Back-to-Back OZip-DC/DC Boost-Buck Operation

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Through the proper configuration of two OZip-DC/DC Intelligent Power Modules, it is possible to transfer energy between two DC power sources with overlapping voltage ranges. In this configuration the DC-DC Converters are connected "back-to-back" such that they share a common, intermediary rail voltage. This application note provides details on how to wire and operate two OZip-DC/DC converters in the back-to-back, Boost-Buck configuration.

Figure 1 illustrates a "Back-to-Back" Boost-Buck DC/DC converter. The Boost converter is configured to operate in voltage control mode and is responsible for regulating the intermediary voltage. The Buck converter can either regulate the output voltage or the output current, depending on the application requirements. In this example the input voltage can vary between 280 and 400V_{DC} while the Boost converter maintains the intermediary voltage at 800V_{DC}. The Buck converter regulates the output voltage (280 to 750V_{DC}) or output current as desired. Note that the back-to-back converter is bi-directional, i.e. it can sink or source current between the input and output terminals.

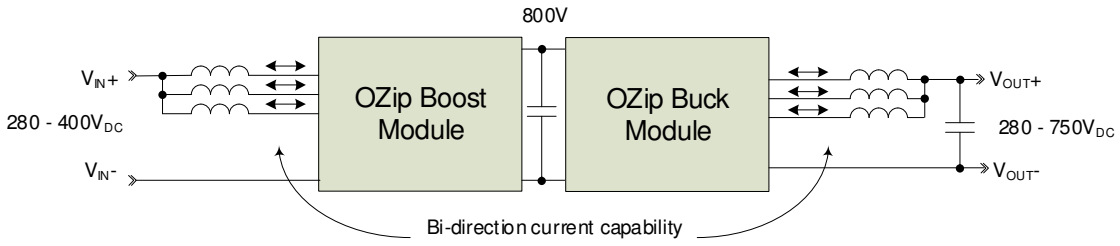

Figure 1 – "Back-to-Back" Boost-Buck Configuration

This application note assumes a familiarity with the OZip-DC/DC hardware platform, its underlying Intelligent Power Module, Oztek's Power Studio™ user interface tool, and the OZip DC/DC Converter firmware. Details of each of these can be found here:

Document	Description
UM-0052	Oztek Power Studio™ User's Manual
UM-0055	OZip-R Intelligent Power Module Hardware User's Manual
UM-0060	Oztek DC/DC Converter User's Manual
UM-0065	OZip DC-DC Converter Hardware User's Manual

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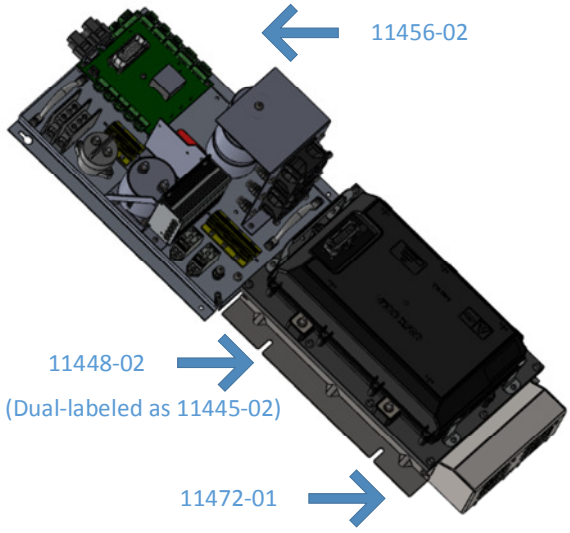
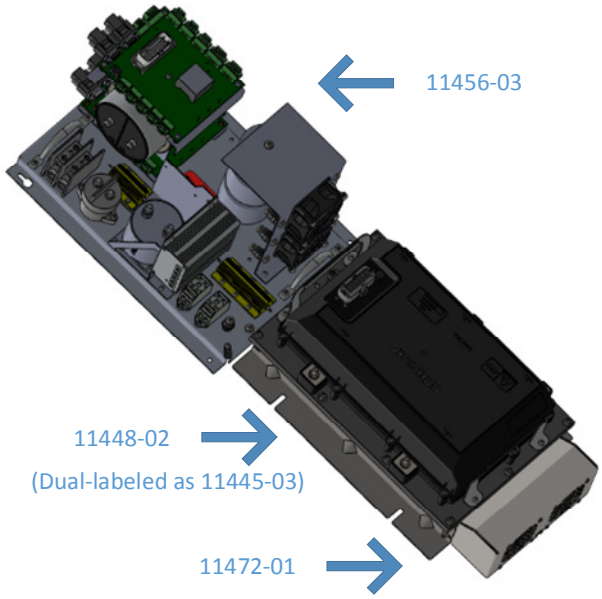
Oztek Open Frame DC/DC Converter Solutions

The OZip-DC105A family of open frame, bi-directions, DC/DC converters include magnetics, switchgear, and cooling solutions in addition to the OZip power module. When unpacking the subassemblies, care should be taken to ensure proper identification of the comprising subsystems so that each module is employed in its intended application. The following table illustrates the differences in the subassemblies.

