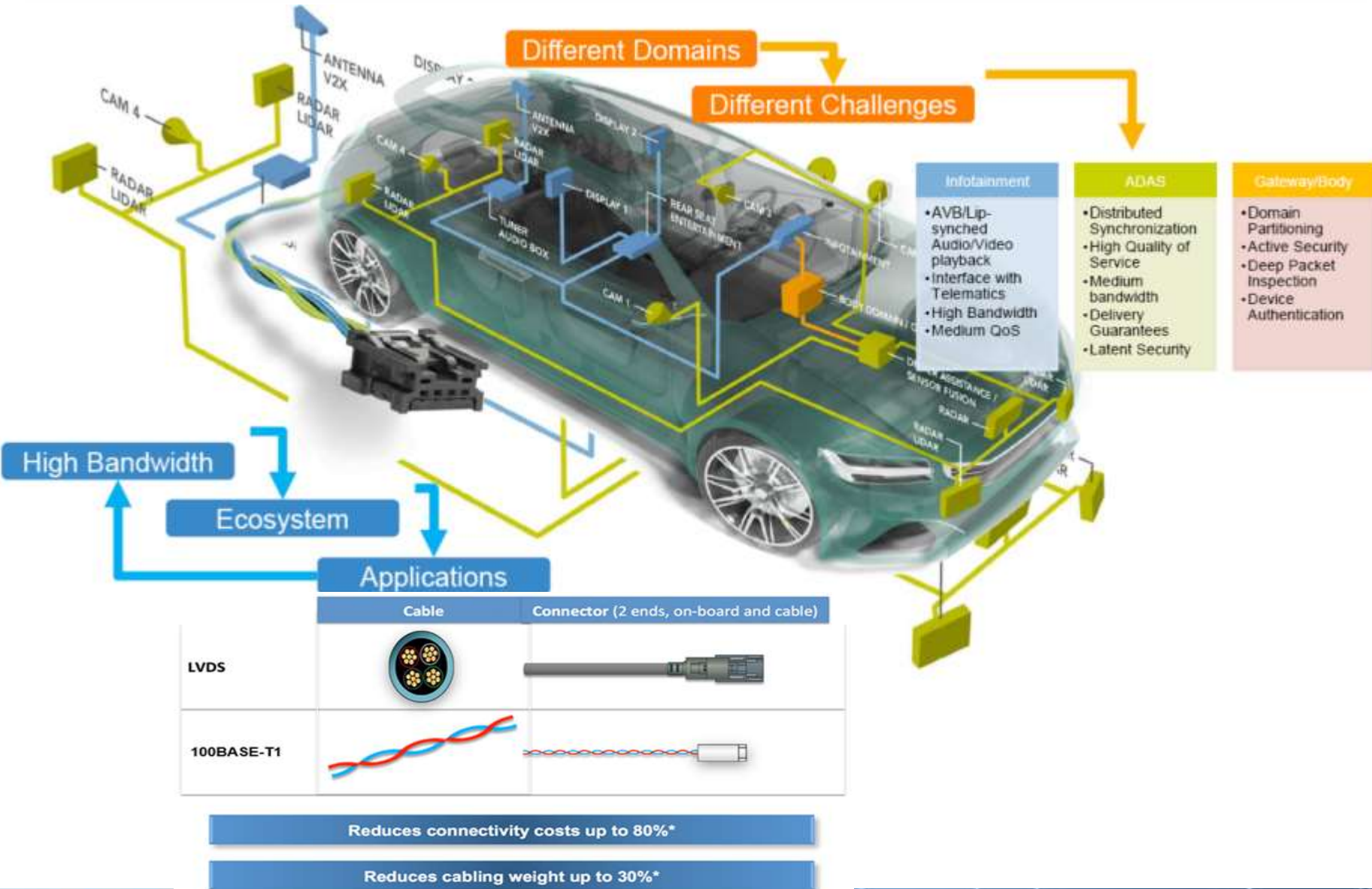


Overview of Automotive Network

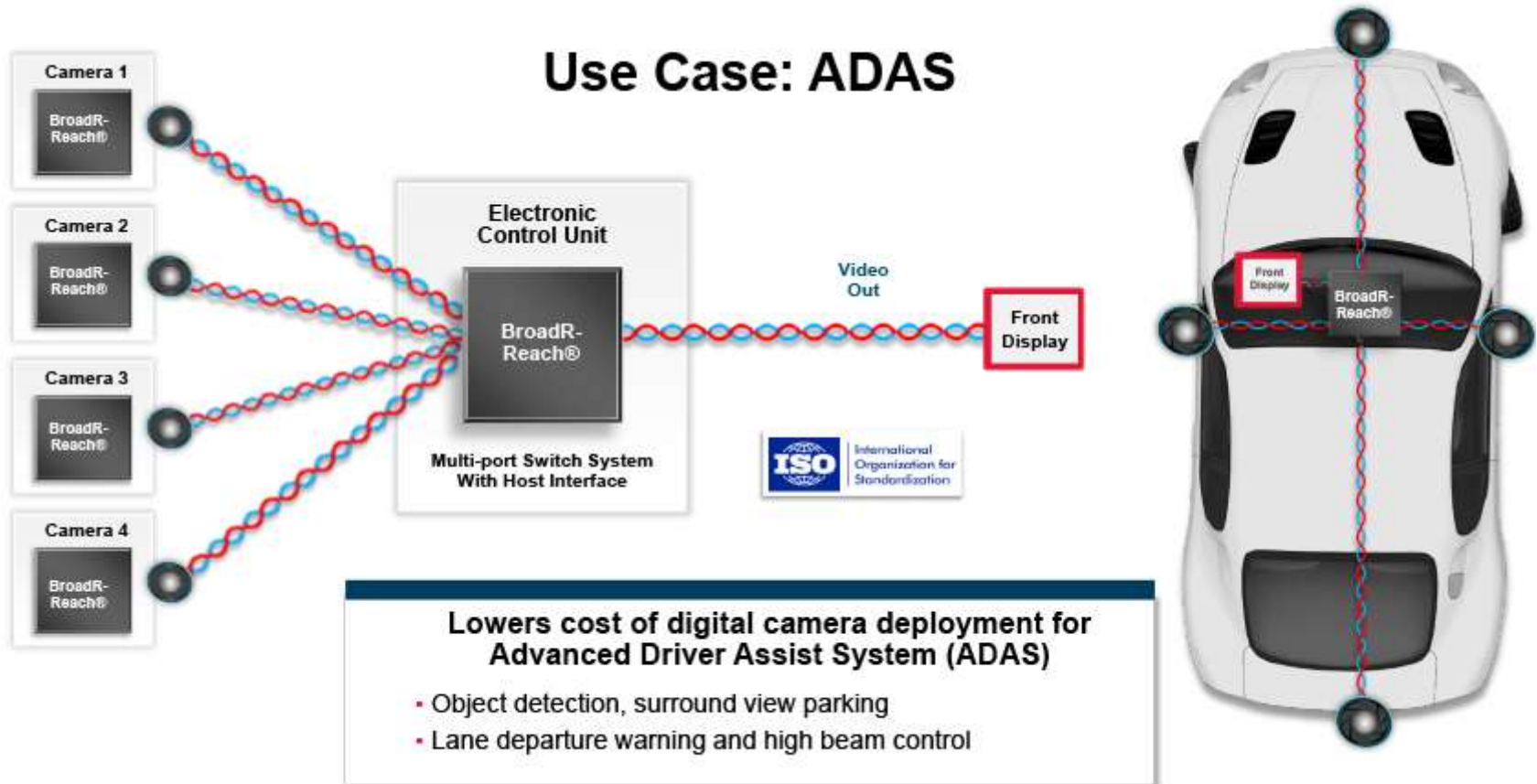
