

FEATURES

- ▶ Industrial Standard 2"x1" Package
- ▶ Ultra-wide Input Range 36-160VDC
- ▶ I/O Isolation 3000VAC with Reinforced Insulation
- ▶ Excellent Efficiency up to 90%
- ▶ Operating Ambient Temp. Range -40°C to +77.5°C
- ▶ No Min. Load Requirement
- ▶ Under-voltage, Overload/Voltage and Short Circuit Protection
- ▶ Remote On/Off Control, Output Voltage Trim
- ▶ Vibration and Shock/Bump Test EN 61373 Approved
- ▶ Cooling, Dry & Damp Heat Test IEC/EN 60068-2-1, 2, 30

Approved

- ▶ Railway EMC Standard EN 50121-3-2 Approved
- ▶ Railway Certified EN 50155 (IEC60571) Approved
- ▶ Fire Protection Test EN 45545-2 Approved
- ▶ UL/cUL/IEC/EN 62368-1 Safety Approval & CE Marking



PRODUCT OVERVIEW

The MINMAX MKZI40 series is a latest generation of 40 Watt railway certified and isolated DC-DC power modules with ultra-wide input range of 36-160Vin for railway DC system and 7 models available for 5/12/15/24/54/±12/±15VDC tightly output voltage within compact size 2"x1" size with shielded and encapsulated package which specifically design for railway/railroad, battery-powered and harsh environmental applications. Key performance featuring high I/O isolation 3000VAC with reinforced insulation, high efficiency up to 90%, operating ambient temp. range -40°C to +77.5°C, no min. load requirement, very low no-load power consumption, remote on/off, output voltage trim, build-in fault condition protection include under-voltage, overload, over-voltage and short circuit protection.

The MKZI40 series complies with railway certification EN 50155 (IEC 60571) which conform to vibration and shock/bump test EN 61373 approved, cooling/dry/damp heat test IEC/EN 60068-2-1,2,30 approved, railway EMC standard EN 50121-3-2 approved and fire protection test EN 45545-2 approved. The MKZI40 series has been intensely qualified to safety approval UL/cUL/IEC/EN 62368-1 with CB report and CE marking which offer a solution for the applications where wide input voltage range, high efficiency for wide operating ambient temp. range, isolated power with high I/O isolation & insulation level, robust environmental & mechanical sustainability and even railway certification are required.

Model Selection Guide

Model Number	Input Voltage (Range) VDC	Output Voltage VDC	Output Power W	Output Current	Input Current		Over Voltage Protection VDC	Max. capacitive Load µF	Efficiency (typ.) %
				Max. mA	@Max. Load mA(typ.)	@No Load mA(typ.)			
MKZI40-110S05	110 (36 ~ 160)	5	40.00	8000	413	40	6.2	13600	88
MKZI40-110S12		12	39.96	3330	408		15	2400	89
MKZI40-110S15		15	40.05	2670	409		18	1500	89
MKZI40-110S24		24	40.08	1670	409		30	600	89
MKZI40-110S54		54	40.01	741	404		66	130	90
MKZI40-110D12		±12	40.08	±1670	409		±15	1200#	89
MKZI40-110D15		±15	39.90	±1330	408		±18	750#	89

For each output

Input Specifications					
Parameter	Model	Min.	Typ.	Max.	Unit
Input Surge Voltage (100ms. max)	All Models	-0.7	---	170	VDC
Start-Up Threshold Voltage		---	---	36	
Under Voltage Shutdown		30	33	35.5	
Start Up Time		---	30	--	mS
Input Filter		Internal Pi Type			

