

MxC™ 200 Evaluation Boards

Helix Semiconductors offers three MxC 200 DC-DC Evaluation Boards configurations: Single 12V output, Triple 24V/12V/6V outputs, and a 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

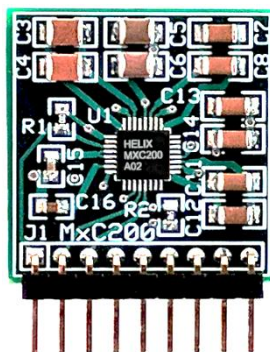
- Telecom Blades, Data Centers
- PoE: Wireless Access Points, Security Cameras, VoIP Phones
- Electric & Hybrid Automobiles
- Industrial Controllers, HVAC
- IoT & IIoT Gateways

Features

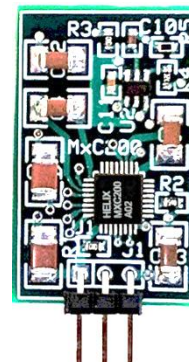
- Three Configurations
 - Single 12V Output
 - Triple 24V/12V/6V Outputs
 - Regulated 5V Output
- 15W Output (Multiple Outputs)
 - $P_{out} = P_{out1} + P_{out2} + P_{out3}$
- Idle Operation: Active, No-Load
 - 1mW Non-Switching
 - 48mW Switching
- > 97% Efficiency @ 2.6W
- > 90% Efficiency @ 15W
- Fault Detectors
 - Output Over Current
 - Thermal Shutdown
- External Control Signals
 - Enable
 - External Clock Enable
 - External Clock Input



Single 12V Output
P/N: MxC 291C-EB3-1



Triple 24/12/6V Outputs
P/N: MxC 290C-EB9-1



Regulated 5V Output
P/N: MxC 292C-EB3-1

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4. MxC 200 Single 12V Output EVB

The MxC 200 Single 12V Output EVB can be operated as a standalone Divide-By-4 voltage reducer (Figure 1) or synchronized with a SMPS (Figure 2).

When the MxC 200 is providing power to a SMPS, the synchronization feature of the MxC 200 allows the MxC 200 MuxCapacitor switching to slow down as the SMPS enters pulse skipping. This operation reduces switching power losses at no-load to light-load conditions. The EXTCLK can be provided by either a FET gate drive signal or a buck regulator's switched output. Both the EXTCLKSEL and EXTCLK inputs accept up to 30V signals.

The MxC 200 Single 12V Output EVB provides the highest efficiency 12 Volt output configuration.

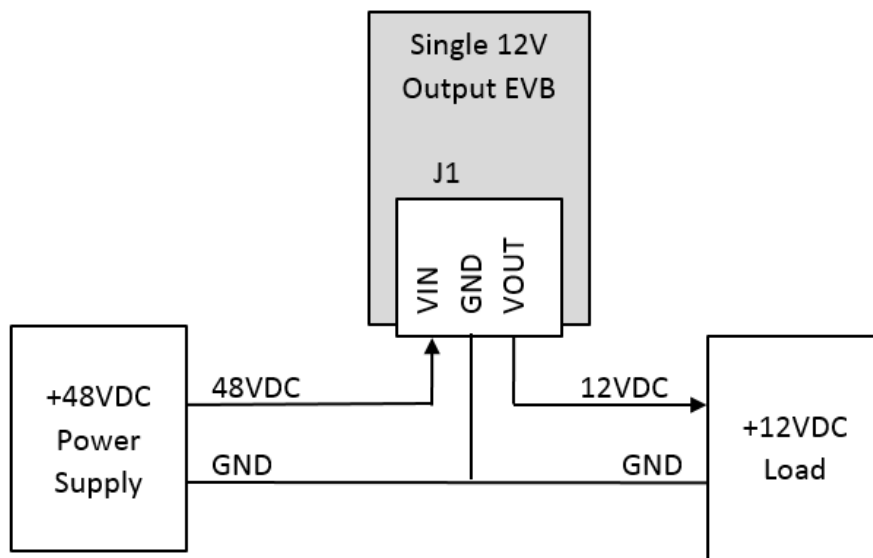


Figure 1: MxC 200 Single 12V Output EVB Standalone Wiring Diagram

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.

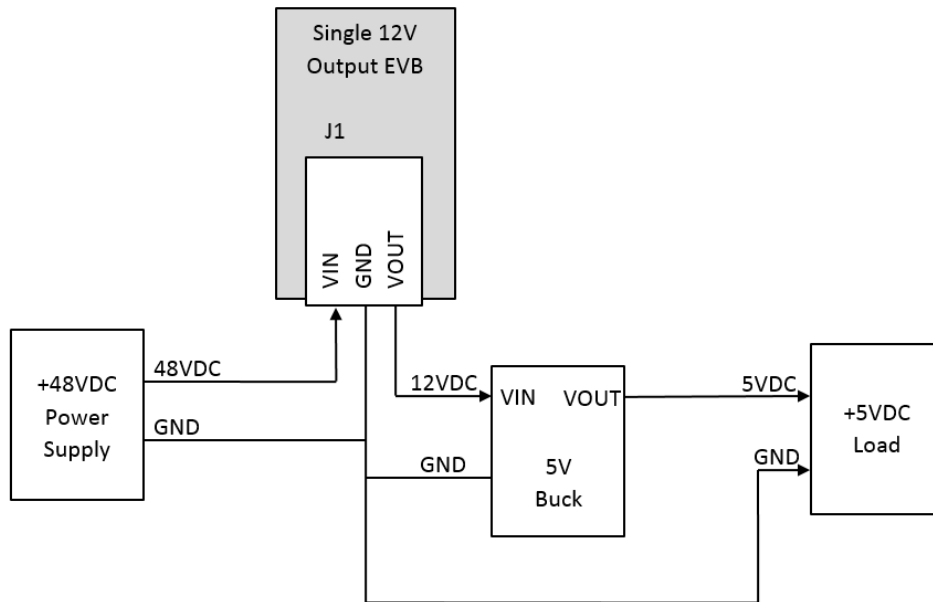


Figure 2: MxC 200 Single 12V Output EVB SMPS Wiring Diagram

Table 1: MxC 200 Single 12V Output EVB Connector – J1

Pin No.	Name	Description
1	VIN	+48VDC Input Power Pin
2	GND	Power GND Pin
3	VOUT	+12VDC Output Power Pin

Note:

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- 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 6Vout.

