



# Eaton Automotive Electronics Components & Target Applications



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# Agenda

1. Automotive Electronics Market Projection
2. Eaton's Standard Automotive Magnetic Products
3. Eaton's Standard Automotive Supercap Products
4. Eaton's Standard Automotive Circuit Protection Products
5. Target Applications Served

# Auto Industry Market Projection

- 3% yearly global growth expected in automobile industry till 2020
  1. Asia: +10% YoY
  2. Mexico: +6% YoY
  3. Europe: +4% YoY
- 25-30% share of electronics of vehicle production cost with ~10% growth yearly

**Total automobile electronics business is expected to DOUBLE by 2020.**





# Eaton Electronics Automotive Products



Supercap



Fuse  
ESD Suppressor  
Resettable PPTC







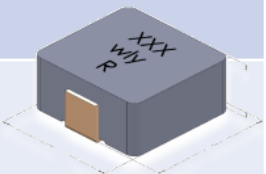


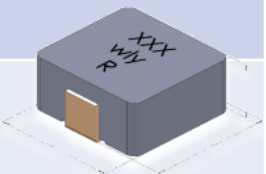
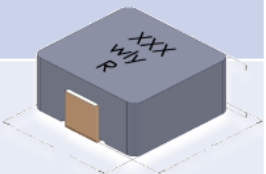
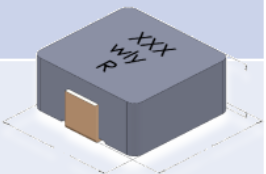


Small/Medium Power Inductor  
High Power Inductor  
Transformer



# MAGNETICS

# AEC-Q200 Qualified Inductors

Part Series	Part Image	Part Size (mm)	Inductance Range (uH)	AEC-Q Grade	Date Of Qualification
DRA73		7.6x7.6x3.55	0.33-1000	1 - 165C	2006
DRA74		7.6x7.6x4.5	0.33-1000	1 - 165C	2006
DRA124		12.5x12.5x4.5	1-1000	1 - 165C	2006
DRA125		12.5x12.5x6	1.5-1000	1 - 165C	2006
DRA127		12.5x12.5x7.5	2.2-1000	1 - 165C	2006
DRAQ127		12.5x12.5x7.5	10-47	1 - 165C	2011
MPIA4040		4.7x4.3x1.2-2	0.09-22	3 - 125C	2014
HCMA0503		5.5x5.3x3	0.1-22	3 - 125C	2014
HCMA0703		7.3x7x3	0.15-33	3 - 125C	2014
HCMA1104		11x10x4	0.2-10	3 - 125C	2014
HCMA1305		12.5x13.8x5	0.1-33	3 - 125C	2014
HCMA1707		17.2x16.8x7	1.5 - 68	3 - 125C	2014






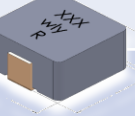





# AEC-Q200 Qualified Inductors – Roadmap



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## 2015-2016

\* - samples are available

Part Series	Part Image	Part Size (mm)	Inductance Range (uH)	AEC-Q Grade	Available From
LD1A *		4.5x4x3.2	1-330	3 – 125C	Q4 2015
HCMA2015		2.5x2x1.2	0.1-10	3 – 125C	Q4 2016
HCMA1105 *		10x10x5	0.36-6.8	3 – 125C	Q2 2016
HCM1A0503 *		5.5x5.3x3	0.1-22	1 – 155C	Q3 2016
HCM1A0703 *		7.3x7x3	0.15-33	1 – 155C	Q2 2015
HCM1A0805 *		8.3x8.1x5.4	1-100	1 – 155C	Q2 2016
HCM1A1305 *		12.5x13.8x5	0.1-33	1 – 155C	Q2 2016
HCM1A1307 *		12.5x13.8x7	0.47-3.3	1 – 155C	Q2 2016
HCM1A1707 *		17.2x16.8x7	1.5 - 68	1 – 155C	Q4 2016
HC31A		33x27x25	3.2-10	1 – 165C	Q3 2016
DRAQ74 *		7.6x7.6x4.5	10-47	1 – 165C	Q3 2016





# DRA & DRAQ Series

## Construction

Shielding  
(Ferrite NiZn)



Winding



Drumcore  
(Ferrite NiZn)



Terminals



Baseplate  
(Plastic)



## Features/Benefits

- Lowest DCR
- Highest Irms current rating
- High Isat current
- Enhanced shock&vibration performance
- Optimized for best peak current performance
- 125C ambient / 165C total temp operation

## Typical Applications

- LED Lighting
- Powertrain control module (PCU)
- Engine Control unit (ECU)
- Transmission Control Unit (TCU)
- Hybrid electric vehicle (HEV) Inverter controller, Charger

## Cross Reference

EATON	Bourns	Coilcraft	Sumida	TDK - Epcos
DRA73	SRR0735A	NA	NA	NA
DRA74	NA	MSS7341T	NA	B82472P6
DRA124	NA	MSS1246T	NA	NA
DRA125	SRR1260A	MSS1260T	CDRH12D58L	NA
DRA127	SRR1280A	MSS1278T	CDRH12D78L	B82477P4
DRAQ127	NA	NA	CDRCH12D78	B82477D4



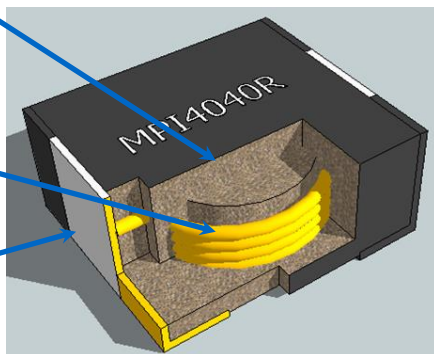
# MPIA Series

## Construction

Molded core (composite)

Winding

Terminals



## Features/Benefits

- Flat inductance rolloff versus applied current
- Highest power in smallest package
- Superior EMI shielding
- Lower core losses & higher efficiency performance



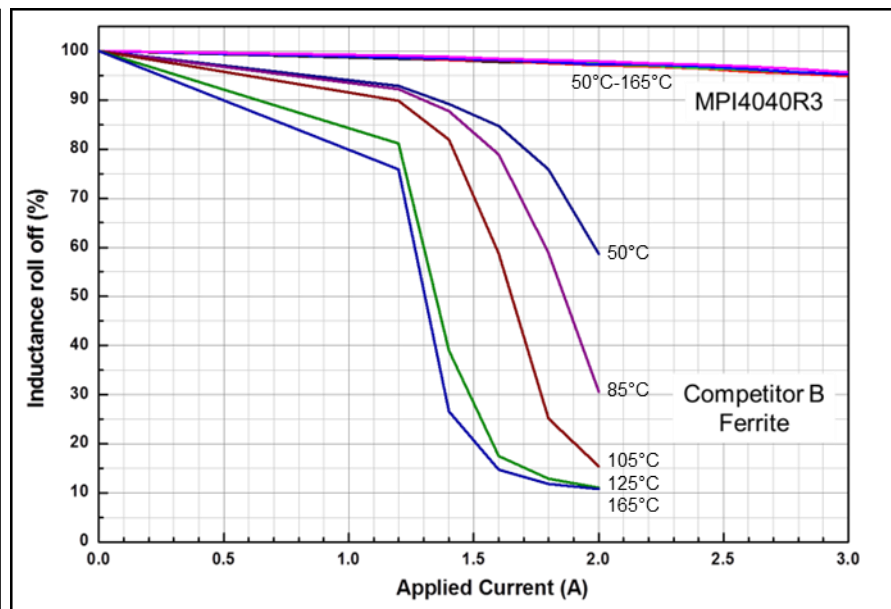
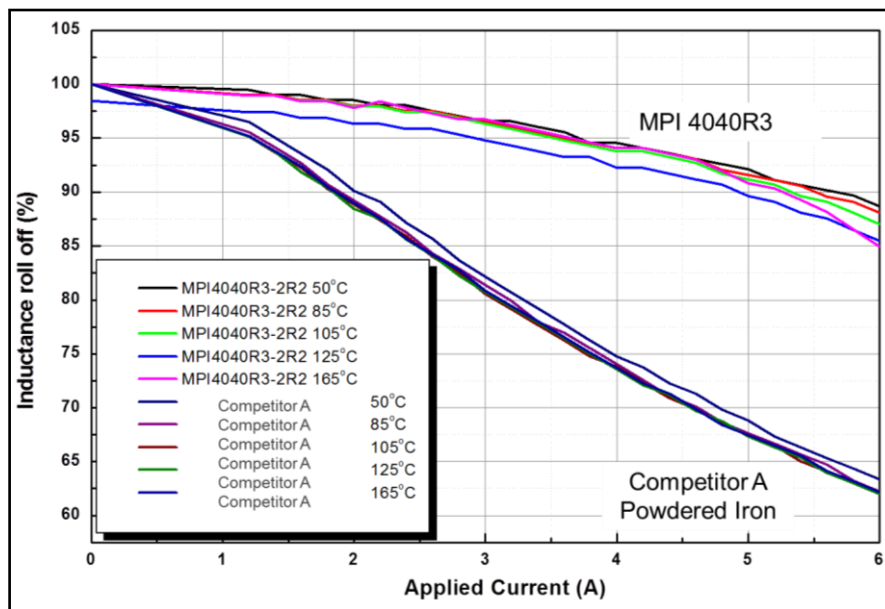
## Typical Applications

