MxC™ 200 TL EVB Manual

MxC™ 200 Evaluation Boards

Helix Semiconductors offers three MxC 200 DC-DC TL (Transformerless Isolation) Evaluation Board configurations: 10W 48V to isolated unregulated 12V output, 5W 5V to isolated unregulated 5V output and 5W 48V to isolated unregulated ±12V and regulated 5V output. Each evaluation board is self-contained and ready for use.

Wiring connection diagram, schematic and BOM for each board are included in this manual. Gerber files are available upon request.

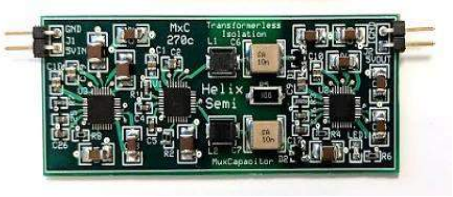
Target Applications

- PoE: Wireless Access Points, Security Cameras, VoIP Phones
- Electric & Hybrid Automobiles
- Industrial Controllers, HVAC
- Industry 4.0 Peripherals
- IoT & IIoT Gateways

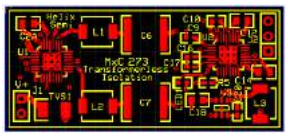
Features

- Three Isolated Configurations
  - 10W 48V to 12V Output
  - 5W 5V to 5V Output
  - 5W 48V to ±12V/5Vreg Outputs
- 90% Efficiency @ 5W
- 85% Efficiency @ 10W
- Highest Power Density
- Low profile board module
- All SMD manufacture
- Adjustable On-Board Oscillator
- Fault Detectors
  - Output Over-Current
  - Thermal Shutdown
- External Control Signals
  - Enable
  - External Clock Enable
  - External Clock Input

48V to 12V Transformerless Isolation
P/N: MxC 270C-EB-1



5V to 5V TL Tranformerless Isolation
P/N: MxC 271C-EB-1



48V to ±12V & 5Vreg Transformerless Isolation
P/N: MxC 273C-EB-1

Future Product

PoE 48V to ±12V & 5Vreg Transformerless Isolation
P/N: MxC 274C-EB-1

1. Table of Contents

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4. MxC 270 48V to 12V Output TL EVB

The MxC 270C-EB-1 48V to 12V Output TL (Transformer less Isolation) EVB is a standalone isolated Divide-By-4 voltage reducer (Figure 2). The EVB is configured for 10W operation. A 4W configuration is provided (see Figure 4) using cheaper, smaller components.

Isolation is provided via the isolation barrier capacitors. Different types of capacitors are to be used depending on the required equipment safety classification. The 1.5KV capacitors used for 10W operation are not Y1/Y2 safety rated. Safety rated film capacitors can be substituted as required. The 4W TL EVB configuration references Y2 safety rated MLCC capacitors.

The MxC 270 48V to 12V Output TL EVB provides the highest power density for an isolated 12V output configuration. Additionally, a low-profile module can be manufactured using all SMD components.

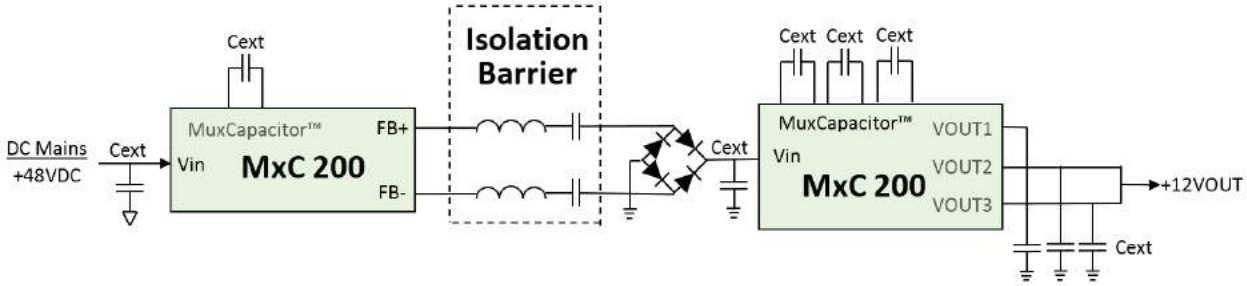

Figure 1: MxC 270 48V to 12V Output TL EVB Block Diagram

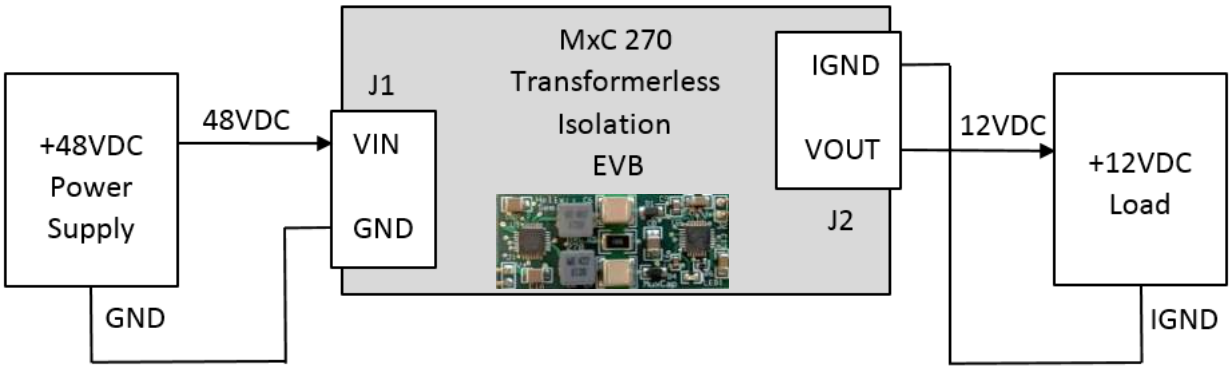

Figure 2: MxC 270 48V to 12V Output TL EVB Standalone Wiring Diagram

Warning: Do not "Hot-Plug" the power supply or electronic load.

Recommended start-up procedure:

1) With power supply turned off, attach power supply wires.
2) With electronic load disabled (monitor mode), attach electronic load wires.
3) Turn on power supply.
4) Enable electronic load with no load current, and then ramp up load current.