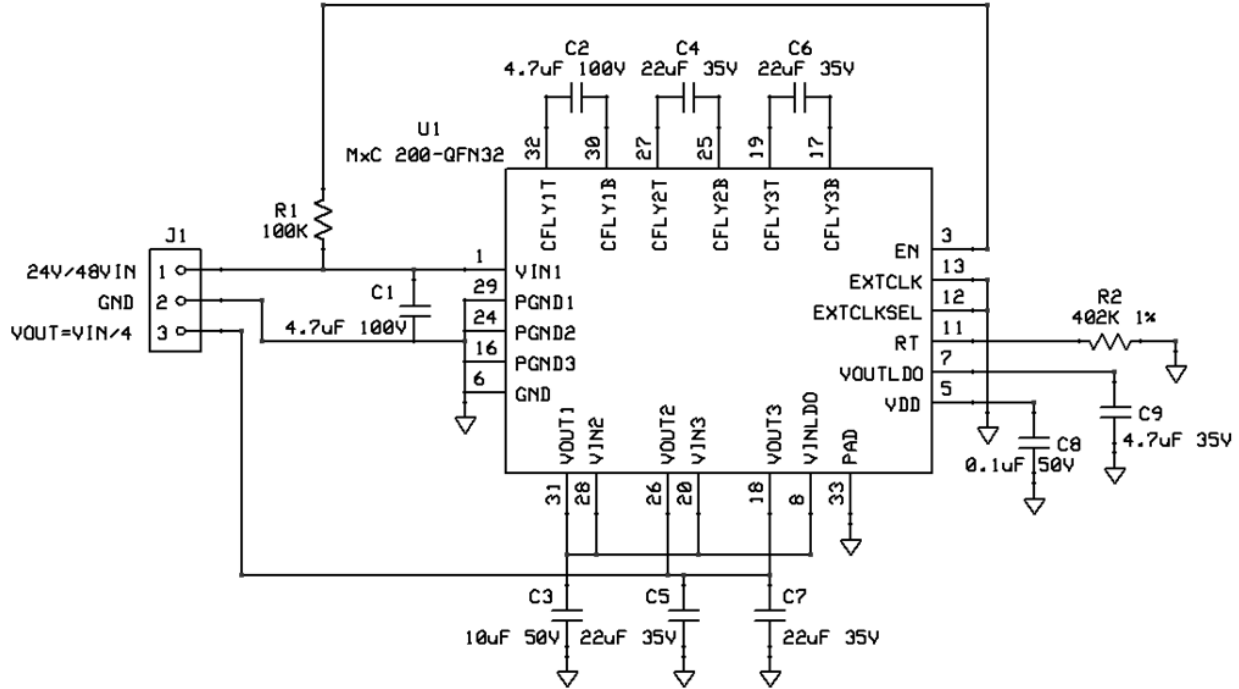


Figure 3: MxC 200 Single 12V Output EVB Schematic

Table 2: MxC 200 Single 12V Output EVB Bill of Materials (BOM)

Qty	Ref. No.	Description	Package	Manufacturer
1	C8	CAP, 0.1μF±10%, 50V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012206095
1	C9	CAP, 4.7μF±10%, 35V	0603 1608 Metric	TDK C1608X5R1V475M080AC
1	C3	CAP, 10μF±10%, 50V	1210 3225 Metric	TDK C3225X7S1H106M250AB
4	C4, C5, C6, C7	CAP, 22μF±10%, 35V	1206 3216 Metric	TDK C3216X5R1V226M160AC
2	C1, C2	CAP, 4.7μF±10%, 100V	1210 3225 Metric	TDK C3225X7S2A475M200AB
1	R1	RES, 100KΩ±10%	0603	Rohm

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			1608 Metric	ESR03EZPJ104
1	R2	RES, 402 K Ω ±1%	0603 1608 Metric	Rohm MCR03ERTF4023
1	U1	IC, MxC 200, QFN5x5, 32P 0.5	QFN32	Helix Semiconductors MxC 200C-QFN32-1
1	J1	CONN, 6P, M, R/A, 0.100	SIP100P6	Wurth Elektronik WR-PHD 61300611021

