# Developing a Smart Cockpit Solution with MPS and Semidrive

## Introduction

There are a wide array of features in a smart car's cockpit that can enhance driving experience. For example, full LCD central control screens and high-definition displays have made user experience smoother and simpler. With the addition of voice recognition, drivers can make calls and use intelligent navigation. High-quality sound and ambient lighting provide an immersive experience while listening to music, or while passengers watch movies. Furthermore, over-the-air (OTA) technology seamlessly connects the driver's mobile phone to the in-vehicle system. Lastly, driving is safer than ever now that the smart cockpit can monitor the driver's status and provide early warnings of emergency road conditions.

The automotive smart cockpit is a powerful travel assistant and an interactive interface that connects users to digital intelligence. Due to close-range, frequent contact between the vehicle and consumer, the cockpit is a concrete way for consumers to see that cars are becoming more intelligent and creative.

Based on data from iCVTank, the global smart cockpit market was valued at $23.1 billion in 2020, and it is expected to reach $44 billion by 2026. In particular, in-vehicle infotainment comprises the largest market size at 64.3%, followed by the cockpit display system at 27.05%, and the head-up display system at 4.62%. Among the key factors influencing users' purchasing decisions (e.g. power, space, and price), the cockpit's configurability has become an important consideration.

This article will explore the hardware that supports an automotive smart cockpit solution using a joint collaboration with MPS and Semidrive. We will then discuss three key power schemes with the primary power supply, secondary power supply, and backlight drive.

## Computing Power of the Automotive Smart Cockpit

The 2021 Automotive Intelligent Cockpit White Paper proposes that the computing power of the main system-on-chip (SoC) is integral to determining the function and performance of the cockpit. The central processing unit (CPU) computing power is primarily measured in Dhrystone million instructions per second (DMIPS), wherein millions of machine language instructions are processed per second. To meet this increasingly extensive application coverage, the required CPU computing power is increasing. Currently, an SoC exceeding 20kDMIPS is sufficient for a smart cockpit processor, but the computing power demands continue to rise.

Automotive smart cockpits provide various functions, including the head-up display system, visual perception system, and voice interaction system. Figure 1 shows a comprehensive overview of the smart cockpit's typical functions.

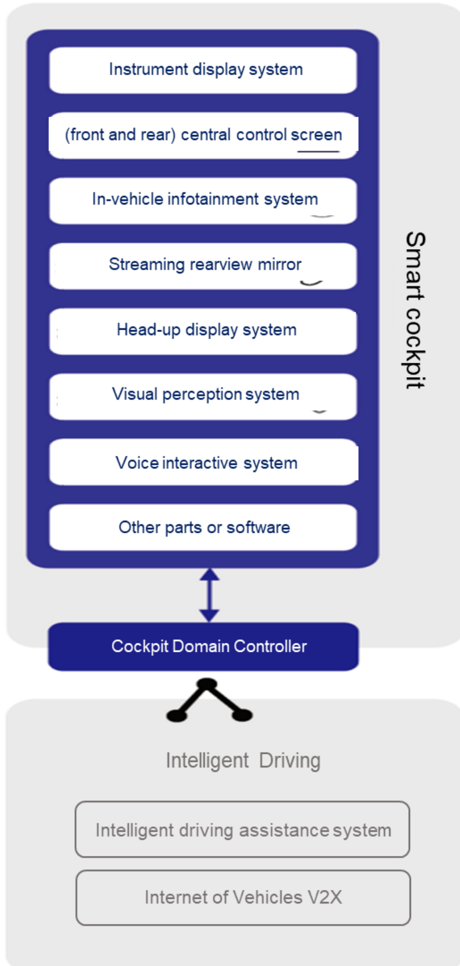


**Figure 1: Typical Functions of a Smart Cockpit**

Using the high-performance Semidrive X9 chip, we will explore the hardware architecture of a smart cockpit solution (see Figure 2).