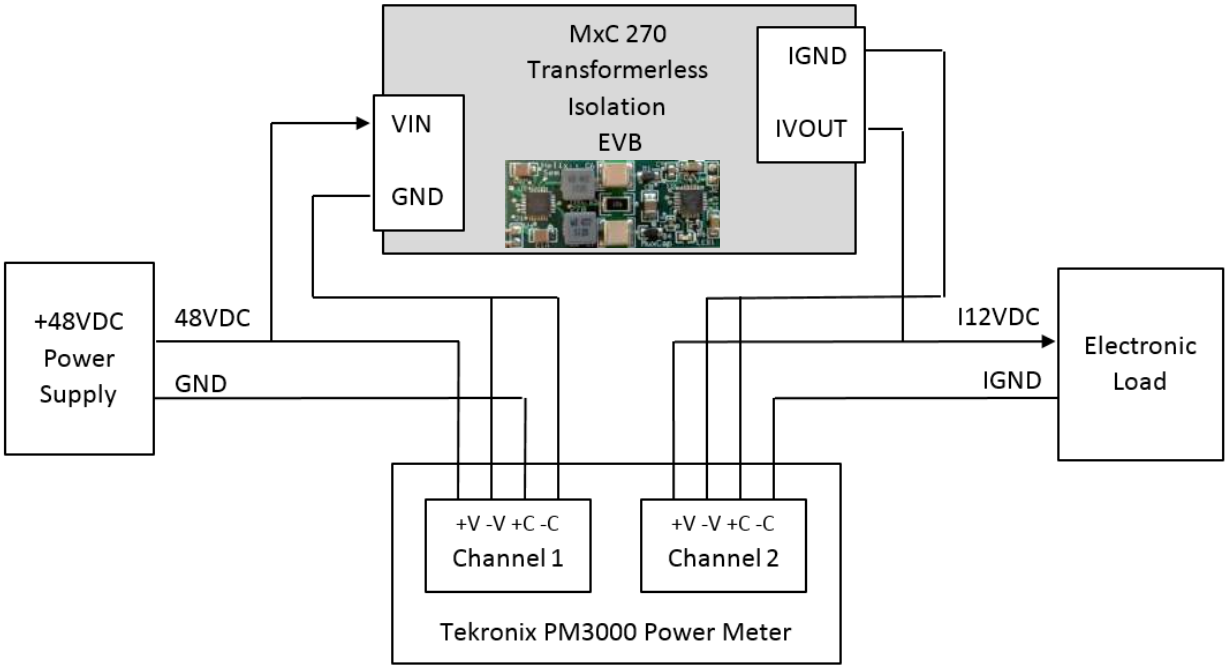

Figure 3: MxC 270 48V to 12V Output TL EVB Test Wiring Diagram

Table 1: MxC 270 48V to 12V Output TL EVB Connectors – J1 and J2

Pin No.	Name	Description
J1-1	VIN	+48VDC Input Power Pin
J1-2	GND	Power GND Pin
J2-1	IVOUT	Isolated unregulated +12VDC Output Power Pin
J2-2	IGND	Isolated Power GND Pin

Note:

1) Due to board's small size, thermal dissipation is limited and may exceed the over-temperature shutdown threshold.
2) The MxC 270 can be powered from 24V delivering 6Vout.

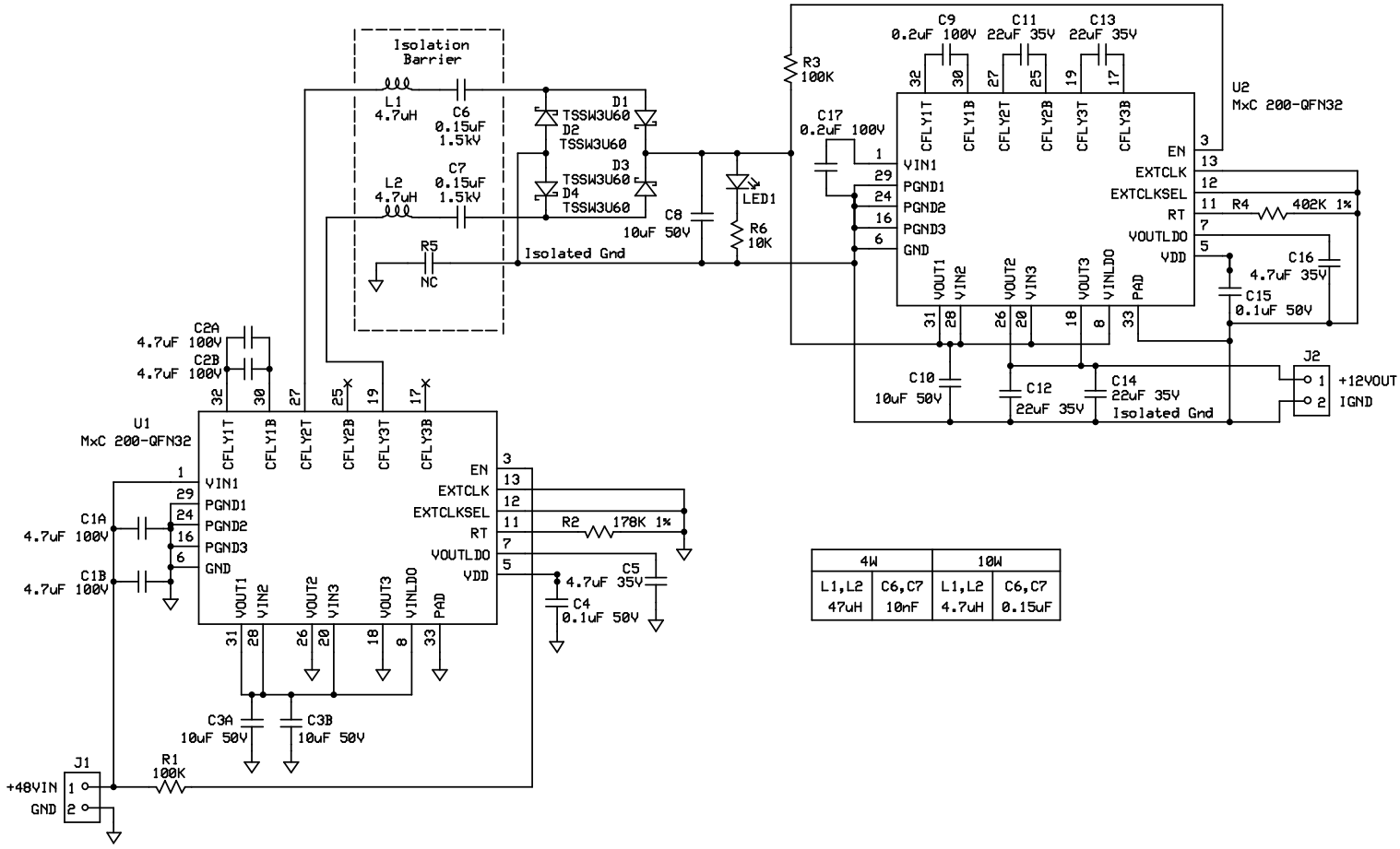

Figure 4: MxC 270 48V to 12V Output TL EVB Schematic

Table 2: MxC 270 48V to 12V Output TL EVB Bill of Materials (BOM)