June 27, 2017

BOURNS®

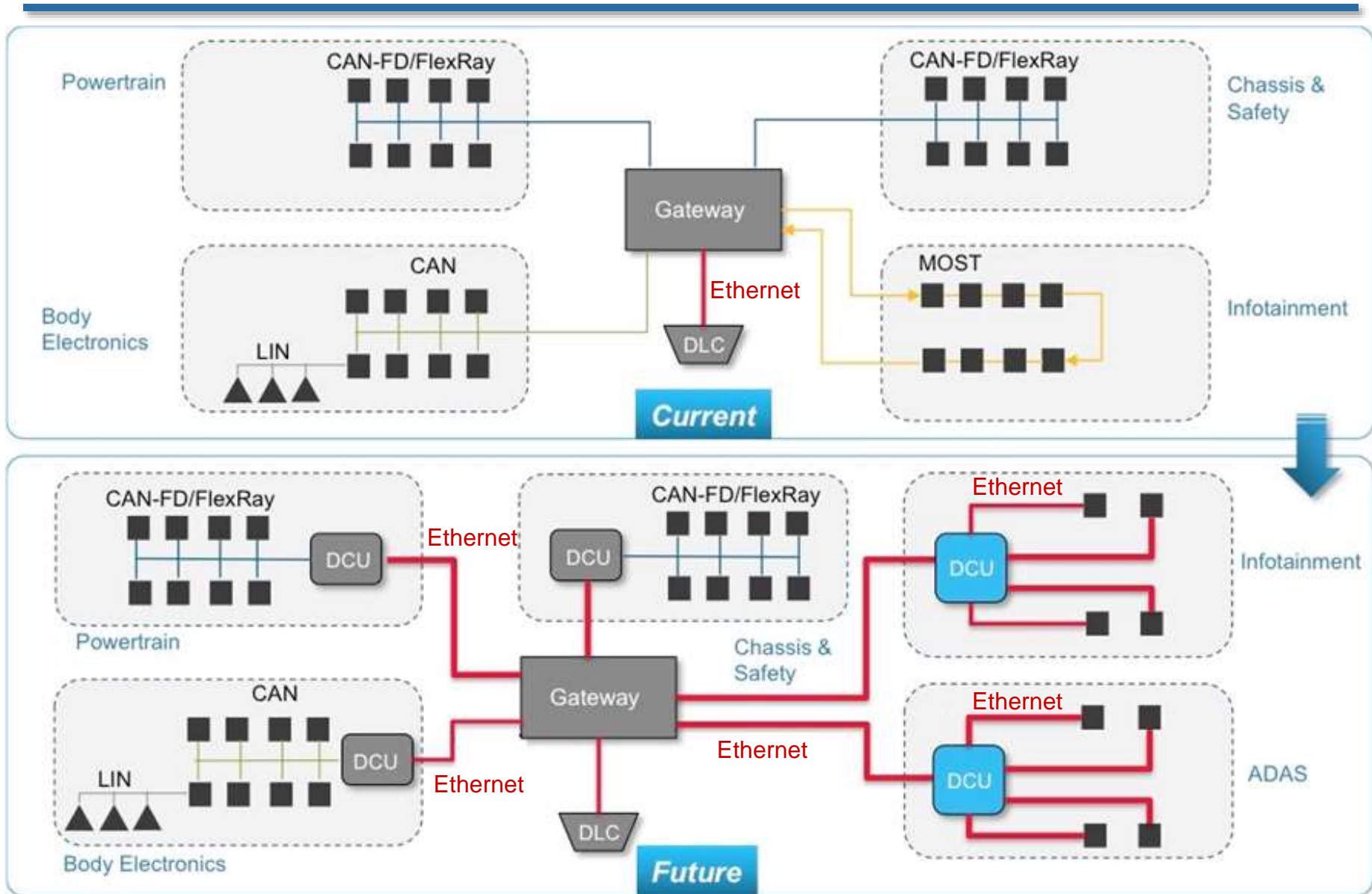
Automotive Ethernet



