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TOUCH SCREEN EMI/ESD PROTECTION

INTRODUCTION

The touch screen revolutionized the computing industry user interfaces and user experiences especially after the perfection of multi-touch technology. A major force behind the resurrection of the once sleepy touch screen industry is the spread of touch panels and the benefits they offer in the way of intuitive operation. Since they can be used for input through direct contact with icons and buttons, they're easy for unaccustomed users to comprehend and the ease of usage. Touch panels also permit miniaturization and simplification of devices by combining display and input into a single piece hardware. Since touch panel buttons are software, not hardware, their interfaces can be integrated throughout the usage cycle.

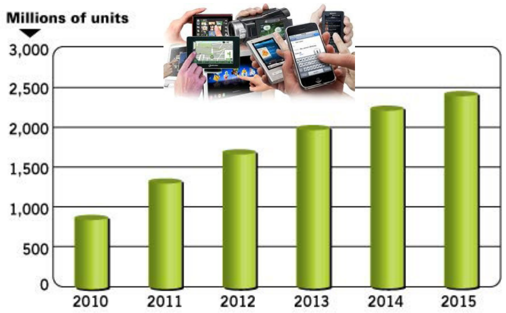

Figure 1. Worldwide Shipment Forecast of Touch-Screen Controller *(SOURCE: IHS iSuppli Research, March 2012)*

Projected capacitive touch screens like those first featured by leading smartphone and tablet manufacturers is as high as 54% of the touch market in 2011. They also will remain the dominant implementation for the space in the years to come, ahead of other touch-sensor technologies like infrared, optical, resistive and surface acoustic wave.

TRENDS IN TOUCH SCREENS

There are five main touch screen technologies: resistive, surface capacitive, projected capacitive, surface acoustic wave, and infrared. In terms of cost and size, the first three suit mobile products. In all cases, the system consists of a sensing mechanism, a control circuit, and an interface to the control circuit. For the purpose of this paper only Projected Capacitive and Resistive Touch Screen EMI/ESD are discussed.

Projected Capacitive Touch Panels

Leading smartphone and tablet manufacturers adopt this method to achieve high-precision multi-touch functionality and high response speed. Projected capacitive touch panels are often used for smaller screen sizes than surface capacitive touch panels. The internal structure of these touch panels consists of a substrate incorporating an IC chip for processing computations, over which is a layer of numerous transparent electrodes is positioned in specific patterns. The surface is covered with an insulating glass or plastic cover. When a finger approaches the surface, electrostatic capacity among multiple electrodes changes simultaneously, and the position were contact occurs can be identified precisely by

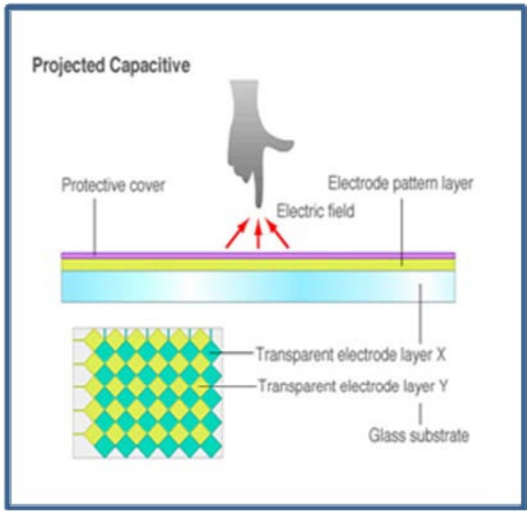

Figure 2. Projected Capacitive Touch Screen

TOUCH SCREEN EMI/ESD PROTECTION

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measuring the ratios between these electrical currents as shown in Figure 2.

A unique characteristic of a projected capacitive touch panel is the fact that the large number of electrodes enables accurate detection of contact at multiple points (multi-touch). However, the projected capacitive touch panels featuring indium-tin-oxide (ITO) found in smart phones and similar devices are poorly suited for use in large screens, since increased screen size results in increased resistance (i.e., slower transmission of electrical current), increasing the amount of error and noise in detecting the points touched.

Larger touch panels use center-wire projected capacitive touch panels in which very thin electrical wires are laid out in a grid as a transparent electrode layer. While lower resistance makes center-wire projected capacitive touch panels highly sensitive, they are less suited to mass production than ITO etching.

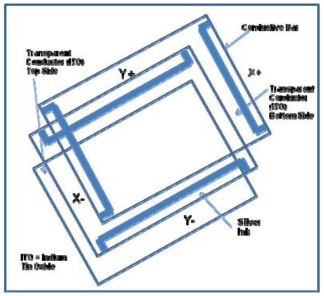
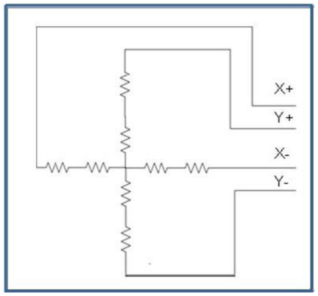


Figure 3. 4-wire Touch Screen Construction



Resistive Touch Panels

A resistive touch screen works by applying a voltage across a resistor network and measuring the change in resistance at a given point on the matrix where a screen is touched by an input stylus, pen, or finger. The change in the resistance ratio marks the location on the touch screen. The two most popular resistive architectures use 4-wire or 5-wire configurations as shown in Figure 3.

A 4-wire touch screen is constructed as shown in Figure 3. It consists of two transparent resistive layers. The 4-wire touch screen panel works by applying a voltage across the vertical or horizontal resistive network. The A/D converts the voltage measured at the point the panel is touched. A measurement of the Y position of the pointing device is made by connecting the X+ input to a data converter chip, turning on the Y+ and Y– drivers, and digitizing the voltage seen at the X+ input.

The voltage measured is determined by the voltage divider developed at the point of touch. For this measurement, the horizontal panel resistance in the X+ lead doesn't affect the conversion due to the high input impedance of the A/D converter. Voltage is then applied to the other axis, and the A/D converts the voltage representing the X position on the screen through the Y+ input. This provides the X and Y coordinates to the associated processor as shown in Figure 4.

