Optimization of Single, Double and Triple Voltage DC to DC Step down Voltage Regulators

Anju Kumari[1] Shelej Khera[2]
[1]P.G. Student [2]Assistant Professor
[1,2]Department of Electronics & Communication Engineering
[1,2]BRCM CET Bahal

Abstract— Switching type voltage regulators are commonly used as the power source of the IC circuit loads. To ensure the voltage stability switching type voltage regulators uses LC low pass filter in the output terminal. The inductor size and the cost are two of the major concerns in the circuit designing, changing the input parameters like inductance capacitance and switching frequency in order to observe changes in output voltage has been added with simulation graphs .These parameters and there equations should be well understood before designing step down converters. Simulation procedures in PSPICE are also added in this paper. This paper presents an optimization of integrated circuit based step down dc – dc switching voltage regulators.

Key words: Voltage Regulation, DC to DC converters, Step down converter, Buck Converter PWM

I. INTRODUCTION

Step- down switching or buck converters are vital to modern electronics. They can convert a voltage source (typically 8 V to 25 V) into a lower regulated voltage (typically 0.5 V to 5 V). Step down converters transfer small packets of energy using a switch, a diode, an inductor and several capacitors. Though considerably larger and noisier than their linear-regulator counterparts, buck converters offer higher efficiency in most cases. The LT3692 is a dual current mode PWM step-down DC/DC converter with two internal 3.8A switches. Independent input voltage, shutdown, feedback, soft- start, current limit and comparator pins for each channel simplify complex power supply tracking and sequencing requirements.

To optimize efficiency and component size, both converters have a programmable maximum current limit and are synchronized to either a common external clock input, or a resistor settable fixed 250 kHz to 2.25MHz internal oscillator. A frequency divider is provided for channel 1 to further optimize component size. At all frequencies, a 180° phase relationship between channels is maintained, reducing voltage ripple and component size. A clock output is available for synchronizing multiple regulators. The LTCR3891 is a high performance step-down switching regulator DC/DC controller that drives an all N- channel synchronous power MOSFET stage. The constant frequency current mode architecture allows a phase-lockable frequency of up to 750 kHz. The 50µA no-load quiescent current extends operating run time in many battery-powered systems. OPTI-LOOP compensation allows transient response to be optimized over a wide range of output. The LTM4634 integrates three complete 5A/5A/4A high efficiency switching mode DC/DC converters into one small package. Switching controllers, power FETs, inductors, and most support components are included, operating over an input voltage range of 4.75V to 28V, the line and load changes without sacrificing stability. The device supports frequency synchronization, multiphase parallel operation, soft-start and output voltage tracking for supply rail sequencing. The LTMR4633 regulator combines three complete 10A switching mode DC/DC converters into one small package. Included in the package are the switching controllers, power FETs, inductors, and most support components. The LTM4633's three regulators operate from 4.7V to 16V input rail(s) or 2.375Vt16V with an external 5V bias. The VOUT1 and VOUT2 output range is 0.8V to 1.8V, while the VOUT3 output range is 0.8V to 5.5V. Each output is set by one external resistor. High switching frequency and current mode architecture enable a very fast transient response to line and load changes without sacrificing stability. The device supports frequency synchronization, multiphase parallel operation of VOUT1 and VOUT2, soft-start and output voltage tracking for supply rail sequencing.

II. DESIGN CONFIGURATION

The Design Configuration includes four different circuits used for different applications. It may be noted that these circuits are reliable for different applications operating on DC voltage. Various compensators, attenuators and filters are also used. The figure1 below depicts Single synchronized step down voltage controller. This circuit is a high performance step-down switching regulator DC/DC controller that drives an all N-channel synchronous power MOSFET stage. The constant frequency current mode architecture allows a phase-lockable frequency of up to 750 kHz. The 50µA no-load quiescent current extends operating run time in battery-powered systems. The compensation can be easily achieved by employing a compensator which allows the transient response to be optimized over a wide range of output capacitance and ESR values. A wide 4V to 60V input supply range encompasses a wide range of intermediate bus voltages and battery chemistries. The output voltage of the LTC3891 can be programmed.

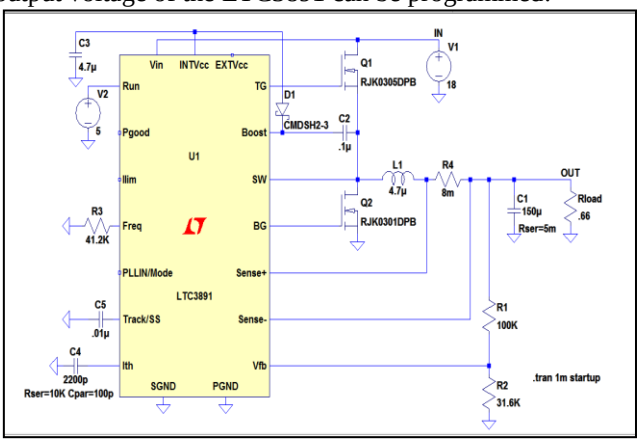

Fig. 1: LTC3891Single output Dual phase step-down regulator

The figure 2 below depicts Dual tracking step down switching regulator. This circuit is a dual current mode step-down DC/DC converter with two internal 3.8A switches. Independent input voltage, shutdown, feedback, soft-start, current limit and comparator pins for each channel simplify complex power supply tracking and sequencing requirements.