- Vision systems (ADAS)
- Infotainment systems
- Power Port (USB HUB)
- LED Lighting
- Door entry unit
- Alarm system

## Cross Reference

Supplier	Product Line	Inductance
EATON	MPIA4040	0.09 - 22 $\mu$ H
Vishay	IHLP1616AB/BZ	0.047 - 2.2 $\mu$ H
Coilcraft	XAL4020 (XFL4020)	0.22 - 15 $\mu$ H

# MPI(A) Advantage: Current Rating Stability

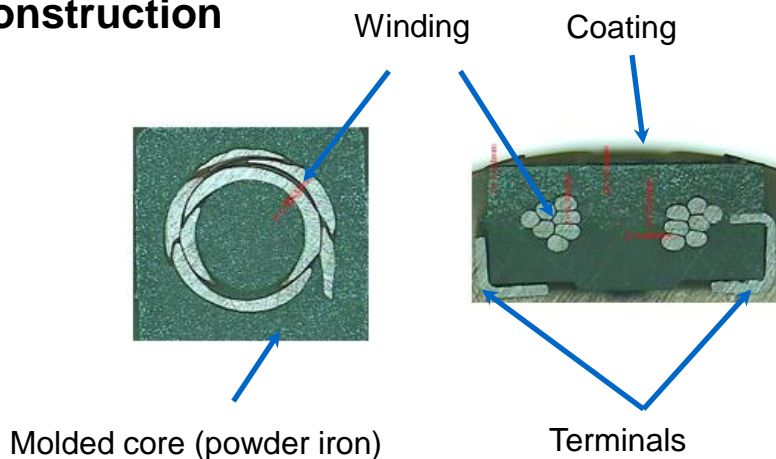


**MPI has much less roll-off than competitive solutions**

# HCM(1)A Series



## Construction



## Features/Benefits

- Lower core loss than other powder iron solutions
- Higher Isat
- Lower DCR
- Soft roll-off characteristics
- Magnetically shielded - Reduces EMI
- HCM1A with 155C total temperature

## Typical Applications

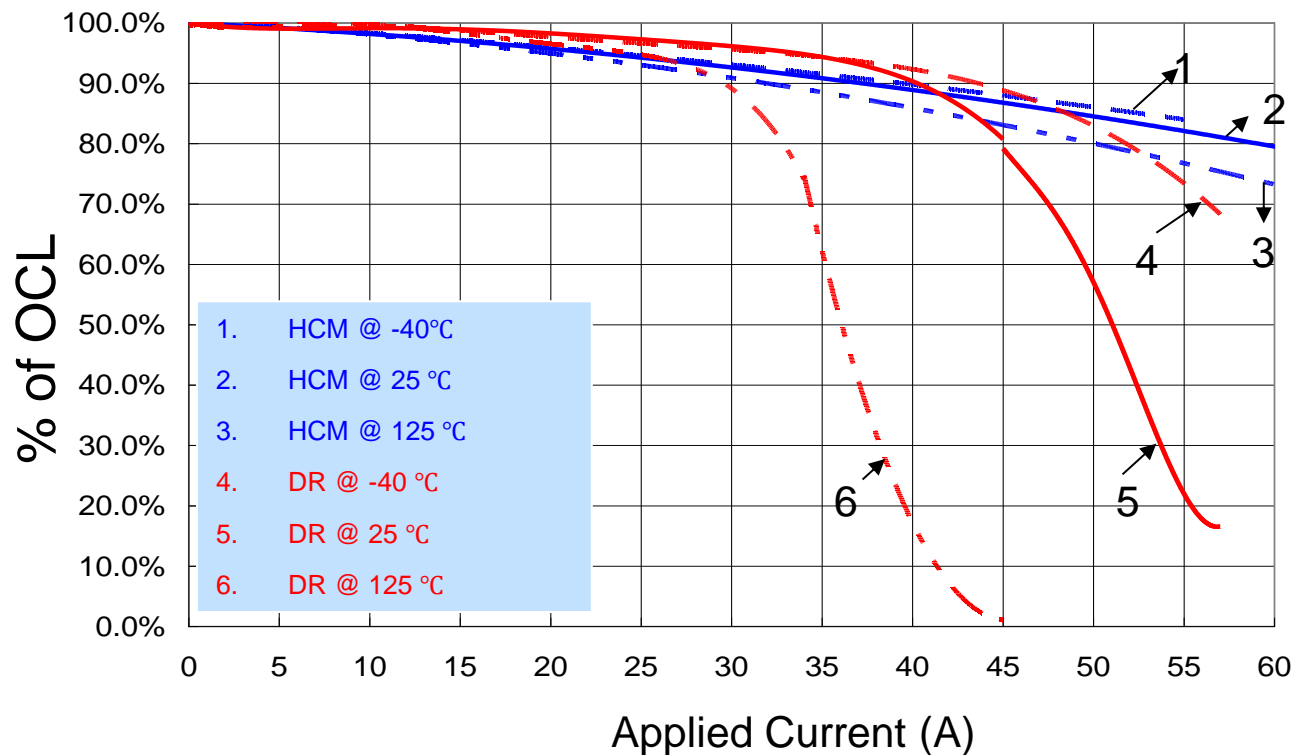
- Engine Control Unit – ECU
- Infotainment Systems
- Transmission Control Unit – TCU
- LED Lighting