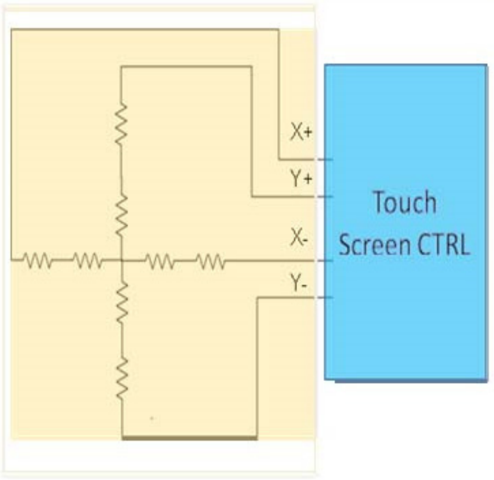


Figure 4. Wire Simplified Schematic

TOUCH SCREEN EMI/ESD PROTECTION

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The benefits of this design is unparallel than other touch screen design; include the low-cost manufacture, due to the simplicity of structure. This design consumes less power and is strongly resistant to external impurity such as dust and water since the surface is covered in film. In addition, input relies on pressure being applied to the film. It can be used for input not just with bare fingers, but even when wearing gloves or using a stylus. These screens can also be used to input handwritten text. Drawbacks include lower light transmittance (reduced display quality) due to the film and two electrode layers. Relatively lower durability and shock resistance. And reduced precision of detection with larger screen sizes. (Precision can be maintained in other ways – for example, splitting the screen into multiple areas for detection.)

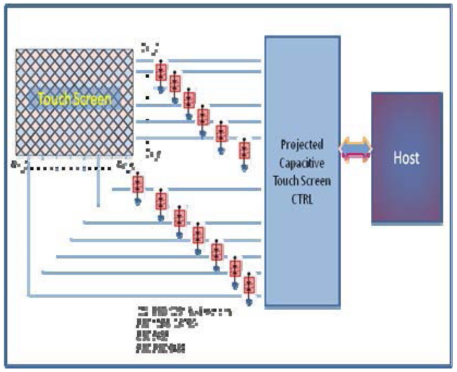


Figure 5. Projected Capacitive Touch Screen with External ESD Protection

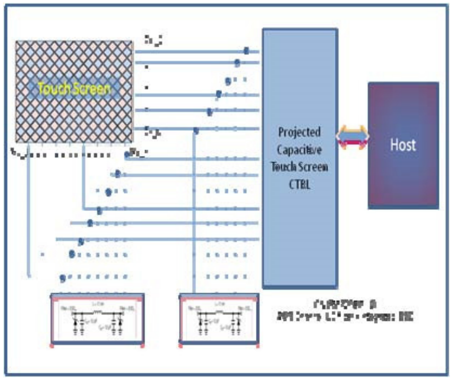


Figure 6. Projected Capacitive Touch Screen withExternal LC Filer + Integrated ESD Protection

The market trend continues to produce thinner mobile devices. This means projected and capacitive touch screens are the designs of choice, as they allow direct lamination of capacitive touch sensors to the display, migration of the sensor inside the display, and so comes with many other challenges of EMI/ESD with antennas, charger and ground loading. Unwanted EMI/ESD is one of the biggest concerns related to capacitive touch screens. This is noise that is physically coupled into the sensor through the mobile device during the touch event. It can be seen as degraded accuracy or linearity of touch, false or phantom touches, or just simply erratic behavior. The culprits include marginal layouts, poor antenna designs, and poor peripherals. These prove to be significant sources of EMI/ESD. With PCB real estate continuing to be at a premium within the mobile device, layouts and designs can sometimes be compromised: components are literally being placed on top of each other. This sometimes leads to antennas being placed in extremely closes proximity to the touch sensors, and can create problems with the radios falsely activating the touch sensor. Common mechanical countermeasures such as metal shields no longer are effective solutions for resolving the EMI problems.

On chip protection solutions for CMOS ICs often include high-voltage suppression circuits on input and output pins. These are active RC shunts which turn on whenever the pad voltage goes outside of the normal operating range. However, the effectiveness is limited by gate oxide thickness and size; as they dissipate high voltage energy, some of that energy is converted to heat can cause a thermal event within the chip itself. In addition, these internal ESD circuits have a maximum allowable current density proportional to their size. In an ESD event, as maximum current density is reached,

TOUCH SCREEN EMI/ESD PROTECTION

CONTINUED

the forward voltage potential across the circuit begins to rise. A highly energetic ESD event can cause this potential to rise above the circuit's maximum allowable forward voltage, causing damage, the IC's internal ESD protection circuits melt or break down (primary failure), and high energy is passed without attenuation to the device's internal circuits, damaging them as well (secondary failure). Because of the speed of the ESD event (most last less than a microsecond), the damage from heating will tend to stay within the local region of the IC's ESD protection circuit. Also, the amount of energy any single protection circuit can carry is directly proportional to its size. ESD immunity tests introduce a single, measured amount of energy to the IC. As a result, if that energy can be spread between several protection circuits both internally and external ESD protection circuits the likelihood of damage is greatly reduced. To do this, additional external ESD protection devices are implemented shown in Figures 5 and 6.

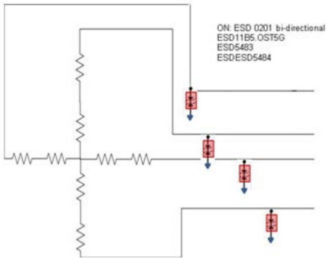


Figure 7. 4-wired Touch Screenwith External ESD Protection

CONCLUSION

Projected capacitive touch screens like those first featured by smartphones will remain the dominant implementation for the space in the years to come, ahead of other touch-sensor technologies like infrared, optical, resistive and surface acoustic wave. Design considered trade offs are a direct function of the die area (and thus product cost) devoted to the internal protection circuits versus the cost of adding extra protection devices outside the capacitive sensing controller for those lines in the system which may be more vulnerable to ESD events. Impedance of the integrated circuit's pin is a significant factor in the usefulness of external ESD protection circuits.

External circuits can be designed to work synergistically with the complex impedance of the IC's pad circuitry and its packaging. The combination can provide an effective level of ESD control that is hard to achieve by using only on-chip, integrated protection circuitry. Levels of ESD protection for CMOS circuits are based on a balance between product cost and expected requirements forprotection in production and end-use. For applications requiring high ESD immunity on some lines, additional external protection can be provided using inexpensive methods by employing single channel ESD protection or low pass filer couple with ESD circuit plastic package.