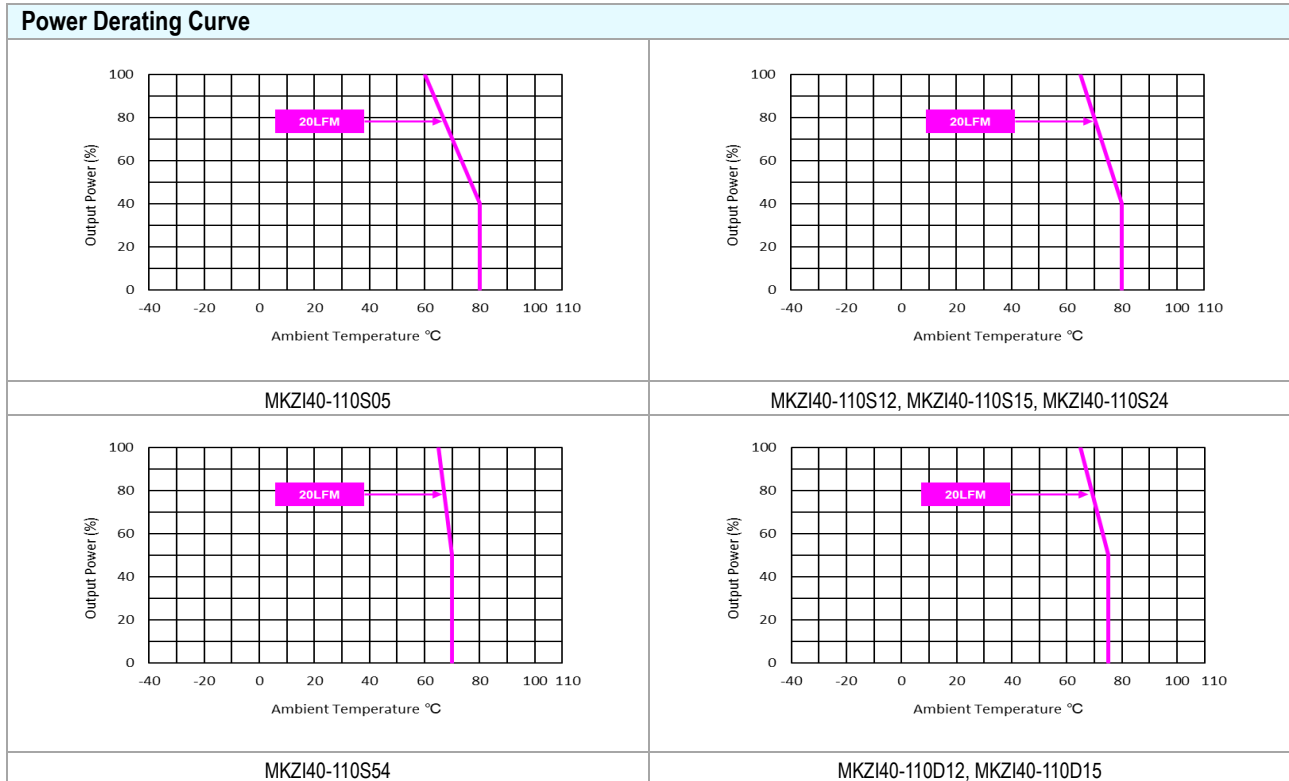
Remote On/Off Control					
Parameter	Conditions	Min.	Typ.	Max.	Unit
Positive logic (Standard)	Converter On	3.5V ~ 12V or Open Circuit			
	Converter Off	0V ~ 1.2V or Short Circuit			
Negative logic (Option)	Converter On	0V ~ 1.2V or Short Circuit			
	Converter Off	3.5V ~ 12V or Open Circuit			
Control 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 1μF/100V MLCC	---	75	85	mV P-P
		12Vo, 15Vo, ±12Vo, ±15Vo		---	125	140	mV P-P
		24Vo		---	150	170	mV P-P
		54Vo		---	250	280	
Transient Recovery Time	25% Load Step Change (2)		---	250	---	μsec	
Transient Response Deviation			---	±3	±5	%	
Temperature Coefficient			---	---	±0.02	%/°C	
Trim Up / Down Range(7)	% of Nominal Output Voltage	Other Models	---	---	±10	%	
		54Vo Output	---	---	+5 / -15	%	
Over Load Protection	Hiccup	110	150	185	%		
Short Circuit Protection	Continuous, Automatic Recovery (Hiccup Mode 0.5Hz typ.)						

