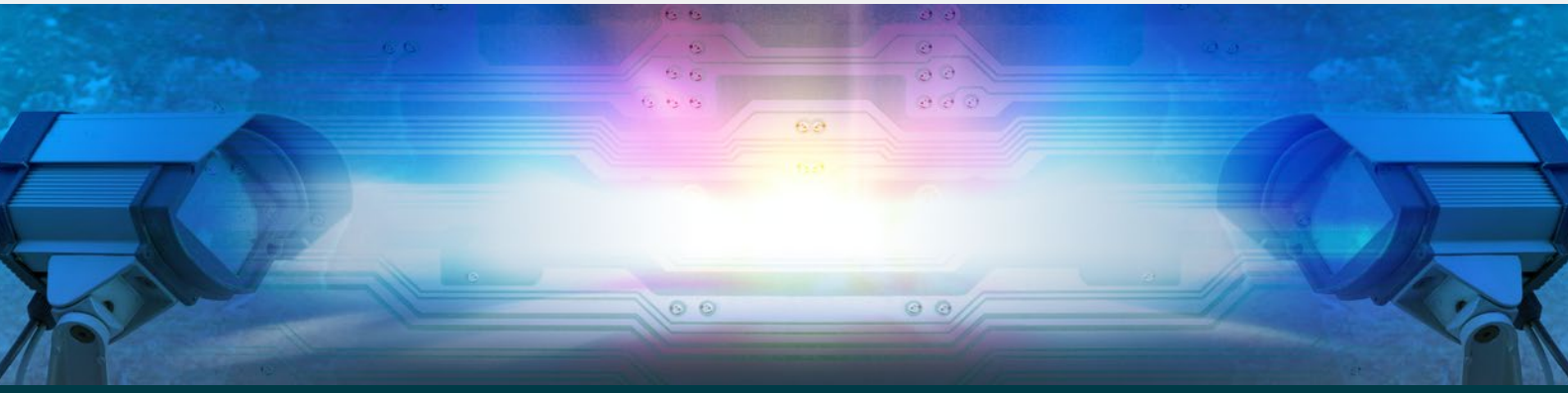

Components that Enhance Video Surveillance Reliability

WHITE PAPER

BACKGROUND

The video surveillance industry has experienced tremendous growth over the past several years, driven in part by the advances in communications and Information Technology (IT). As wireless networks, high-speed data transfer, and compact hardware have advanced and become mainstream, video surveillance systems that previously were cost-prohibitive are now viable and useful additions in a wide range of applications. Because many of these systems will be operated remotely and may be installed outside of structures, it is crucial that they provide reliable operation regardless of environmental conditions. Therefore, electronic components for these surveillance systems must help ensure this reliability giving careful consideration to power, energy consumption, extended temperature and size requirements. Video surveillance system design is further challenged to meet fundamental or real-time functionality, while safeguarding against overcurrent and overvoltage surges.

Components that Enhance Video Surveillance Reliability

VIDEO SURVEILLANCE SYSTEM BASICS

A video surveillance system can be broken down into four main blocks: control, measurement, power conversion and communications. The control portion of the design consists of Human-Machine Interface (HMI) controls. The measurement block must address the complementary Machine-Machine Interface (MMI) position feedback sensors as well as current sensing, while power conversion handles power rectification, power conditioning and filtering, and protection from overvoltage and overcurrent conditions. Depending on the application or type of equipment, port protection of the communications block must comply with a variety of communication standards. The components that go into each of these blocks play a critical role behind the scenes of the application, acting as the foundation for the performance and protection of the system. This paper will introduce the component technologies available that meet the critical function requirements for each of these blocks.

CHANGING THE FRAME OF VIDEO SURVEILLANCE

Several driving forces are extending video surveillance beyond its common security use. Advancements in technology are making it easier for video surveillance to be deployed more universally through the capture of high-quality images and their seamless transmission using a variety of data transfer protocols. Standards organizations such as the Open Network Video Interface Forum (ONVIF), Physical Security Interoperability Alliance (PSIA) and HDcctv Alliance are expanding their influence on the market, defining specifications, parameters and expectations for video systems. Improvements in digitization, integration and wireless technology are driving the market forward. Expansions in connectivity bandwidth and the pervasive internet are driving the capabilities now available for intra-office and inter-building connections.