Design Case

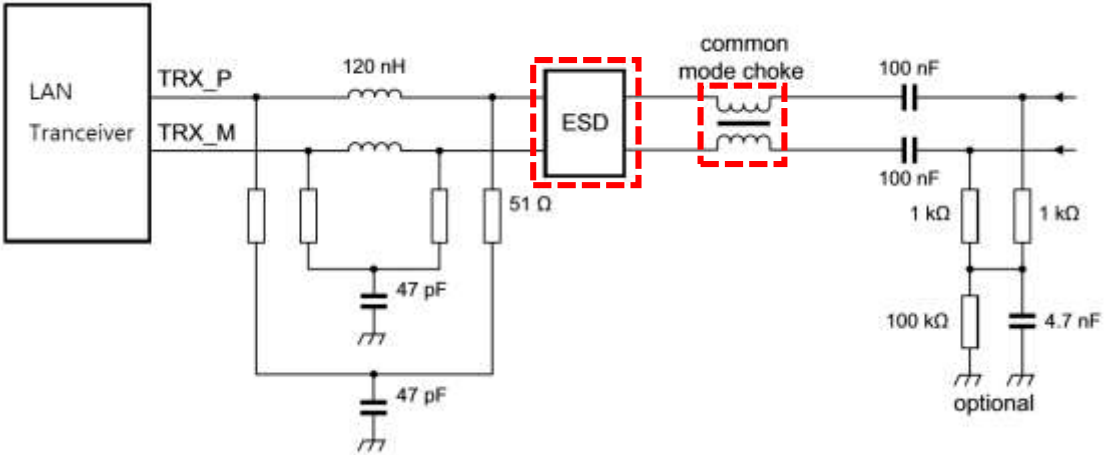
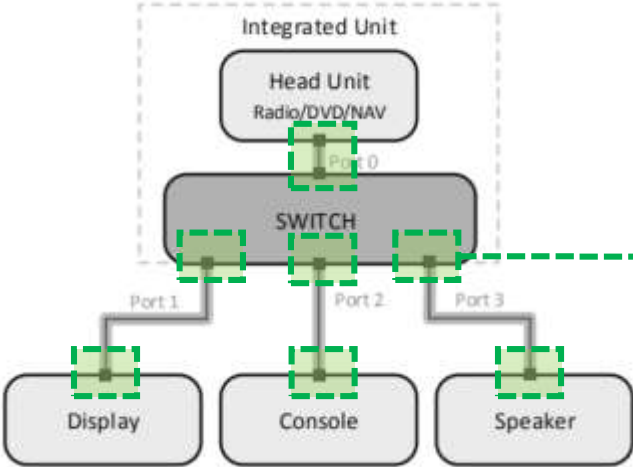