Boost Module (11445-02) Subsystems	Buck Module (11445-03) Subsystems
• 11456-02 Boost Switchgear • 11448-02 CAN-Based OZip-R IPM • 11472-01 Cooling Fan Assembly	• 11456-03 Buck Switchgear • 11448-02 CAN-Based OZip-R IPM • 11472-01 Cooling Fan Assembly
	

Application Wiring

Wiring the two converters is straightforward, as illustrated in Figure 2. The following connections need to be made:

- **Input Voltage**: The input source should be wired to TB1-1 (positive) and TB1-2 (negative) on the 11445-02 Boost Assembly.

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- **Output**: The output should be wired to the load at TB1-1 (positive) and TB1-2 (negative) on the 11445-03 Buck assembly.

- **Intermediate Voltage Link**: Wire TB2-1 on the 11445-02 Boost Assembly to TB2-1 on the 11445-03 Buck assembly. Similarly, TB2-2 should be wired to TB2-2 on the two assemblies.

- **Bias Supply**: A 18-30V bias supply should be wired to the M2 interface board connector J6 pin 1 (+) and J6 pin3 (-) on both assemblies.

- **Communications**: The M2 interface board provides two 9-pin D-Subminiature connectors to allow easy daisy-chaining of assemblies. A communication cable should be wired directly from the host (or PC) to connector P5 on either assembly. A daisy-chain cable can then be used to connect P4 on that converter to P5 on the second converter. ***Note: Only the module at the end of the network (the Boost Module as illustrated) should have its termination resistor enabled via SW1 on the Interface Board.***