Qty	Ref. No.	Description	Package	Manufacturer
2	C4, C15	CAP, 0.1µF±10%, 50V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012206095
2	C5, C16	CAP, 4.7µF±10%, 35V	0603 1608 Metric	TDK C1608X5R1V475M080AC
4	C3A, C3B, C8, C10	CAP, 10µF±10%, 50V	1210 3225 Metric	TDK C3225X7S1H106M250AB
4	C11, C12, C13, C14	CAP, 22µF±10%, 35V	1206 3216 Metric	TDK C3216X5R1V226M160AC
2	C9, C17	CAP, 0.22µF±10%, 100V	0805 2012 Metric	TDK C2012X7S2A224K085AE
4	C1A, C1B, C2A, C2B	CAP, 4.7µF±10%, 100V	1210 3225 Metric	TDK C3225X7S2A475M200AB
1	R6	RES, 10KΩ±10%	0603 1608 Metric	Rohm ESR03EZPJ103
2	R1, R3	RES, 100KΩ±10%	0603 1608 Metric	Rohm ESR03EZPJ104
1	R2	RES, 178KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF1783
1	R4	RES, 402KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF4023
1	R5	NC		
4	D1, D2, D3, D4	DIODE, SCHOTTKY	SOD-123W	Taiwan Semiconductor TSSW3U60
1	LED1	LED, Blue	0603 1608 Metric	Visual Communications VAOL-S6SB4
2	U1, U2	IC, MxC 200, QFN5x5, 32P 0.5	QFN32	Helix Semiconductors MxC 200C-QFN32-1
2	J1,J2	CONN, 2P, M, R/A, 0.100	SIP100P2	Wurth Elektronik WR-PHD 61300211021
2	L1, L2	IND, 4.7uH	7.3mm x 6.60mm	Wurth Electronik WE-LHMI 74437346047
2	C6, C7	CAP, 0.15uF, 1.5KV	2220 5750 Metric	Knowles Syfer 2220Y150154KXTWS2

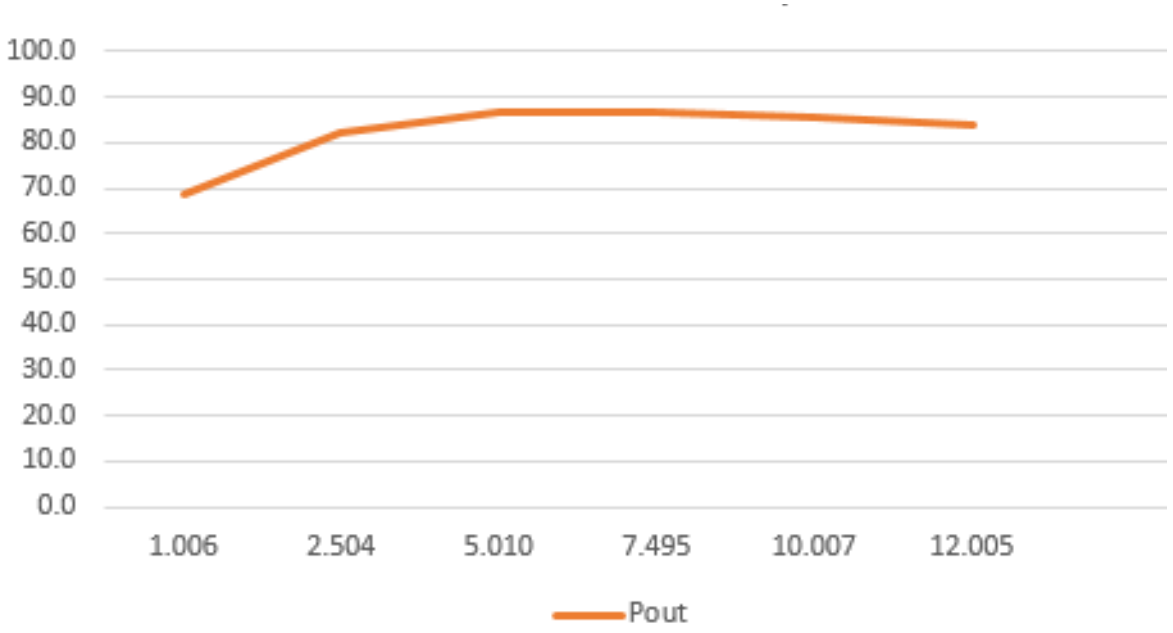

Figure 5: MxC 270 48V to 12V Output TL EVB Efficiency Curve

5. MxC 271 5V to 5V Output TL EVB

The MxC 271C-EB-1 5V to unregulated 5V Output TL (Transformer less Isolation) EVB is a standalone isolated unity gain power interface (Figure 7). The EVB is configured for 5W operation.

Isolation is provided via the isolation barrier capacitors. Different types of capacitors are to be used depending on the required equipment safety classification. The 1.5KV capacitors used for 5W operation are not Y1/Y2 safety rated. Safety rated film capacitors can be substituted as required.

The MxC 273 5V to unregulated 5V Output TL EVB provides the highest power density for a non-transformer based isolated 5V output configuration. Additionally, a low-profile module can be manufactured using all SMD components.