Further Inner Vehicle Network



Automotive Ethernet

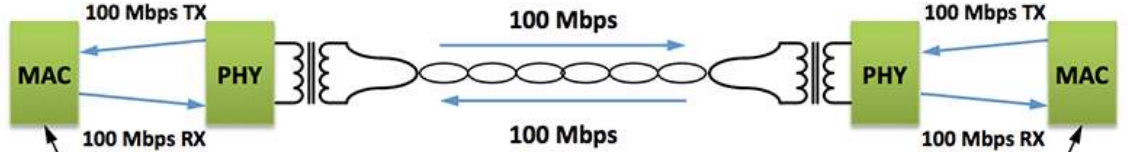
Basic Ethernet Transceiver Circuit



Normal Ethernet Cable

Automotive Ethernet Cable

100 Mbps symmetrical operation using standard Ethernet PHY components



Full Duplex 100 Mbps single pair operation achieved

Only change is to wire-side, MAC-side remains the same

Standard IEEE 802.3 100Mbps MAC Interface

Standard IEEE 802.3 100Mbps MAC Interface

Bourns Magnetics Manufacturing capabilities

- Bourns China - Custom, unique, high quality magnetics. For automation projects Bourns SEMS (Specialist engineering manufacturing systems) group is used and also provides support to CM's to ensure the best, most efficient design is implemented
 - AEC-Qualified manufacturing
- Possible to utilize Bourns Mexico facilities for suitable products for America's markets
- CM's providing products across magnetic spectrum (e.g. chip inductors, LAN, Power, Telecom, automotive, power), all levels of production from manual to full-auto are used. Product type, volumes and location of manufacture dictate what level of automation is used
 - Winding – manual, semi-auto and full auto used across range of products (toroids, drum core, shaped cores)
 - Taping – manual, semi-auto and full auto (shaped cores)
 - Termination – Soldering and welding manual, semi-auto, full auto
 - Testing - manual, semi-auto and full auto covering both electrical and mechanical measurements
 - Packaging - manual, semi-auto and full auto
- Examples of equipment used is shown in the following slides



Small toroid winders, typically for LAN products

Auto testing



SM Inductor winding, termination, epoxying





Semi auto winding



Banks of three axis multi-spindle winders and taping



Example of full-auto assembly from winding to termination





SM drum core inductor winding and welding



Custom Auto soldering



Common mode choke winding, welding and assembly

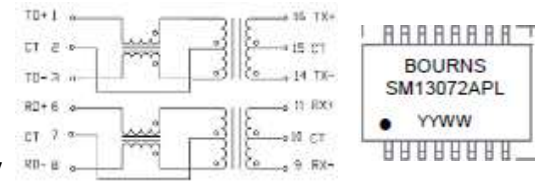
Automotive Grade Signal Magnetics



- Ethernet, CANbus, Flexray rely on magnetics for providing
 - Isolation and Protection
 - Filtering and removal of common mode noise from Signal Lines (Eg ECU bus on 48V to 12V converter)

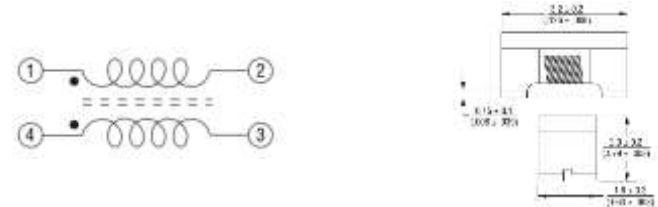
SM13072APL LAN Transformer

- 2 Channel Transformer + CMC
- High Quality (<1Dppm)
- Conforms to IEEE802.3 Standard
- Temperature Rating -40C to 125C
- Applications: Isolation and Common Mode Noise Ethernet Gateway



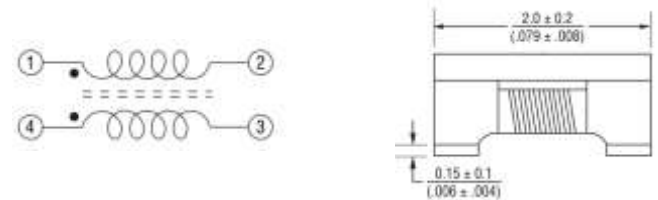
SRF3216A Family Common Mode Chip Inductor

- 1206 (inch) (3.2x1.6mm) Case
- Impedance of 90-2200 Ω at 100MHz
- Applications: Common Mode Noise on CANbus
- Temperature Rating -40C to 125C



SRF2012AA Family Common Mode Chip Inductor



- 0805 (inch) (2 x 1.2mm) Case
- Impedance of 67-370 Ω at 100MHz
- Applications: Common Mode Noise on CANbus
- Temperature Rating of -40 to 125C



XREF list for Pulse part in IsoSPI/BMS

Bourns P/N	Compeitor	Specification
SM13072APEL	Halo TG110– AE050N5LF	16pins SMT SOIC LAN Transformer, 60V(est)/1.5kVrms,6.4*12.7*9.5mm,–40°C to 85/125°C
PT61018AAPEL	Pulse HX1188FNL	16pins SMT LAN Transformer, 60V (est) 1.5kVrms, 6*12.7*9.7mm, –40°C to 85°C
SM91074AL SM13072APEL	Pulse HM1188NL	16pins SMT LAN Transformer, 60V (est) 1.5kVrms, 6*12.7*9.7mm, –40°C to 105°C
SM91501AL	Pulse HM2102NL	12 SMT Dual TSF, –40°C to 125°C 1000V 4.3kVdc 4.9mm 14.8mm 14.7mm
SM91502AL	Pulse HM2101NL /2103NL	6 SMT –40°C to 105°C 1000V 4.3kVdc – 5.7mm 7.6mm 9.3mm
PT20095AL BA60565CS (4578)	Sumida CEEH96BNP	600V/2.5kVrms 7*9.2*12mm 4SMT Transformers,Input voltage=9-16V, Output voltage=5V. inductance=650uH±15%, Current=180mA, Turn ratio=60:30, Hi-Pot test =3KVrms@1mA,2sec.