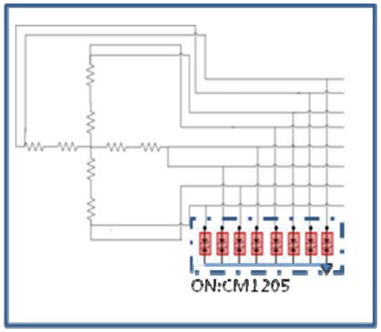


Figure 8. 8-wired Touch Screenwith External ESD Protection

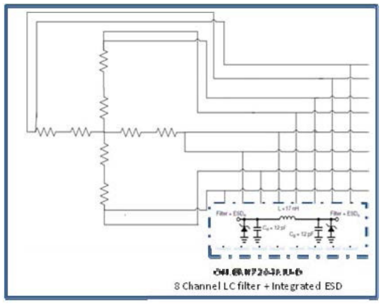


Figure 9. 8-wired Touch Screen with LC Filter + Integrated ESD Protection

TND6233/D

EVALUATING FUNCTIONAL SAFETY IN AUTOMOTIVE IMAGE SENSORS

ABSTRACT

Almost all Advanced Driver Assistance Systems (ADAS) both today and in the foreseeable future are built primarily on machine vision to drive the decision process. With the rapid proliferation of ADAS solutions and the introduction of the ISO 26262 safety standard for passenger vehicles, functional safety considerations for those imaging systems becomes paramount. The manner in which safety measures are implemented and verified can have significant impact to the overall system design including cost, reliability, and complexity. This paper will examine functional safety in the imaging subsystem and it implications to system design.

INTRODUCTION

The first rear view cameras appeared in vehicles as early as 1991, primarily as an aid to safe reversing. In 2004, ON Semiconductor introduced the first CMOS sensor for automotive applications. In the United States the National Highway Transportation Safety Administration (NHTSA) mandated that by May 2018, all new passenger vehicles are required to include back-up cameras. Auto makers are now incorporating increasing levels of autonomy to further improve vehicle safety. As ADAS features like lane keeping assist, adaptive cruise control, and automated braking for collision avoidance evolve into true autonomy, additional cameras are making their way into production vehicles. The primary sensor in almost all ADAS systems is the image sensor. As ADAS systems progress from assistance to automation, the safe operation of the vehicle will depend more and more on the reliability of the imaging subsystem.

Underlying this trend is the fact that to ensure a level of safety in ADAS and autonomous systems, the image sensor becomes a critical component in the system's overall functional safety. With the introduction of ISO 26262, the concept of automotive safety integrity levels has been defined. ASIL levels range from the lowest, ASIL–A (lowest), to ASIL–D (highest). An ASIL level is determined by three factors, severity of a failure, the probability of a failure occurring, and the ability for the effect of the failure to be controlled. This paper will explore the issue of functional safety as it relates to the image sensor as well as to examine failure modes and safety mechanisms that can be implemented to detect, protect, and/or correct image sensor failures. The key metrics that affect the safety performance of the system include detection, delay, efficiency, and effect.

Faults in semiconductor devices arise from a number of causes including cosmic radiation, electromigration, early mortality, and a host of other reasons. It is not the objective of this paper to examine the causes of faults in image sensors, rather it will be to examine the nature of

EVALUATING FUNCTIONAL SAFETY IN AUTOMOTIVE IMAGE SENSORS

CONTINUED

faults, methods of fault detection i.e. safety mechanisms, and the effectiveness of those mechanisms. Here we will also discuss some factors that differentiate fault coverage claims and methodologies.

FUNCTIONAL SAFETY

To implement functional safety in an ADAS system requires that the system prevent or mitigate any action or behavior that could cause harm. The assessment of the probability of harm and the severity of that harm caused by a failure in the system allows system designer to classify levels of risk the system and to take appropriate measures to minimize the risk.

Often this requires fundamental changes not only in the development process, but also in the corporate safety culture ranging from organization structure to safety roles/officers and safety documentation, manuals, and standards. Responsibility for functional safety compliance in a system involves not only the ADAS supplier, but the entire supply chain from OEM to ADAS supplier to component providers. For robust functional safety, all key safety relevant components in the system must contribute to the overall functional safety, specifically, that safety starts at the source.

In order to minimize the risk caused by a particular failure, the system designers must, of course, identify possible failure modes that could affect the safety of the vehicle and determine an appropriate action to mitigate the risk. A key part of this process is the identification of all components that could impact the safe operation of the system. For each such component, an analysis of every possible failure mode must be made to determine whether a given failure mode might contribute to a failure in the system. Once the failure modes have been identified, mechanisms can be implemented to detect, correct, and/or protect the system from, a given failure.

The specific implementation of safety mechanisms for a given system has a tremendous impact on the cost, reliability and complexity of the solution, as well as its effectiveness at mitigating the risks to the system. Various levels of safety mechanisms can be implemented that range from simple fault detection and reporting, to mechanisms that protect from the occurrence of faults all the way to actually correcting a fault that has already occurred. A careful and balanced selection of system components can contribute to a more optimized and efficient implementation.

In order to further consider the concept of functional safety, a definition of failure must be made. In the case of ADAS, we can generally accept that a failure is any condition that causes the system to make an incorrect or even less than optimal decision. Examples of undesired decisions include late braking, over-steering, false object identification, or unintended acceleration.

IMAGE SENSORS AND THE ADAS APPLICATION

Image sensors are a core component of an ADAS system and the primary source of all vision system data. They provide the raw data which the rest of the system uses to analyze the environment and then make operational decisions in the vehicle. In effect, image sensors are the eyes of the autonomous vehicle. Other sensors like radar and lidar may also be used, but the primary source of data are the image sensors. In addition to the sensors, other components

EVALUATING FUNCTIONAL SAFETY IN AUTOMOTIVE IMAGE SENSORS

CONTINUED

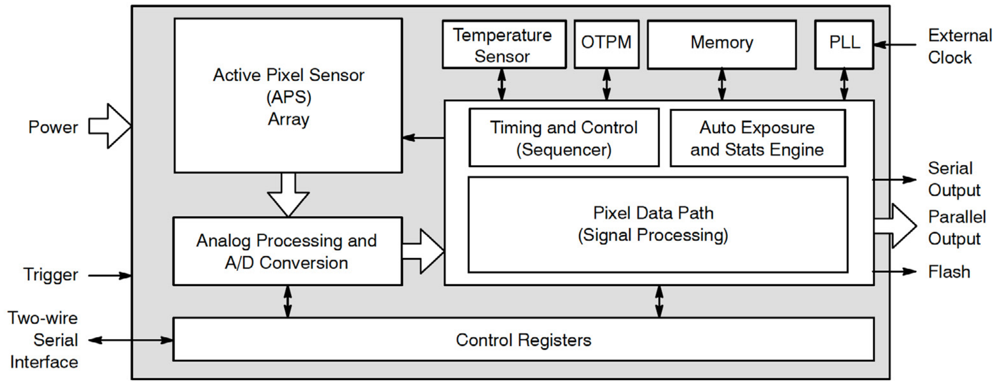
in the ADAS system include components that perform the functions of image processing, analysis and decision making.