Building Automation Systems (BAS), is one area that can benefit from using video surveillance. For example, active management analytics allow building owners, facilities managers and others to continuously monitor the HVAC and lighting efficiency of a building equipped with BAS. Video surveillance analysis for BAS emphasizes a field terminal over a centralized terminal approach. This model can be extended to building and public area security systems, which play an important role in fighting crime. Video surveillance systems can expand to be combined with biometric systems that track, for example, the unique physical traits of individuals. These applications depend on the highest levels of reliability and accuracy.

ADDRESSING RELIABILITY REQUIREMENTS

Because a video surveillance system is expected to be resilient and operate nonstop in a variety of environments, it should not fail from an electrical or transient surge incident. Therefore, early design decisions regarding circuit protection components are important. Testing to UL, surge, and reliability compliance standards further ensures that reliability needs are met.

The video surveillance system must also be energy-efficient. Power management requirements can be met with low loss magnetics, trimmers, shunts, and overvoltage and overcurrent circuit protection. Rugged position sensors help address the need to meet high reliability operation in harsh environmental conditions. In addition, to meet low power and space-constrained application requirements, component package sizes must be compact. Component miniaturization using Surface Mount Technology (SMT) solves the growing need for more integrated solutions and helps to reduce the Bill of Materials (BOM) costs.

CONTROL AND MEASUREMENT BY HUMANS AND MACHINES

The control portion of the video surveillance system uses two types of components, namely panel controls and trimmers, as a means for Human to Machine Interface (HMI). Whether the system is digital or analog should have no impact on the user, though this choice determines which components are used on the design side. A rotary encoder is used to produce a digital output signal related to the absolute or incremental angular position of its shaft. Designs that require precision position sensing, high resolution, or fast data acquisition tend to use encoders. Available with contacting, optical and magnetic technology, the encoder is chosen based on the cost and performance requirements of the application. If an analog output is desired, single and multiturn panel controls and sealed trimmers are used. The number of turns and the type of package desired are factors in determining the type of analog control. Bourns can help developers with customization options and off-the-shelf products that offer a vast range of features to ensure that the chosen panel control or trimmer conforms to the application.

Measurement is twofold, in that it must provide measurements both mechanical and electrical in nature. The MMI position feedback sensors indicate the mechanical position and provide such information to a processing unit. This allows the video system to be adjusted as necessary. The mechanical feedback is provided by contacting and non-contacting feedback sensor technologies. Whether analog or digital, a Bourns® sensor can be chosen from an extensive lineup and customized as necessary to fit the application. To provide precise electrical values, custom shunt resistors are used to sense current in power conversion and motor control circuits for Pan, Tilt and Zoom (PTZ) control. This current sensing requires low resistance values with tight tolerances, low inductance and a low Temperature Coefficient of Resistance (TCR). To handle harsh environments, the current sense resistor must have a high peak power rating and high temperature rating. Bourns offers a variety of open air shunts and metal strip surface mount current sense resistors that meet these criteria.

SUPPORTING AN EFFICIENT POWER SYSTEM

The power system utilizes a wide array of components for rectification, conditioning and filtering, and for overcurrent and overvoltage protection. Transformers, inductors, power chokes, diodes, pulse power resistors, ferrite beads, metal oxide varistors, resettable fuses, gas discharge tubes, and single blow fuses are among the components that are found in this portion of the design. Power rectification uses bridge rectifiers, Schottky diodes and high voltage, fast response rectifier diodes, depending on the voltage and current necessary for the design. Bridge rectifiers are available in 200 V – 800 V over the current range of 800 mA – 1 A. Schottky diodes are for lower voltages, 20 V – 100 V and higher current, 1 A – 3 A. A good solution is the use of high voltage, fast response rectifier diodes, which offer a large voltage range of 50 V – 1000 V with the same 1 A – 3 A current range as the Schottky diodes.