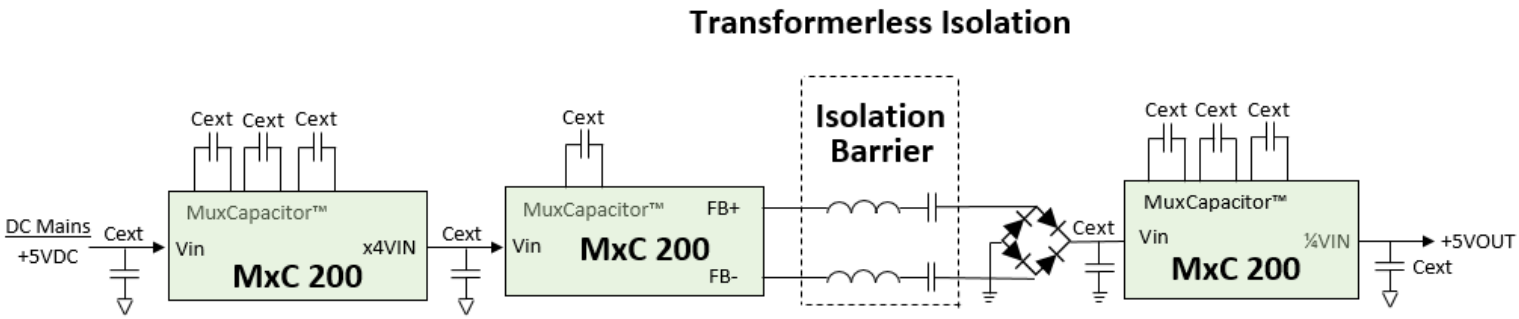

Figure 6: MxC 271 5V to 5V Output TL EVB Block Diagram

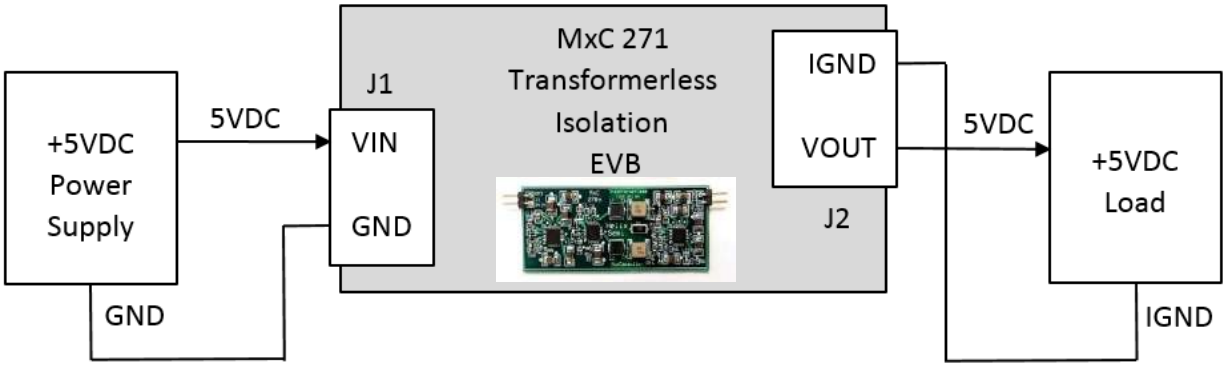

Figure 7: MxC 271 5V to 5V Output TL EVB Standalone Wiring Diagram

Warning: Do not "Hot-Plug" the power supply or electronic load.

Recommended start-up procedure:

1) With power supply off, attach power supply wires.
2) With electronic load disabled (monitor mode), attach electronic load wires.
3) Turn on power supply.
4) Enable electronic load with no load current, and then ramp up load current.

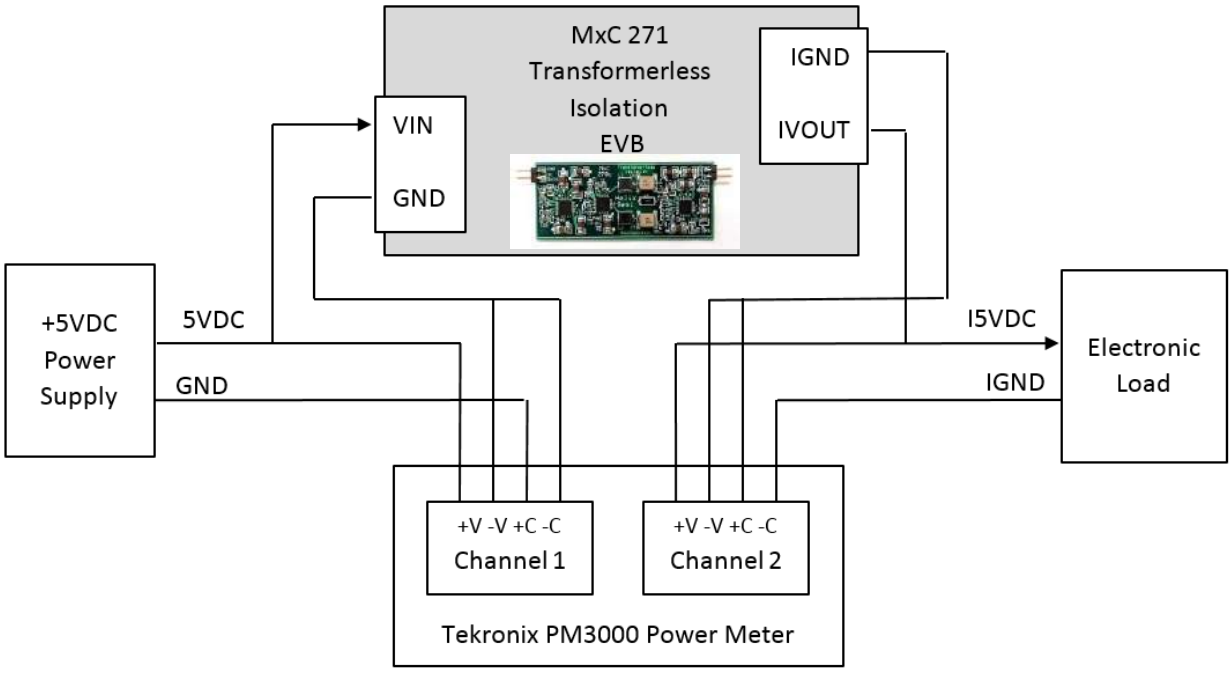

Figure 8: MxC 271 5V to 5V Output TL EVB Test Wiring Diagram

Table 3: MxC 271 5V to 5V Output TL EVB Connectors – J1 and J2

Pin No.	Name	Description
J1-1	VIN	+5VDC Input Power Pin
J1-2	GND	Power GND Pin
J2-1	IVOUT	Isolated unregulated +5VDC Output Power Pin
J2-2	IGND	Isolated Power GND Pin

Note:

1) Due to board's small size, thermal dissipation is limited and may exceed the over-temperature shutdown threshold.