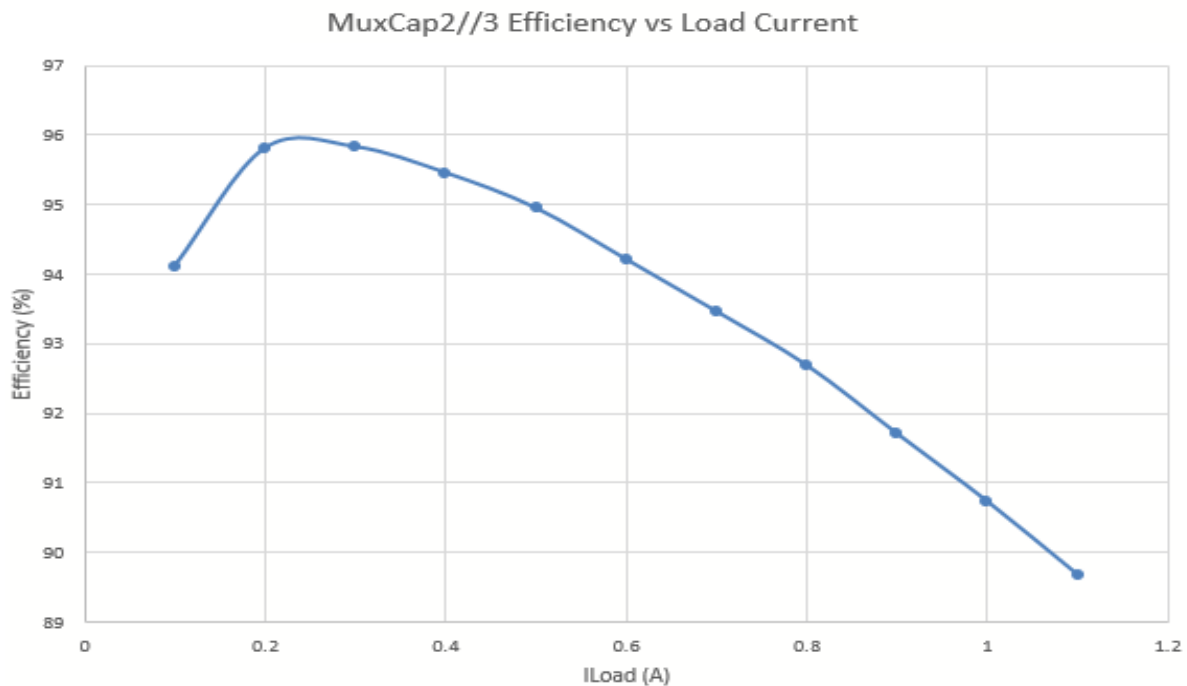


Figure 4: MxC 200 Single 12V Output EVB Efficiency Curve

5. MxC 200 Triple 24V/12V/6V Output EVB

The MxC 200 Triple 24V/12V/6V Output EVB can be operated as a standalone fixed frequency voltage reducer (Figure 5) or synchronized with a SMPS (Figure 6).

When the MxC 200 is providing power to a SMPS, the synchronization feature of the MxC 200 allows the MxC 200 MuxCapacitor switching to slow down as the SMPS enters pulse skipping. This operation reduces switching power losses at no-load to light-load conditions. The EXTCLK can be provided by either a FET gate drive signal or a buck regulator's switched output. Both the EXTCLKSEL and EXTCLK inputs accept up to 30V signals.