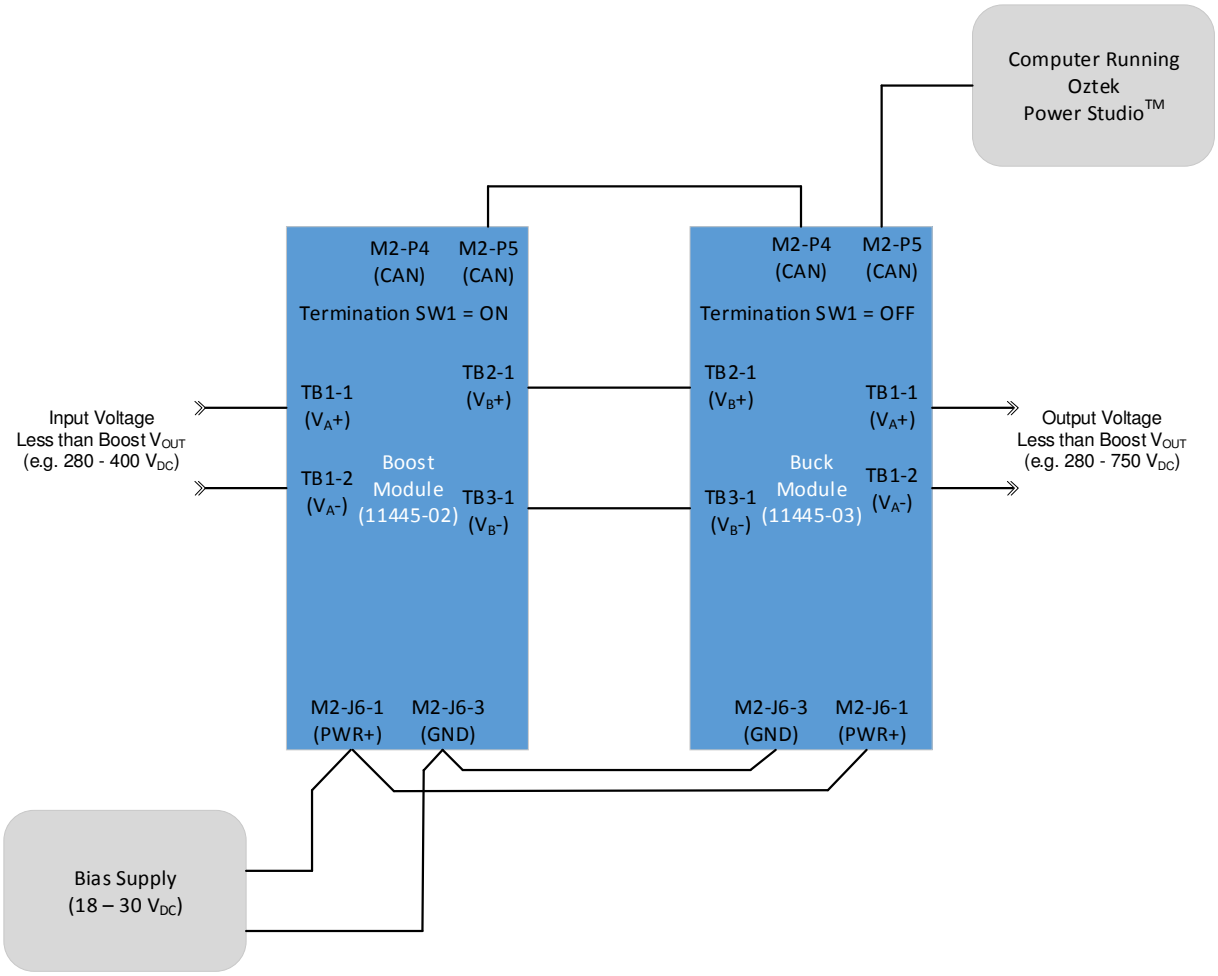


Figure 2 – System Level Boost-Buck Wiring Diagram

Using Power Studio™ to Control Two Targets

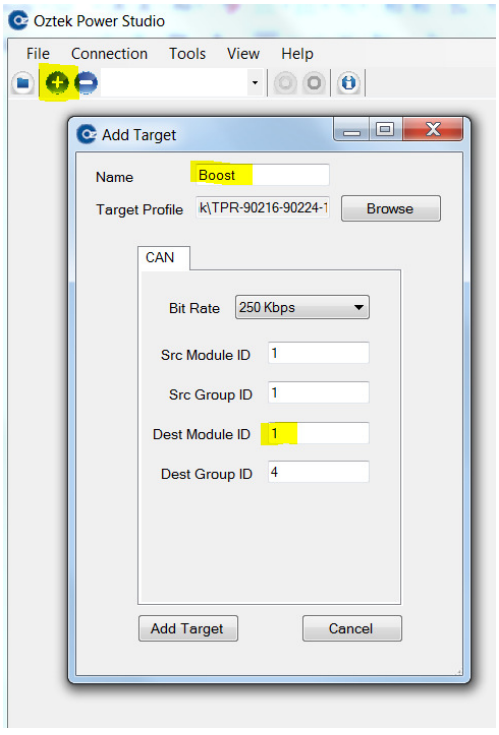
Oztek's Power Studio™ tool can be used to control the two converters by loading two target profiles. Consult the Oztek website for the appropriate target profile to be used:

- For systems using RS-485 serial communication: TPR-90216-90224-101
- For systems using CAN protocol communication: TPR-90216-90224-102

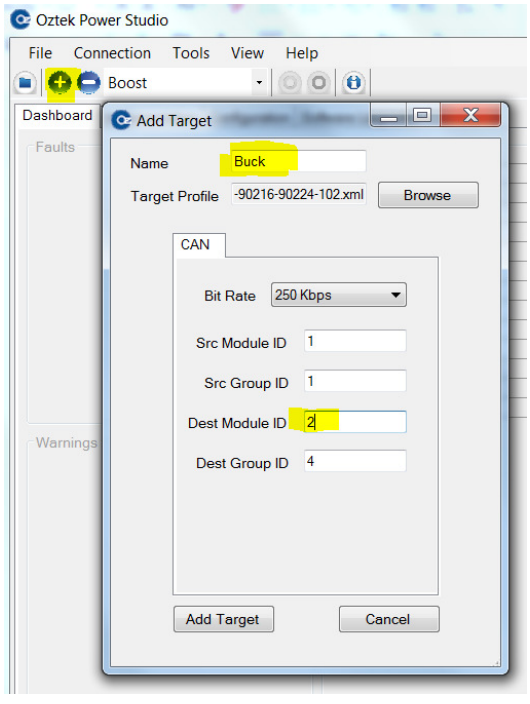
The target profile for the Boost converter is added using the ⊕ icon and selecting the appropriate Target Profile file. The name can be changed from the default "Target 1" to Boost or any other meaningful name. The Destination Module ID should be left at the default value of "1".

