

Application Bulletin AB-28

Power Conversion for the Data Communications Market

Abstract

This application bulletin discusses the transition from traditional telephony to converged voice and data over Internet Protocol (IP) and its implications for the power conversion of such systems. A few power conversion examples are provided complete of applications schematics.

Introduction

The arm wrestling between voice and data has concluded in favor of the latter with all the major players now posturing for leadership of the migration from traditional voice to Internet Protocol (IP) telephony. On the short term the huge investments in both traditional telephony infrastructure and data over IP warrants that over the next few years we will have to provide power conversion for both types of systems as well as for the converged systems to come.

Current Environment with Separate Networks

Fig. 1 shows the current situation with voice going through traditional PBX (Private Branch Office), Central Office, and Switch to the Public Switch Telephone Network (PSTN). On independent paths the data travels from Routers to wide Area Networks (WAN) and the video goes through a third independent path.

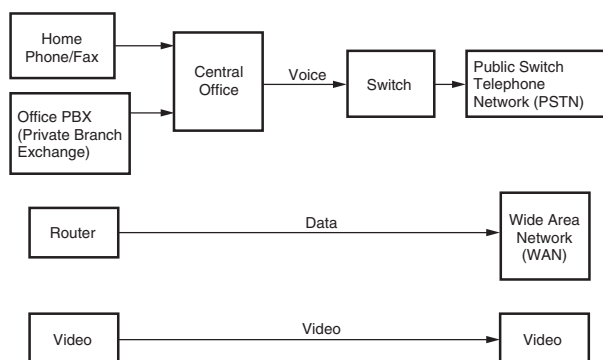
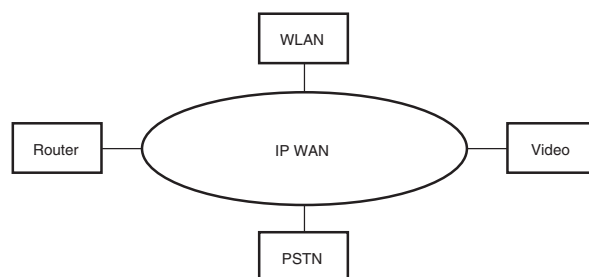


Fig.1. Separate Networks for Voice, Data and Video

Migration to Converged Voice/Data IP

Fig. 2 shows the envisioned converged Voice/Data/Video system over IP. At the center of this new universe is the Internet Protocol Wide Area Network, with all the services, including voice, data, video and wireless communications gravitating around it.



IPWAN = Internet Protocol Wide Area Network
WLAN = Wireless Local Area Network
PSTN = Public Switched Telephone Network

Fig. 2. Voice/Data/video Over IP

Telecom –48V DC Power Distribution

Traditionally telecom systems have been distributing a DC power (–48V typically) obtained from a battery back up being continually charged by a Rectifier/Charger from the AC line. Subsequently the –48V is converted into various low positive DC voltages (Fig. 3 shows 12V only for simplicity) as well as back to AC voltages as necessary.

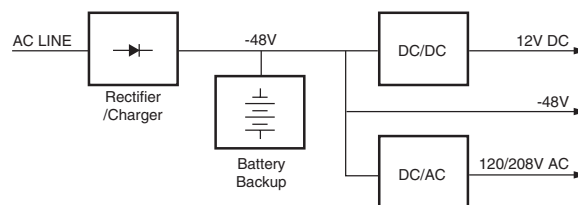


Fig. 3. Telecom –48V DC power distribution

Datacom AC Power Distribution

Data centric systems tend to rely on an Uninterruptible Power Supply (AC UPS) front-end for distributing AC power, which subsequently is converted into the basic constituents, –48V, AC power and low voltage DC (again, for simplicity we are only showing a 12V DC in Fig. 4).

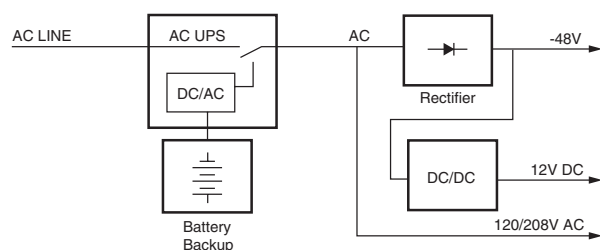


Fig. 4. Datacom AC Power Distribution

With the advent of the converged systems, these separate approaches to power distribution will converge into new architectures but the bottom line is that at the board or back-plane level the usual voltages will need to be delivered, namely 12V and 5V, as well as 0.9V, 1.8V, 2.5V, 3.3V with more to come.