Ferrite beads and inductors are used for power conditioning and filtering. Ferrite beads filter out high frequency signals to help prevent interference with the rest of the circuits on a board or at an interface. Shielded or unshielded surface mount power inductors in a variety of shapes and sizes also are used for power conditioning and filtering in video surveillance power design.

Providing optimal solutions for efficient power system design are the Bourns® Model SDR, SRR, SRU, and SRN series inductors. The Bourns® Model SDR series inductors are non-shielded surface mount components with numerous models in square, oval and round shapes. Shielded inductor models ideal for video surveillance power circuits include those in the SRR series, which can handle high current, and the SRU series. Bourns® Model SRN series is made up of semi-shielded inductors. Inductors from these four series are ideal at input or output of DC-DC converters and also can be used in power supplies for portable communication equipment or standalone electronics. Among these inductors are options with low profile packages suitable for designs with height and space constraints.

Deciding between shielded and unshielded inductors for a particular design requires taking into account the environment of the circuit board and characteristics of the application. In many situations, the noise generated by a non-shielded inductor can interfere with the reliable behavior of the rest of the circuitry. This often is the case when microcontrollers or high frequency components are used in neighboring circuits or within the board assembly. For such situations, a shielded inductor is typically the better choice.

SUPPORTING AN EFFICIENT POWER SYSTEM (*Continued*)

Once a decision between shielded and unshielded components is reached, size, shape, inductance, and current rating are the biggest differentiators within each family. For example, an oval SDR model is available with current rated up to 16 A, but a round SDR model combines a lower current rating with a higher inductance of 15,000 µH. The SRN series inductors offer a balance between shielded and unshielded benefits by providing approximately 85 % of the shielding and taking up much less space when compared to a shielded inductor. Table 1 contains the size (where Outer Diameter is given for length and width of the round shape), inductance range, and current of the Bourns® Model SDR, SRR, SRU and SRN series of inductors.

Table 1. | *Characteristics of Bourns® Inductors Used for Power Conditioning and Filtering*

Family	Shielded	Shape	Models	Length (mm)	Width (mm)	Height (mm)	Inductance (µH)	Current (A)
SDR	No	Rectangle	7	5.8 - 12.7	4.5 - 12.7	2.2 - 4.8	1 - 10,000	0.08 - 7
SDR	No	Oval	4	6.6 - 22	4.5 - 15	4.5 - 7	0.68 - 10,000	0.07 - 16
SDR	No	Round	8	3 - 13 (OD)	3 - 13 (OD)	2.5 - 7	1 - 15,000	0.06 - 9.5
SRR	Yes	Square	21	3.8 - 12.7	3.8 - 12.7	1.2 - 8.5	0.47 - 15,000	0.07 - 20
SRR	Yes	Oval	4	10.5 - 18.3	8 - 14	3 - 6.8	1 - 3,300	0.1 - 4.5
SRU	Yes	Octagon	23	2.8 - 10	2.8 - 10	0.9 - 4.8	0.8 - 1,000	0.15 - 8
SRN	Semi	Square	7	3 - 10	3 - 10	1 - 4.5	0.5 - 4.70	0.28 - 10

COMPLEMENTARY TRANSIENT PROTECTION

Video surveillance cameras are often mounted on streetlight poles or outside of buildings, exposing them to harsh conditions such as wind, water, lighting, or other environmental variables. Transients from lightning strikes and other surges can introduce overvoltage and overcurrent conditions that could damage video surveillance equipment. It is necessary to include protection in the power block of the design and several components are used in combination for highly effective protection against unsafe voltage and current levels.

Overvoltage protection is necessary to battle damaging surge conditions, and a combination of clamping and crowbar technologies is offered. Power Transient Voltage Suppressor (PTVS) and Transient Voltage Suppressor (TVS) diodes operate by rapidly moving from high impedance to a non-linear resistance characteristic that clamp surge voltages in the presence of excess current. The PTVS diode is used for a higher range of 3 kA – 15 kA current. TVS diodes and TVS diode arrays are rated for use on lower current lines. Bourns offers TVS diodes in small CDDFN10, CDSOT23, CDSOT236 and CDSOD323 packages, which are ideal candidates for use in video surveillance equipment.