Common Mode Chokes -SMD

Inductor Model	SRF – Power Application Shielded	DR, SRF - Signal Line Application Shielded
Appearance		
Features	<p>Ferrite core</p> <p>Shielded construction – low radiation</p> <p>High current</p> <p>Wide frequency range</p>	<p>Ferrite core</p> <p>Shielded construction – low radiation</p> <p>Wide frequency range</p>
Applications	Power line RFI / EMI Filters, noise suppression	Signal line RFI / EMI Filters, noise suppression, CAN Bus
Models Available	9	8
Footprint	5.2x5 to 13x13 mm	2x1.2 to 9x5.4 mm
Height	1.7 to 8 mm	1.2 to 4.7 mm
Inductance	0.33 to 6,500 μ H	--
Impedance	5 – 15,000 Ohms	1 – 10,000 Ohms
Frequency	100k – 1GHz	100k – 1GHz
Rated Current	0.2 to 9 A	0.08 – 0.5 A

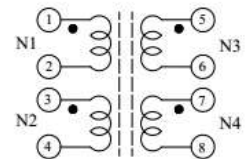
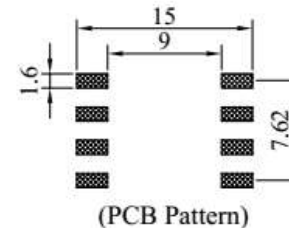
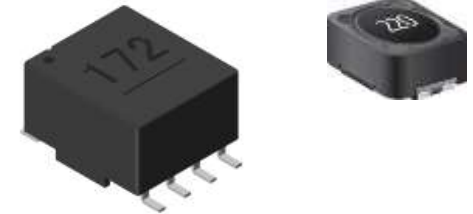
Common Mode Chokes – Power

7100, 7300, 7400, 7500, 8100

PM3700, SRF0703, SRF1260, SRF1280

- Power conversion application
- High perm. toroid or UU core, close magnetic loop construction to maximize CM impedance
- Available Models: 9
- Inductance Range: 0.2 – 50mH
- Rated Current Range: 0.27 – 20A
- Frequency Range: 10K – 50MHz
- Size Range:

0.75-1.7" (L) x 0.43-0.9" (W) x 0.6-1.2" (H)



Common Mode Chokes – Data Line

DR221, DR331, SRF4530/3225/2012



- Data line application
- Toroid, close magnetic loop construction to maximize CM impedance
- Available Models: 10
- Inductance Range: 11 – 4700uH
- Impedance Range: 60 – 15K Ohms
- Frequency Range: 100K – 1GHz
- Rated Current Range: 100 – 500mA
- Size Range:
2 – 9 (L) x 1.3 – 5.4 (W) x 1.3 – 4.7 (H) mm



Reference Designs

- DR331 Sieries Common Mode Chokes in TI CAN Network App-Nptes



Application Hint 2: Common-Mode Choke Choice

3 Application Hint 2: Common-Mode Choke Choice

To completely avoid the situation that causes the transient from a dc short circuit on the bus, the common-mode choke could be removed, which would eliminate the inductively generated voltage transient. However, if a common-mode choke is mandatory, there are various common choke designs and values that minimize the inductive voltage transient generation. With proper selection, the transient effect can be minimized while allowing the benefits of the common-mode choke, if one is required.

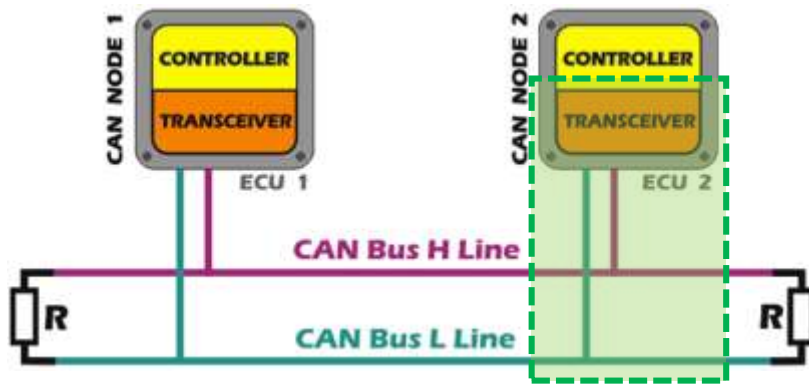
Measurements have shown that the transient voltage levels are highly dependent on the common-mode chokes core type and inductance value.