To optimize efficiency and component size, both converters have a programmable maximum current limit and are synchronized to either a common external clock input, or a resistor settable fixed 250kHz to 2.25MHz internal oscillator. This circuit also employs compensators, filters and attenuators for efficient voltage regulation. The input voltage range for this circuit ranges from 3V to 36V and generates corresponding dual outputs as per particular requirement. The synchronized output can be easily yielded by employing this circuitory.

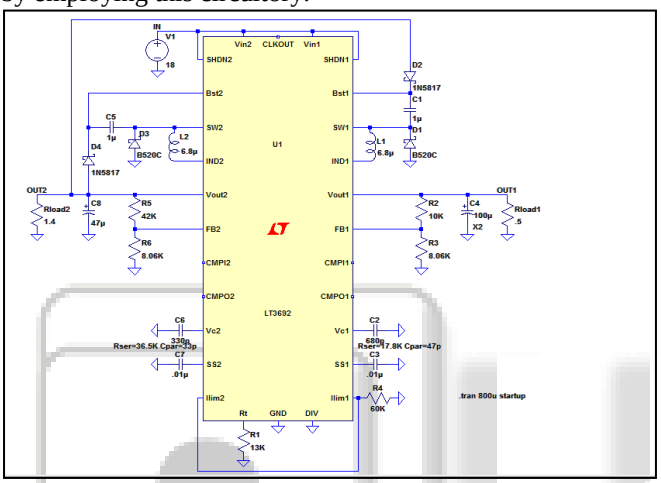

Fig. 2: LT 3692 monolithic dual tracking step down regulator

The figure 3 below depicts Triple output step down regulator. This circuit employs LT4634 to integrate three complete 5A/5A/4A high efficiency switching mode DC/DC converters into one small package. This voltage regulator includes switching controllers, power FETs, inductors, and most support components for efficient voltage regulation. It operates over an input voltage range of 4.75V to 28V to provide three independent output voltages, out of which VOUT1 and VOUT2 are adjustable from 0.8V to 5.5V, while VOUT3 is adjustable from 0.8V to 13.5V. All the three outputs of this regulator are synchronized.

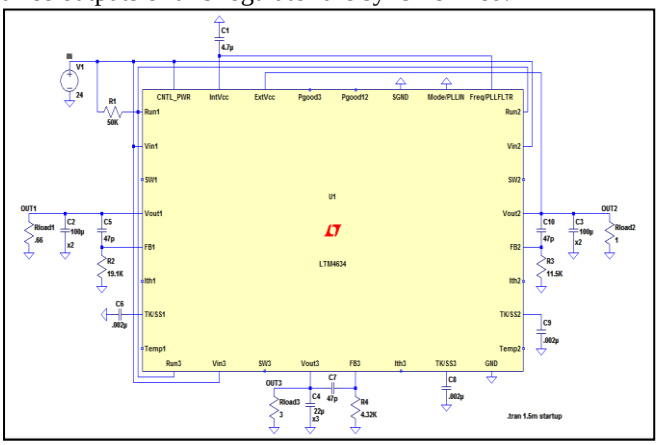

Fig. 3: LTM 4634 Triple output step down voltage regulator

The figure 4 below depicts Triple 10A step down voltage regulator. This step down voltage regulator combines three complete 10A switching mode DC/DC converters into one small package. It includes the switching controllers, power FETs, inductors, and most support components for suitable operation. This regulator operate from 4.7V to 16V.Out of three outputs VOUT1 and VOUT2 output range is 0.8V to 1.8V, while the VOUT3 output range is 0.8V to 5.5V.