As stated previously, the number of image sensors in a typical ADAS system is rapidly growing. From a single forward looking camera, to full surround view systems, the number of cameras in a vehicle can be anywhere from one (1) to over ten (10). The effect of failures in the sensor depend on the nature of the failure and can range from insignificant to critical. The ability for a system to detect, protect and correct individual failures in the image sensor have significant ramifications to the overall safety and reliability of the system.

At its core, a CMOS image sensor is a rectangular array of photo-sensitive pixels organized in rows and columns. These pixels convert the incident light into voltage or current with a per-pixel analog circuit. The current/voltage is then converted into digital values, typically in a row-by-row order. Additional digital logic enables the data to be stored, processed, and transmitted to other devices in the system for subsequent processing and analysis.

The data captured by the image sensor in an ADAS application is typically used by the system to make decisions that affect the operation of the vehicle. As ADAS systems have increased in complexity, these decisions have advanced from generating simple audible and visual warnings, to much more complex decisions including braking, acceleration and steering, and in the future will progress to completely autonomous driving. These advances in autonomous and semi-autonomous vehicles places increasing reliance on the image sensor and it safe operation.

Figure 1. Block Diagram of a Typical Image Sensor



FAILURES IN IMAGING APPLICATIONS

A very conservative view of a failure in an image sensor would be to define an unsafe fault as any output that differs from a “fault-free” model or known-good device output as shown by the diagram below. At a granular level, this would imply that errors even at the pixel level could constitute a failure. At higher levels, row, column and frame errors could also constitute a failure. Implied are any problems in the internal operation of the device, either analog or digital, that could manifest themselves as pixel, row, column, or frame errors. Finally, errors in the physical transmission of data from the sensor to the rest of the system present another potential cause for failure. Due to the dynamic nature of video, faults can be both static, e.g. permanent or fixed, and dynamic, both spatially and temporally.

CLICK HERE for the complete technical note

AND8181/D

TVS DIODE SELECTION GUIDELINES FOR THE *CAN* BUS

INTRODUCTION

The Controller Area Network (CAN) is a serial communication protocol designed for providing reliable high speed data transmission in harsh environments. This document provides guidelines to select Transient Voltage Suppression (TVS) diodes to protect CAN data bus lines. TVS diodes provide a low cost solution to conducted and radiated Electromagnetic Interference (EMI) and Electrostatic Discharge (ESD) noise problems. The noise immunity level and reliability of CAN transceivers can be easily increased by adding external TVS diodes to prevent transient voltage failures.

UP2105L *CAN* BUS *TVS* DIODE ARRAY

The NUP2105L provides a transient voltage suppression solution for CAN data communication lines. The NUP2105L is a dual bidirectional TVS device in a compact SOT−23 package. This device is based on Zener technology that optimizes the active area of a PN junction to provide robust protection against transient EMI surge voltage and ESD. Figure 1 provides a circuit diagram of the NUP2105L.

The NUP2105L has been tested to EMI and ESD levels that exceed the specifications of popular high speed CAN networks. Listed below is a summary of the NUP2105L's EMI and ESD specifications:

- 350 W Peak Power Dissipation per line, (8 x 20 s)
- Human Body Model ESD protection, 16 kV
- IEC−61000−4−2 ESD level, 30 kV for contact discharge
- ISO 7637−1, nonrepetitive EMI surge pulse 2, 9.5 A (1 x 50 s)
- ISO 7637−3, repetitive Electrical Fast Transient (EFT) EMI surge pulses, 50 A (5 x 50 ns)
- IEC 61000−4−5 lightning and load switch immunity, 10 A (8 x 20 s)

The NUP2105L uses silicon semiconductor technology to offer distinct advantages over alternative TVS protection devices such as MOVs and choke filters. A TVS diode provides a fast response time, low line capacitance and low clamping voltage. The NUP2105L has a time response time of less than 1.0 ns and is able to clamp fast surge transient voltages before damage can occur. The silicon design has a line capacitance less than 30 pF, which is required for the high 1.0 MHz data transmission rate. The voltage clamping limit of the device, defined by the 8 x 20 s exponential waveform, is approximately equal to 42 V for a surge current of 10 A. The low clamping voltage ensures that the transient sure voltage will not exceed the CAN transceiver's maximum voltage specification for the CAN_H and CAN_L data lines.

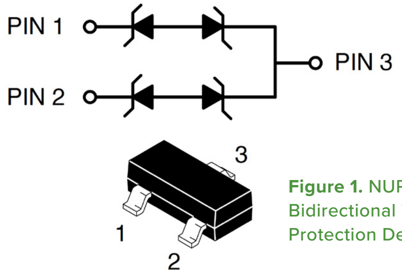


Figure 1. NUP2105L Bidirectional TVS/ESD Protection Device

TVS DIODE SELECTION GUIDELINES FOR THE CAN BUS

CONTINUED

Figure 2 provides an example of a typical CAN bus protection circuit. The circuit provides protection for the CAN_H and CAN_L data lines by clamping the surge voltage to a level that will not damage the CAN transceiver. Further details on CAN protection circuits are provided in reference (1).

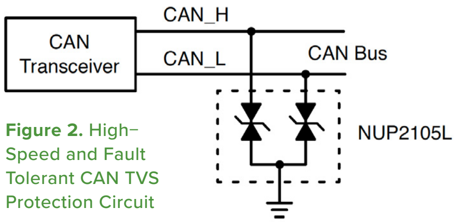


Figure 2. High–Speed and Fault Tolerant CAN TVS Protection Circuit

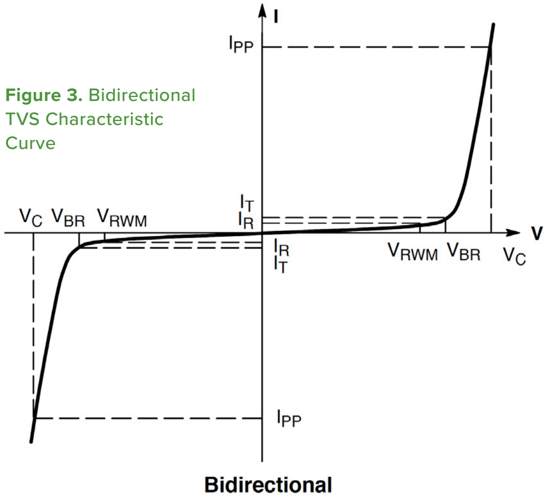
TVS DIODE TERMINOLOGY

The first step in selecting a TVS diode device is to define the device parameters. Figure 3 provides a graphical definition of the bidirectional TVS diode parameters.