Another effective overvoltage protection component is the Metal Oxide Varistor (MOV). The current of this voltage-dependent resistor increases exponentially with increasing voltage. In clamping surges, the MOV absorbs a substantial amount of the surge energy. These devices range in size from 7 mm – 20 mm, providing reliable protection in a workable footprint.

A Gas Discharge Tube (GDT) is frequently found in power overvoltage protection designs. This high impedance gas-filled device creates a short circuit under surge conditions and returns to a high impedance state after the surge. For power overvoltage protection* in video surveillance equipment, Bourns® offers GDT devices in a wide range of voltages and current ratings. GDTs should be selected based on the expected exposure conditions of the circuit. For installations requiring heavy duty surge performance, Models 2047, 2061 and 2063 offer multi-strike current handling capabilities in the range of 40-60 kA on an 8/20 µs surge current waveform. In addition, high voltage GDT series such as the 2097 and SA2 series can support system voltages requirements from 1 kV up to 7.2 kV.

**….GDT used in DC power circuits must be selected so that the maximum expected follow-on current can be extinguished. GDT used in AC circuits must be paired with other technologies such as MOV that will limit follow-on current and extinguish the GDT after operating. Please contact Bourns for further information on the proper selection and use of GDT in power applications.*

COMPLEMENTARY TRANSIENT PROTECTION (*Continued*)

Overcurrent protection, which is the other challenge, begins with a Polymer Positive Temperature Coefficient (PPTC) device, such as a Bourns® Multifuse® PPTC device. The Bourns® Multifuse® PPTC is a thermistor with negligible resistance, so it remains essentially invisible to the circuit in normal operating conditions. It reacts to an increase in current during a surge by dramatically increasing its resistance to create an open circuit. Once the surge has cleared, power can be cycled to restore the Bourns® Multifuse® PPTC device close to its original value and resume normal operation of the circuit. This resettable overcurrent protection is available with current ratings ranging from 50 mA – 14 A. The model MF-RM is ideal for use in video surveillance applications, with a line voltage rating of up to 240 V_{rms} and a current rating of up to 550 mA.

When resettable protection is not required, a single-use fuse such as a Bourns® SinglFuse™ Thin Film Chip Fuse can be used. This device maintains low resistance and low inductance during normal operation. A SinglFuse™ device heats up during a surge event until the temperature on the element exceeds its melting point, after which the device converts to an open circuit. Fast acting and slow blow options are available over the current range of 500 mA – 7 A. SinglFuse™ devices must also be derated to ensure the correct value is chosen.

High performance or especially sensitive systems can benefit from a Bourns® TBU® High-Speed Protector (HSP). Bourns® TBU® HSP devices are resettable, silicon based components that react to an overcurrent situation by restricting current to less than 1 mA, while blocking out-of-range voltages. These TBU® HSPs react in nanoseconds to the overcurrent condition. The TBU® HSP will greatly reduce the energy let-through to the sensitive node being protected.

DISTRIBUTING THE VIDEO IN THE SYSTEM

Numerous communications standards are used in video surveillance systems. To simplify the process of selecting a particular port protection solution, Bourns provides single-page PortNote® Solutions that include an overview of the port type, a proven circuit and a set of components. As video surveillance systems and communications ports evolve, Bourns® PortNote® Solutions are valuable reference resources for designers using a variety of protocols. The components for the various ports are listed in table 2.

Ethernet is a common communications protocol that has several variations based on speed and power and thus several protection schemes. Standard Ethernet protocols utilize 2 V digital signals on a 125 MHz clock. In indoor, short-cable applications where Electrostatic Discharge (ESD) is the primary threat, TVS diode arrays are used to protect the port from ESD events. Power over Ethernet (PoE) interfaces combine data and 48 V DC to provide remote power to a powered device. One solution provides ESD and overcurrent protection for the powered device unit using TVS diodes and diode arrays, transformers and bridge rectifiers. Another solution provides ESD and overcurrent protection for the Powered Sourcing Equipment (PSE) unit using TVS diode arrays, transformers and Bourns® Multifuse® PPTC Resettable Fuses.