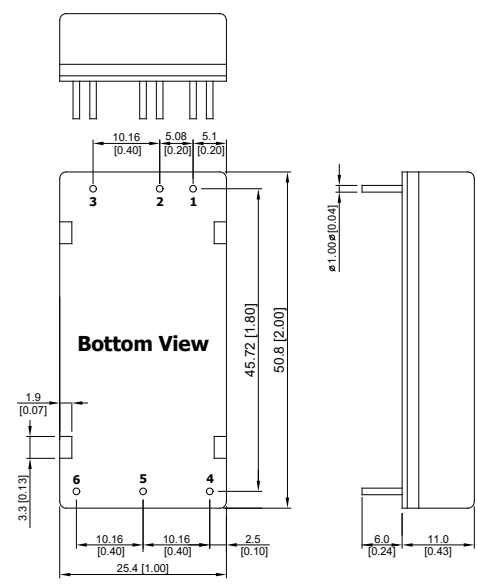
General Specifications					
Parameter	Conditions	Min.	Typ.	Max.	Unit
I/O Isolation Voltage	Reinforced Insulation, Rated For 60 Seconds	3000	---	---	VAC
Isolation Voltage Input/Output to case	Rated For 60 Seconds	1500	---	---	VAC
I/O Isolation Resistance	500 VDC	1000	---	---	MΩ
I/O Isolation Capacitance	100kHz, 1V	---	1500	---	pF
Switching Frequency		220	265	310	kHz
MTBF(calculated)	MIL-HDBK-217F@25°C Full Load, Ground Benign	900,000	---	---	Hours
Safety Approval	UL/cUL 62368-1 recognition(UL certificate), IEC/EN 62368-1(CB-report), EN 50155, IEC 60571				

EMC Specifications					
Parameter	Standards & Level			Performance	
General	Compliance with EN 50121-3-2 Railway Applications				
EMI	Conduction	EN 55032, EN 55011	With external components	Class A ₍₅₎	
	Radiation				
EMS	EN 55035				
	ESD	Direct discharge	Indirect discharge HCP & VCP		
		EN 61000-4-2 Air ± 8kV, Contact ± 6kV		Contact ± 6kV	
	Radiated immunity	EN 61000-4-3 20V/m			A
	Fast transient ₍₆₎	EN 61000-4-4 ±2kV			A
	Surge ₍₆₎	EN 61000-4-5 ±2kV			A
	Conducted immunity	EN 61000-4-6 10Vrms			A
PFMF	EN61000-4-8 100A/M for Continuous ; 1000A/M for 1 Sec.			A	

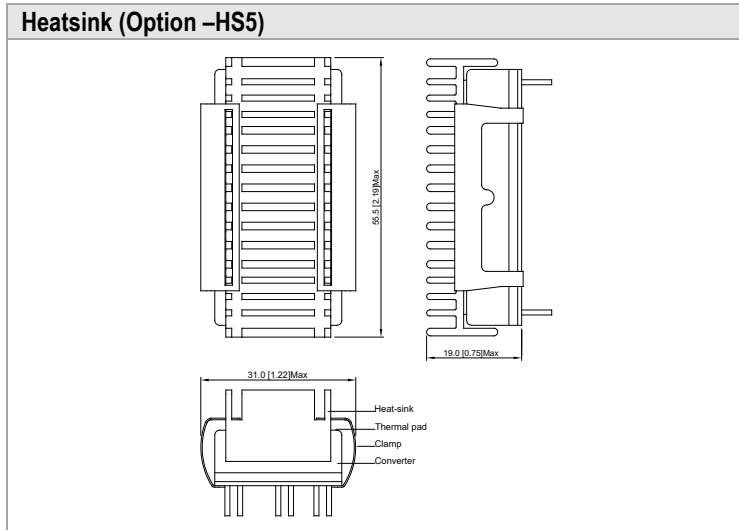
Environmental Specifications				
Parameter	Conditions / Model	Min.	Max.	Unit
Operating Temperature Range Nominal Vin, Load 100% Inom. (for Power Derating see relative Derating Curves)	MKZI40-110S05	-40	+60	°C
	MKZI40-110S12, MKZI40-110S15, MKZI40-110S24			
	MKZI40-110S54		+65	
	MKZI40-110D12, MKZI40-110D15			
Thermal Impedance	20LFM Convection	TBD	TBD	°C/W
Case Temperature		---	+105	°C
Storage Temperature Range		-50	+125	°C
Humidity (non condensing)		---	95	% rel. H
Altitude		---	4000	M
Cooling	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	°C