The key TVS parameters are:

1. **Reverse Working Voltage (V_{RWM})** is defined as the maximum DC operating voltage. At this voltage the device is in a non–conducting state and functions as essentially a high impedance capacitor. V_{RWM} is also known as the stand–off voltage.
2. **Reverse Breakdown Voltage (V_{BR})** is the point where the device conducts in an avalanche mode and becomes a low impedance. The breakdown voltage is typically measured at a current of 1.0 mA.
3. **Maximum Clamping Voltage (V_C)** is the maximum voltage drop across the diode at the maximum peak pulse current.
4. **Reverse Leakage Current (I_R)** is the current measured at the reverse working voltage.
5. **Test Current (I_T)** is the current where the breakdown voltage is measured.
6. **Peak Pulse Current (I_{PP})** is the maximum surge current specified for the device.

Figure 3. Bidirectional TVS Characteristic Curve



TRANSCEIVER SPECIFICATIONS

There are several CAN transceiver specifications that must be evaluated in order to select an appropriate TVS diode. The critical transceiver characteristics include:

1. Maximum supply voltage
2. Common mode voltage
3. Maximum transmission speed
4. ESD
5. EMI Immunity
    a. Coupled Electrical Disturbance on the Data Lines
        i. Nonrepetitive Surge
        ii. Repetitive Surge / Electrical Fast Transient (EFT)

Table 1 provides a summary of the system requirements for a CAN transceiver. The ISO 11898–2 physical layer specification forms the baseline for most CAN systems.

TVS DIODE SELECTION GUIDELINES FOR THE CAN BUS

CONTINUED

The transceiver requirements for the Honeywell Smart Distribution Systems (SDS) and Rockwell (Allen–Bradley) DeviceNetE high speed CAN networks are similar to ISO 11898–2. The SDS and DeviceNet transceiver requirements are similar to ISO 11898–2; however, they include minor modifications required in an industrial environment.

MAXIMUM SUPPLY VOLTAGE

The TVS diode V_{RWM} and V_{BR} should be greater than the maximum system supply voltage because the transceiver must be immune to an indefinite short between the battery power lines and CAN signal lines. In addition, some applications often have unique short duration maximum supply voltage specifications. For example, some 12 V automotive systems have the provision of allowing a jump start from a 24 V battery. The minimum VRWM and VBR of the NUP2105L are specified at 24 V and 26.2 V, respectively.

The NUP2105L has a nominal VBR of 27 V which is measured with a 1.0 mA, 1.0 ms pulse test current. The TVS's Zener technology produces a breakdown voltage characterized with a sharp knee and very low leakage current. The sharp knee of the NUP2105L provides predictable device performance over potential system deviations. Figure 4 shows the VBR versus IT characteristics of the NUP2105L over a temperature range of −55°C to +150°C.

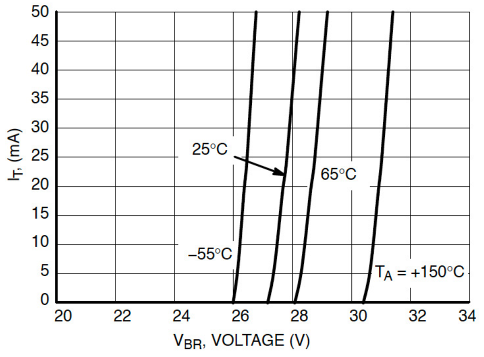


Figure 4. V_{BR} versus $_{IT}$ Characteristics of the NUP2105L

TABLE 1. TRANSCEIVER REQUIREMENTS FOR HIGH–SPEED CAN NETWORKS

Parameter	ISO 11898–2	SDS Physical Layer Specification 2.0	DeviceNet
Min / Max Bus Voltage (12 V System)	–3.0 V / 16 V	11 V / 25 V	Same as ISO 11898–2
Common Mode Bus Voltage	CAN_L: –2.0 V (min) 2.5 V (nom) CAN_H: 2.5 V (nom) 7.0 V (max)	Same as ISO 11898–2	Same as ISO 11898–2
Transmission Speed	1.0 Mb/s @ 40 m 125 kb/s @ 500 m	Same as ISO 11898–2	500 kb/s @ 100 m 125 kb/s @ 500 m
ESD	Not specified, recommended ≥ ±8.0 kV (contact)	Not specified, recommended ≥ ±8.0 kV (contact)	Not specified, recommended ≥ ±8.0 kV (contact)
EMI Immunity	ISO 7637–3, pulses 'a' and 'b'	IEC 61000–4–4 EFT	Same as ISO 11898–2
Popular Applications	Automotive, Truck, Medical and Marine Systems	Industrial Control Systems	Industrial Control Systems

COMMON MODE VOLTAGE

The common mode voltage specification is required because there can be a significant difference in the voltage potential between the ground reference of the transmitting and receiving CAN nodes. The CAN transceivers must be able to function with a signal line voltage that can be offset by as much as 2.0 V above or below the nominal voltage level of the CAN_H and CAN_L signal lines.

TVS DIODE SELECTION GUIDELINES FOR THE CAN BUS

CONTINUED

A solution to the common mode problem is to use bidirectional TVS devices that will not clamp if the voltage at the signal lines is offset.

MAXIMUM TRANSMISSION SPEED

The CAN data transmission rate determines the maximum capacitance of the TVS device. A large capacitance on the data lines causes distortion in the signal waveforms. The distortion on the data lines is minimized by selecting a low capacitance TVS device. It is recommended that the maximum capacitance of the protective network measured from each signal line to ground should be less than 35 pF for 1.0 Mbits/s and 100 pF for 125 kbits/s.

The capacitance versus bias voltage relationship of the NUP2105L is shown in Figure 6. The capacitance between the signal lines and ground was measured by varying the DC bias, at a frequency of 1.0 MHz and peak−to−peak amplitude of 60 mV. A diode's data sheet specifies the maximum capacitance at a bias voltage of 0 V; however, the average voltage of the data lines will provide a more accurate estimation of the capacitive loading. The average DC voltage of the high−speed and fault tolerant CAN transceivers can be estimated to be equal to the recessive voltage of 2.5 V. The typical capacitance of the NUP2505L is approximately 19 pF at 2.5 V.

