Semester Project

P0

Group INTRO-760

Autumn Semester 2018

xxx	xxx	xxx
111	*111*	*111*

Contents

Introduction 1

1.1 Non-inverting buck-boost converter

The Non-inverting Buck-Boost converter is a DC to DC converter that allows the voltage at its output to be higher or lower than the voltage at its input. The topology can be seen in figure 1.1. It uses 4 switches, of which 2 are controlled devices.

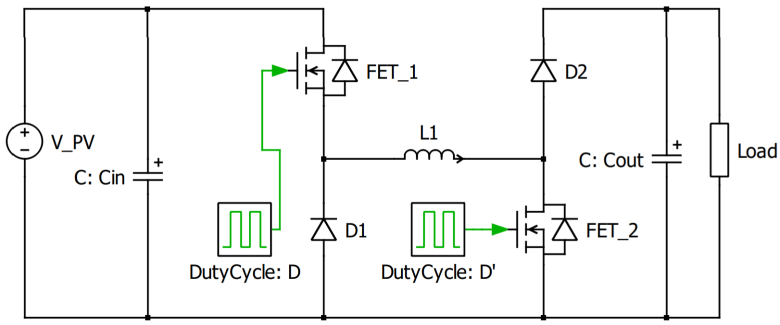

Figure 1.1. Non-inverting buck-boost converter.

The controller can force the system to work in any of the following modes:

1. Buck $\rightarrow D \subset [0,1]; D' = 0$
2. Boost $\rightarrow D = 1; D' \subset [0,1]$
3. Buck-Boost $\rightarrow D \subset [0,1]; D' \subset [0,1]$

One of the main drawbacks of the topology is the control's complexity, which must calculate the appropriate duty cycle D and D' in any of the modes and also the transition between these modes.

Usually the inverter's input voltage is fixed to some value higher than the grid's voltage. The possibility of higher and lower voltages at the converter's output allows different ways of associating photovoltaic modules. Then the user is able to arbitrarily decide how many PV modules to link in series. Differently of what would happen in the case of Buck or Boost converters where the constraints regarding the number of panels are tighter.

Compared with other topologies that can have both higher and lower voltages at the output, such as the SEPIC or ZETA converters, this converter features a single inductor and no intermediate capacitor. With such reduction in passive components the price, efficiency and power density rises significantly [Under the hood of a noninverting buck-boost converter].

Although this topology exhibits appropriate features, it can be further improved by replacing the diodes by MOSFETs. The circuit may be seen in figure 1.2, it's called Bidirectional Non-Inverting Buck-Boost converter. With this variation, the following changes occur:

1. The system becomes bidirectional.
2. The conduction losses are decreased. −> **Discuss with supervisor**

If the system is bidirectional it can be used in different MIC strategies, such as ++**reference to the introduction figure with the MICs outputting power to the PV**++. Or even implement diagnosis features with the panels' electroluminescence, whenever these are fed enough power.

As seen in figure 1.2, notice that duty cycles of the switches that replace the diodes are $\overline{D}$ and $\overline{D'}$.

The main drawback is the increased difficulty of the driver circuitry. And the requirement of a dead time in order to avoid the short circuit of FET_1 and FET_3 or FET_2 and FET_4 which could damage the system. When using diodes, the system is intrinsically protected against a shoot-through event.

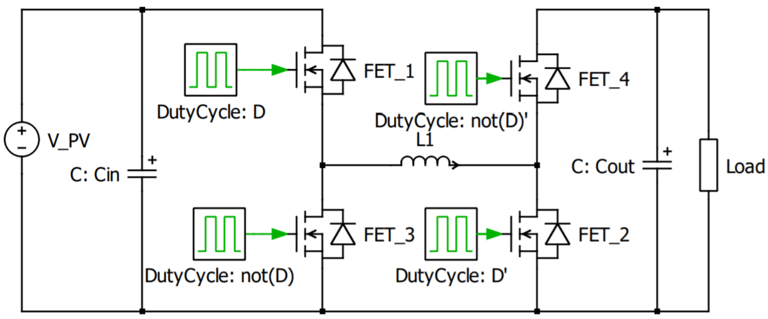

Figure 1.2. Bidirectional Non-inverting buck-boost converter.

To this date, sustainable energy sources have become an area in focus worldwide in an attempt to reduce the environmental impact due to emissions of CO2 and other greenhouse gasses. The development of competitive systems to exploit renewable energy sources is the best alternative to reduce the use of fossil fuels for the production of electricity. Over the last years there have been a considerable increase in electricity production from renewable energy sources being the fastest growing sector wind and solar energy. In 2017, solar photovoltaic was the renewable energy source which experienced the highest increased in newly installed capacity amounting a total installed capacity of approximately 402 GW.

Photovoltaic (PV) is referred to the production of electricity in the form of direct current (DC) directly from sunlight shining on solar cells. Solar cells are semiconductor devices which typically can produce around 0.5 V DC so they are series connected to form a PV module/panel which can also be connected to other PV panels resulting in a PV array. This way, according to the system´s requirements, the PV panels can be interconnected in series or parallel in order to get at the output a higher voltage or current, respectively. Connecting PV panels either in series or parallel will result in an increase of the system´s overall electricity production.

Nevertheless, it is essential to keep into consideration the mismatches that may appear between the power generated by the different PV panels, which will result in losses in the PV system and thus in a lower efficiency. Mismatches occur when the PV modules operate in a different operating point than its maximum power point (MPP) due to partial shading, manufacturing tolerances, defects in the PV modules due to weather conditions and aging, among others. Mismatch losses in a PV system can be reduced by forcing every PV module to work at its MPP by using a technique known as Maximum Power Point Tracking (MPPT). This can be reached by using electronic devices called Module Integrated Converters (MICs) which basically consist on DC-AC micro inverters or DC-DC converters with a MPPT unit to ensure that the output power of the MIC is the one corresponding to the MPP of the PV module.