## Cross Reference

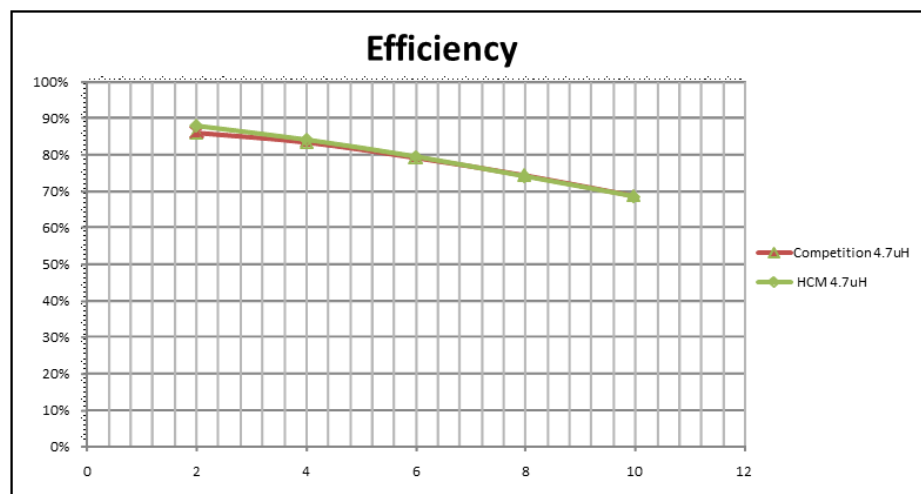
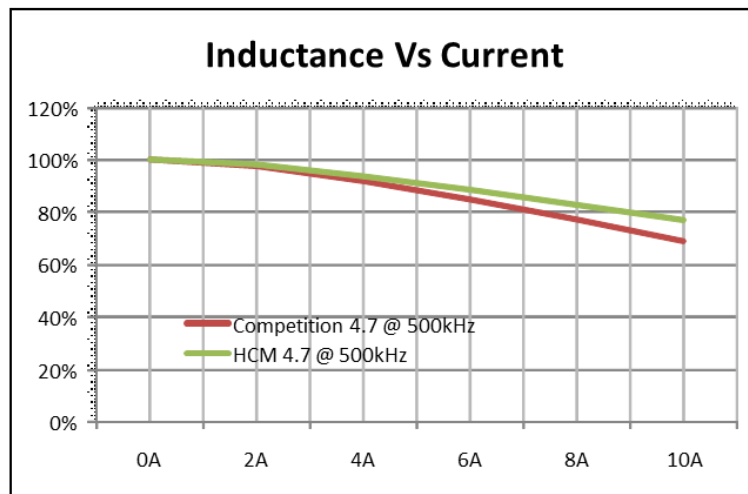
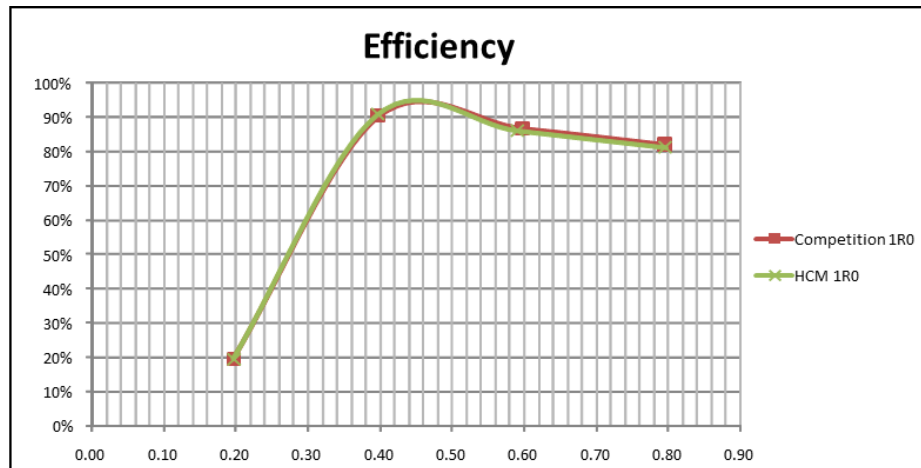
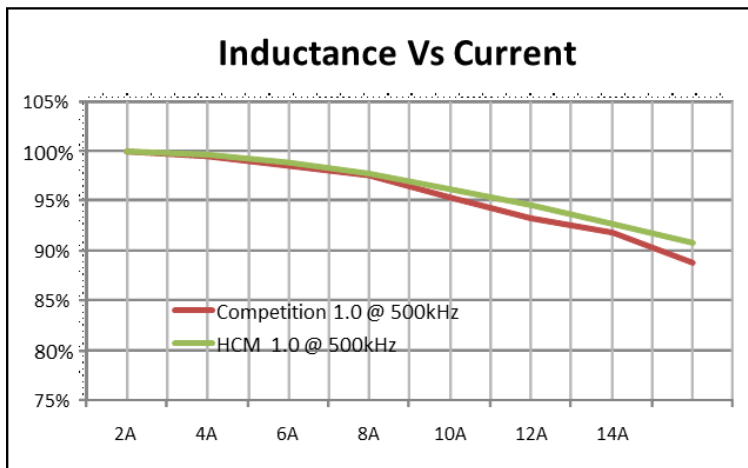
Grade	EATON	Vishay	Bourns
AECQ-200 G3 +125C total	HCMA0503	IHLP-2020CZ-1A	NA
	HCMA0703	IHLP-2525CZ-1A	SRP07028A
	HCMA1104	IHLP-4040DZ-1A	SRP1038A
	HCMA1105	NA	NA
	HCMA1305	IHLP-5050EZ-A1	SRP1245A
	HCMA1707	IHLP-6767GZ-1A	NA
AECQ-200 G1 +155C total	HCM1A0703	IHLP-2525CZ-5A	NA
	HCM1A0805	IHLP3232DZ-5A	NA
	HCM1A1305	IHLP-5050EZ-5A	NA
	HCM1A1307	IHLP-5050FD-5A	NA
	HCM1A1707	IHLP-6767GZ-5A	NA

# HCMA Inductor Features

HCM has stable inductance over the complete temperature range => ideal choice for wide temperature range applications required by automotive



# HCMA0703 Performance vs. Competition



**HCM has better roll-off with same efficiency**

# HCMA vs. Competition Comparism

Other performance aspects:

- Thermal aging: HCMA use an improved binder material which ages less than the typical binder materials used in the industry. HCM1A is not subject to thermal aging.
- HCMA & HCM1A is fully covered to protect against corrosion. Competition is typically not.

HCMA with grey coating after subjected to salt-spray test



Competition without antirust protection subjected to salt-spray test



# HCM1A - High Temperature AEC-Q200 Grade1



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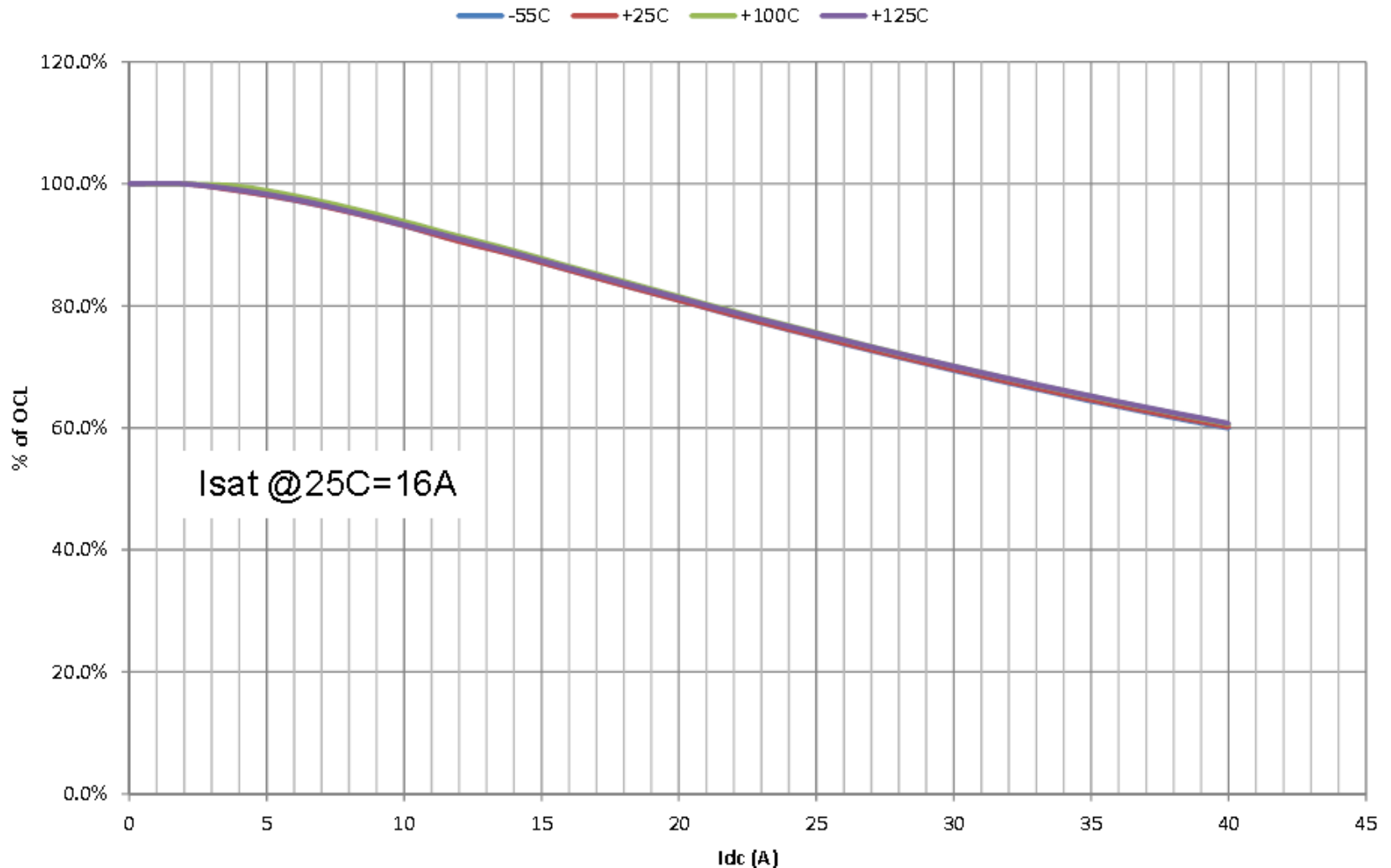
## Features:

