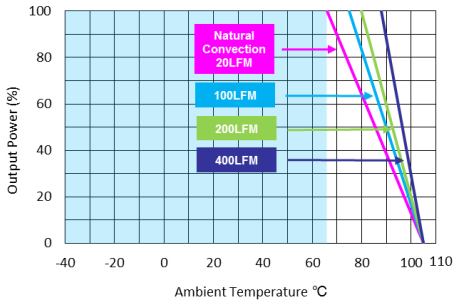
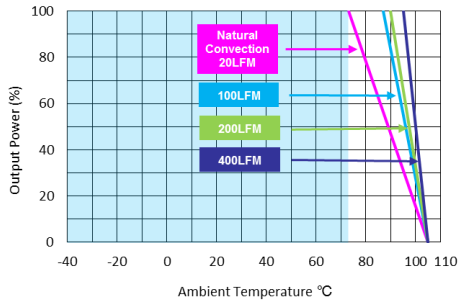
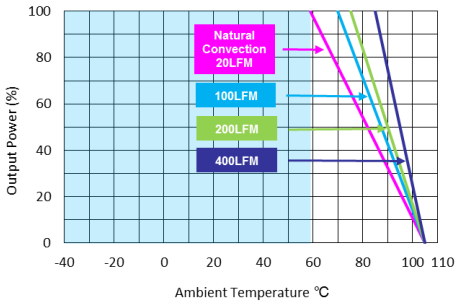
MKZI20-48S05, MKZI20-48D12, MKZI20-48D15
Derating Curve with Heatsink



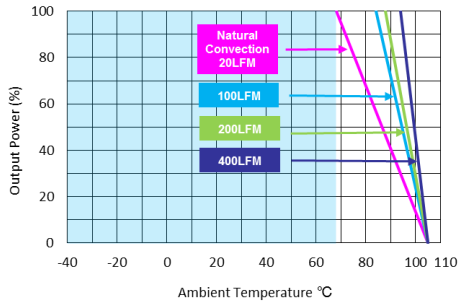
MKZI20-24D12, MKZI20-24D15, MKZI20-110S12, MKZI20-110S15
MKZI20-110S24,MKZI20-110D12, MKZI20-110D15
Derating Curve without Heatsink



MKZI20-24D12, MKZI20-24D15, MKZI20-110S12, MKZI20-110S15
MKZI20-110S24,MKZI20-110D12, MKZI20-110D15
Derating Curve with Heatsink



MKZI20-110S05 Derating Curve without Heatsink

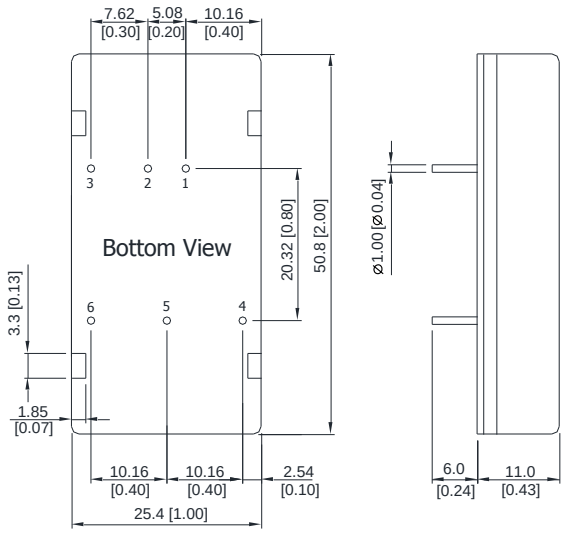


MKZI20-110S05 Derating Curve with Heatsink

Notes	
1	Specifications typical at Ta=+25℃, resistive load, nominal input voltage and rated output current unless otherwise noted.
2	Transient recovery time is measured to within 1% error band for a step change in output load of 75% to 100%.
3	We recommend to protect the converter by a slow blow fuse in the input supply line.
4	Other input and output voltage may be available, please contact factory.
5	To meet EN61000-4-4 & EN61000-4-5 an external capacitor across the input pins is required. Suggested capacitor: 24XXX: CHEMI-CON KY Series 390μF/63V. 48XXX: CHEMI-CON KY Series 330μF/100V. 110XXX: CHEMI-CON KXJ Series 390μF/200V.
6	That “natural convection” is about 20LFM but is not equal to still air (0 LFM).
7	Specifications are subject to change without notice.