The measurement results for different chokes are summarized in [Table 1](#) and [Table 2](#). The test conditions for these measurements are as shown in [Figure 3](#), where the $R_{Term,x}$, C_{Term} , and D_{ESD} are left open, $C_{BUS} = 100$ pF, and a short circuit to 12 V is applied to either CANL or CANH at R_{TERM} , the external termination at the opposite end of the 1-m long CAN bus cable.

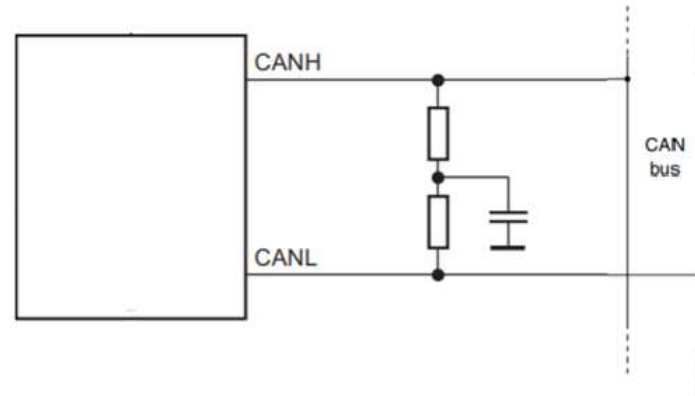
Table 1. Measurement of Transients for Different Common-Mode Chokes With CANL Shorted to 12 V

Choke	Winding	Core	L_r (μ H)	$L_{s, typ}$ (nH)	I_R (mA)	R_{max} (m Ω)	Measured Transient Voltage at Transceiver Bus Pins (V)	
							CANL	CANH
Bourms DR331-513AE	Sector	Toroid	51	2000	500	300	38,7	34,7
Bourms DR331-513BE	Bifilar	Toroid	51	600	500	300	48,8	46,6