**Figure 2: Semidrive X9 Series Cockpit Chip (Image Source: Semidrive)**

The X9 series processor is an automotive-grade chip for the new generation of automotive electronic cockpits. The latest smart cockpit technology integrates a high-performance CPU, graphics processing unit (GPU), AI accelerator, video codec processor, and additional acceleration units. An X9 processor can simultaneously drive up to 10 high-definition displays (e.g. instruments, central control, rearview mirror, and rearview entertainment) and supports multi-screen sharing and interaction, which meets the functional requirements of future automotive smart cockpits (see Figure 3). The X9 processor integrates rich interfaces and bus protocols, such as peripheral component interconnect express (PCIe), USB, controller area network flexible data-rate (CAN FD), and Ethernet. As a result, the X9 series processor can seamlessly connect with various on-board systems at a low cost.


**Figure 3: The X9U Can Drive Up to 10 Screens**

The X9 series include the X9E, X9M, X9H, X9HP, and X9U. These processors are configured with different numbers of CPUs and CPU cores with a maximum computing power of 100kDMIPS, which covers a variety of cockpit application scenarios, such as liquid crystal display (LCD) instruments, central control navigation, and high-end smart cockpits. In addition, the entire X9 series is compatible with a wide array of software and hardware, which helps customers reduce development costs, shorten the development cycle, and support the applications of different models with one design.

## MPS and Semidrive’s Collaboration to Develop an X9H Reference Board

In addition to several R5 cores, the X9H adopts a 6-core A55, with a CPU computing power up to 36kDMIPS, and a GPU computing power up to 140GFLOPS. MPS and Semidrive developed a X9H reference board to realize a smart cockpit solution with up to four screens. The reference board’s input end is directly powered by a 12V battery. Since the SoC power supply rail is typically below 1V, a two-level power supply scheme is recommended to improve the system’s conversion efficiency and support battery voltage fluctuations during crank and load dump conditions.

### *Primary Power Supply Scheme*

The primary circuit converts 12V to 5V using the MPQ4436-AEC1, a configurable-frequency, synchronous, step-down, automotive-grade switching regulator with a maximum input voltage ($V_{IN}$) of 45V and a maximum output current ($I_{OUT}$) of 6A, which supports parallel configurations (see Figure 4).

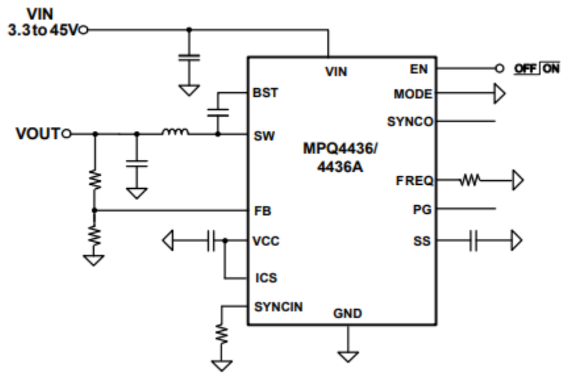


**Figure 4: MPQ4436-AEC1 Primary Power Scheme**

The features of the MPQ4436-AEC1 are described below:

- An ultra-small (4mmx4mm) package size reduces layout area.
- Ultra-high conversion efficiency supports complex heat dissipation in the car cabin.
- Dynamic performance provides a stable output for the subsequent circuit.
- Multi-phase capability allows for a flexible and scalable customer design by supporting multiple parallel devices.
- Rich, internal protection functions include over-current protection (OCP) with hiccup mode and input under-voltage protection (UVP), which help to guarantee system reliability.

The MPQ4436A-AEC1 automotive-grade switching regulator is a version of the MPQ4436-AEC1 that provides frequency spread spectrum (FSS), which can reduce the EMI in the system and make it easier for the entire board to meet EMI requirements. Customers can select a regulator that meets their needs.

### *Secondary Power Supply Scheme*

The MPQ217x automotive-grade switching regulator series — including the MPQ2177-AEC1 (1A output current ($I_{OUT}$)), MPQ2178-AEC1 (2A $I_{OUT}$), and MPQ2179-AEC1 (3A $I_{OUT}$) — can be used to achieve flexible pin-to-pin compatibility for the X9E, X9M, and X9H. These devices support a unified hardware layout for different platforms.

Consider the X9H, where the secondary circuit is comprised of multiple MPQ2179-AEC1 devices and the MPQ2167A-AEC1 (which has a 6A $I_{OUT}$), according to the current requirements of different SoC power rails.

Figure 5 shows the secondary power supply scheme.