Package Specifications

Mechanical Dimensions



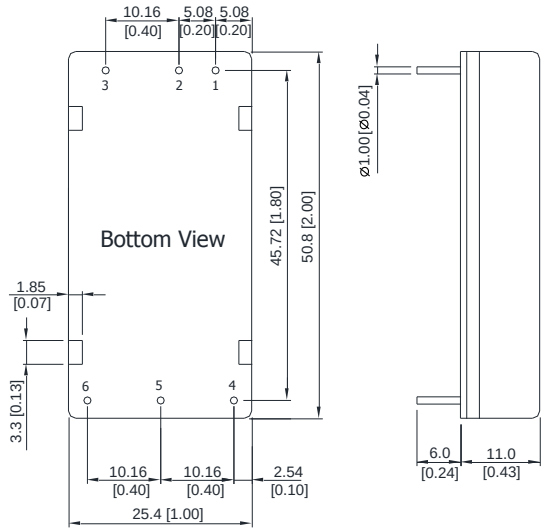
Pin Connections

Pin	Single Output	Dual Output
1	+Vin	+Vin
2	-Vin	-Vin
3	Remote On/Off	Remote On/Off
4	+Vout	+Vout
5	Trim	Common
6	-Vout	-Vout

- All dimensions in mm (inches)
- Tolerance: X.X±0.75 (X.XX±0.03)
  X.XX±0.25 (X.XXX±0.01)
- Pin diameter ∅ 1.0 ±0.05 (0.04±0.002)

Package Specifications with "A" Pinning (order code suffix A)

Mechanical Dimensions



Pin Connections

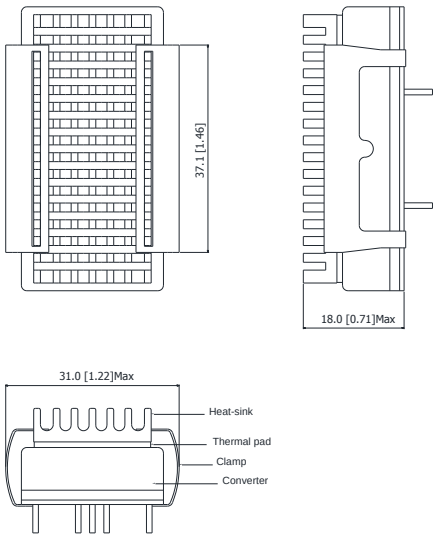
Pin	Single Output	Dual Output
1	+Vin	+Vin
2	-Vin	-Vin
3	Remote On/Off	Remote On/Off
4	+Vout	+Vout
5	-Vout	Common
6	Trim	-Vout

- All dimensions in mm (inches)
- Tolerance: X.X±0.75 (X.XX±0.03)
  X.XX±0.25 (X.XXX±0.01)
- Pin diameter ∅ 1.0 ±0.05 (0.04±0.002)

Physical Characteristics

Case Size	:	50.8x25.4x11.0 mm (2.0x1.0x0.43 inches)
Case Material	:	Red Copper, Powder Coating
Base Material	:	FR4 PCB (flammability to UL 94V-0 rated)
Insulated Frame Material	:	Non-Conductive Black Plastic (flammability to UL 94V-0 rated)
Pin Material	:	Tinned Copper
Potting Material	:	Epoxy (flammability to UL 94V-0 rated)
Weight	:	40.5g

Heatsink (Option, –HS)