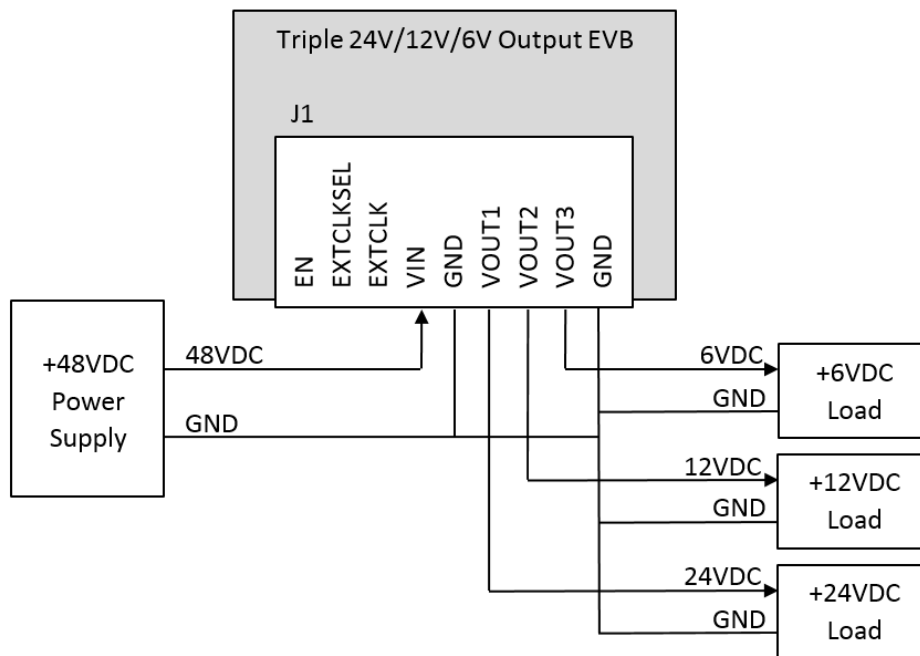


Figure 5: MxC 200 Triple Output EVB Standalone Wiring Diagram

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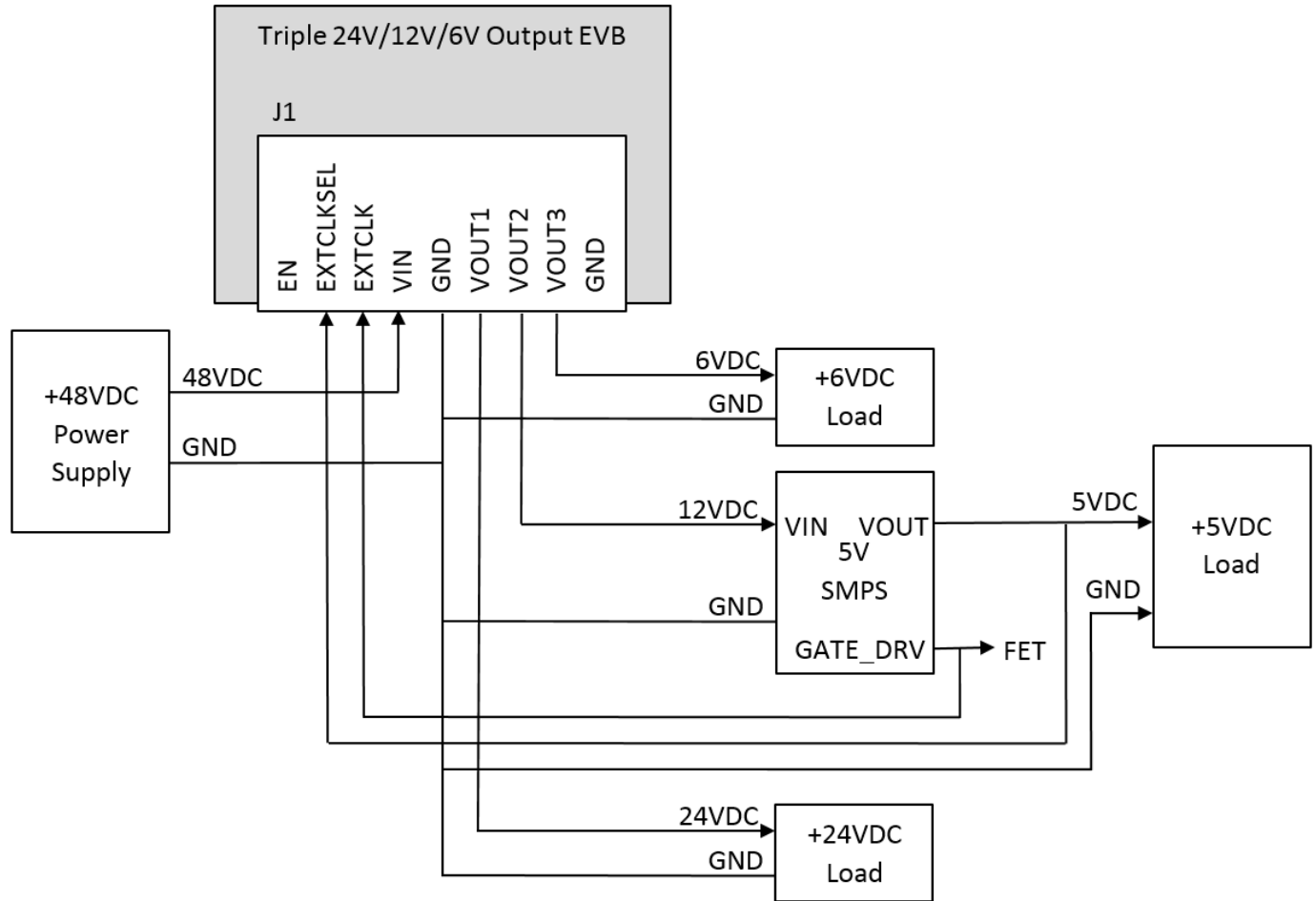


Figure 6: MxC 200 Triple Output Evaluation Board Synchronized to SMPS Wiring Diagram

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.

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Table 3: MxC 200 Triple 24V/12V/6V Output EVB Connector – J1

Pin No.	Name	Description
1	EN	Device Enable: Input Pin, On-board 100K Ω Pull-Up, 60Vmax 0 = Disable, 1 = Enable
2	EXTCLKSEL	External Clock Sync Enable: Input Pin, Internal 2M Ω Pull-Down, 30Vmax 0 = Internal Clock, 1 = External Clock
3	EXTCLK	External Clock Sync: Input pin, Internal 2M Ω Pull-Down, 30Vmax
4	VIN	+48VDC Input Power Pin
5	GND	Power GND Pin
6	24VOUT	+24VDC Output Power Pin, See Note 2.
7	12VOUT	+12VDC Output Power Pin, See Note 2.
8	6VOUT	+6VDC Output Power Pin, See Note 2.
9	GND	Power GND Pin

Note:

- 1) Maximum thermal dissipation occurs when high currents are drawn from 6VOUT. Due to board's small size, thermal dissipation is limited and may exceed the over-temperature shutdown threshold.
- 2) The 24VOUT output provides 0.5A and 12VOUT/6VOUT outputs provide 1A. Actual delivered power depends on the output voltage of each stage.
- 3) The MxC 200 can be powered from 24V delivering one-half the output voltage at pins 6-8 as stated in Table 3.

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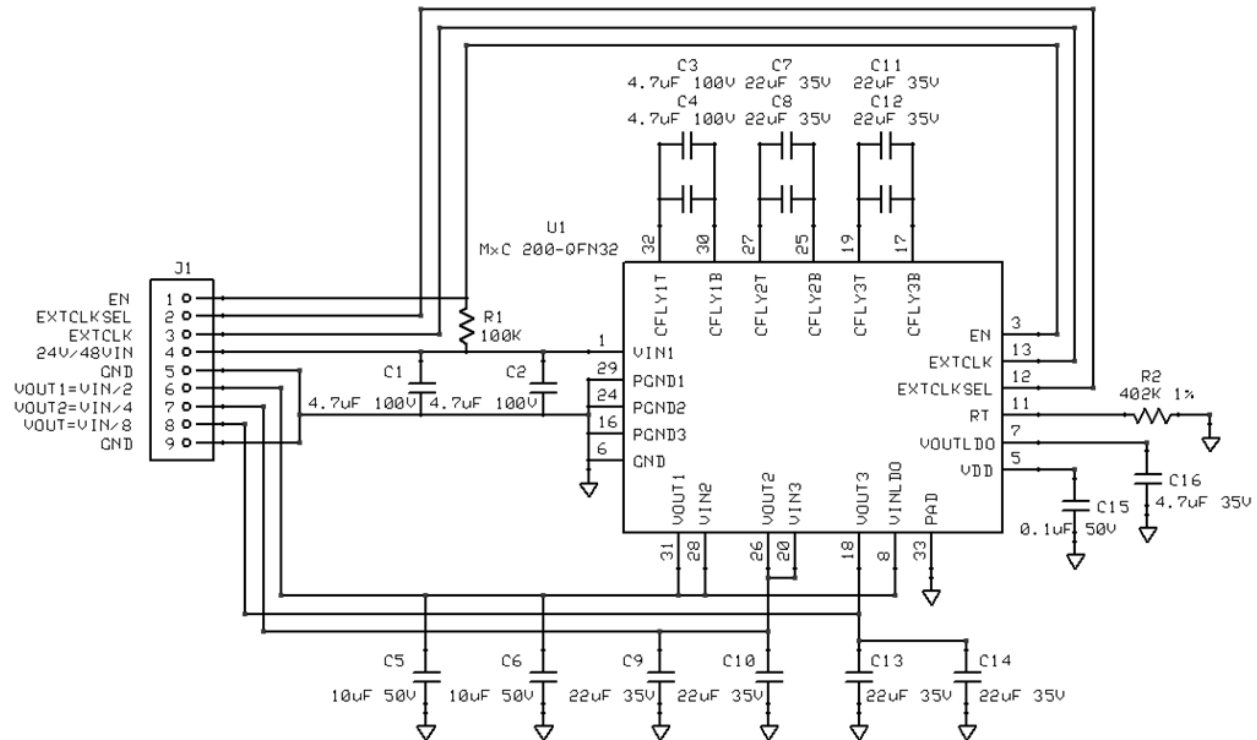