 

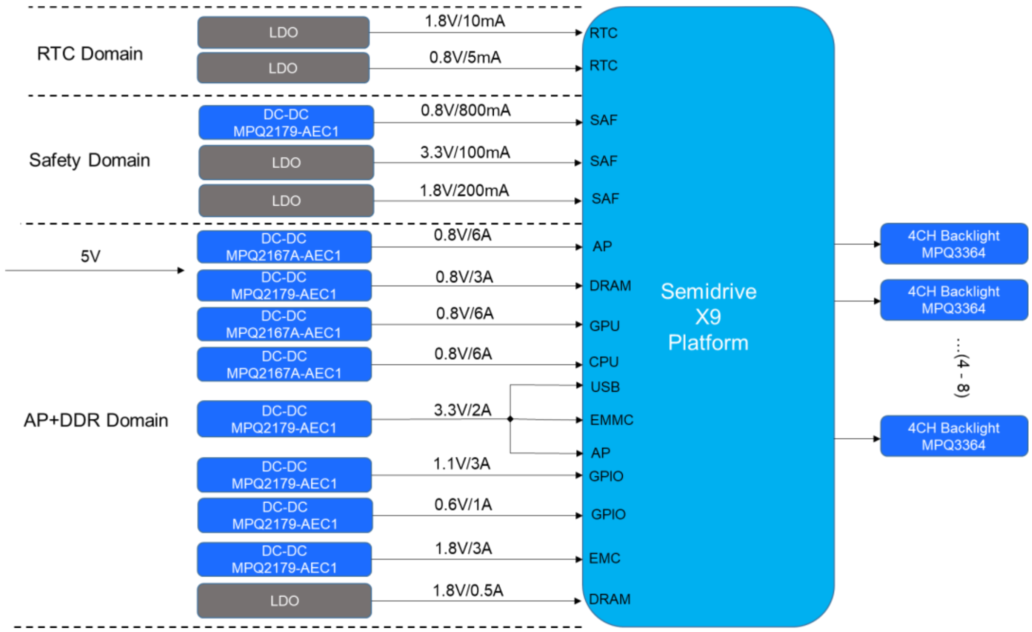


**Figure 5: Secondary Power Solution System Architecture**

The advantages of a secondary circuit using the MPQ2179-AEC1 and MPQ2167A-AEC1 are described below:

- Specifically designed for 5V applications (e.g. infotainment systems, advanced driver assistance systems (ADAS), cameras, and smart cockpits) that require fast transient response, ultra-low noise, high-precision output, and excellent thermal performance.
- Adopts MPS's latest Bipolar-CMOS-DMOS (BCD) low-resistance process, combined with an advanced flip-chip packaging process, to achieve high system efficiency.
- The MPQ2179-AEC1's high 2.4MHz switching frequency ($f_{SW}$) reduces inductor size, avoids the AM radio band, and reduces interference on the automotive radio band.
- The MPQ2167A-AEC1 comes in a small (3mmx3mm) package, and its operating frequency can be configured with external resistors up to a maximum of 2.2MHz. Additionally, the device integrates rich protection functions, including cycle-by-cycle OCP, output short-circuit protection (SCP), input UVP, and output over-voltage protection (OVP).

### *Backlight Drive Scheme*

The X9H can support up to four channels of full HD display. The backlight driver chip is required for screen lighting and dimming. Consider the MPQ3364-AEC1, a boost WLED driver with a 2.2MHz maximum operating frequency, 150mA maximum driving current per channel, and can support up to a 50V maximum output voltage ($V_{OUT}$) (see Figure 6).