One popular protocol in industrial and other environments that requires a high reliability data interface is RS-485. In video surveillance applications, RS-485 is used to allow computers and remote controllers to control camera or CCTV movements such as zoom, tilt, rotate or pan functions. RS-485 is a balanced data transmission scheme that operates with voltage levels from -7 V – +12 V at data rates up to 10 Mbps. A suggested solution for protecting this port against ESD, EFT and power and surge faults uses TBU® HSPs, MOVs, TISP® Thyristor Surge Protectors, and TVS diodes. Another protocol that is popular in video interfaces and standardized by the Society of Motion Picture and Television Engineers (SMPTE), is the Serial Data Interface (SDI). High-Definition SDI (HD-SDI) is standardized in SMPTE 292M and operates at a nominal data rate of 1.485 Gbps. Combining TBU® HSPs, GDTs and TVS diodes provides lightning surge protection for these high-speed ports. This often is needed in the outdoor and high-exposure environments in which they are used.

DISTRIBUTING THE VIDEO IN THE SYSTEM (*Continued*)

Universal Serial Bus (USB) interfaces have been popular with consumer and industrial customers for many years. USB 2.0 ports provide up to 480 Mbps data transfer rates and 5 V power up to 500 mA. The newer USB 3.0 standard is emerging to provide greatly increased data transfer rates of up to 5 Gbps and 5 V power up to 900 mA. As a hot-pluggable interface, USB typically requires protection against ESD and short circuits. Multifuse® PPTC resettable fuses and ChipGuard® ESD protection devices combine to provide this protection in USB 2.0. USB 3.0 uses Multifuse® PPTC resettable fuses and TVS diodes.

Table 2. | *Products Covered in Bourns® PortNote® Solutions for Port Protection*

Part	Ethernet	Ethernet PoE	RS-485	HD/SD/SDI	USB 2.0	USB 3.0
TBU® High-Speed Protectors	Optional		PortNote® Solution	PortNote® Solution		
TVS Diodes/Arrays	PortNote® Solution	PortNote® Solution	PortNote® Solution	PortNote® Solution		PortNote® Solution
TISP® Thyristor Surge Protectors			Optional		PortNote® Solution	
Metal Oxide Varistors			PortNote® Solution			
Gas Discharge Tubes			Optional	PortNote® Solution	PortNote® Solution	
ChipGuard® ESD Suppressors	Optional					
Transformers	Optional	PortNote® Solution				
TCS™ High-Speed Protectors	Optional					
Multifuse® PPTC Resettable Fuses					PortNote® Solution	PortNote® Solution
Bridge Rectifiers		PortNote® Solution				

PROTECTING FASTER GIGABIT ETHERNET SYSTEMS

As data transmission rates increase, Gigabit Ethernet (GbE) is becoming a leader in video surveillance. This high-speed interface can take advantage of high performance Bourns® TCS™ High-Speed Protector (TCS™ HSP) technology to protect the sensitive GbE PHY chip. Bourns® Model TCS-DL004-250-WH significantly reduces the current seen by the GbE PHY signal inputs. After the initial peak, the current is reduced by approximately 90 %.

The Bourns® Model TCS-DL004-250-WH also isolates the PHY inputs from the voltage across the TVS diode. Its ESD protection and the current determine the peak PHY input voltage through the TCS-DL device. In this case, the voltage level is reduced by over 50 %. The full solution is shown in figure 1, featuring Bourns® Model TCS-DL004-250-WH HSP with generic BAV99S clamp diodes to supply and ground and Bourns® Model SM51589L Ethernet transformer. The TCS™ HSP features very fast response to transient surge conditions and very low let-through energy. It has low resistance, matched well in the dual-channel device, and offers excellent linearity. The device offers low insertion loss up to at least 6 GHz and has a small Printed Circuit Board (PCB) footprint.