Figure 7: MxC 200 Triple 24V/12V/6V Output EVB Schematic

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Table 4: MxC 200 Triple 24V/12V/6V Output EVB Bill of Materials (BOM)

Qty	Ref. No.	Description	Package	Manufacturer
1	C15	CAP, 0.1 μ F $\pm$ 10%, 10V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012206095
1	C16	CAP, 4.7 μ F $\pm$ 10%, 35V	0603 1608 Metric	TDK C1608X5R1V475M080AC
2	C5, C6	CAP, 10 μ F $\pm$ 10%, 50V	1210 3225 Metric	TDK C3225X7S1H106M250AB
8	C7, C8, C9, C10, C11, C12, C13, C14	CAP, 22 μ F $\pm$ 10%, 35V	1206 3216 Metric	TDK C3216X5R1V226M160AC
4	C1, C2, C3, C4	CAP, 4.7 μ F $\pm$ 10%, 100V	1210 3225 Metric	TDK C3225X7S2A475M200AB
1	R1	RES, 100K Ω $\pm$ 10%	0603 1608 Metric	Rohm ESR03EZPJ104
1	R2	RES, 402 K Ω $\pm$ 1%	0603 1608 Metric	Rohm MCR03ERTF4023
1	U1	IC, HS200, QFN5x5, 32P 0.5	QFN32	Helix Semiconductors MxC 200C-QFN32-1
1	J1	CONN, 9P, M, R/A, 0.100	SIP100P9	Wurth Elektronik WR-PHD 61300911021

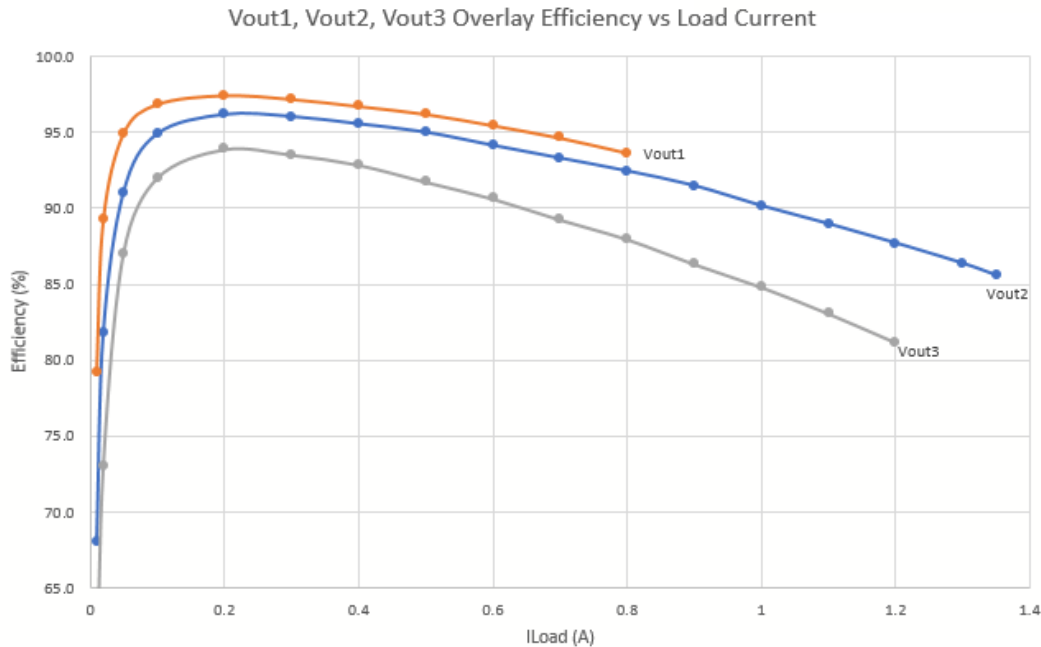


Figure 8: MxC 200 Triple 24V/12V/6V Output EVB Efficiency Curve

6. MxC 200+5V Buck Reg. Output EVB

The MxC 200+5V Buck Reg. Output EVB can be operated as a standalone regulated 5V output board (Figure 9).

When the MxC 200 is providing power to another SMPS, the synchronization feature of the MxC 200 allows the MxC 200 MuxCapacitor switching to slow down as the SMPS enters pulse skipping. This operation reduces switching power losses at no-load to light-load conditions. The EXTCLK can be provided by either a FET gate drive signal or a buck regulator's switched output to enhance light-load efficiency. Both the EXTCLKSEL and EXTCLK inputs accept up to 30V signals.

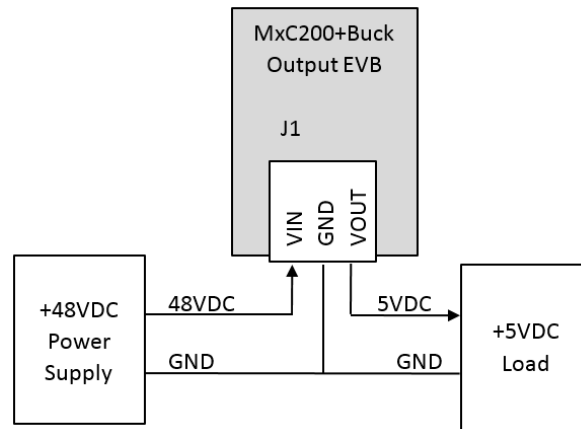


Figure 9: MxC 200+5V Buck Reg. Output EVB Standalone Wiring Diagram

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.