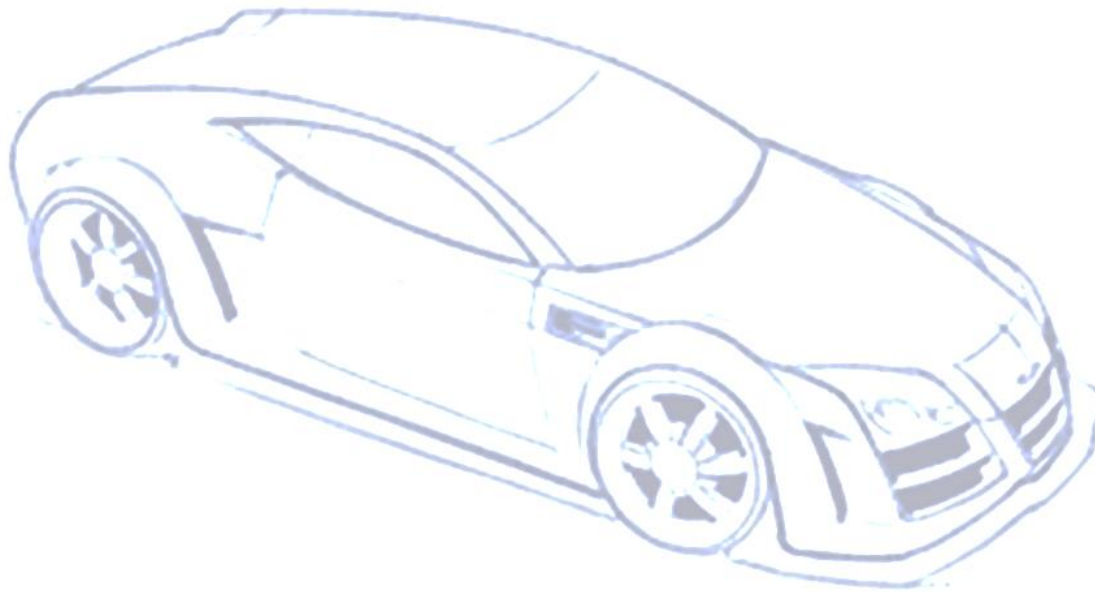
- Rated to 125C ambient operation (155C max)
- Low DCR – ideal for input/output filtering
- High current (saturation current is typically lower than HCMA due to different core material)
- Non-aging core material
- Excellent high temp performance
- Low EMI
- Very little competition with AEC-Q200 Grade1 products
- 1305, 1307 & 1707 sizes can cover most high current under-the-hood applications
- Additional sizes are in works: 0703, 0805, 1104 & 1105 coming soon





# HCM1A – Inductance Rolloff Characteristic





# SUPERCAPACITORS



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# HV Series Supercapacitors

## Automotive OEM Qualified:

- 25F used for qualification testing to OEM requirements
- Qualification test elements:
  - Leakage Current
  - Self Discharge
  - Cycle life – 6000 charge/discharge cycles (-40, +25, +80C)
  - 80C Aging Test – 4700hrs
  - Mechanical Shock test: 30g/6ms, half sine, 100k shocks

## Features/Benefits

- Broad capacitance ratings
- Lowest ESR (Aerogel Technology)
- Broad temperature range: -40 - +85C
- Long lifetime (15yrs)
- Robust mechanical construction

## Typical Applications

- Electrification of vehicles require localized power for
  - Safety
  - Cabling cost reduction
  - Pulse/peak power reduction
- Door locks (design in)
- Trunk locks (in design)
- E-call unit backup power (in design)
- Dynamic suspension (early discussion)

## Cross Reference

Cap	Eaton HV Series	Maxwell	Nichicon
1	X	X	-
3	X	X	-
5	X	X	-
6	X	-	X
10	X	X	X
15	X	-	X
25	X	X	X
35	X	-	-
60	X	X (50)	-
100	X	X	-

# X Series Supercapacitors

## XV/XB Series Features/Benefits

- Highest energy density in 300F, 400F, 600F
- Lowest ESR (Aerogel Technology)
- Broad temperature range: -40 - +85C
- Long lifetime (15yrs)
- Robust mechanical construction

## Applications

- Energy regeneration up to 10kW
- Peak power battery support (start-stop system, EPS)
- Backup power for GPS tracking systems



## XL Series Features/Benefits

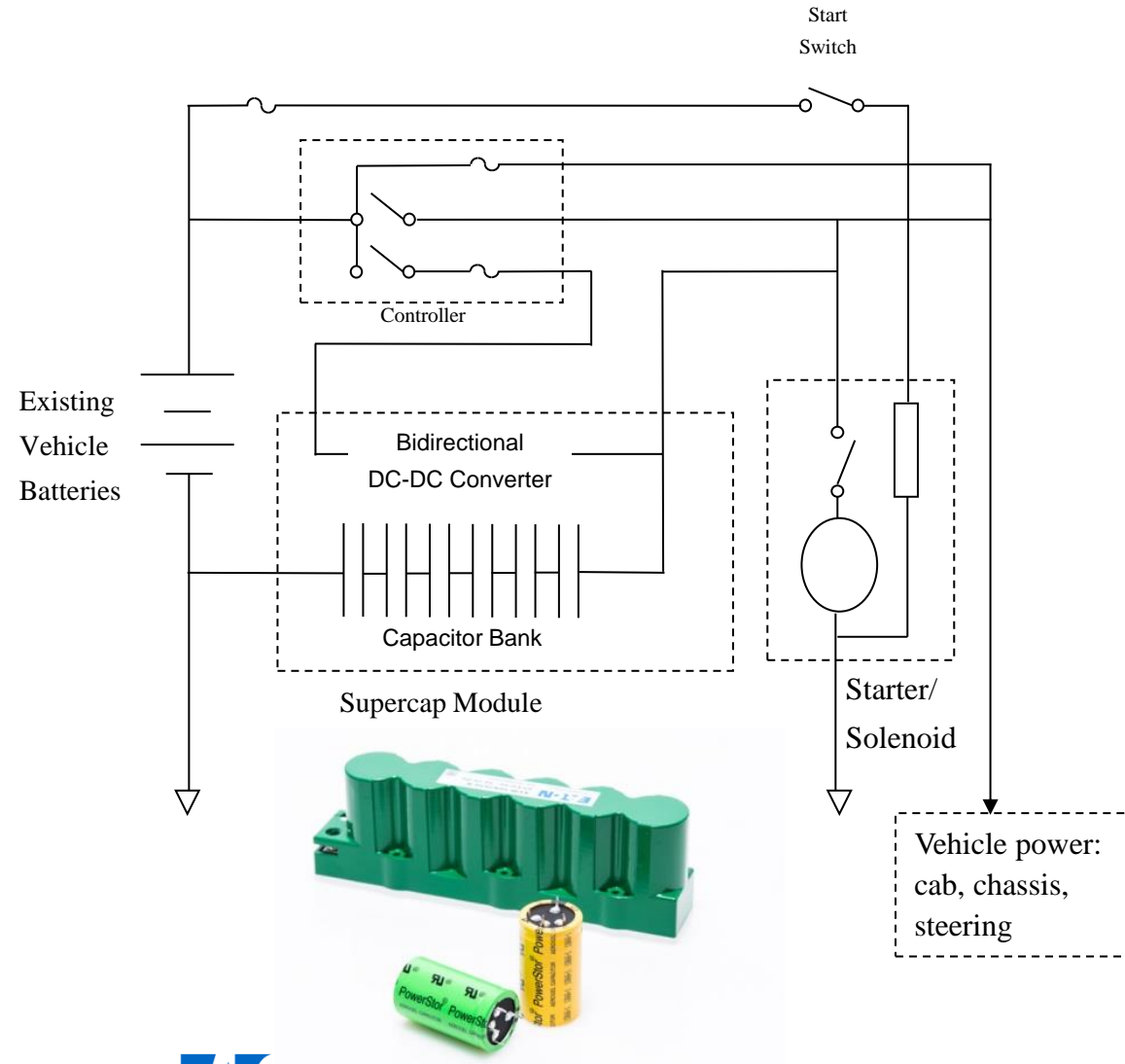
- Highest power density on the market (0.23mOhm DC ESR)
- High capacitance
- Ideal for high energy transfer applications
- Broad temperature range: -40 - +85C
- Available with weldable or scew-mount terminals to comply with high shock&vibration requirements in vehicles