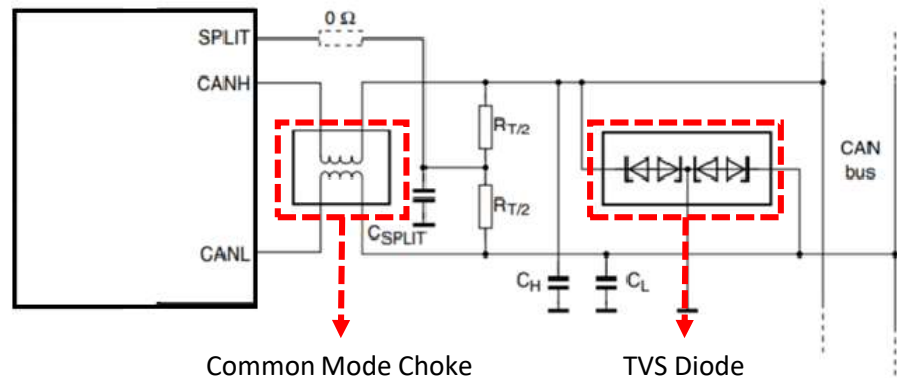
CAN (Controller Area Network) Bus



Basic CAN BUS Transceiver Circuit



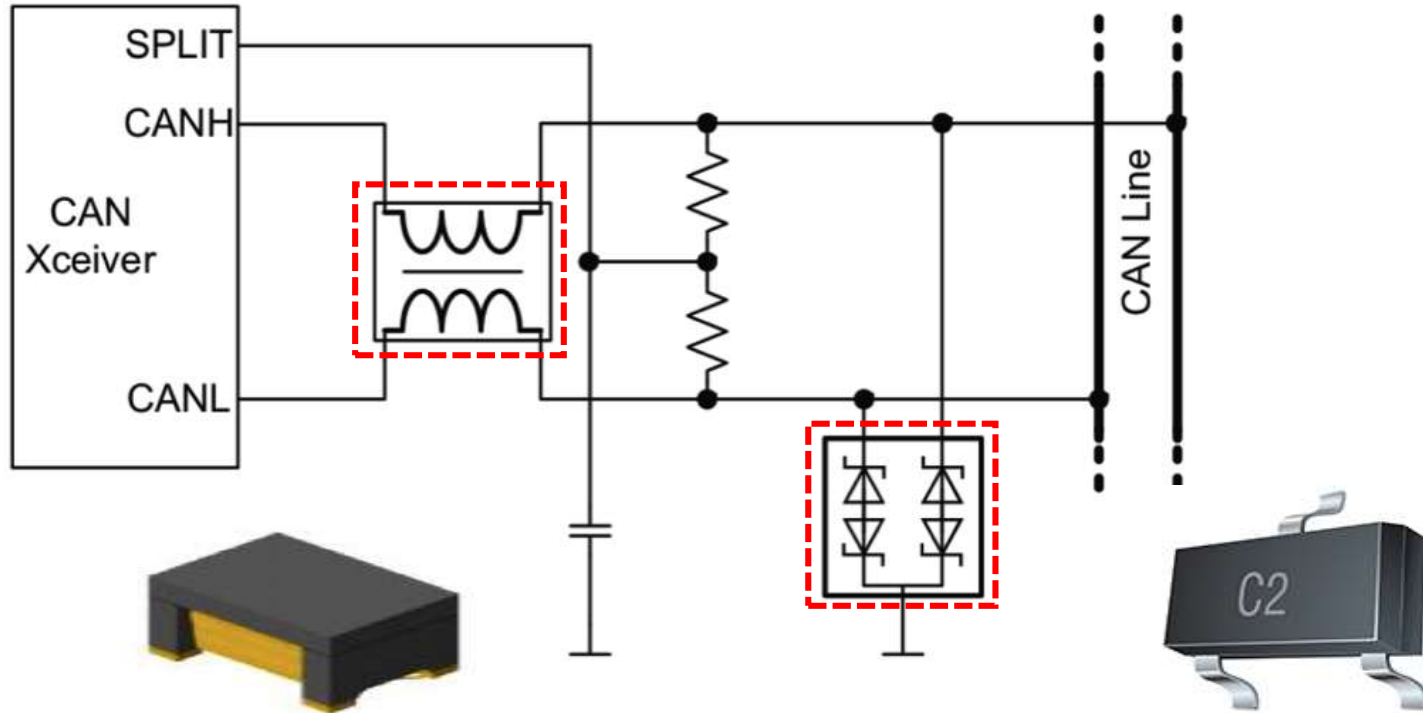
Enhanced CAN BUS Transceiver Circuit



Common Mode Choke : To reduce noise.

TVS Diode : To offer ESD protection

CAN Bus Solution in Car Camera



Common Mode Choke (CMC)

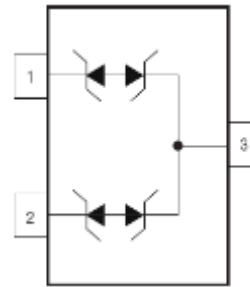
- **SRF4530A-510Y** : Size 4530
Competitor : PE-1812ACC510STS (Pulse)
ACT45B-510-2P-TL(TDK)
- **SRF3225TA-510Y** : Size 3225
Competitor : ACT1210-510-2P (TDK)

TVS Diode

- **CDSOT23-T24CAN** :
Competitor : NUP2105L (On-Semi)
SM24CANA (Littelfuse)
PESD2CAN (NXP)

CDSOT23-T24CAN

Specifications



Comparison to Devices with a Similar Surge Rating

Parameter	Units	Bourns CDSOT23-T24CAN	OnSemi NUP2105L	Littelfuse SM24CANB
V_{DRM}	V	24	24	24
I_{PPSM} (8/20 μ s Current Waveform)	A	8	8	10
ESD (Contact)	kV	30	30	30
V_{BR} min. @ $I_{BR} = 1$ mA	V	26.2	26.2	26.7
V_{BR} max. @ $I_{BR} = 1$ mA	V	32	32	Not Specified (NS)
I_R max.	μ A	0.1	0.1	0.1
Typical V_C @ I_{PPSM}	V	40	44 max.	50 max.
C (Line to GND), typical	pF	22	30 max.	30
AEC-Q101 Qualified	—	No ⁽³⁾	Yes	Yes

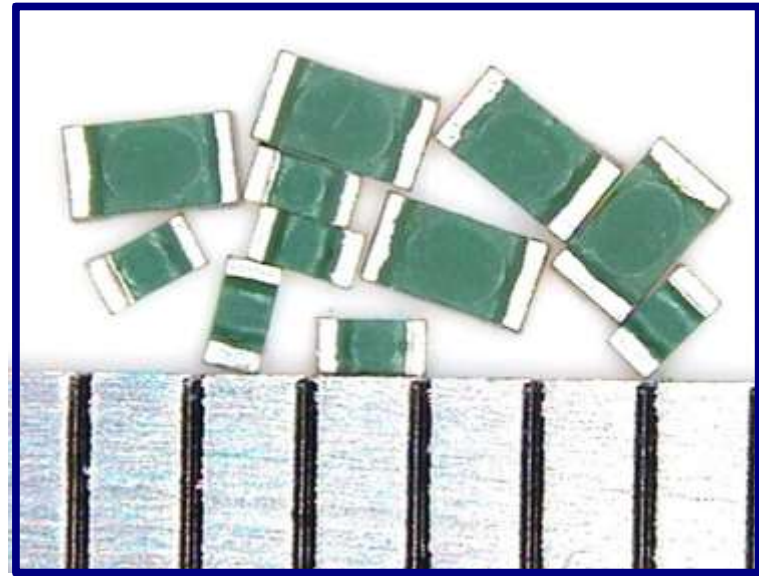
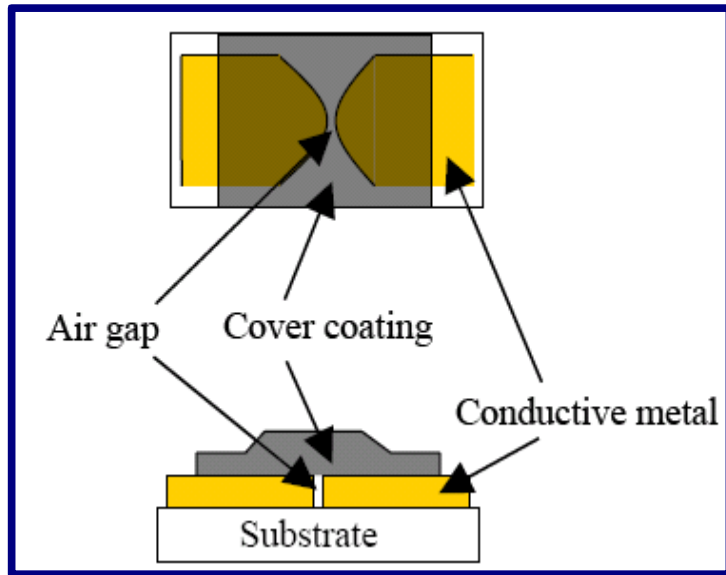
Absolute Maximum Ratings (@ $T_A = 25$ °C Unless Otherwise Noted)