Table 5: MxC 200+5V Buck Reg. Output EVB Connector – J1

Pin No.	Name	Description
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1	VIN	+48VDC Input Power Pin
2	GND	Power GND Pin
3	VOUT	+5VDC Output Power 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. The minimum VIN for the TPS565201 is 4.5V
- 3) Other buck regulator output voltages are available by changing R4. Refer to the VOUT Table in Figure 10.

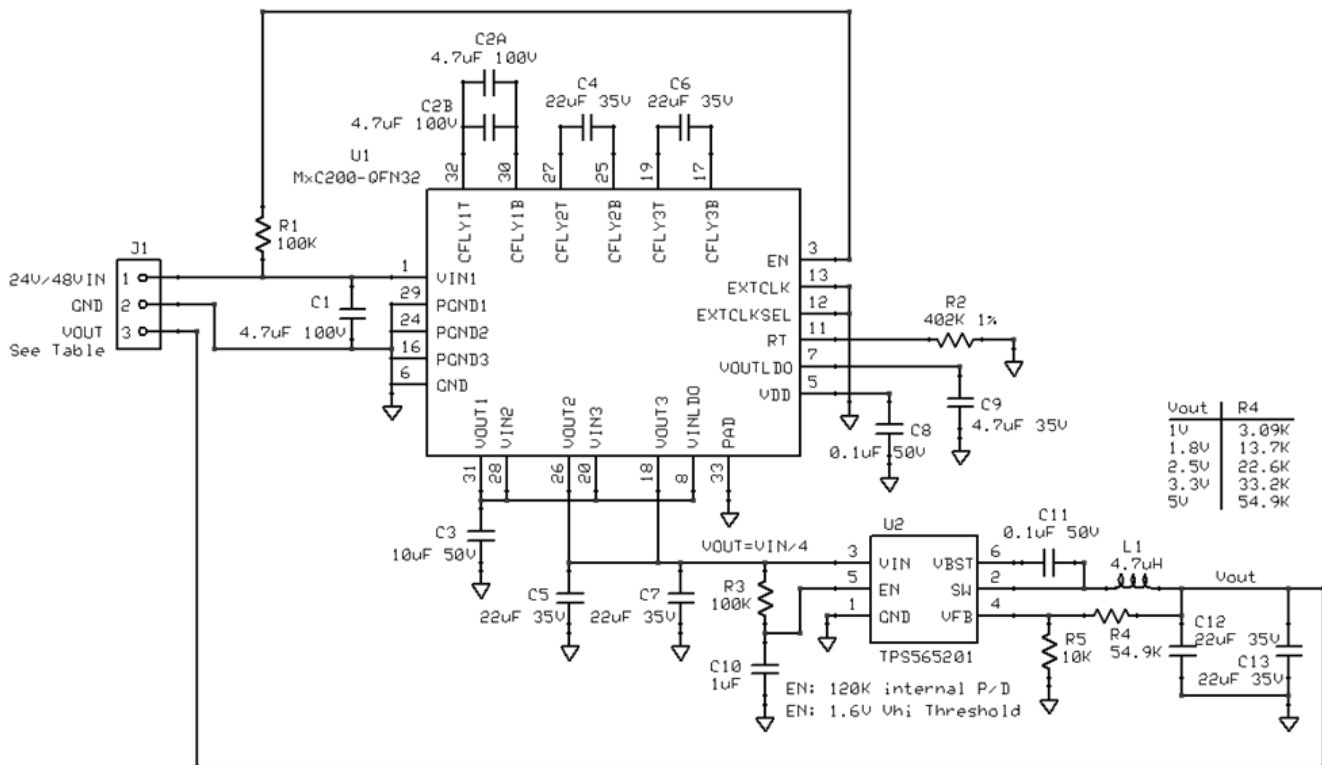


Figure 10: MxC 200+5V Buck Reg. Output EVB Schematic

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Table 6: MxC 200+5V Buck Reg. Output EVB Bill of Materials (BOM)

Qty	Ref. No.	Description	Package	Manufacturer
1	C8	CAP, 0.1μF±10%, 50V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012206095
1	C9	CAP, 4.7μF±10%, 35V	0603 1608 Metric	TDK C1608X5R1V475M080AC
1	C3	CAP, 10μF±10%, 50V	1210 3225 Metric	TDK C3225X7S1H106M250AB
4	C4, C5, C6, C7	CAP, 22μF±10%, 35V	1206 3216 Metric	TDK C3216X5R1V226M160AC
3	C1, C2A, C2B	CAP, 4.7μF±10%, 100V	1210 3225 Metric	TDK C3225X7S2A475M200AB
1	R1	RES, 100KΩ±10%	0603 1608 Metric	Rohm ESR03EZPJ104
1	R2	RES, 402KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF4023
1	U1	IC, HS200, QFN5x5, 32P 0.5	QFN32	Helix Semiconductors MxC 200C-QFN32-1
1	J1	CONN, 3P, M, R/A, 0.100	SIP100P3	Wurth Elektronik WR-PHD 61300611021
1	C10	CAP, 1μF±10%, 16V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012106017
1	C11	CAP, 0.1μF±10%, 25V	0603 1608 Metric	Wurth Elektronik WCAP-CSGP 885012206071
2	C12, C13	CAP, 22μF±10%, 35V	1206 3216 Metric	TDK C3216X5R1V226M160AC
1	R3	RES, 100KΩ	0603 1608 Metric	Rohm ESR03EZPJ104
1	R4	RES, 54.9KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF5493
1	R5	RES, 10.0KΩ±1%	0603 1608 Metric	Rohm MCR03ERTF1003
1	L1	IND, 4.7μH, 9A	PG0642	Wurth Elektronik WR-LHMI 74437349047
1	U2	IC, TPS565201	TSOP8	TI TPS565201D