## Applications

- Energy regeneration up to 100kW
- Electric engine boost
- Peak power battery support



# Smart Start For Combustion Engines



- Smart Start
- Start from battery, supercap or combination
- Optimize starting and system capability
- Utilize energy for other functions to optimize performance and lifetime

# Engine Start Examples

## Peugeot 308 2014- with start-stop

- 700k sold cars with supercap feature
- 2x1200F caps with boost converter circuit



## Lamborghini Aventador 2015- with start-stop

- Supercap is helping to reduce battery size and overall weight
- 7% overall fuel efficiency improvement
- 16V/58F module implemented



# Energy Regeneration: Mazda 6 i-Eloop

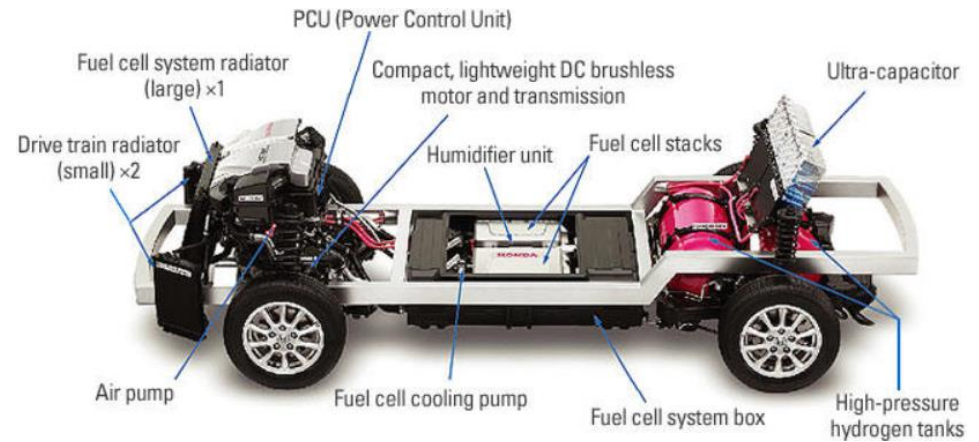
Supercap solution: 10x3000F cells



# Energy Regeneration and Power Boost: Honda FCX



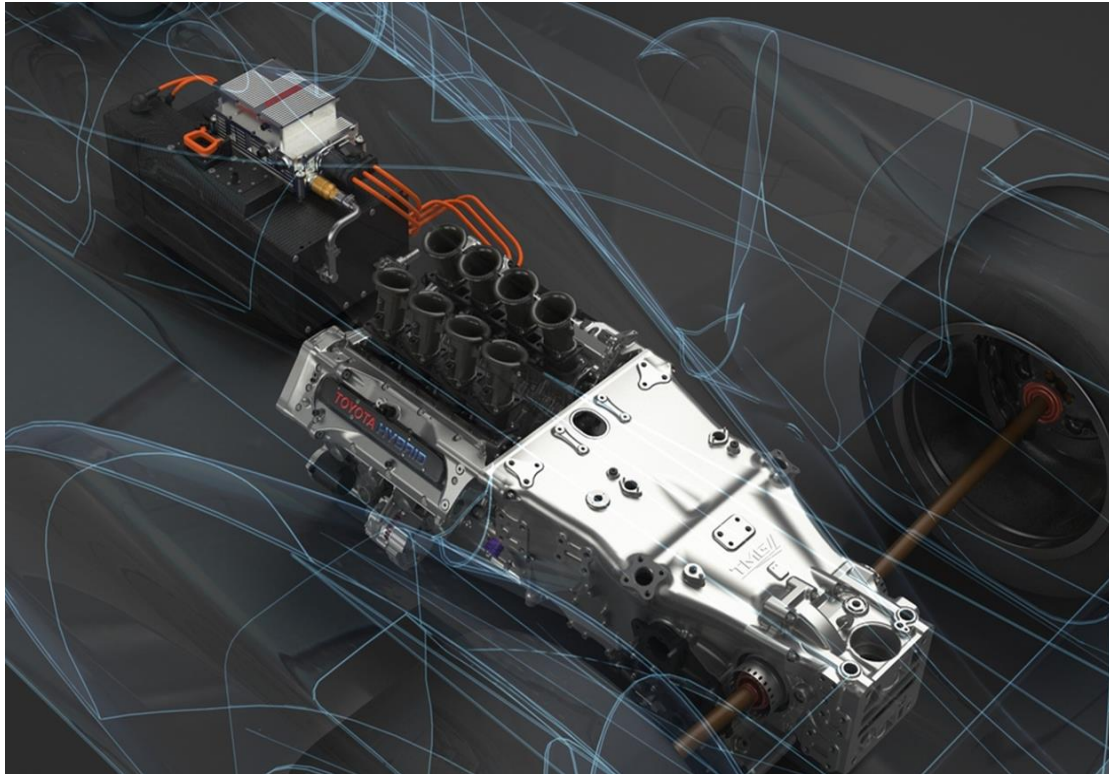
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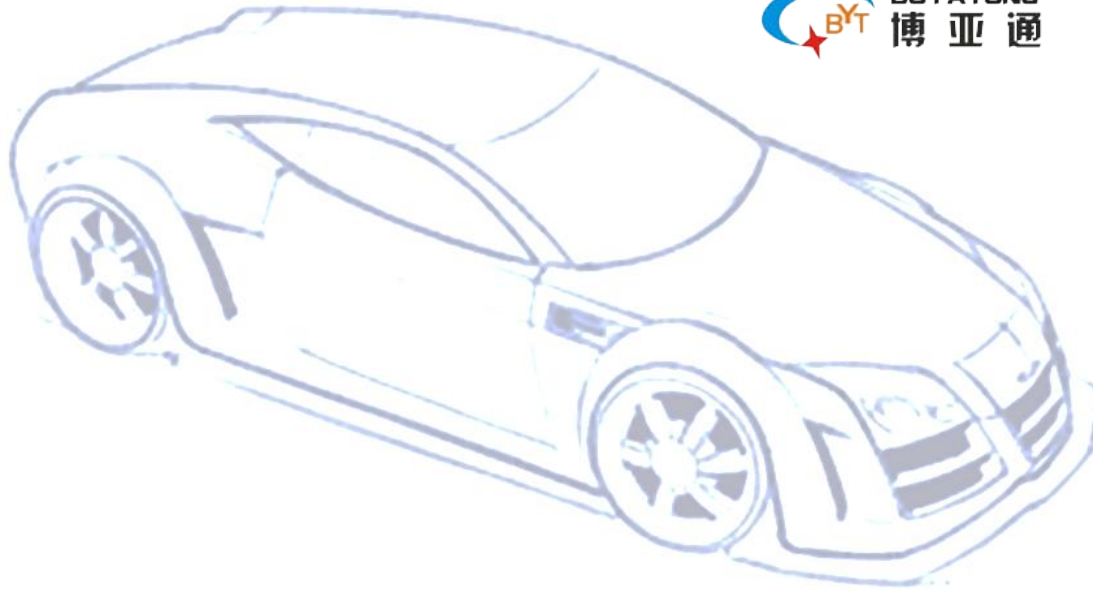
- Fuel cell vehicle + 70x ~3000F supercap cells
- Supercap is regenerating breaking energy and re-supplies to the electric engine
- Using supercap improves efficiency and acceleration performance