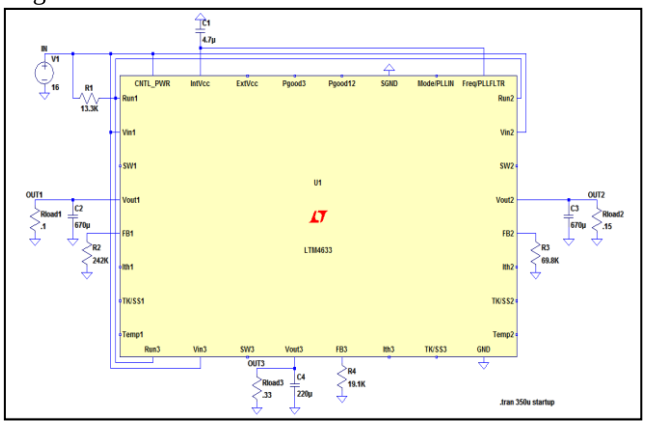

Fig. 4: LTM 4633 Triple output step down voltage regulator

III. RESULTS AND DISCUSSIONS

The figure 5 shown below depicts simulated output of single output dual phase step down switching regulator. From the graph it is clear that the circuit works as an efficient synchronized dual phase step down switching regulator. The output of the regulator is Vout1 = 1.887V and generated corresponding to the input voltage (Vin) of 18V. This efficient voltage regulation is can be easily achieved by using proper selection of input and output capacitances & inductances.

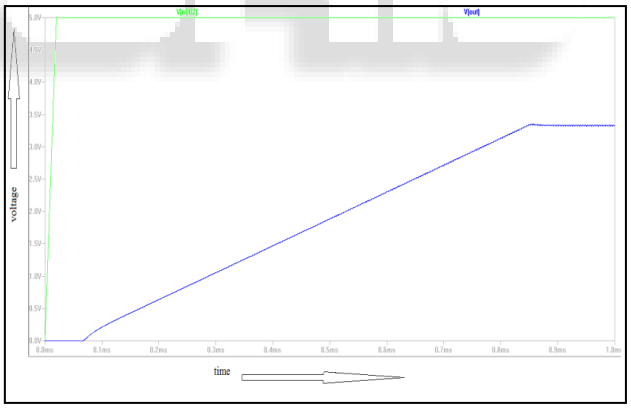

Fig. 5: simulated output of LTC3891 single output step down regulator

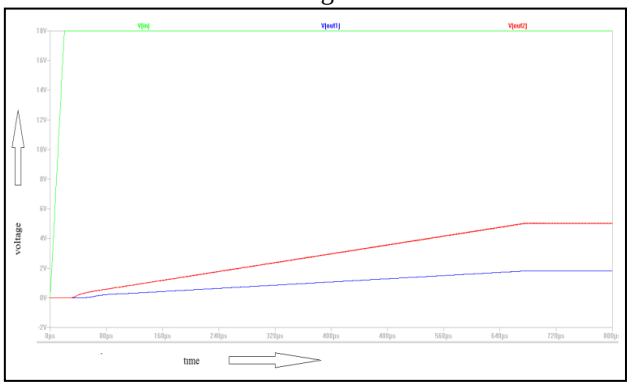

Fig. 6: Simulated output of dual tracking step down regulator

The figure 6 shown below depicts simulated output of Dual tracking step down switching regulator. From the graph it is clear that the circuit works as an efficient synchronized dual step down switching regulator. The two outputs i.e. Vout1 = 1.06V and Vout2 = 2.97V respectively are generated corresponding to the input voltage (Vin) of 18V. This efficient voltage regulation is can be easily achieved by using compensators, attenuators and filters.

The figure 7 shown below depicts simulated output of monolithic triple output step down switching regulator. From the graph it is clear that the circuit works as an efficient synchronized triple output step down switching regulator. The three outputs Vout1 = 1.95V, Vout2 = 2.94V Vout3 = 7.03V respectively are generated corresponding to the input voltage (Vin) of 24V.

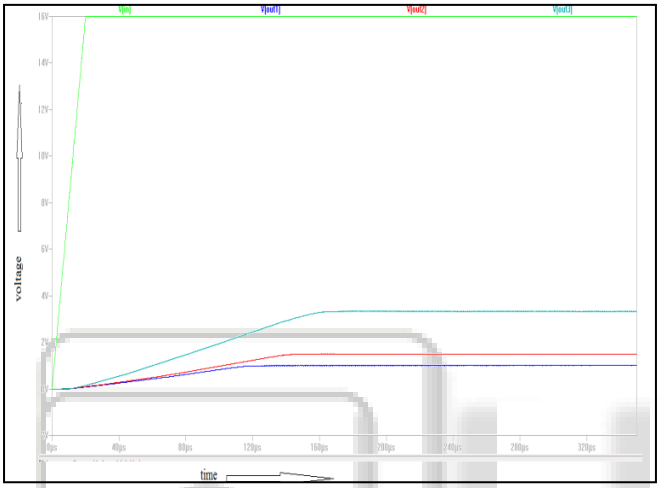

Fig. 7: Simulated output of LTM 4633

The figure 8 shown below depicts simulated output of Dual tracking step down switching regulator. From the graph it is clear that the circuit works as an efficient synchronized dual step down switching regulator. The three outputs i.e. Vout1 = 1.95V, Vout2 = 2.94V and Vout3 = 7.03V respectively are generated corresponding to the input voltage (Vin) of 24V. This efficient voltage regulation is easily achieved by using compensators, attenuators and filters.