Rating	Symbol	Value	Unit
Repetitive Peak Off-state Voltage	V_{DRM}	24	V
Non-Repetitive Peak Impulse Current, 8/20 μ s Waveform	I_{PPSM}	8	A
Non-Repetitive Peak Impulse Current, 1.2/50 μ s Waveform	I_{PPSM}	6	A
ESD (IEC 61000-4-2 Contact)		30	kV
Junction Temperature	T_J	-40 to +150	°C
Storage Temperature	T_{stg}	-55 to +150	°C

Very High ESD Rating

Easily meets IEC61000-4-5 Level 1 requirements for unshielded symmetrical interconnection lines

ChipGuard[®] ESD Suppressor Product *Using Air Gap*



- Air Gap technology fabricated in surface mount devices (SMD, 0603 / 0402 chip type)
- Designed by air space discharge technology; provides bidirectional protection

Bourns Automotive Approved ESD Protectors

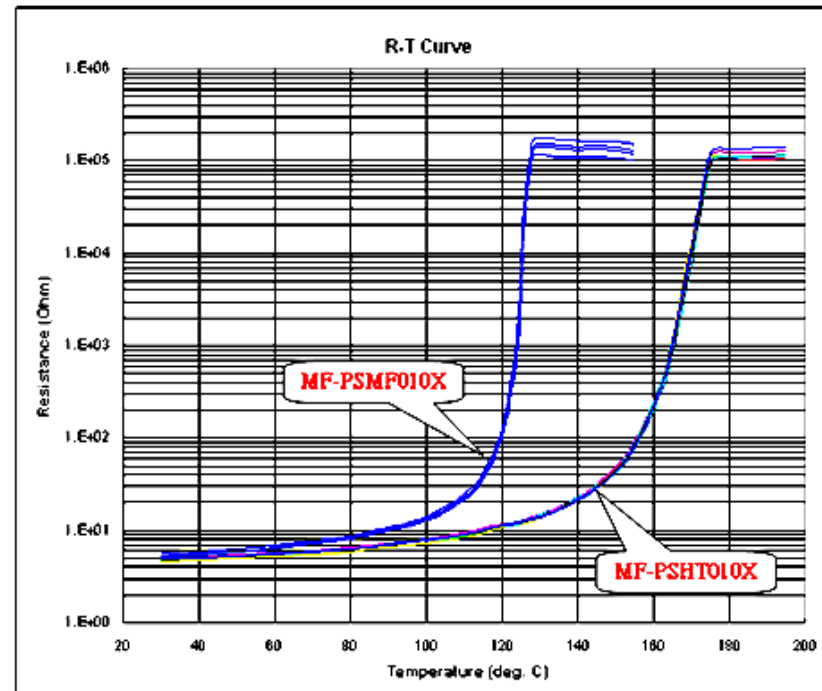
Part Number	Working Voltage (V)	ESD Rating	BreakDown Voltage	Capacitance	Clamping Voltage(V)
CG0603MLC-05E	5	8KV Contact, 15KV Air	250V	0.5pF	25
CG0603MLC-12E	12	8KV Contact, 15KV Air	250V	0.5pF	25
CGA0402MLC-05E	5	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0402MLC-12E	12	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0402MLC-24E	24	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0603MLC-05E	5	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0603MLC-12E	12	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0603MLC-24E	24	8KV Contact, 15KV Air	300V	0.05pF	30

AECQ PTC in Rear view Cameras

- Background :
 - Cameras using CMOS technology typically run very hot, 95 °C or 100°C
 - This rules out many standard PTCs (e.g. MF-PSMF010X),
- Solution :
 - NEW MF-PSHT010X
 - Use freeXpansion SMD design, 0805 size
 - Uses High temperature material
 - Operates up to 125°C



MF-PSHT010X & MF-PSMF010X R-T curve comparison



Thank you!

BOURNS®