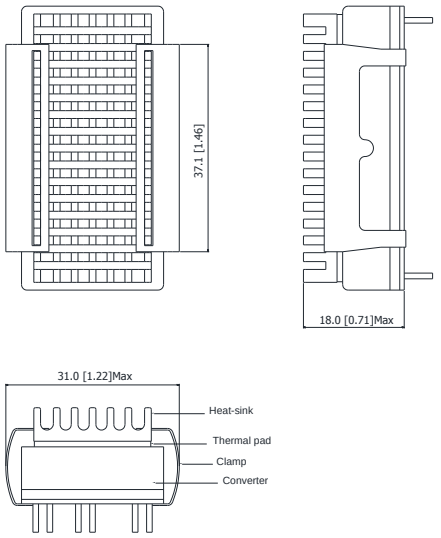


Physical Characteristics		
Heatsink Material	:	Aluminum
Finish	:	Black Anodized Coating
Weight	:	9g

► The advantages of adding a heatsink are:

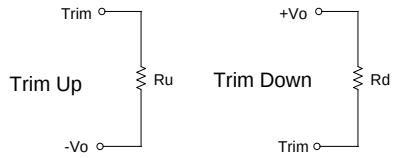
1. To improve heat dissipation and increase the stability and reliability of the DC/DC converters at high operating temperatures.
2. To increase Operating temperature of the DC/DC converter, please refer to Derating Curve.

"A" Pinning Heatsink (Option, –HS)



External Output Trimming

Output can be externally trimmed by using the method shown below



MKZI20-XXS05 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	156.81	70.69	41.99	27.64	19.03	13.29	9.18	6.11	3.72	1.80	KOhms
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox1.01	Vox1.02	Vox1.03	Vox1.04	Vox1.05	Vox1.06	Vox1.07	Vox1.08	Vox1.09	Vox1.10	Volts
Ru=	119.77	53.70	31.67	20.66	14.05	9.65	6.50	4.14	2.31	0.84	KOhms

MKZI20-XXS12 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	419.81	187.68	110.30	71.61	48.40	32.93	21.87	13.58	7.13	1.98	KOhms
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox1.01	Vox1.02	Vox1.03	Vox1.04	Vox1.05	Vox1.06	Vox1.07	Vox1.08	Vox1.09	Vox1.10	Volts
Ru=	344.74	154.37	90.92	59.19	40.15	27.46	18.39	11.59	6.31	2.07	KOhms

MKZI20-XXS15 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	602.92	269.91	158.91	103.41	70.10	47.90	32.05	20.15	10.90	3.50	KOhms
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox1.01	Vox1.02	Vox1.03	Vox1.04	Vox1.05	Vox1.06	Vox1.07	Vox1.08	Vox1.09	Vox1.10	Volts
Ru=	482.88	215.89	126.89	82.40	55.70	37.90	25.18	15.65	8.23	2.30	KOhms

MKZI20-XXS24 Trim Table

Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox0.99	Vox0.98	Vox0.97	Vox0.96	Vox0.95	Vox0.94	Vox0.93	Vox0.92	Vox0.91	Vox0.90	Volts
Rd=	598.97	267.93	157.59	102.42	69.31	47.25	31.48	19.66	10.46	3.11	KOhms
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout=	Vox1.01	Vox1.02	Vox1.03	Vox1.04	Vox1.05	Vox1.06	Vox1.07	Vox1.08	Vox1.09	Vox1.10	Volts
Ru=	486.83	217.87	128.21	83.38	56.49	38.56	25.75	16.14	8.67	2.69	KOhms