# Energy Regeneration and Power Boost: Toyota Yaris R







- Supercap regenerates braking energy
- No battery used
- Supercap releases 120HP boost for max 5s during acceleration






# CIRCUIT PROTECTION

# Traditional Automotive Blade Fuses

Part Series	Part Image	Part Description	Current Range (A)	Voltage Rating
ATC		Mid Size Fast Acting Blade Fuse	1-40	32V
ATM		Minature Fast Acting Blade Fuse	2 – 30	32V
Low Profile ATM		Miniature Fast Acting Blade Fuse	5-30A	32V
MAX		Large Size Fast Acting Blade Fuse	20-80A	32V




**ISO 8820-3 Compliant**

# Illuminating Automotive Blade Fuses





Part Series	Part Image	Part Description	Current Range (A)	Voltage Rating
ATC easyID		Mid Size Fast Acting Blade Fuse	3-40	32V
ATM easyID		Minature Fast Acting Blade Fuse	3-30	32V
MAX easyID		Large Size Fast Acting Blade Fuse	20-100A	32V

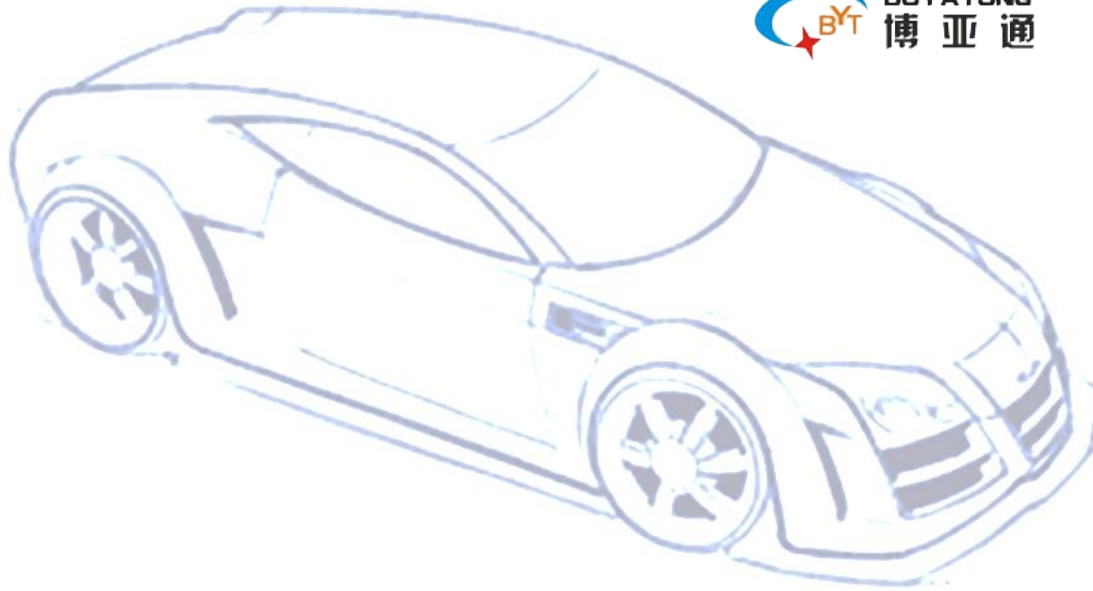
easyID: LED illuminated fuse top in case of fuse „open”

# Space Saving Automotive Blade Fuses

Part Series	Part Image	Part Description	Current Range (A)	Voltage Rating
ATR		Micro Size 2-Blade Fuse 9.1x15.3mm	5-30	32V
FMM		Micro Female Maxi Fuse 9.7x15mm	15-40	32V
ATL		Micro Size 3-Blade Fuse 14.3x15.3mm	5-15A	32V

# AEC-Q200 Qualified Circuit Protection Elements

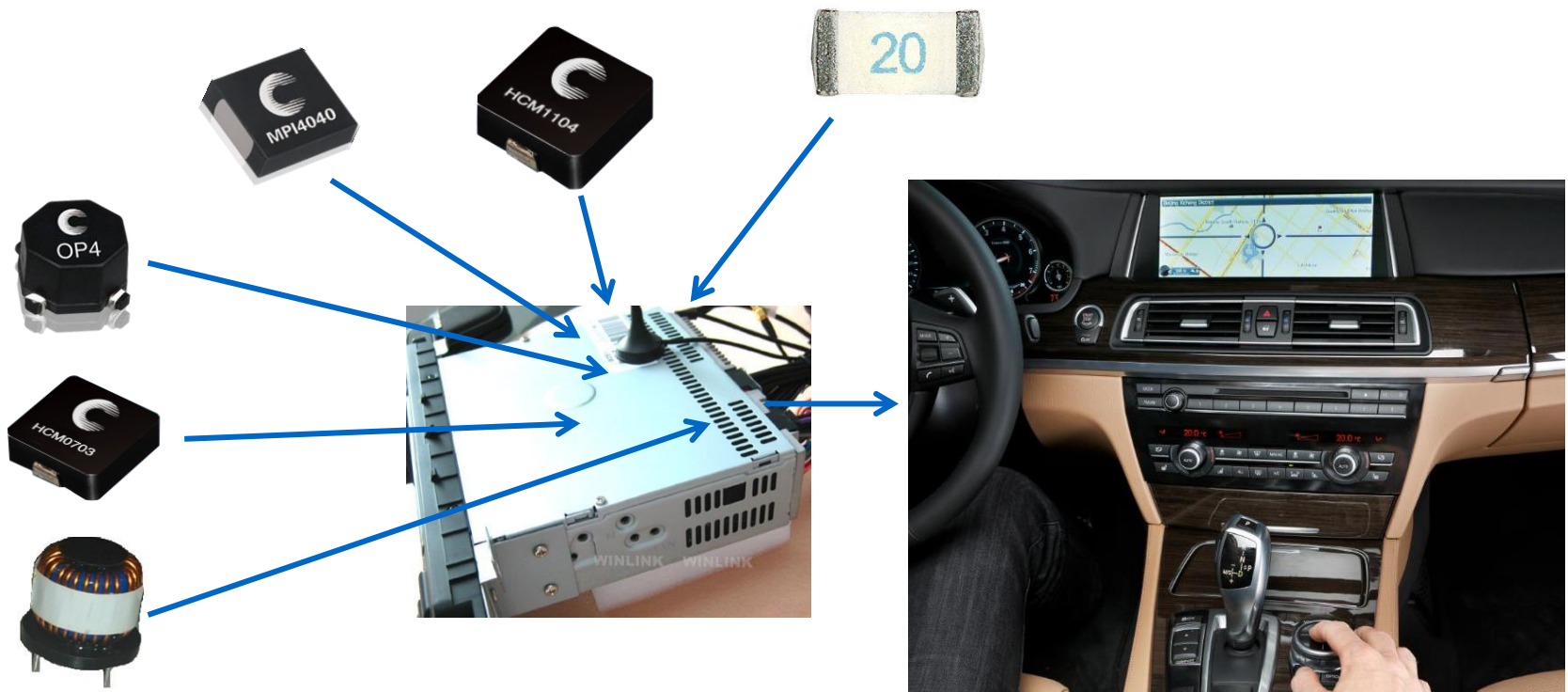
Part Series	Part Image	Part Description	Current Range (A)	AEC-Q Grade	Date Of Qualification
3216FF		Fast Acting Chip Fuse	0.25 - 30	1	2010
CC12H		High Inrush Current Chip Fuse	1 - 20	1 - <20A 3 - 20A	2014
PS04LTVA		Ultra Low Capacitance ESD Suppressor	N/A	1	2010
PTR030V0090		PPTC Resettable Fuse 30VDC	0.9	3	2013



