Designing a Module for High-Speed Optical Communication

Introduction

As we navigate the reality of COVID-19, in-person interactions have become less commonplace. Thus, with the latest wave of digitalization and informatization that embraces countless new technologies, our access to the internet has become a vital means of accurate, real-time socialization and communication.

Optical communication sends signals in the form of light. These signals have been used to build the network skeleton of the entire information age, expanding servers into data centers and forming the backbone of metropolitan area networks. This process has led us into the F5G gigabit era of ultra-wide, high-speed optical communication.

The ultimate goal for all-optical connectivity with an ultra-high F5G bandwidth is to increase transmission rates. Optical modules — the foundation of optical communication networks — face the design challenges of requiring higher density power, integration, and improved efficiency conversion.

MPS provides compact and comprehensive solutions that feature high efficiency and low ripple characteristics to meet the design requirements of high-speed optical module power supply solutions. These products include buck and buck-boost conversion power modules (integrated inductors), negative charge pumps, thermoelectric cooler (TEC) controllers, and soft-start load switches.

Figure 1 shows an overview of MPS's optical module solutions.

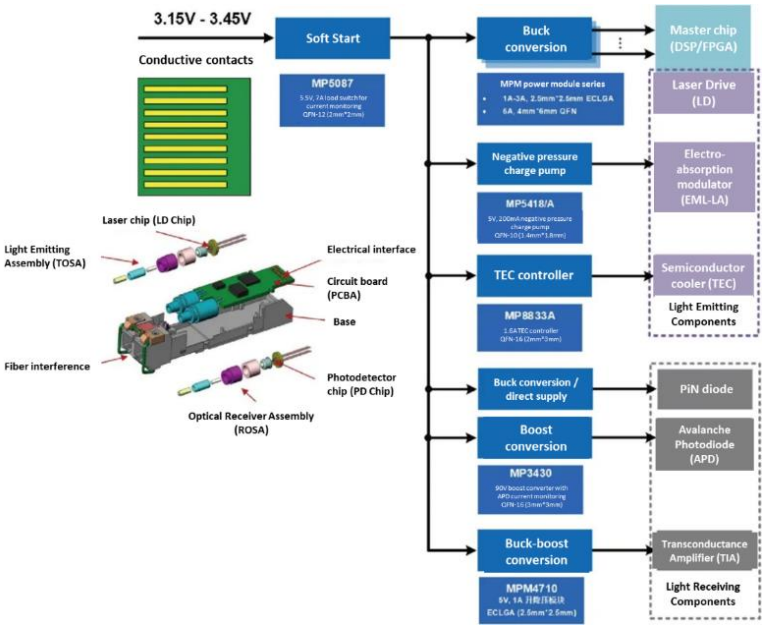

Figure 1: MPS Optical Module Solutions

MPM Power Module Series with Integrated Inductors

MPS has accumulated many years of experience in power module products with integrated inductors, providing industry-leading, high power density power module solutions.

For the 400G/200G/100G optical modules that are widely used in data communication and fiber-optic backbone infrastructures, MPS provides a 5V power module solution with smaller size and improved efficiency compared to discrete component solutions, which boosts optimization and product iteration.

The MPM38x4C: 5V, Low-Voltage, Low-Current Series

MPS provides pin-compatible, 1A to 3A, small form factor solutions with the MPM3814C, MPM3824C, and MPM3834C. Figure 2 shows an overview of these devices.

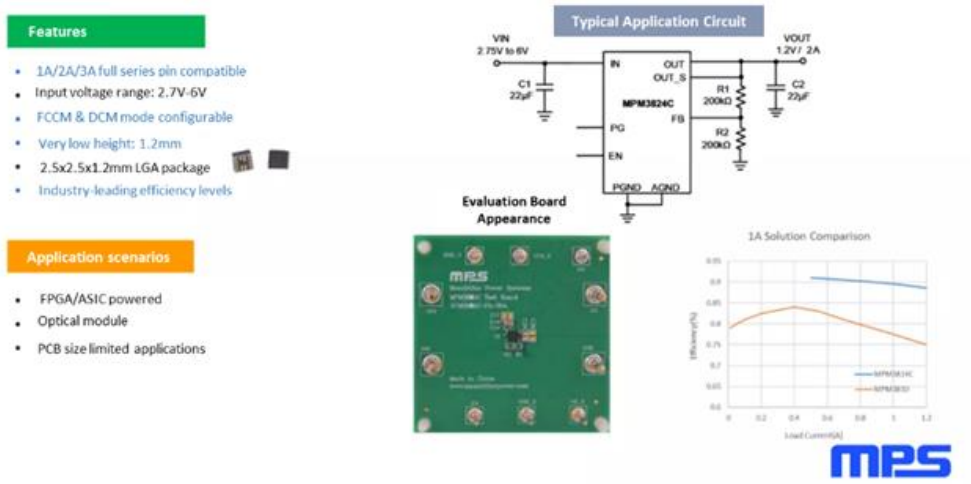

Figure 2: Introduction to the MPM38x4C Series

The MPM3860: 6A, Fully Integrated, Single-Channel Module

The MPM3860 is a low-voltage, high-efficiency, 6A, single-channel power module solution. It is available in a QFN-24 (4mmx6mm) package (see Figure 3).