The delivery of such low voltages starting from DC or AC power will be the focus of this document from here on.

DC-DC conversion

Fig. 5 shows the -48V to +Vout (+5, +12V etc.) with a forward converter architecture based on the ML4823 high frequency PWM controller:

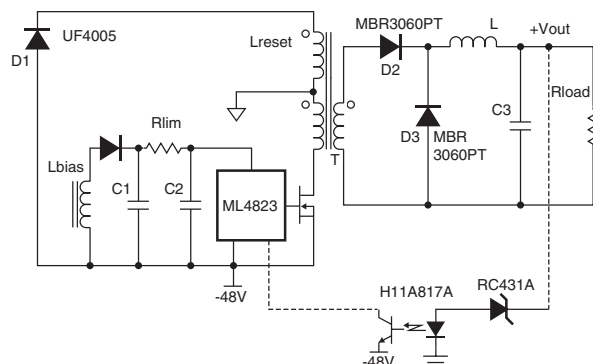


Fig. 5. -48V to +Vout Conversion

Fig. 6 shows the DC-DC conversion from 12V and 5V down to a slew of typical low voltages required by modern electronic loads.

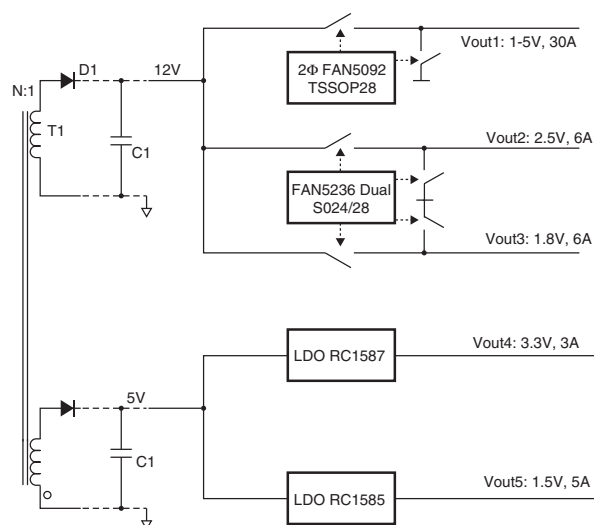


Fig. 6. DC-DC Conversion Diagram

The conversion down to heavy loads is done with synchronous rectification switching regulators of single or multiphase interleaved type, while for lighter loads linear regulators can be utilized.

AC-DC conversion

Fig. 7 shows the conversion of AC power directly down to one of the DC voltages listed earlier, all low enough to be safely distributed on the motherboard. The AC line is rectified first by means of a full bridge diode rectifier that converts the alternate AC voltage into a continuous but still poorly regulated intermediate voltage. Next this voltage is converted down to a low voltage usable by the electronics on the motherboard by means of a “fly-back” converter (KA5H03xx family) with minimum number of external components. This conversion requires electrical isolation between the high input and the low output voltages: this is accomplished via the utilization of a transformer (T) in the forward conversion path and an opto-coupler in the feedback path.

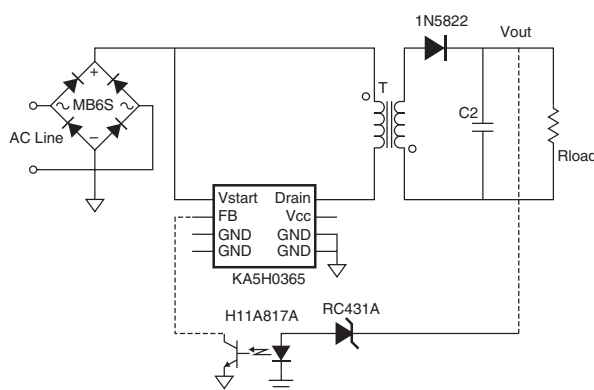


Fig. 7. AC/DC Conversion Diagram

An integrated version of the opto-coupler (H11A817A) and secondary voltage reference (RC431A) is also available (FOD2712).

In the following sections we dive into some details of the conversion from 12V and 5V down to final electronic load voltage.