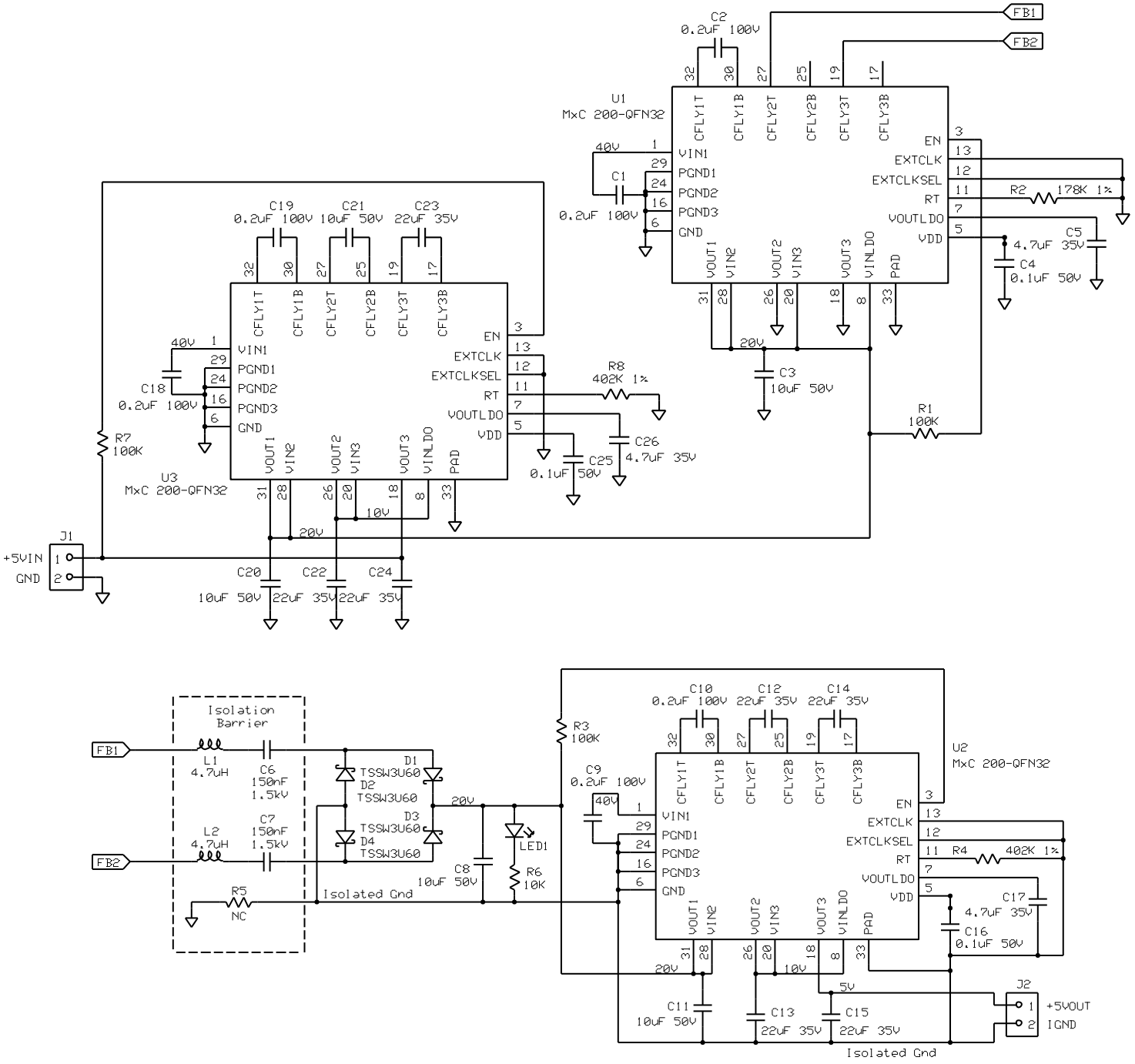

Figure 9: MxC 271 5V to 5V Output TL EVB Schematic

Table 4: MxC 271 5V to 5V Output TL EVB Bill of Materials (BOM)

Qty	Ref. No.	Description	Package	Manufacturer
3	C4, C16, C25	CAP, 0.1µF±10%, 50V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012206095
3	C5, C17, C26	CAP, 4.7µF±10%, 35V	0603 1608 Metric	TDK C1608X5R1V475M080AC
5	C3A, C3B, C8, C11, C20, C21	CAP, 10µF±10%, 50V	1210 3225 Metric	TDK C3225X7S1H106M250AB
7	C12, C13, C14, C15, C22, C23, C24	CAP, 22µF±10%, 35V	1206 3216 Metric	TDK C3216X5R1V226M160AC
6	C1, C2, C9, C10, C18, C19	CAP, 0.22µF±10%, 100V	0805 2012 Metric	TDK C2012X7S2A224K085AE
1	R6	RES, 10KΩ±10%	0603 1608 Metric	Rohm ESR03EZPJ103
3	R1, R3, R7	RES, 100KΩ±10%	0603 1608 Metric	Rohm ESR03EZPJ104
1	R2	RES, 178KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF1783
2	R4, R8	RES, 402KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF4023
1	R5	RES, 10MΩ±10%	2512 6432 Metric	Stackpole RMCF2512JT10M0
4	D1, D2, D3, D4	DIODE, SCHOTTKY	SOD-123W	Taiwan Semiconductor TSSW3U60
1	LED1	LED, Blue	0603 1608 Metric	Visual Communications VAOL-S6SB4
3	U1, U2, U3	IC, MxC 200, QFN5x5, 32P 0.5	QFN32	Helix Semiconductors MxC 200C-QFN32-1
2	J1,J2	CONN, 2P, M, R/A, 0.100	SIP100P2	Wurth Elektronik WR-PHD 61300211021
2	L1, L2	IND, 4.7uH	7.3mm x 6.60mm	Wurth Electronik WE-LHMI 74437346047
2	C6, C7	CAP, 0.15uF, 1.5KV	2220 5750 Metric	Knowles Syfer 2220Y150154KXTWS2

Future Product

Figure 10: MxC 271 5V to 5V Output TL EVB Efficiency Curve

6. MxC 273 48V to ±12V & +5V Buck Reg. Output EVB

The MxC 273C-EB-1 48V to unregulated ±12V & regulated +5V Output TL (Transformer less Isolation) EVB is a standalone isolated Divide-By-4 voltage reducer with a PoL regulator (Figure 12). The EVB is configured for 5W operation. The PoL regulator can be added to the MxC 270 for a 10W power configuration.

Isolation is provided via the isolation barrier capacitors. Different types of capacitors are to be used depending on the required equipment safety classification. The 1.5KV capacitors used for 5W operation are not Y1/Y2 safety rated. Safety rated film capacitors can be substituted as required.

The MxC 273 48V to ±12V & regulated +5V Output TL EVB provides the highest power density for an isolated multi-output 12V & 5V configuration. Additionally, a low-profile module can be manufactured using all SMD components.