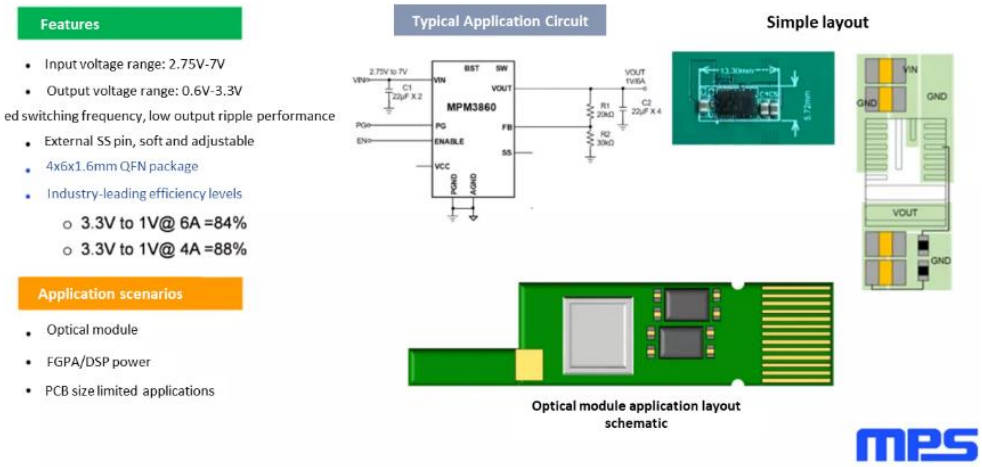

Figure 3: Introduction to the MPM3860

The MPM4710: Buck-Boost Power Module in a Small Package

The MPM4710, a buck-boost power module solution in a small ECLGA-14 (2.5mmx2.5mmx1.2mm) package, provides excellent output voltage ripple and input surge performance (see Figure 4). The MPM4710 is well-suited for transconductance amplifier (TIA) power solutions.

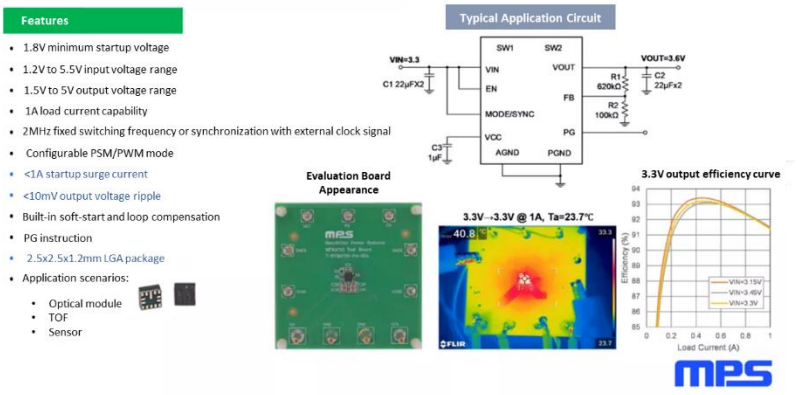

Figure 4: Introduction to the MPM4710

Laser Diodes

Laser diodes convert electrical signals into optical signals in the optical module. Commonly used laser diodes are classified as surface-emitting and edge-emitting, according to the type of light emission. Surface-emitting lasers are typically vertical-cavity surface-emitting lasers (VCSELs). There are many types of edge-emitting lasers; the most widely used are distributed-feedback (DFB) lasers and electro-absorption modulated lasers (EMLs). These three laser diodes are described in more detail below.

A VCSEL has certain advantages in terms of power consumption, temperature drift, cost, integration, and heat dissipation. However, since VCSELs in practical applications are concentrated in the 850nm/980nm wavelength range, this laser is more suitable for short-distance data centers in high-speed data transmission, and access networks.

Compared to VCSEL, DFB lasers have a longer wavelength and are commonly used for medium- and long-distance transmissions, which makes them well-suited for transmission networks, wireless base stations, and data center interconnection. The DFB laser can be considered a directly modulated laser (DML), where the signal's 0/1 modulation controls the current to adjust the laser's output intensity. Due to the changing modulation current, the laser has more obvious frequency chirping, which produces broader pulses and signal distortion. Because of this, a DML is not recommended for high-speed, long-distance transmission.

An EML is a laser diode (i.e. a DFB laser) integrated with an electro-absorption modulator (EAM). When an EML works, the injection current to the laser remains constant and relies on the external modulator to modulate the optical signal, making it difficult to generate a chirp effect. The signal transmission quality is ideal for high-speed, long-distance telecommunications backbone networks, metropolitan area networks, and data center interconnection applications. However, the advantages of using an EML in terms of price and power consumption are not immediately obvious without providing an additional negative pressure bias to the modulator EAM. It is also necessary to use a semiconductor cooler (TEC) for precise ambient temperature control to ensure high signal transmission quality.