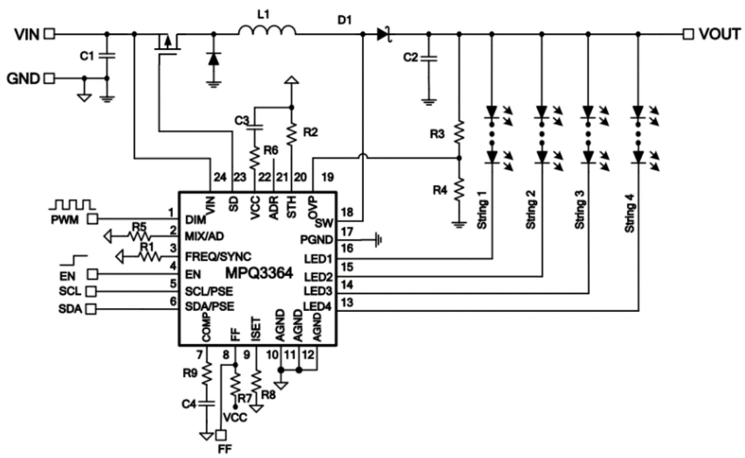


**Figure 6: MPQ3364-AEC1 Typical Application Block Diagram**

The features of the MPQ3364-AEC1 are described below:

- Supports an I²C interface with three I²C addresses. This means that the I²C interface can support three chips, which makes it simple to configure more than one device during operation.
- Provides three available dimming modes: pulse-width modulation (PWM) dimming, analog dimming, and mixed dimming (PWM and analog dimming). The dimming method can be selected via external pins; meanwhile, the PWM dimming ratio and analog dimming ratio can reach 15000:1 and 200:1, respectively. This ratio enables users to fine-tune the screen's brightness.
- Supports cycle-by-cycle current protection, LED open-circuit protection and SCP, inductor SCP, output OVP, and over-temperature protection (OTP). Rich, internal protection functions guarantee safe and reliable operation for the backlight drive system.

Figure 7 shows a demonstration of the X9H reference board's multi-screen interactive solution, where the panel is driven by the MPQ3364-AEC1.

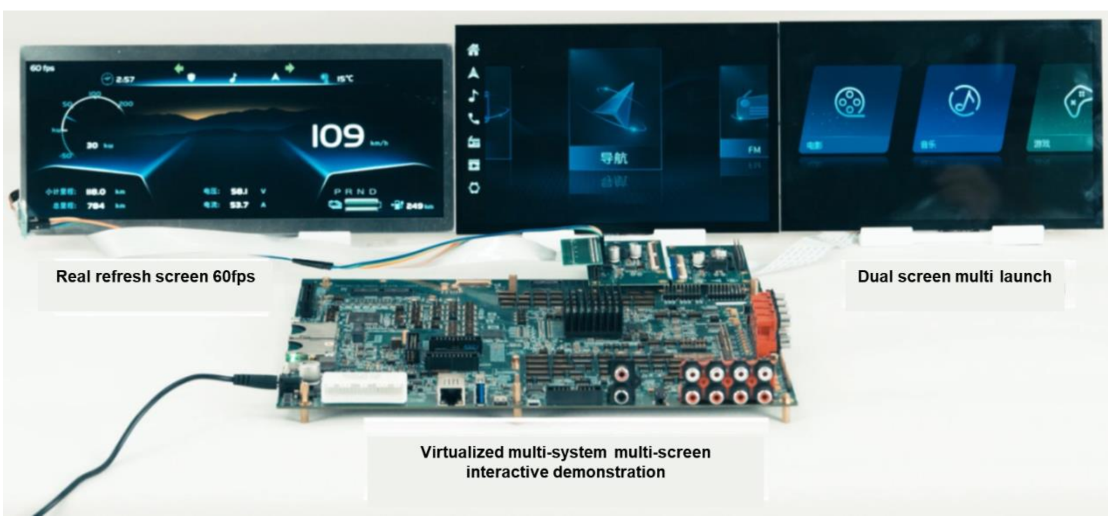


**Figure 7: Multi-Screen Interactive Solution of the X9H Reference Board (Source: Semidrive)**

## Conclusion

The advancement of the automotive smart cockpit's SoC technology will require increased computing power, main frequency, and dynamic response speed. It will also require single-phase and multi-phase solutions with a higher $I_{OUT}$ and additional safety features. These combined factors can present challenges when selecting and designing power chips.

To address these challenges, MPS and Semidrive developed a smart cockpit solution with the X9H reference board. This article then explored a two-level power supply scheme to improve the system's conversion efficiency and support battery voltage fluctuations, in addition to the backlight drive scheme. Based on the ongoing developments in the vehicle power supply industry, MPS continues to innovate and launch products for a competitive portfolio that leads the smart cockpit revolution. To learn more about our automotive-grade products such as the MPQ2179-AEC1, click here.