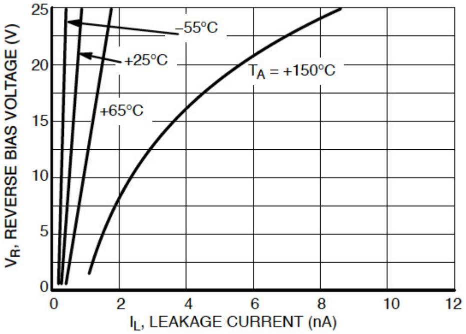


Figure 5. I_R versus Temperature Characteristics of the NUP2105L

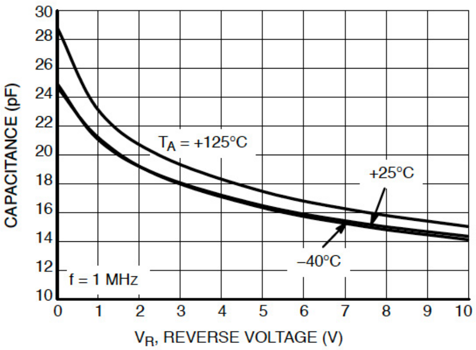
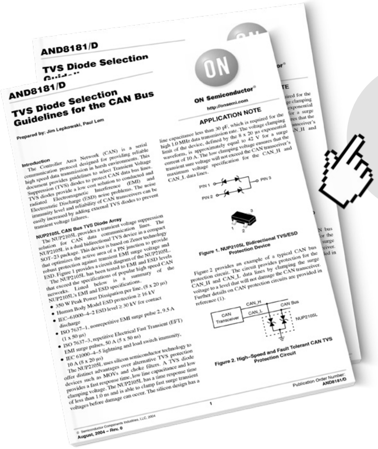


Figure 6. Capacitance versus V_R Characteristic of the NUP2105L

CAN EMI IMMUNITY TESTS

Background

Electromagnetic Compatibility (EMC) has become a major design concern for network products. Designers are being challenged to include EMC protection, without incurring a size and cost penalty. CAN modules must be must be compliant with strigent EMI standards and operate without either becoming effected by or adversely effecting the operation of neighboring units. CAN networks must have good noise immunity because the data lines are a major source and entry point for both conducted and radiated EMI and ESD.


AND8181/D

TVS Diode Selection Guidelines for the CAN Bus

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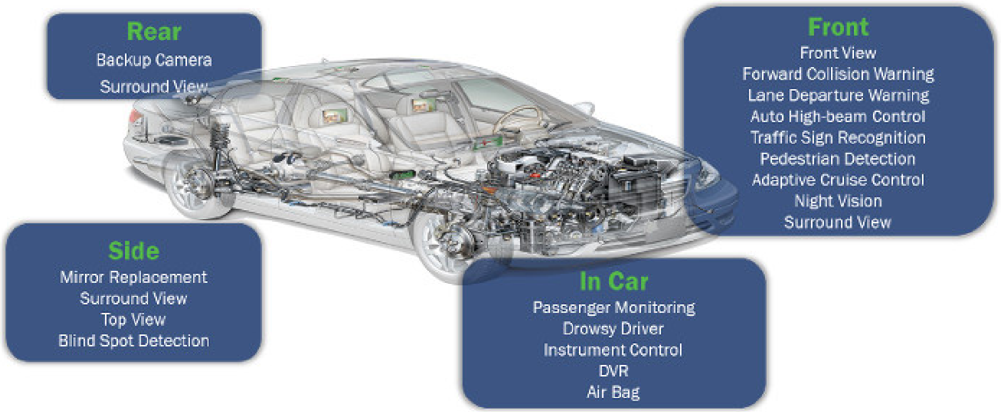
for the complete technical note

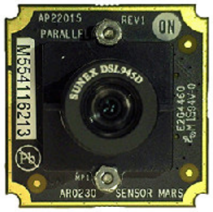
BLOG POST

OPTIMIZING THE AUTOMOTIVE CAMERA DEVELOPMENT PHASE USING A MODULAR DESIGN APPROACH

AS THE AUTOMOTIVE INDUSTRY progresses rapidly toward fully autonomous vehicles, the number and varieties of imaging cameras are increasing. Various camera applications include backup, surround view, forward facing Advanced Driver Assistance Systems (ADAS), Camera Mirror Replacement Systems (CMS), and driver monitoring. Amazingly, some vehicles are already being equipped with more than twelve image sensors.



Each individual camera has its own unique features ranging from different resolutions, optical formats, Color Filter Arrays (CFA), lens types, Automotive Safety Integrity Level (ASIL) functions and transmission protocols. Dramatic market growth combined with multiple camera types makes streamlining development imperative.



While the industry in general provides sufficient tools to evaluate cameras in a laboratory setting, it often leaves designers ill-equipped to develop in real-world scenarios. At present, automotive Original Equipment Manufacturers (OEM), Tier 1's and Tier 2's, and Independent Software Vendors (ISV) spend tens to hundreds of thousands dollars in the camera design phase. A modular compact development system with the flexibility to adapt to the required application and the ability to easily mount on the vehicle has the potential to dramatically reduce cost, make resources more efficient and improve time-to-market.

Understanding this, ON Semiconductor has created an innovative development tool called the Modular Automotive Reference System (MARS). MARS is capable of mixing and matching the various imaging components and transmission protocols using standard boards and connectors. It consists of set of miniature 25mm2 boards with each board containing one or more of the major imaging components in the system.

OPTIMIZING THE AUTOMOTIVE CAMERA DEVELOPMENT PHASE USING A MODULAR DESIGN APPROACH

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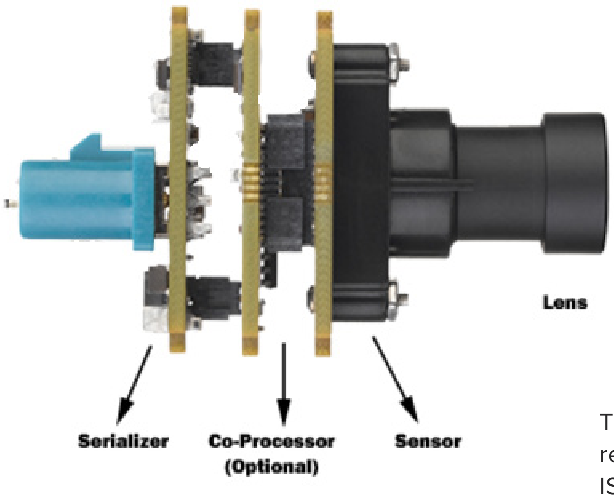


Basic Configuration of MARS

Every single automotive qualified image sensor (or SoC) from ON Semiconductor has a MARS board, meaning that designers can interchange this board nearly seamlessly to test all of our automotive sensor types. All of the boards can be mixed and matched to the automotive imaging system design team's desire. The component boards have consistent signal/power interconnect definitions to enable users to swap individual boards, creating a wide range of options for experimenting, while eliminate the need for constructing custom boards.

The imaging industry almost universally recognizes ON Semiconductor's sensor/ISP evaluation tool, called Devware, as best-in-class. Using a matching deserializer, and adapter the designer can use our world-class evaluation tools in the real-world by mounting the miniaturized MARS camera boards to the vehicle. Additionally, if the designer has an existing ECU system they can connect the MARS camera directly. Since MARS uses known vendors and transmission standards, bring-up time for the camera requires little to no effort.