Notes

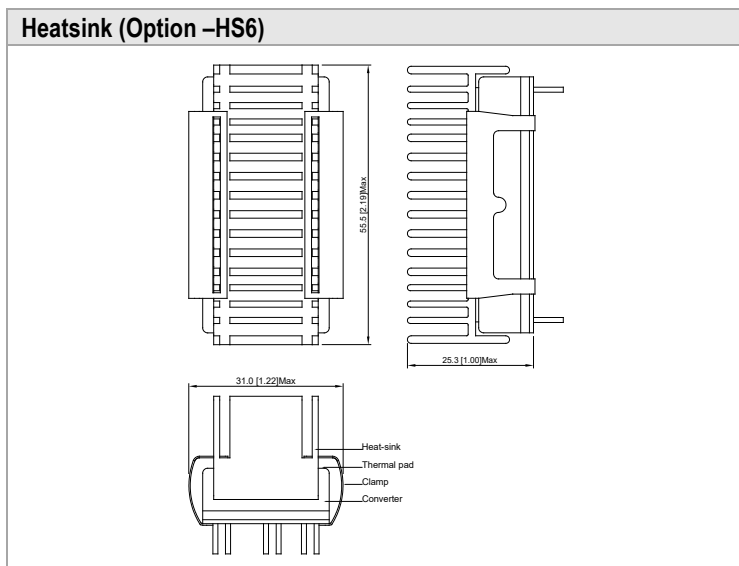
- 1 Specifications typical at Ta=+25°C, resistive load, nominal input voltage and rated output current unless otherwise noted.
- 2 Transient recovery time is measured to within 1% error band for a step change in output load of 75% to 100%.
- 3 We recommend to protect the converter by a slow blow fuse in the input supply line.
- 4 Other input and output voltage may be available, please contact MINMAX.
- 5 To meet EN 55032 Class A an external filter, please contact MINMAX.
- 6 To meet EN 61000-4-4 & EN 61000-4-5 an external capacitor across the input pins is required, please contact MINMAX.
- 7 Do not exceed maximum power specification when adjusting output voltage.
- 8 Specifications are subject to change without notice.

Package Specifications																						
<div style="border: 1px solid black; padding: 10px;"> <p>Mechanical Dimensions</p>  <p style="text-align: center;">Bottom View</p> </div>	<div style="border: 1px solid black; padding: 10px;"> <p>Pin Connections</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>Remote On/Off</td> <td>Remote On/Off</td> </tr> <tr> <td>4</td> <td>+Vout</td> <td>+Vout</td> </tr> <tr> <td>5</td> <td>-Vout</td> <td>Common</td> </tr> <tr> <td>6</td> <td>Trim</td> <td>-Vout</td> </tr> </tbody> </table> </div>	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
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																				
<ul style="list-style-type: none"> ▶ All dimensions in mm (inches) ▶ Tolerance: X.X±0.75 (X.XX±0.03) X.XX±0.25 (X.XXX±0.01) ▶ Pin diameter $\varnothing 1.0 \pm 0.05$ (0.04±0.002) 																						