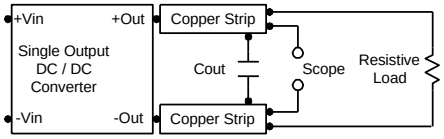
Order Code Table

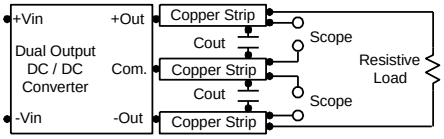
Standard	With heatsink	With "A" Pinning	With "A" Pinning & heatsink
MKZI20-24S05	MKZI20-24S05-HS	MKZI20-24S05A	MKZI20-24S05A-HS
MKZI20-24S12	MKZI20-24S12-HS	MKZI20-24S12A	MKZI20-24S12A-HS
MKZI20-24S15	MKZI20-24S15-HS	MKZI20-24S15A	MKZI20-24S15A-HS
MKZI20-24S24	MKZI20-24S24-HS	MKZI20-24S24A	MKZI20-24S24A-HS
MKZI20-24D12	MKZI20-24D12-HS	MKZI20-24D12A	MKZI20-24D12A-HS
MKZI20-24D15	MKZI20-24D15-HS	MKZI20-24D15A	MKZI20-24D15A-HS
MKZI20-48S05	MKZI20-48S05-HS	MKZI20-48S05A	MKZI20-48S05A-HS
MKZI20-48S12	MKZI20-48S12-HS	MKZI20-48S12A	MKZI20-48S12A-HS
MKZI20-48S15	MKZI20-48S15-HS	MKZI20-48S15A	MKZI20-48S15A-HS
MKZI20-48S24	MKZI20-48S24-HS	MKZI20-48S24A	MKZI20-48S24A-HS
MKZI20-48D12	MKZI20-48D12-HS	MKZI20-48D12A	MKZI20-48D12A-HS
MKZI20-48D15	MKZI20-48D15-HS	MKZI20-48D15A	MKZI20-48D15A-HS
MKZI20-110S05	MKZI20-110S05-HS	MKZI20-110S05A	MKZI20-110S05A-HS
MKZI20-110S12	MKZI20-110S12-HS	MKZI20-110S12A	MKZI20-110S12A-HS
MKZI20-110S15	MKZI20-110S15-HS	MKZI20-110S15A	MKZI20-110S15A-HS
MKZI20-110S24	MKZI20-110S24-HS	MKZI20-110S24A	MKZI20-110S24A-HS
MKZI20-110D12	MKZI20-110D12-HS	MKZI20-110D12A	MKZI20-110D12A-HS
MKZI20-110D15	MKZI20-110D15-HS	MKZI20-110D15A	MKZI20-110D15A-HS

Test Setup

Peak-to-Peak Output Noise Measurement Test

Use a 1μF ceramic capacitor and a 10μF tantalum 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

Remote On/Off

Positive logic remote on/off turns the module on during a logic high voltage on the remote on/off pin, and off during a logic low. To turn the power module on and off, the user must supply a switch to control the voltage between the on/off terminal and the -Vin terminal. The switch can be an open collector or equivalent. A logic low is 0V to 1.2V. A logic high is 3.5V to 12V. The maximum sink current at the on/off terminal (Pin 3) during a logic low is -100μA.

Overload Protection

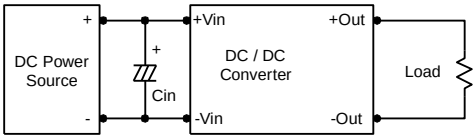
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

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.

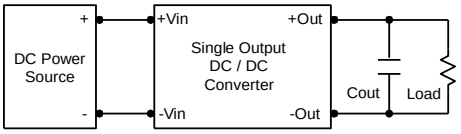
Input Source Impedance

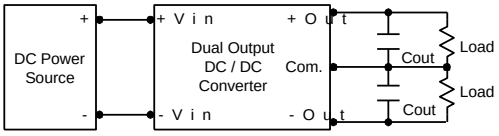
The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup. Capacitor mounted close to the power module helps ensure stability of the unit, it is recommended to use a good quality low Equivalent Series Resistance (ESR < 1.0 Ω at 100 KHz) capacitor of a 4.7μF for the 24V input devices, a 2.2μF for the 48V devices and a 1μF for the 110V devices.



Output Ripple Reduction

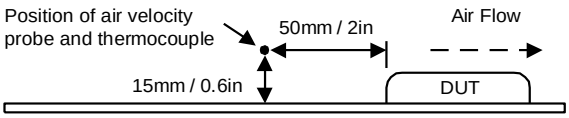
A good quality low ESR capacitor placed as close as practicable across the load will give the best ripple and noise performance. To reduce output ripple, it is recommended to use 4.7μF capacitors at the output.





Maximum Capacitive Load

The MKZI20 series has limitation of maximum connected capacitance at the output. The power module may be operated in current limiting mode during start-up, affecting the ramp-up and the startup time. 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 105°C. The derating curves are determined from measurements obtained in a test setup.