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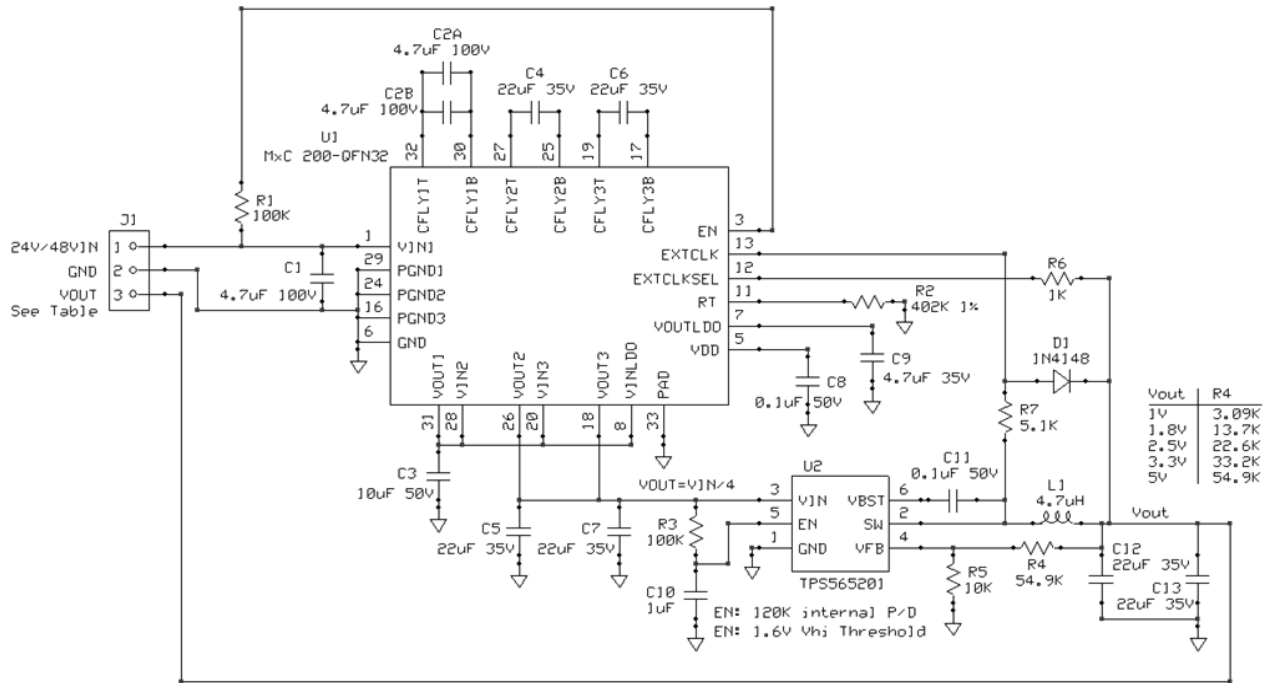


Figure 11: MxC 200 w/Synchronous 5V Buck Reg. Output EVB Schematic

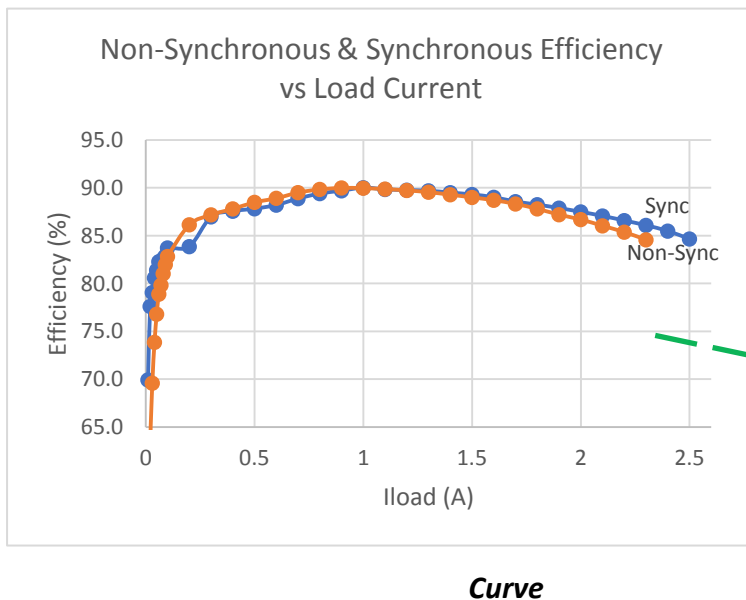
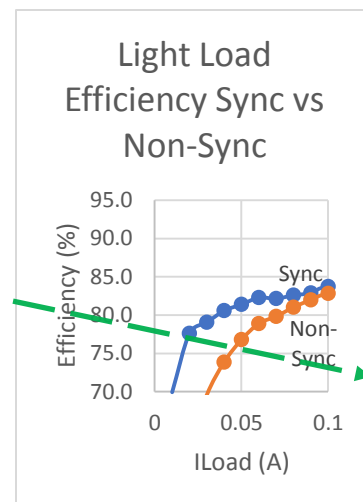


Figure 12: MxC 200

w/Synchronous Buck 5V Output EVB Efficiency



7. Output Current Sharing

The MxC 200 MuxCapacitor outputs can be wire-ORed for higher output current capacity. No special synchronization is required. The following examples use the Single 12V Output EVB schematic. Each individual MxC 200 cell is connected in parallel with adjacent cells: All the VIN1 pins are reconnected together. Similarly, all GND pins and all VOUT2 and VOUT3 pins are connected together, respectively. The VOUT2 and VOUT3 outputs of each MxC 200 cell are connected in parallel for maximum efficiency.