This project focuses on the design and test of a MIC based on a non-inverting buck-boost DC/DC converter for integration with a PV module in order to operate at its MPP and thus harvest maximum energy from the sunlight.

1.2 PV generation

1.3 State of The Art

Example of including a picture

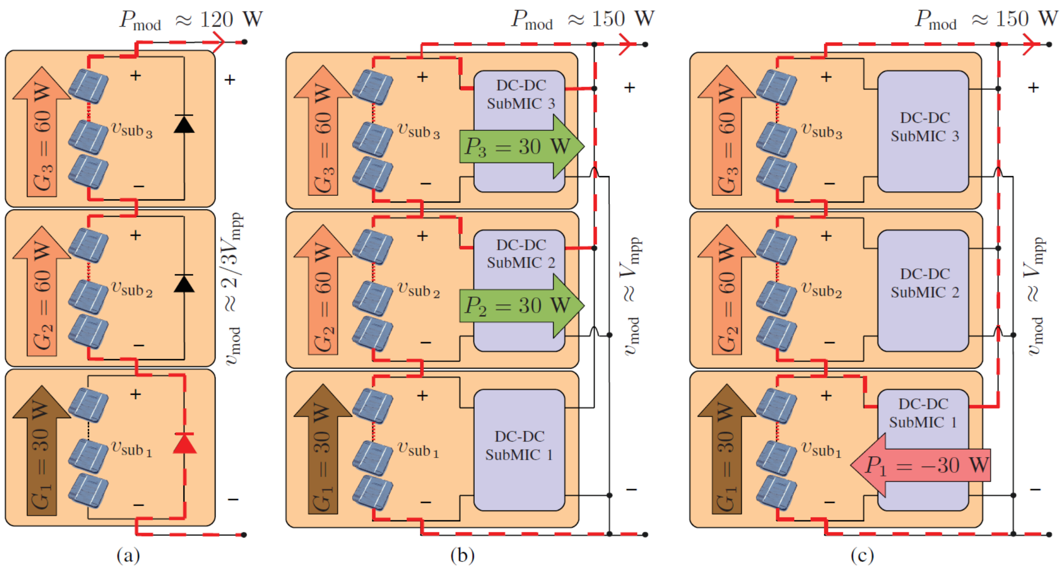

Figure 1.3. Functional flow block diagram

Example of creating a table **??**.

ID	Technical Requirements	Requirement Type	Verification Method
AX-1	The pod shall be center-mountable on the Royal Danish Air Force (RDAF) F-16 AM/BM fighter aircrafts in version M6.5	M	A
AX-2	The pod shall have a mass less than 700 pounds in total	M	A
AX-3	The pod shall have a geometric cross-section of $0.40m^2$ or less as seen from the front	M	A
AX-4	The pod should have a geometric cross-section of $0.25m^2$ or less as seen from the front	D	

Table 1.1. Flight requirements

1.4 Buck-converter

The task of a buck converter is to be changing the input voltage to a lower output voltage. The components, which are needed, are a DC-source for input voltage, a switch contained of a diode and a MOSFET, an inductor, a capacitor and a resistor for the load. The equivalent diagram in figure 1.1 illustrated a buck-converter with an ideal switch.

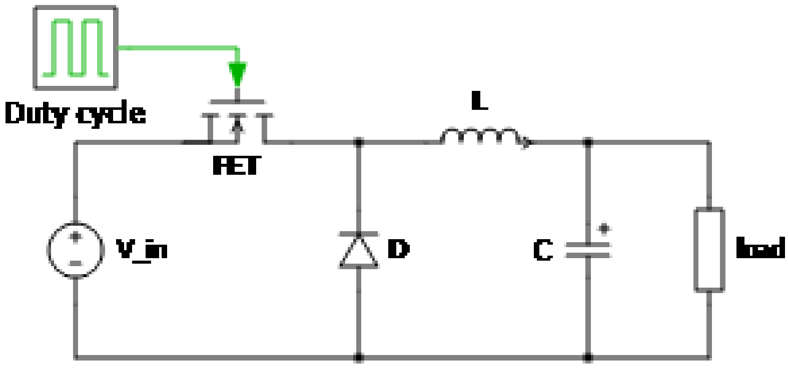

Figure 1.4. Buck-converter.

A buck-converter perform in two operating modes. In both operating modes have been approach that the converter is in steady state and the average of a value is constant. Therefore, we can assume a DC-voltage at the load. At the case, that the MOSFET conducts current (position 1), the diode will be gesperrt. During the switch is in position 1 the voltage dropes at the inductor and you can measure a lower voltage at the load. Furthermore, the capacitor is charging voltage and the inductor is stored current. For the position 2 the inductor works as a current source and feeds the closed circuit with current. The capacitor enstored is energy from the electrical field. The advantage for using a buck converter is that the structure is very simple and you need one power switch. The size for the component is small and the cost for this are low. Furthermore, the buck converter has a high effiency over 90

So we come to the disadvantgages eines buck converters. The transient response is slow for changes. The input has got a filter. Thus, could a buck converter no signal, where you need a unfilter signal,can used.

Problem Analysis 2

2.1 Specifications

2.2 Research Question

3 Objectives

Future Work 4

The following list contains the subjects which will be addressed after the hand-in of the P0 report.

1. Non-inverting Buck-Boost converter design
2. Design of control system
3. Hardware implementation
4. Test & validation of converter
5. Further development
6. Conclusion

Appendix 5