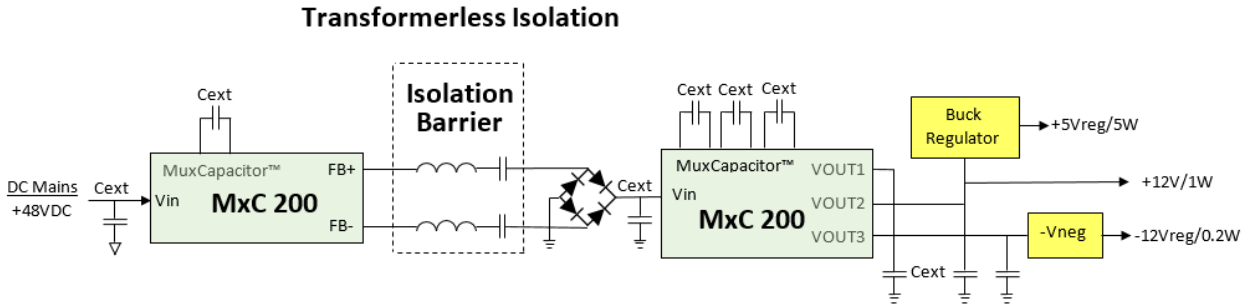

Figure 11: MxC 273 48V to ±12V & +5Vreg Output TL EVB Block Diagram

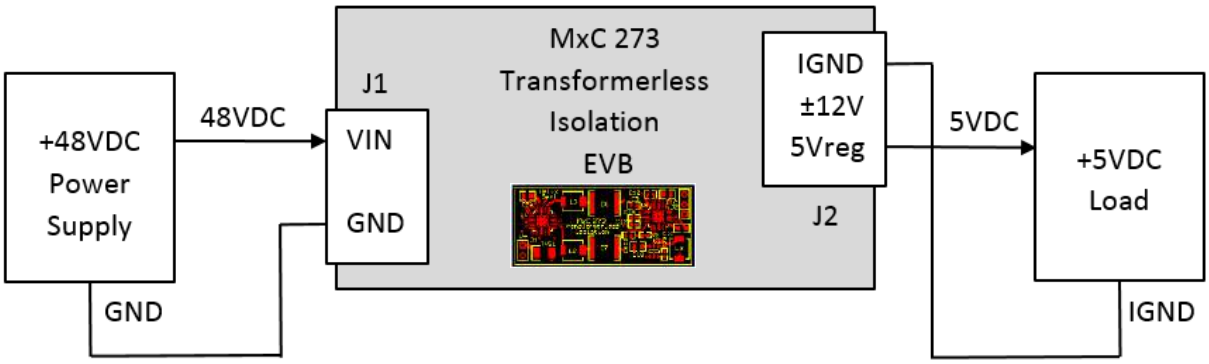

Figure 12: MxC 273 48V to ±12V & +5Vreg Output TL EVB Standalone Wiring Diagram

Warning: Do not “Hot-Plug” the power supply or electronic load.

Recommended start-up procedure:

1) With power supply off, attach power supply wires.
2) With electronic load disabled (monitor mode), attach electronic load wires.
3) Turn on power supply.
4) Enable electronic load with no load current, and then ramp up load current.

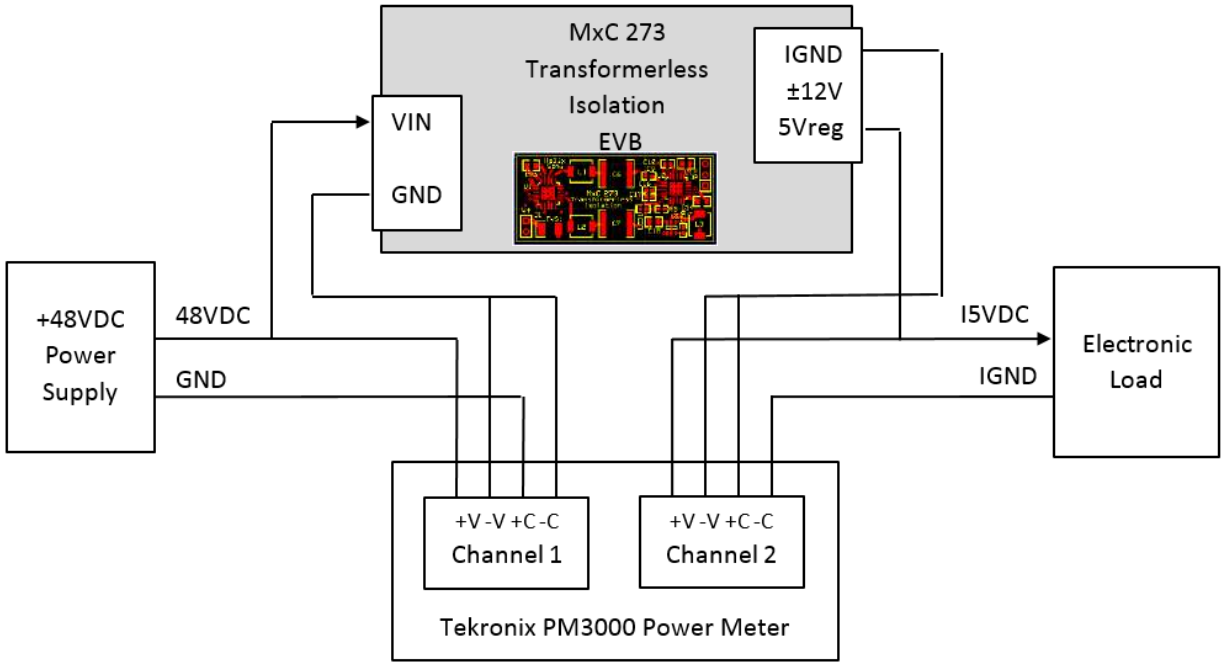

Figure 13: MxC 273 48V to ±12V & +5Vreg Output TL EVB Test Wiring Diagram

Table 5: MxC 273 48V to ±12V & +5Vreg Output TL EVB Connectors – J1 and J2

Pin No.	Name	Description
J1-1	VIN	+5VDC Input Power Pin
J1-2	GND	Power GND Pin
J2-1	I5VREG	Isolated regulated +5VDC Output Power Pin
J2-2	I+12V	Isolated unregulated +12VDC Output Power Pin
J2-3	I-12V	Isolated unregulated -12VDC Output Power Pin
J2-4	IGND	Isolated Power GND Pin

Note:

1) Due to board's small size, thermal dissipation is limited and may exceed the over-temperature shutdown threshold.
2) The MxC 200 can be powered from 24V delivering 6V to the buck regulator at reduced output power. The minimum VIN for the TPS565201 is 4.5V.
3) Other buck regulator output voltages are available by changing R8. Refer to the VOUT Table in Figure 14 schematic.