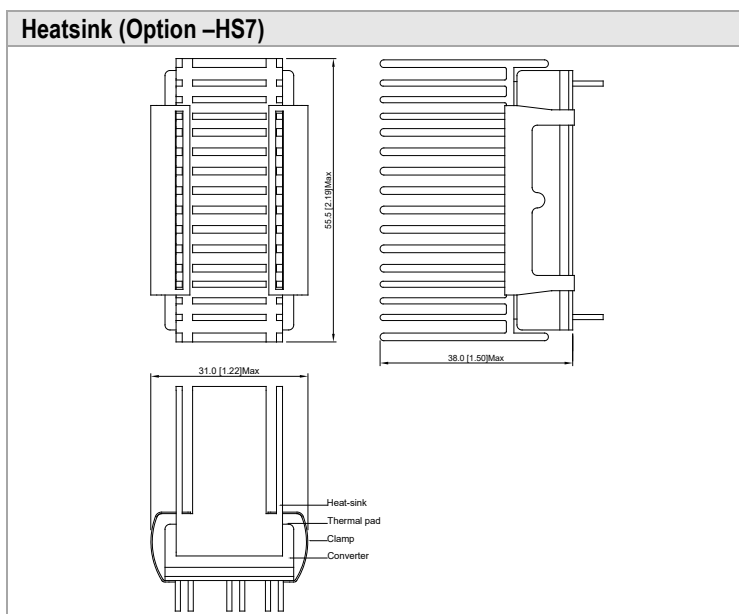
Physical Characteristics	
Case Size	: 50.8x25.4x11.0 mm (2.0x1.0x0.43 inches)
Case Material	: Red Copper, Powder Coating
Base Material	: FR4 PCB (flammability to UL 94V-0 rated)
Insulated Frame Material	: Non-Conductive Black Plastic (flammability to UL 94V-0 rated)
Pin Material	: Copper Alloy with Tin Plate Over Nickel Subplate
Potting Material	: Epoxy (flammability to UL 94V-0 rated)
Weight	: 51.5g



Physical Characteristics	
Heatsink Material	: Aluminum
Finish	: Black Anodized Coating
Weight	: 10g



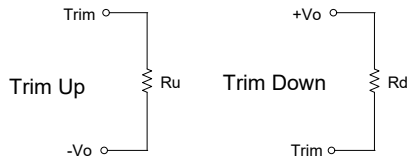
Physical Characteristics	
Heatsink Material	: Aluminum
Finish	: Black Anodized Coating
Weight	: 16g



Physical Characteristics	
Heatsink Material	: Aluminum
Finish	: Black Anodized Coating
Weight	: 28g

External Output Trimming

Output can be externally trimmed by using the method shown below

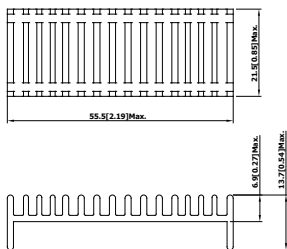
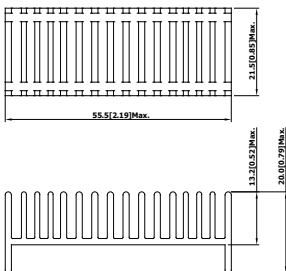
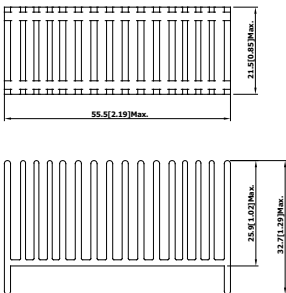