FAN5092 Two-Phase Interleaved Buck Converter

The FAN5092 step-down (buck) converter is ideal for data communications applications. This IC is a two-phase interleaved buck converter switching up to 1MHz per phase. The application diagram illustrates conversion from 12V down to 3.3V in a 12V-only input voltage source environment. The chip integrates the controller and the drivers on a single die. The high frequency of operation is enabled by:

- The monolithic approach of integrating controller and drivers on board
- A fast proprietary “leading edge valley control” architecture with 100ns of response time
- The strongest drivers in the industry at 1 Ω of source and sink impedance for both high and low side driver of each phase

Such combination of features, together with loss-less current sensing via $R_{DS(on)}$ sense, allows for a very efficient delivery of power with very small passive components leading to new record levels of power density.

The application diagram of the IC is shown in Fig 8 for a 3.3V, 30A load. Optimum companions of the FAN5092 are the Fairchild discrete DMOS FDB6035AL for high side pass transistors Q1,2 and FDB6676S for low side synchronous rectification transistors Q2,4.

Two FAN5092 can be paralleled by means of doubling the above application and connecting together two pins (pin 26 and pin 15). This will allow handling of loads up to 120A.

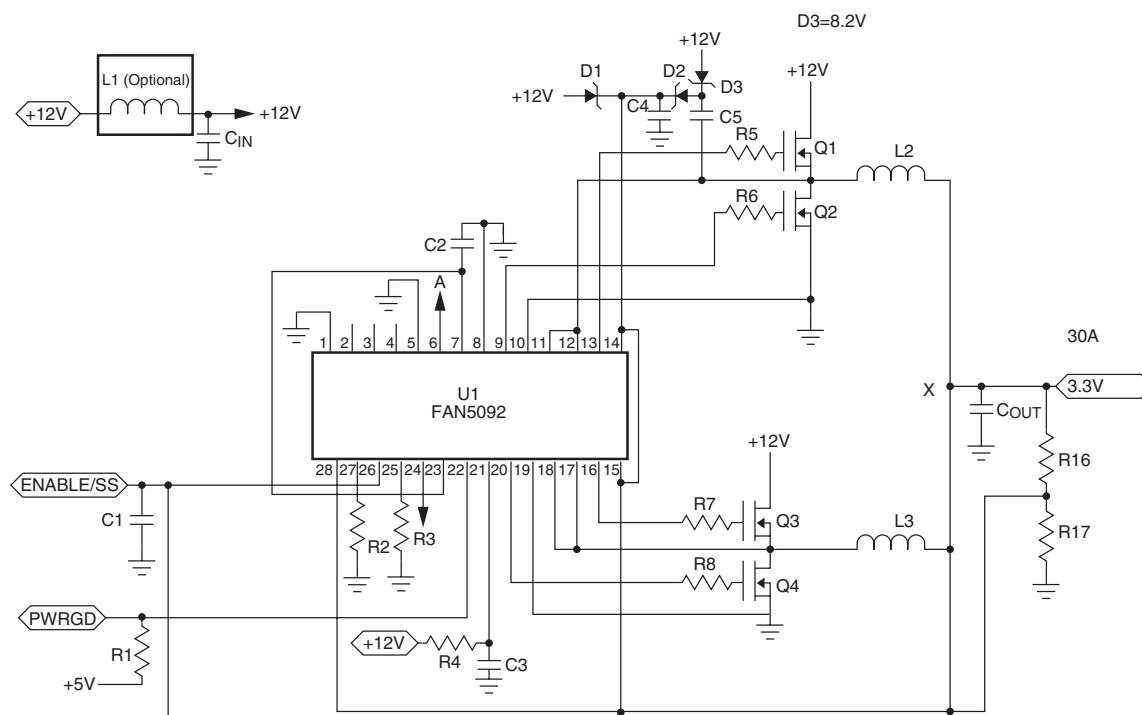


Fig. 8. FAN5092 Application Circuit

FAN5236 Dual Synchronous Buck Converter

The FAN5236 PWM controller (Fig. 9) provides high efficiency and regulation for two output voltages adjustable in the range from 0.9V to 5.5V. Synchronous rectification and hysteretic operation at light loads contribute to a high efficiency over a wide range of loads. The hysteretic mode of operation can be disabled separately on each PWM converter if PWM mode is desired for all load levels. Again high efficiency is obtained by using MOSFET's $R_{DS(on)}$ for current sensing. Out-of-phase operation with 180-degree phase shift reduces input current ripple.