## Target Applications Served

# Market Served: Infotainment Systems

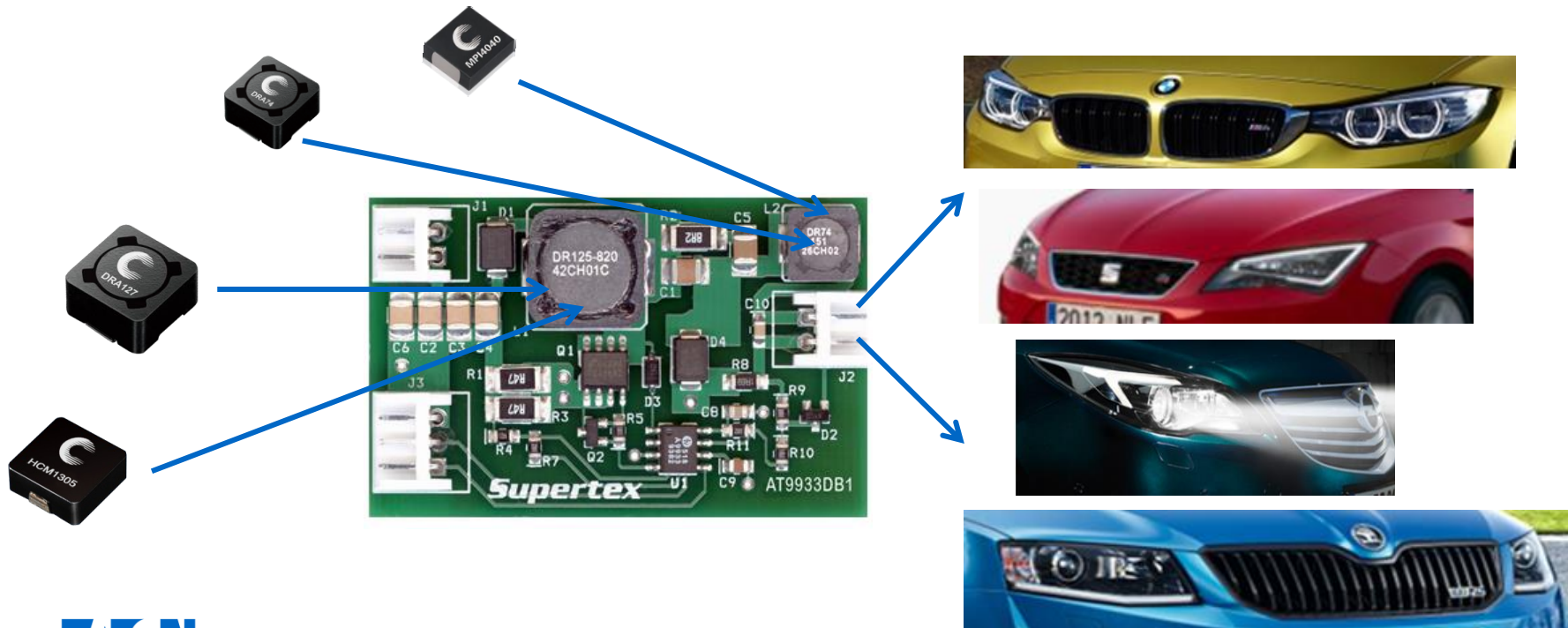
- Standard and custom design inductors for high end infotainment
- Challenges: high power density and very low EMI parts needed





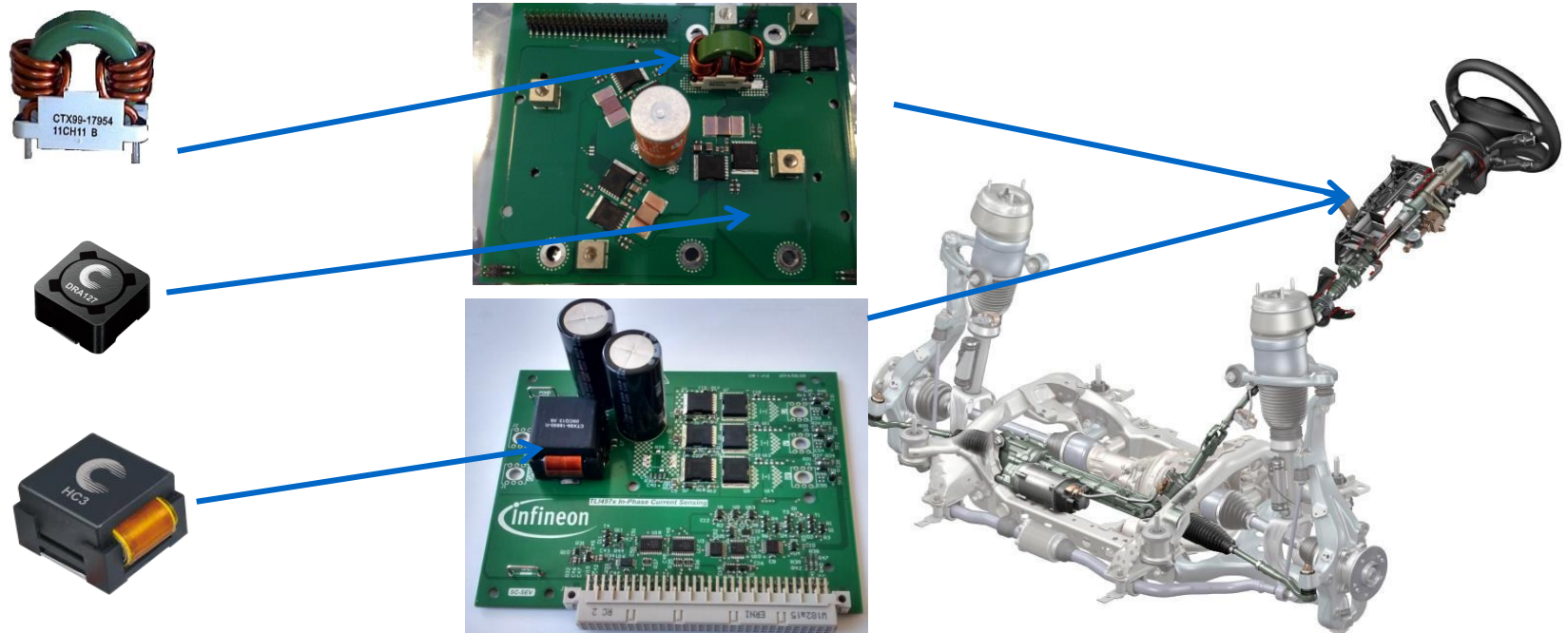
# Market Served: Automotive LED Lighting

- Standard inductors and custom design transformers for LED headlight, DRL, and back light units for
- Challenges: high efficiency and high temperature capable (Grade1)