Figure 5 shows the typical application scenarios for different laser types.

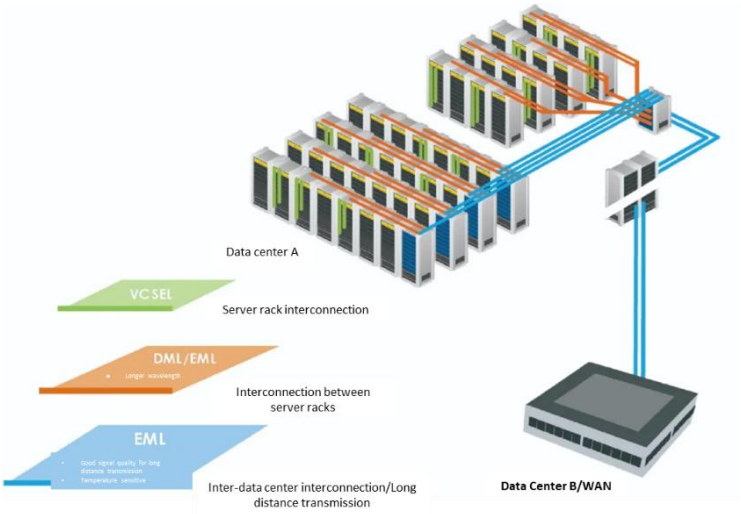

Figure 5: Typical Application Scenarios of Different Laser Types

MPS provides robust products for EML applications. Engineers can select devices such as negative voltage power supplies, as well as TEC controllers for EAM.

Negative Voltage Power Supply for EAM

The MP5418 and MP5418A charge pumps provide variable negative pressure bias for the EAM (see Figure 6).

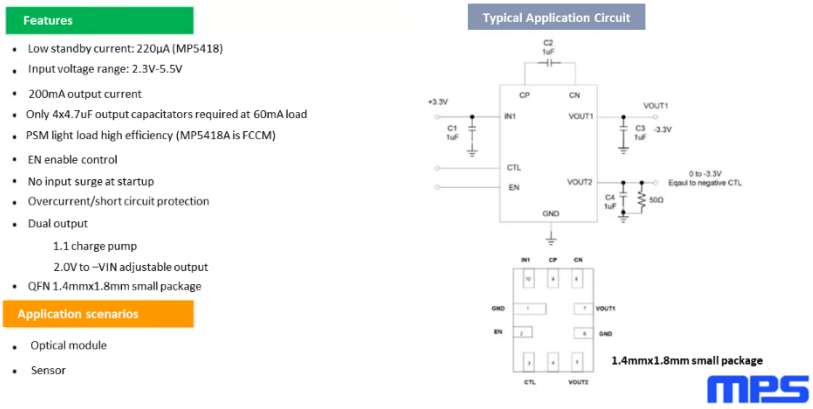

Figure 6: Introduction of the MP5418 and MP5418A

TEC Controller

The MP8833A is a TEC controller with 1.5A (3A optional) of current capability. Figure 7 shows an overview of the MP8833A.

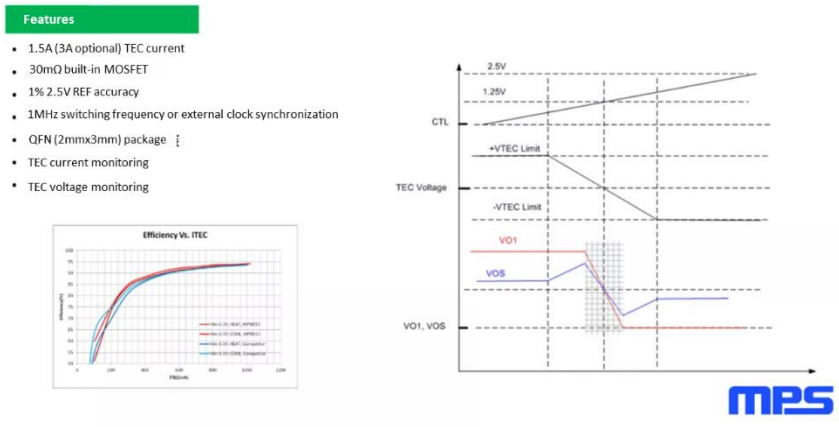

Figure 7: Introduction to the MP8833A

Conclusion

In this article, we reviewed MPS optical module solutions to achieve high-speed optical communication in the F5G gigabit era. These solutions include the MPM38x4C series (including the MPM3814C, MPM3824C, and MPM3834C), MPM3860, MPM4710, MP5418 and MP5418A, and the MP8833A. In addition, MPS provides solutions for laser diodes that convert electrical signals into optical signals, such as VCSEL, DFB, and EML. For more information, explore MPS's robust portfolio of power modules and monolithic design of optical modules.