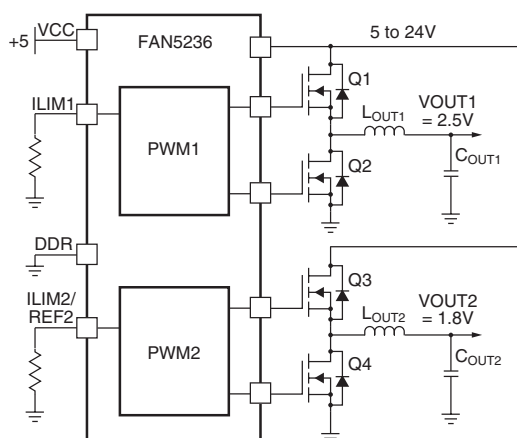


Fig. 9. FAN5236 Block Diagram

RC1585/7 Linear Regulators

In some cases if the input to output voltage difference is sensibly less than the output voltage it make sense to use linear regulators. In Fig.6 Fairchild's RC1587, 3A and RC1585, 5A linear regulators are showcased.

KA5H0365 Offline Converter

The high level of simplicity of the AC/DC converter in Fig. 6 is possible thanks the multi-chip approach to integration of the this controller family (Fig. 10). The TO220 package houses two dies, a controller die and a high voltage MOSFET die on board. Here again power hungry discrete current sense resistors are avoided, in this case by means of a ratioed sense-fet technique on board of the discrete element.

For more details and a complete bill of materials please refer to the FAN5092, FAN5236, RC1585, RC1587 and FOD2712 data sheets available on the Fairchild web site.

For KA5H0365 please refer to the data sheet as well as to FPS Application Notes for SMPS design available on the Fairchild web site.

Conclusion

The merging of data, voice and video blurs the line between computing and communications. The smart loads of either application draw from the same advanced, high-density sub-micron low voltage CMOS technologies and require similar solutions for distributed power conversion. Fairchild expertise in power conversion for computing and communications offers proven solutions to the merging converged data communications market.

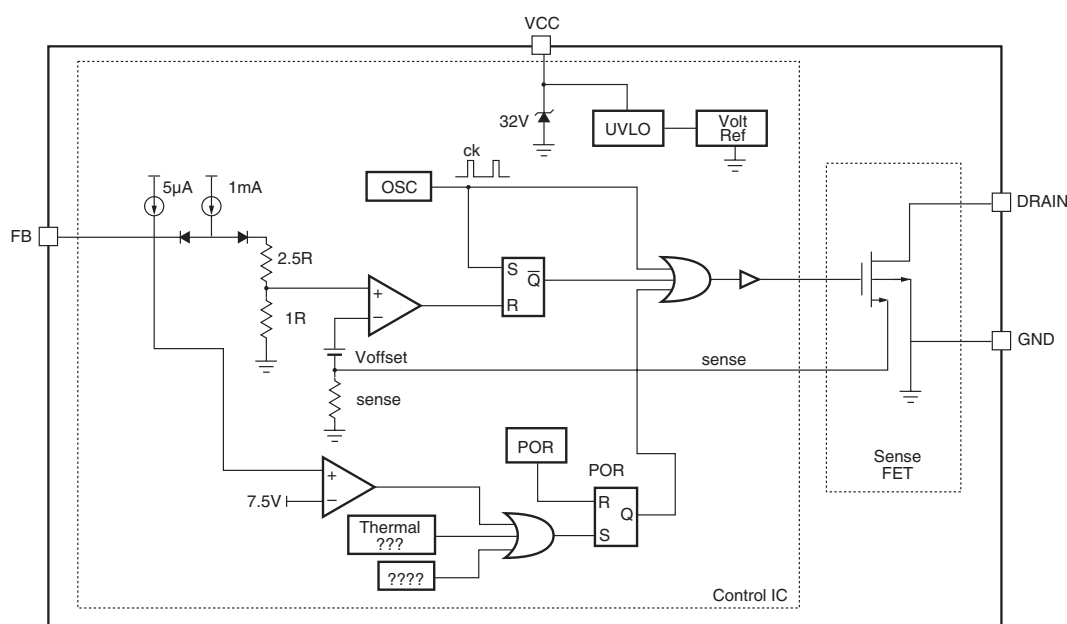


Fig. 10. KA5H0365 converter architecture