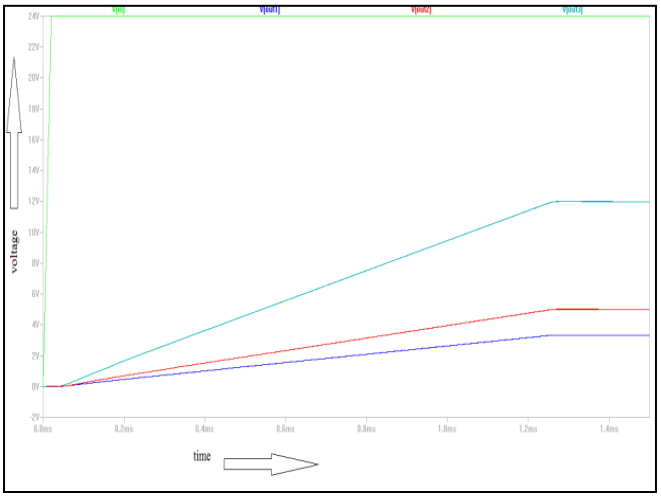

Fig. 8: Simulated output of LTM4634

IV. CONCLUSION

The LTC3891 single output**,** synchronous step-down converter can be easily configured as a single output**,** dual phase converter for high input voltage**,** high output current automotive and telecom applications.

The LT3692 dual output step down converter can be easily configured as dual output step down converter with a very low drop out and therefore suitable for automated systems.

The LTM 4634 and LTM4633 are triple output step down regulator , both gives protection to the circuit from output overvoltage and over current and thus suitable for High Density Point of Load Voltage Regulation.

REFERENCES

[1] Dusan Gleich, Mira Milanovic, Suzana Uran, Franic Mihalic.“Digitally controlled buck converter” IEEE power electronics society ISCAS-2004, pp-V944-V947.
[2] Tarun Gupta, R.R. Boudreaux, R.M. Nelms and John Y Hung, “Implementation of a fuzzy controller for DC-DC converters using an inexpensive 8-bit Microcontroller”, IEEE Transactions on Industrial Electronics, Vol. 44, No.5, October 1997.
[3] Trip, N. D., & Dale, S. (2010). Digital Control for Switched Mode DC-DC Buck Converters, 99–102.
[4] Gupta, T., Boudreaux, R. R., Member, S., Nelms, R. M., & Member, S. (1997). Implementation of a Fuzzy Controller for DC – DC Converters Using an Inexpensive 8-bit Microcontroller, 44(5), 661–669.
[5] R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, 2nd ed., Norwell: Kluwer Academic.
[6] Ned Mohan, Tore M. Undeland and Willian P. Robbins, Power Electronics, 3nd ed., New York: john Willey & Sons, 2003.
[7] Su, J.H.; Chen, J.J.; Wu, D.S.; “Learning feedback controller design of switching converters via Matlab/Simulink” Education, IEEE Transactions on, Volume: 45 Issue: 4, Nov. 2002 Page(s): 307 -315
[8] Mattingly, D.; “Designing stable compensation networks for single phase voltage mode buck regulators” Technical Brief, Intersil, Dec. 2003
[9] Huang, W.; A new control for multi-phase Buck converter with fast transient response, ON Semiconductor (2001).
[10] Ridley, R.B.; “A new, continuous-time model for current mode control” Power Electronics, IEEE Transactions on, Volume: 6 Issue: 2, April 1991 Page(s): 271-280
[11] Ridley, R.B.; “A new small-signal model for current mode control” Ph.D. dissertation, Virginia Polytechnic Institute and State University, Blacksburg, Nov. 1990.
[12] Severns, R.P.; Bloom, G.; Modern DC-TO-DC switchmode power converter circuits, Van Nostrand Reinhold Company (1985)
[13] Locher, R.; “Introduction to POWER MOSFETs and Their Applications”, AN-558, National Semiconductor, Dec 1998
[14] Data Sheet “NCP1570 Low Voltage Synchronous Buck Controller”, ON Semiconductor, 2002
[15] Data Sheet “LTC1625 No Rsense Current Mode Synchronous Buck Step-Down Switching Regulator”, Linear Technology, 2002
[16] Data Sheet “UC1842 Current Mode PWM Controller”, Texas Instrument, 2002

[17] Yao, K.; Meng, Y; Lee, F.; "Control Bandwidth and Transient Response of Buck Converters", Virginia Polytechnic Institute and State University, Blacksburg, Nov.2002.
[18] Goder, D.; Pelletier, W.R.; "V2 architecture provides ultra-fast transient response in switch mode power supplies", Switch Power Inc., Campbell, CA
[19] Datasheets of LT3692, LTC3891, LTM4633, LTM4634.
[20] Online source www.google.com