Table 6: MxC 273 48V to ±12V & +5Vreg Output TL EVB Bill of Materials (BOM)

Qty	Ref. No.	Description	Package	Manufacturer
3	C4, C16, c20	CAP, 0.1µF±10%, 50V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012206095
2	C5, C17	CAP, 4.7µF±10%, 35V	0603 1608 Metric	TDK C1608X5R1V475M080AC
5	C3A, C3B, C8, C11, C18	CAP, 4.7µF±10%, 50V	0805 2012 Metric	SAMSUNG CL21A4475KBQNNNE
5	C12A, C12B, C13, C14, C15	CAP, 10µF±10%, 35V	0805 2012 Metric	MURATA GRM21BCBYA106KE11L
2	C9, C10	CAP, 0.1µF±10%, 100V	0805 2012 Metric	TDK C2012X7S2A104K085AE
4	C1A, C1B, C2A, C2B	CAP, 1µF±10%, 100V	0805 2012 Metric	TDK C2012X7S2A105K125AE
1	R3	RES, 10KΩ±10%	0603 1608 Metric	Rohm ESR03EZPJ103
3	R1, R4, R6	RES, 100KΩ±10%	0603 1608 Metric	Rohm ESR03EZPJ104
1	R2	RES, 178KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF1783
1	R5	RES, 402KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF4023
4	D1, D2, D3, D4	DIODE, SCHOTTKY, 60V, 3A	SOD-123W	Taiwan Semiconductor TSSW3U60
2	U1, U2	IC, MxC 200, QFN5x5, 32P 0.5	QFN32	Helix Semiconductors MxC 200C-QFN32-1
1	J1	CONN, 2P, M, R/A, 0.100	SIP100P2	Wurth Elektronik WR-PHD 61300211021
1	J2	CONN, 4P, M, R/A, 0.100	SIP100P4	Wurth Elektronik WR-PHD 61300411021
3	L1, L2, L3	IND, 4.7uH, 2.2A	4.45mm x 4.06mm	Wurth Electronik WE-LHMI 74437324047
2	C6, C7	CAP, 0.1uF, 1.5KV	2220 5750 Metric	AVX 2220AC104KAT1A
1	C19	CAP, 1µF±10%, 16V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012106017
1	R8	RES, 54.9KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF5493
1	R7	RES, 10.0KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF1003
1	U2	IC, TPS565201	TSOP8	TI TPS565201D
1	D5	DIODE, SCHOTTKY, DUAL	SOT23	ST Microelectronics BAT54SFFILMY

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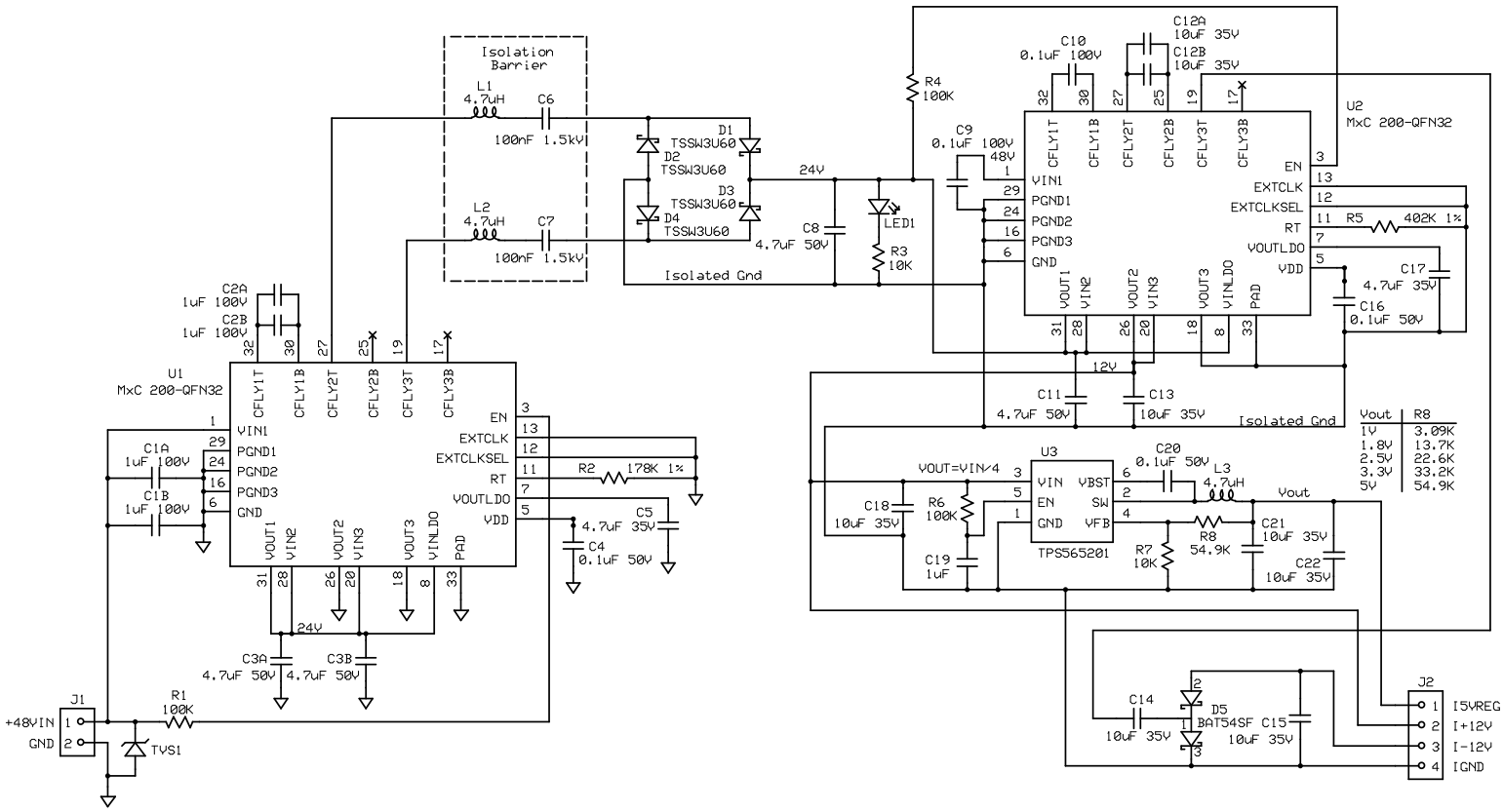

Figure 14: MxC 273 48V to ±12V & +5Vreg Output TL EVB Schematic

Future Product

Figure 15: MxC 273 48V to ±12V & +5Vreg Output TL EVB Efficiency Curve

9. Output Current Sharing

The MxC 200 MuxCapacitor outputs can be wire-OR'ed for higher output current capacity. No special synchronization is required. The following example uses the Single 12V Output MxC 270 EVB. Each individual MxC 200 cell can be connected in parallel with adjacent cells: All the VIN1 pins are connected together. Similarly, all respective GND pins, VOUT2, and VOUT3 pins can be connected together.. The VOUT2 and VOUT3 outputs of MxC 200 are connected in parallel for maximum efficiency.