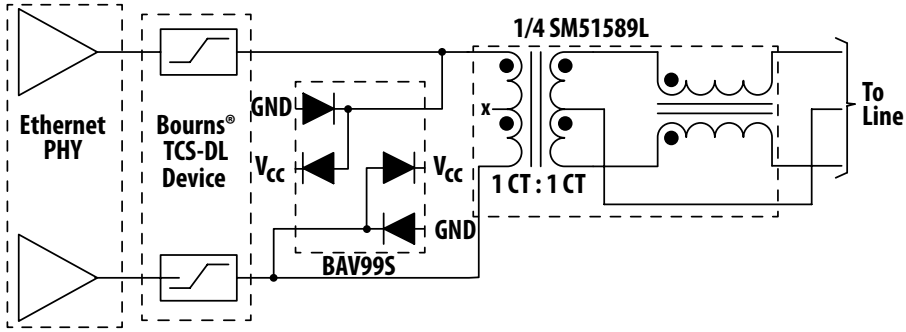

Figure 1. | *Bourns® TCS™ HSP with Generic Clamp Protection*

In addition to the designs in figure 1 and in the PortNote® Solutions, some chipset manufacturers have created reference designs using Bourns® components. A reference design along with layout considerations for transient protection can help designers reliably provide circuit protection against the surge transients the final design must withstand.

COMPONENTS THAT MEET VIDEO SURVEILLANCE SYSTEM DESIGN BLOCK CRITERIA

A collection of components is required to ensure a video surveillance design is reliable and rugged. Size, standards, transition time and tolerance are just a few of the criteria for selecting components for the control, measurement, power and communications portions of the system. Single-phase, low cost, tamper resistance and the availability of custom configurations are just some of the benefits of using resistive shunts for measurement current sensing. Circuit protection components are complementary and when combined properly in a design, they can provide thorough protection for power and communications ports alike. A summary of the components used in the control, measurement, power and communications port blocks of a video surveillance system is provided in table 3, along with the features and benefits of each.

A growing number of video surveillance system applications are now possible with improvements in digitization, integration and connectivity. State-of-the art security systems such as biometric systems, continue to push the envelope. And, video surveillance is becoming more popular in BAS as the benefits are understood and experienced. Proper attention to detail in the design will provide robust, reliable systems that support the growth and expansion of video surveillance systems. Investing the attention at the onset to select the correct components helps to ensure that the power circuits and communications ports remain protected and that control and measurement are accurate over the lifetime of the equipment.

Components that Enhance Video Surveillance Reliability

SUMMARY OF FEATURES

Table 3. | *Summary of Features and Benefits for Components in Video Surveillance Power Conditioning and Filtering, Power Rectification, Port Protection, and Measurement*

Block	Purpose	Component	Feature	Benefit
Power	Power Conditioning/ Filtering	Shielded Inductors	Small Footprint, Wide Range of Inductance	Low EMI
Power	Power Conditioning/ Filtering	Non-shielded Inductors	Small Footprint, Wide Range of Inductance, High Current	Lower Emissions
Power	Rectification	Diodes	Small Footprint, Low Profile	High Peak Inverse Voltage (PIV)
Power	Overcurrent Protection	Multifuse® PPTC Resettable Fuses, TBU® HSPs	Resettable, High-Speed	Low Let-through Energy, Extremely Fast-acting
Power	Overcurrent Protection	SinglFuse™ Thin Film Chip Fuses	Fast-acting, Slow Blow	Small Package, High Reliability
Power	Overcurrent Protection	TVS Diodes, GDTs, TISP® Thyristor Surge Protectors	Standards Compliance	High Reliability
Measurement	Current Sensing	Shunts	Custom Configuration, Low PPM/°C	Ability to Match System, Accurate Revenue-grade Measurements
Communications	Port Protection	TBU® HSPs, MOVs, SinglFuse™ Thin Film Chip Fuses, TISP® Thyristor Surge Protectors, TVS Diodes	Standards Compliance, Reference Design	High Reliability, Tested Solutions, Matched to Chipset

Bourns® PortNote® Solutions for communications interfaces are available online at

http://www.bourns.com/Library.aspx?name=PortNoteSolutions

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