Trim Range (%)	MKZI40-110S05		MKZI40-110S12		MKZI40-110S15		MKZI40-110S24		MKZI40-110S54	
	Trim down (kΩ)	Trim up (kΩ)	Trim down (kΩ)	Trim up (kΩ)	Trim down (kΩ)	Trim up (kΩ)	Trim down (kΩ)	Trim up (kΩ)	Trim down (kΩ)	Trim up (kΩ)
1	156.81	119.77	419.81	344.74	602.92	482.88	598.97	486.83	1946.08	487.21
2	70.69	53.70	187.68	154.37	269.91	215.89	267.93	217.87	907.19	191.10
3	41.99	31.67	110.30	90.92	158.91	126.89	157.59	128.21	560.89	92.40
4	27.64	20.66	71.61	59.19	103.41	82.40	102.42	83.88	387.75	43.05
5	19.03	14.05	48.40	40.15	70.10	55.70	69.31	56.49	283.86	13.44
6	13.29	9.65	32.93	27.46	47.90	37.90	47.25	38.56	214.60	---
7	9.18	6.50	21.87	18.39	32.05	25.18	31.48	25.75	165.13	---
8	6.11	4.14	13.58	11.59	20.15	15.65	19.66	16.14	128.02	---
9	3.72	2.31	7.13	6.31	10.90	8.23	10.46	8.67	99.16	---
10	1.80	0.84	1.98	2.07	3.50	2.30	3.11	2.69	76.08	---
11	---	---	---	---	---	---	---	---	57.19	---
12	---	---	---	---	---	---	---	---	41.45	---
13	---	---	---	---	---	---	---	---	28.13	---
14	---	---	---	---	---	---	---	---	16.71	---
15	---	---	---	---	---	---	---	---	6.82	---

Order Code Table For Converter and Converter With Heatsink

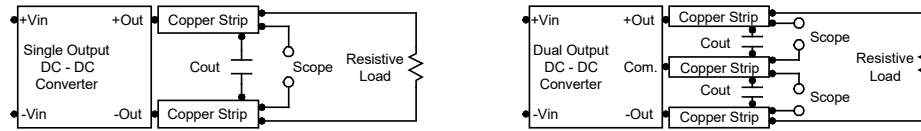
Standard	With heatsink		
	MKZI40 + HS-K004	MKZI40 + HS-K005	MKZI40 + HS-K006
MKZI40-110S05	MKZI40-110S05-HS5	MKZI40-110S05-HS6	MKZI40-110S05-HS7
MKZI40-110S12	MKZI40-110S12-HS5	MKZI40-110S12-HS6	MKZI40-110S12-HS7
MKZI40-110S15	MKZI40-110S15-HS5	MKZI40-110S15-HS6	MKZI40-110S15-HS7
MKZI40-110S24	MKZI40-110S24-HS5	MKZI40-110S24-HS6	MKZI40-110S24-HS7
MKZI40-110S54	MKZI40-110S54-HS5	MKZI40-110S54-HS6	MKZI40-110S54-HS7
MKZI40-110D12	MKZI40-110D12-HS5	MKZI40-110D12-HS6	MKZI40-110D12-HS7
MKZI40-110D15	MKZI40-110D15-HS5	MKZI40-110D15-HS6	MKZI40-110D15-HS7

Order Code Table For Heatsink kit (including: Heatsink x1, Clamp x 2, Thermal Pad x1)

HS-K004	HS-K005	HS-K006
		

Test Setup
Peak-to-Peak Output Noise Measurement Test

Use a 1 μ F ceramic capacitor and a 10 μ F 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 -100 μ A.

Overload Protection

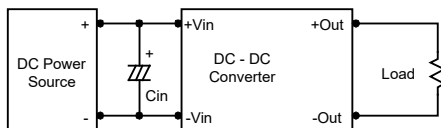
To provide hiccup mode protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure overload for an unlimited duration.

Overvoltage Protection

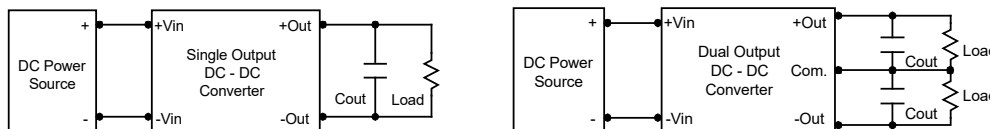
The output overvoltage clamp consists of control circuitry, which is independent of the primary regulation loop, that monitors the voltage on the output terminals. The control loop of the clamp has a higher voltage set point than the primary loop. This provides a redundant voltage control that reduces 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 1 μ F for the 110V input 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 1 μ F capacitors at the output.


Maximum Capacitive Load

The MKZI40 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 $^{\circ}$ C. The derating curves are determined from measurements obtained in a test setup.