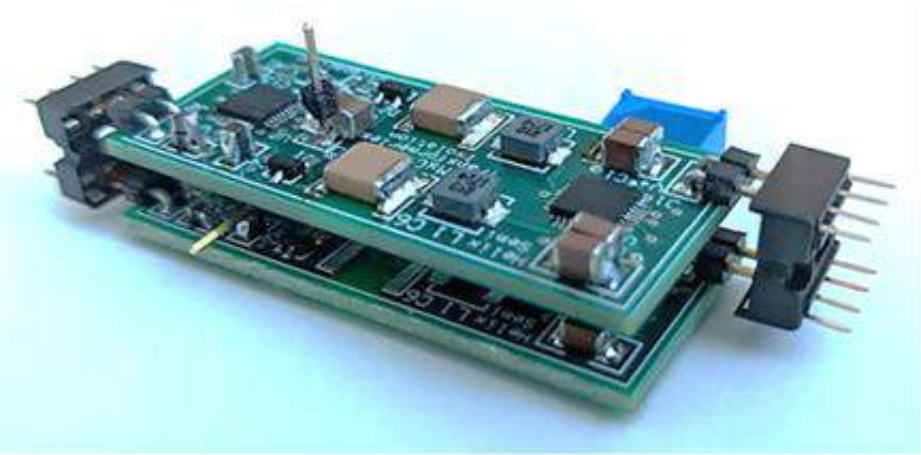

Figure 16: MxC 270 Output Current Sharing 20W 48V-to-12V TL EVM

10. Performance Data

The previous MuxCapacitor efficiency data was measured using a Tektronix PM3000 power meter. The figure below shows the test equipment wiring diagram.

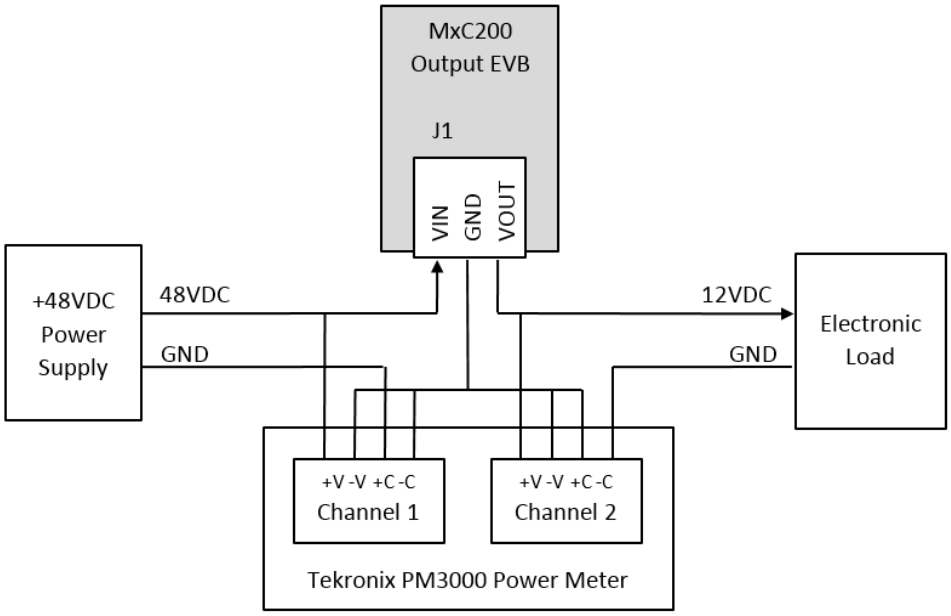

Figure 17: Efficiency Measurement Wiring Diagram

10.1. Operational Guidelines

It is recommended that the auto-ranging feature of current meters be disabled when performing efficiency measurements. The MxC 200 over current detector can trip when the current meter switches between ranges.

The startup waveform of VIN must be monotonic.

Depending on the startup load and VIN rise time, the startup over current detector can trip. A high startup load condition plus distributed filter capacitance could cause an over-current shutdown.

11. Flying Capacitor Value Verses Efficiency

The MxC 200 flying capacitors can be reduced in value for lower output power applications. Lower cost, smaller package size, etc. are tradeoffs that can affect the efficiency performance.

The Flying Capacitor's value is critical to the maximum load operating performance of the MuxCapacitor. If the flying capacitance is too small the efficiency of the MuxCapacitor decreases. Too little capacitance for the required output current effectively behaves as an increase in the impedance of the MuxCapacitor cell.

The effective operating capacitance of ceramic capacitors are subject to a DC Bias derating. As the DC voltage across the capacitor increases, the capacitor's capacitance value decreases. This DC Bias effect must be considered when operating the capacitor too close to its maximum rated voltage or selecting smaller case sizes.

There are other trade-offs that must be analyzed for reliable, efficient and safe capacitor operation.

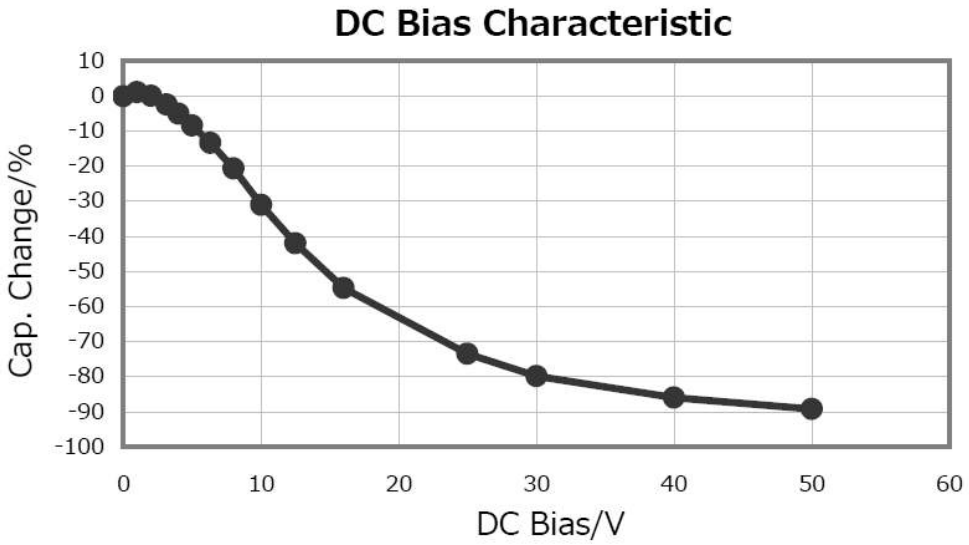

Figure 18: Typical Capacitance verses DC Bias, 50V Device

Table 7: Revision History

Date	Revision	Description
11.5.18	1	Initial Release

Operational Headquarters

9980 Irvine Center Drive
Suite 100
Irvine, CA 92618

Information & Sales

949-748-6057
sales@helixsemiconductors.com

Technical Support

949-748-7026
support@helixsemiconductors.com

Engineering & Design Office

5475 Mark Dabling Blvd.
Suite 206
Colorado Springs, CO 80918

719-594-7098
designs@helixsemiconductors.com

Corporate Headquarters

4808 West Utica Ave.
Broken Arrow, OK 74011