The target profile for the Buck converter is added using the ⊕ icon a second time and selecting the appropriate Target Profile file (same file as was used for the Boost target). The name can be changed from the default "Target 2" to Buck or any other meaningful name. ***Note: The Destination Module ID must be changed to "2" to match the Buck firmware's default setting. Each module on the communications link must have a unique ID.***

Inserting Target 1 – Boost



Inserting Target 2 – Buck



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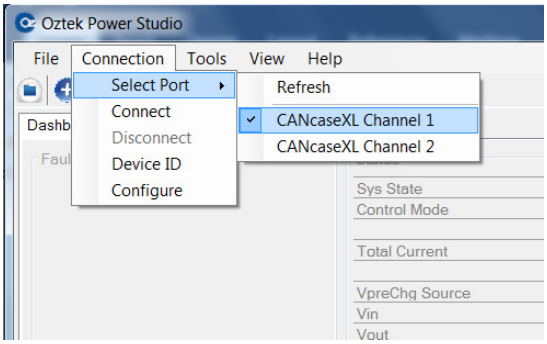
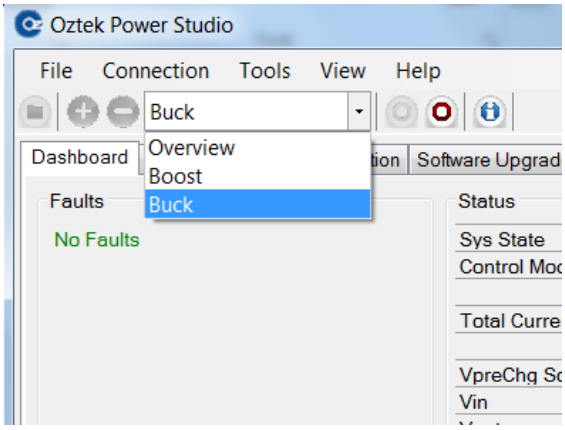
After the target profiles are added, apply bias power and establish communication by selecting a connection port and connecting using the : Connection→Connect button.



At this point Power Studio™ should be communicating with the two converters and should display "Connected to <name of communication device>" and a Green in the lower left corner of the window. You can switch between the two targets using the drop-down list on the menu bar:

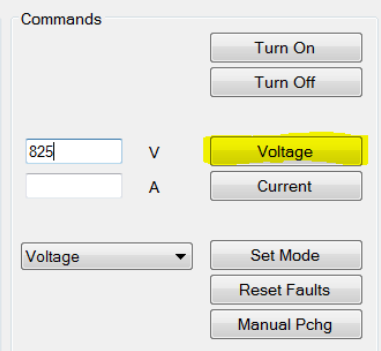


Operating the Two Converters

The system is now ready for the application of input voltage. Please note that the following steps will apply dangerous voltages to the system. Only properly trained and knowledgeable operators should proceed beyond this step. Proper safety precautions, as articulated in the various reference sources, should be followed at all times.

By default, the Boost firmware has ***PID 0x8082 – Pre-Charge Auto-Enable*** set to "1" to automatically pre-charge the intermediate DC link. Application of input voltage on the Boost module should initiate an automated sequence in which the pre-charge circuit is enabled to charge the intermediate DC link shared between the two back-to-back modules. The Boost converter will transition to a system state of "Idle" once the pre-charge sequence has completed.

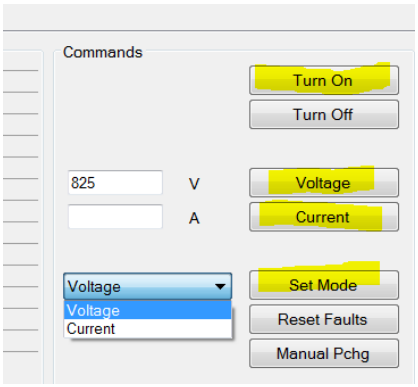
From the Boost target profile, select the "Turn On" command to enable the converter. The converter will regulate the output voltage to the default setting configured by ***PID 0x804C - Default Voltage Setpoint***. The output voltage can be modified while running by using the Voltage setpoint command as shown below. Confirm that Power Studio™ reports the correct Boost output voltage before proceeding.



Switching to the Buck profile, it should be noted that the converter's output is not yet connected to the system. By default, the Buck firmware is configured to manually pre-charge the output capacitor to the system output voltage, as would be the case if the output were connected to a battery, using the following configuration settings:

- ***PID 0x8087 – Pre-Charge Enable = True***
- ***PID 0x8082 – Pre-Charge Auto-Enable = False***
- ***PID 0x808A – Pre-Charge Sense Location = Output***

To pre-charge the Buck's output capacitor to the system voltage, the operator should click the "Enable Pchg" button and observe the two voltages being brought into agreement. Once they are, the system transitions to the "Idle" state and is ready to operate. Next, select the desired mode of operation (current control / voltage control) and the output level as appropriate. Then use the "Turn On" button to enable the output.



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