MARS bridges the gap between laboratory and real-world development. It's a complete development system capable of truly optimizing the automotive camera design.

HELPFUL LINKS
FOR MORE INFORMATION:

watch the Introduction to MARS webcast

CLICK HERE to configure your product with the MARS product recommendation tool.

BLOG POST

AUTONOMOUS DRIVING – GETTING IT RIGHT BEFORE HANDING OVER THE KEYS

RELINQUISHING HUMAN CONTROL of the car on a mass scale is, for sure, a major step to take. There are emotional/human acceptance as well as technical barriers to overcome. Succeeding in the latter needs to be based on a huge amount of data, proving and validation. Accumulating all of this through physical, 'on the highway' testing alone will take a long time and likely slow the realization of the widespread adoption of autonomous cars and other vehicles. Interestingly, large amounts of proving of the effectiveness and safety of autonomous driving technology, with the right publicity, should also help address the human apprehension element – especially for those with many years and a love of 'hands-on' driving.

The time it takes to gather real-world data from autonomous vehicles on the road is why tools such as NVIDIA's DRIVE™ Constellation – an open, cloud-based platform that can perform bit-accurate simulation for large-scale, hardware-in-the-loop testing and validation of autonomous vehicles – are so important. The viability and success of such platforms in supplementing and corroborating real-world testing for the proven, safe and earlier realization of driverless cars, is dependent upon collaboration with specialists in specific technologies that are cornerstones to the implementation of autonomous vehicles.

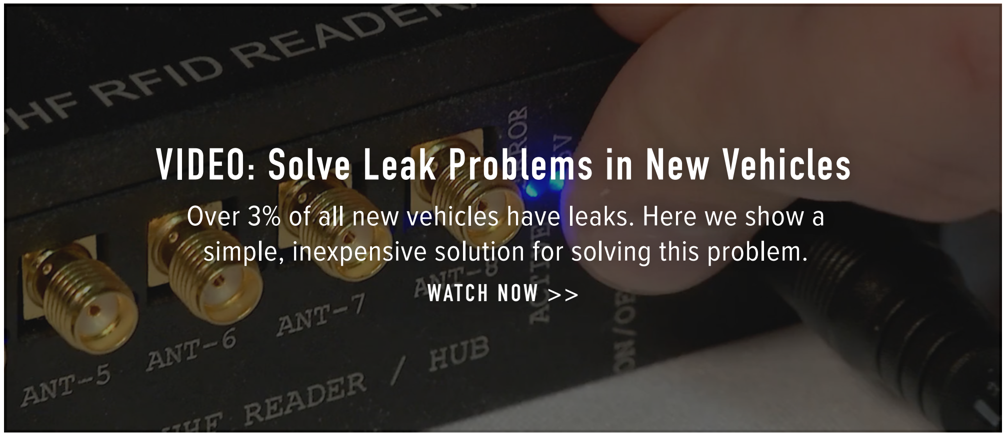
AUTONOMOUS DRIVING – GETTING IT RIGHT BEFORE HANDING OVER THE KEYS

CONTINUED

ON Semiconductor, with its leading image sensor knowhow and technologies, is one such company. Its recent announcement of an agreement to work with NVIDIA underlines its reputation and will see the company's CMOS image sensor modelling technology being used as a primary function to simulating real-world sensor performance within the DRIVE Constellation.

The image sensor model receives both scene information and control signals from the DRIVE Constellation to calculate and output a real-time image based on the inputs. It then transmits the simulated image back to the DRIVE Constellation for processing. The complex sensor model will utilize all critical parameters in the path to provide an accurate output of a real-world image sensor.

The changes to our everyday lives could be massive, as too will be the effect on the safety and environmental impacts of getting from A to B for millions across the globe. The 'virtual proving' provided by tools such as NVIDIA's DRIVE Constellation and supported by collaborators such as ON Semiconductor, will benefit those engaged in the ground-breaking work to take autonomous driving from concepts under test to mainstream reality.



VIDEO: Solve Leak Problems in New Vehicles

Over 3% of all new vehicles have leaks. Here we show a simple, inexpensive solution for solving this problem.

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WANT MORE?

Check out the Avnet Automotive Blog for more resources about autonomous driving, sensor performance, and more!

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AND9708/D

AUTOMOTIVE IMAGING POWER ARCHITECTURE AND DESIGN

INTRODUCTION

Imaging system input and intermediate voltages play a critical role in total system efficiency, performance, and component selection. Proper selection of these voltages depend on multiple system variables, such as: total power consumption of the image sensor/ISP, regulator efficiency, and resistance of the coax cable and filter. This document discusses the trade–offs associated with changing module input voltages, so that informed design–decisions can be made in optimizing automotive imaging modules.

SYSTEM POWER OVERVIEW

Power Transfer

In an automotive imaging system, power and data are combined and transferred to remote parts of the vehicle over a single coaxial cable. This implementation is known as “Power over Coax” (POC). From a power standpoint, the two main figures of merit for this stage are:

1. Conduction Losses

$$P_{loss}\left(I_{in}{}^{2}\right)\left(R_{coax} + 2R_{DCR}\right)$$

2. DC Voltage Drop

$$V_{drop} = \left(I_{in}\right)\left(R_{coax} + 2R_{DCR}\right)$$

Both of these concerns are factors of the DC transfer current, DCR of the filter inductors at each coax connector, and coaxial cable resistance. Higher currents contribute to higher power losses and larger DC voltage drops. Moreover, a large enough DC voltage drop could induce under voltage–lockout in downstream regulators and shut down the system.

Decreasing the transfer current (Iin) will minimize both conduction losses and the DC voltage drop, however, in order to decrease the transfer current, the voltage transmitted over the coaxial cable must be increased to maintain the same amount of

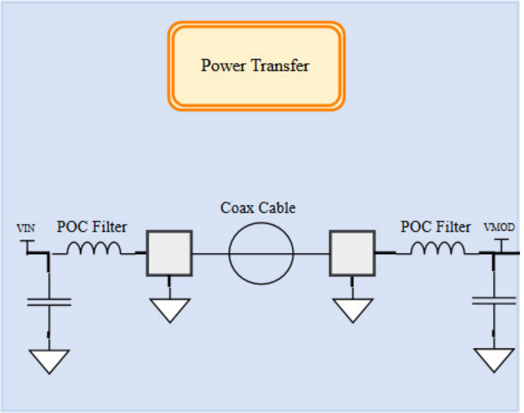
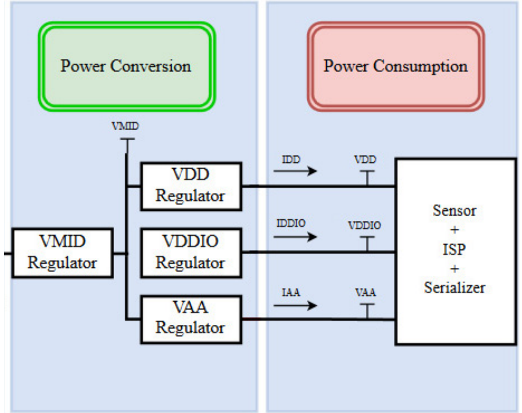


Figure 1. General Overview of an Automotive Imaging System Organized into Three Section



AUTOMOTIVE IMAGING POWER ARCHITECTURE AND DESIGN

CONTINUED

transferred power. This is not always ideal, as increased coaxial voltage will lead to more losses in the power conversion of the image sensor module.