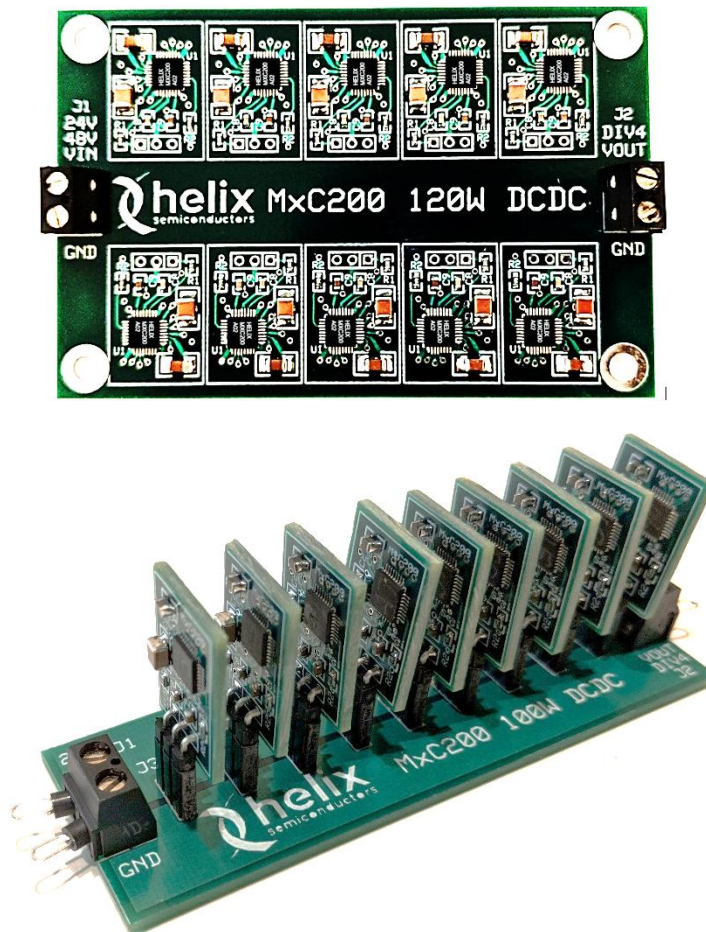


Figure 13: MxC 200 Output Current Sharing 120W 48V-to-12V Voltage Converter

8. Performance Data

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

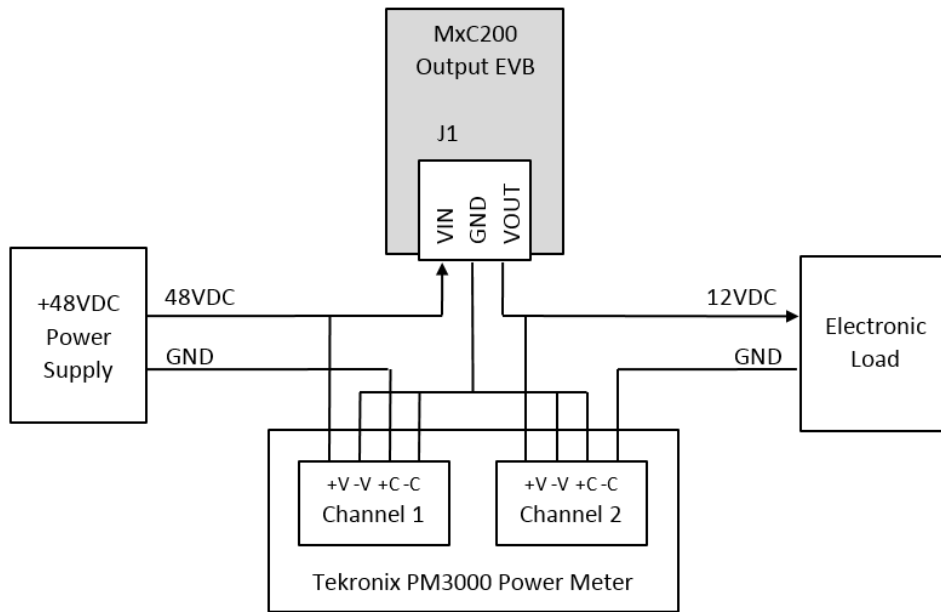


Figure 14: Efficiency Measurement Wiring Diagram

8.1. 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 could trip when the current meter switches from one range to another.

The startup waveform of VIN must be monotonic.

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

9. 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.

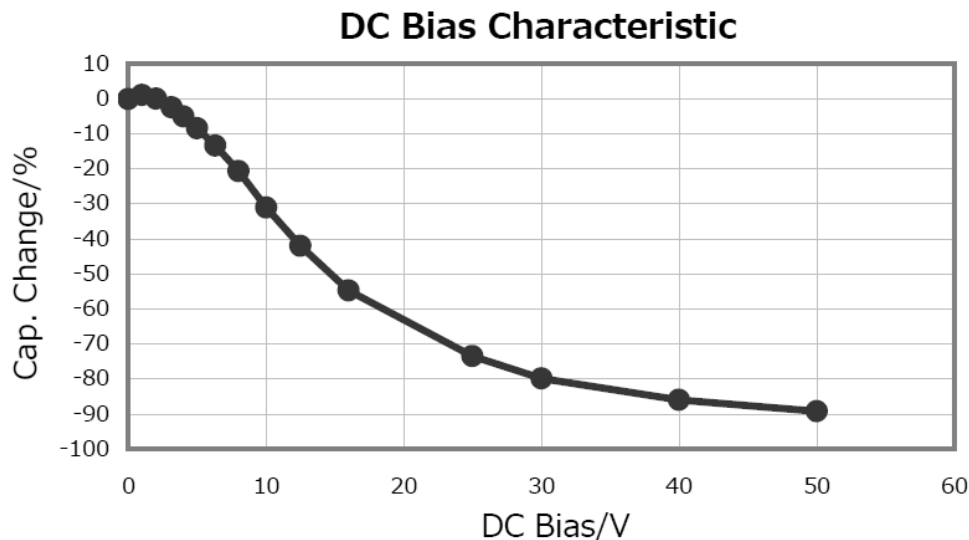


Figure 15: Typical Capacitance verses DC Bias, 50V Device

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Table 7: Revision History

Date	Revision	Description
8.15.17	1	Initial Release
8.30.17	2	Add Fig. 11 Efficiency Data
9.19.17	3	Add Hot-Plug warning
11.12.17	4	Updated schematics
2.24.18	5	General Update
4.10.18	6	Add Part Numbers



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