Power Conversion

Integrated circuits in automotive imaging systems (Image Sensors, Image Processors, SERDES links) normally utilize the voltages 2.8 V, 1.8 V, and 1.2 V. Because of these multiple, low–voltage rails, it is necessary to convert down from a single higher coaxial voltage. The primary power concern in this stage is voltage conversion losses. These losses can be quantified as:

$$P_{loss} = \sum_{i = 1}^{n} P_i\left(\frac{1}{\eta_i} - 1\right)$$

Where η_i is regulator efficiency, and Pi is the regulator's output power. Given a constant output power, the loss is a factor of regulator efficiency. Furthermore, in both switching and linear regulators, efficiency is a factor of input/output voltage ratio (Vin/Vout). The larger the ratio, the worse the efficiency.

Lowering the VIN/VOUT conversion ratio of each regulator will minimize power conversion losses. Because the output voltages are defined by the image sensor, this ratio can be decreased by lowering the input voltage to the power conversion stage. Unfortunately, decreasing the input voltage will increase the transfer current, resulting in larger power transfer losses.

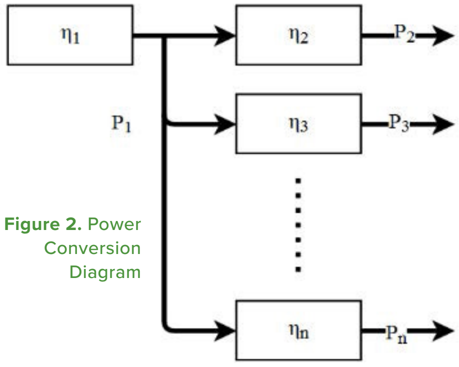


Figure 2. Power Conversion Diagram

Transfer Loss Component factors

- Inductor DCR
- Coaxial Series Resistance
- Coaxial Connector Resistance

The trade–off between transfer and conversion losses must be considered when choosing the proper input voltage. Optimally designed power architectures select an input voltage that results in the lowest total power loss. Again, both transfer and conversion losses are factors of component parameters.

Conversion Loss Component Factors

- Regulator Efficiency at specific Vin/Vout ratio
- Voltage Conversion Topology

SYSTEM PERFORMANCE

Altering the system's input voltage can pose performance risks to the system if the effects are not properly realized. A changing input voltage alters the transfer current levels which affects voltage regulator transients, filter performance, and dark current generation.

Transient Impact

Increased coaxial current consequently increases voltage transients seen at the input of the Vmid Regulator. Large enough transient events could impact the regulator's ability to maintain regulation, or even impact the AC data traveling along the coaxial line. To mitigate the effect of these increased transients, sufficient capacitance should be placed on the input of the Vmid Regulator.

AUTOMOTIVE IMAGING POWER ARCHITECTURE AND DESIGN

CONTINUED

Signal Integrity

Another side–effect of larger coaxial current is the need for larger POC filter inductors. The POC filter is required to prevent the AC coaxial data from reaching the input of the Vmid regulator. If the inductors of the filter are not properly sized, the higher currents could saturate the inductors and lead to degradation of the AC signal integrity, or even lose PLL (Phase Lock Loop) locking of the serialized communication.

Dark Current Temperature Variation

Dark current negatively impacts image quality by altering the black level or reference point of the image sensor. Dark current is also highly temperature dependent; larger temperatures near the sensor lead to larger levels of dark current. Minimizing the heating at or around the image sensor is essential in minimizing dark current levels, which in turn ensures proper image quality. Dark Current generation is reduced by limiting power dissipation in voltage regulators near the image sensor. Ideally, dissipated system power should be remote to the image sensor such as the coaxial cable or filter. Within compact designs, lower conversion voltages and higher coaxial currents are preferred as because it minimizes heating around the image sensor, which reduces image sensor dark currents.

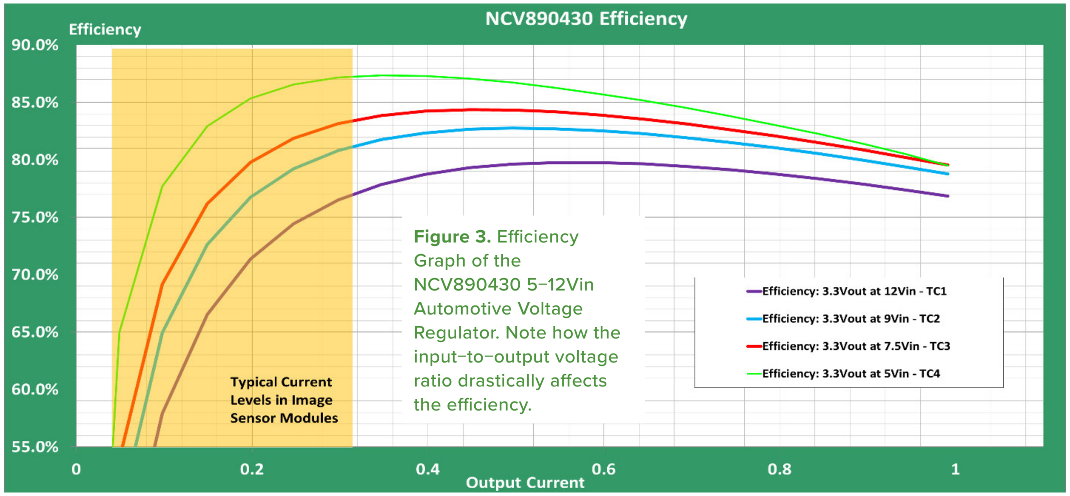


Figure 3. Efficiency Graph of the NCV890430 5–12Vin Automotive Voltage Regulator. Note how the input–to–output voltage ratio drastically affects the efficiency.

CLICK HERE for the complete technical note

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