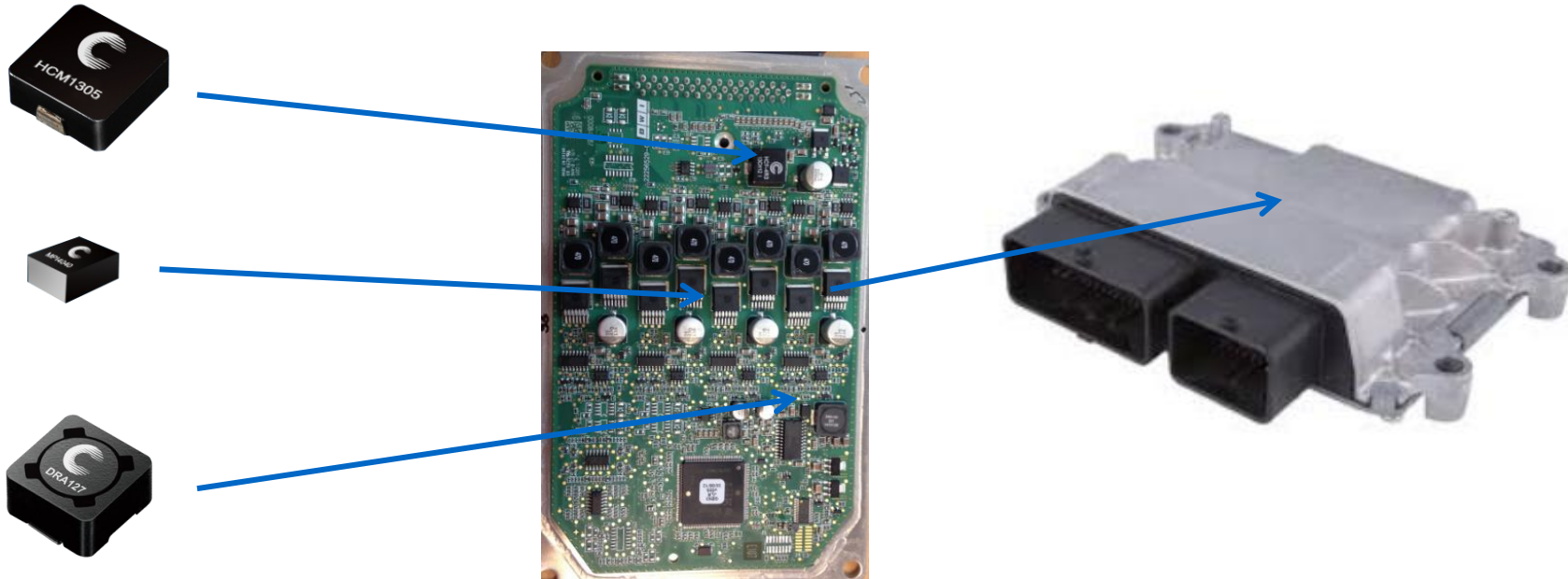
# Market Served: Electronic Power Steering

- Standard inductors and custom design inductors & filters for high power EPS controllers
- Challenges: high power parts, high reliability for critical applications



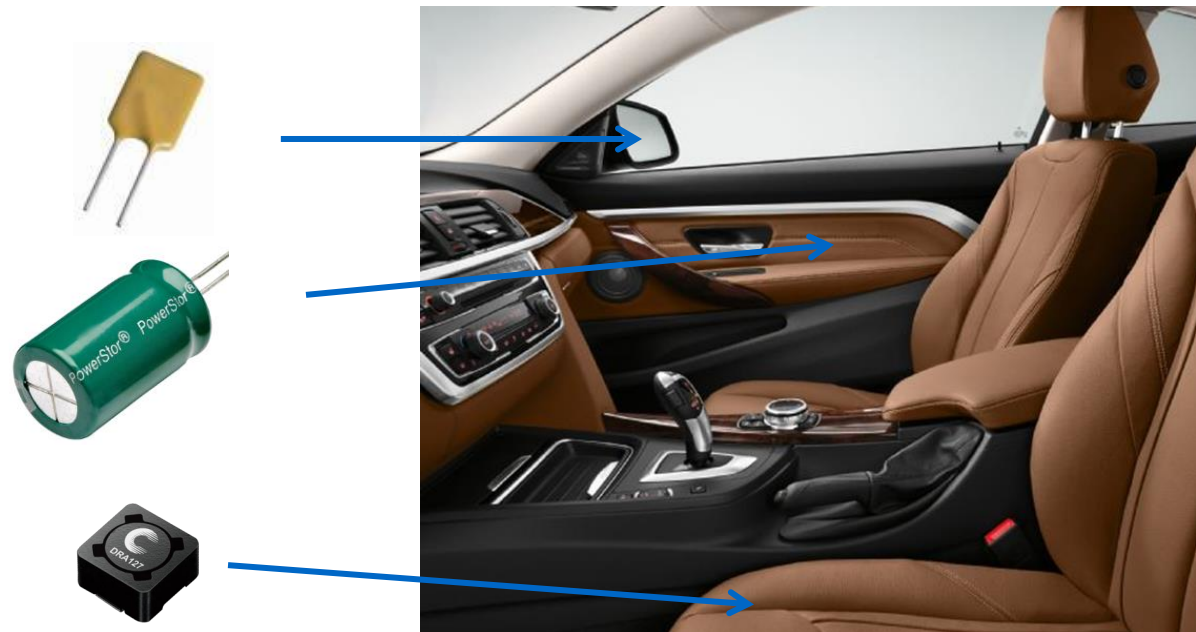
# Market Served: ECU, TCU

- Standard inductors and custom design inductors & filters for engine and transmission control units
- Challenges: high power parts, high reliability for critical applications



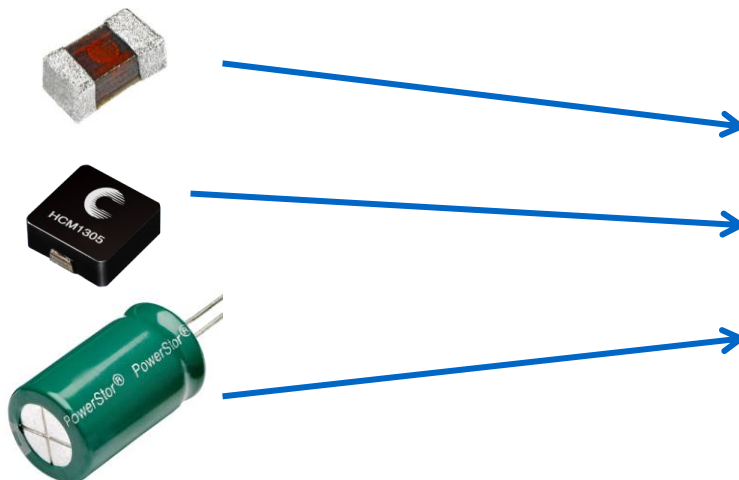
# Market Served: Body Electronics

- Standard inductors, supercapacitors and resettable fuses for power doors, windows, seats, windows and suspension systems
- Challenges: high reliability, high shock&vibration performance



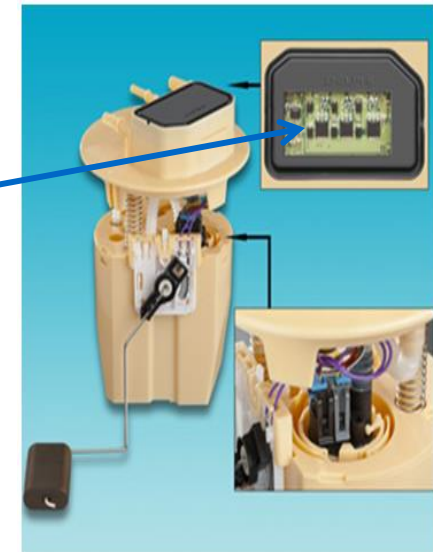
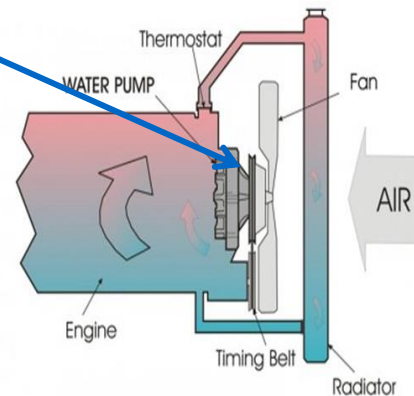
# Market Served: Telematics

- Low EMI inductors for powering - HCMA with special winding
- Ultra low capacitance ESD suppressors for high speed signal line and antenna port protection (4G GSM modems) – 0402ESDA with 0.05pF
- Supercaps for backup power in case of power loss in accident or vehicle theft – PHV series
- Challenges: small size, high frequency operation, high reliability



# Market Served: Water, Fuel Pump & Cooling Fan

- High current inductors (HCM1A) for motor filter
- Challenges: high temperature operation (up to 140C board temperature), very high power density, very low DCR



# Automotive Product Selector

<http://busmannliterature.com/automotive/viewer.php>

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**Automotive Electronic Solutions**  
Select application and product to view data sheet.

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 AIRBAG CONTROL UNIT  
 POWER DOORS, WINDOW LIFT, MIRROR SEAT CONTROL  
 PORT POWER/USB HUB  
 ENGINE START  
 ENGINE & POWERTRAIN CONTROL MODULE  
 ELECTRONIC POWER STEERING/ELECTRIC PARKING BRAKE  
 HEADLAMP, TAIL LAMP, INTERIOR LIGHTING  
 DIGITAL INSTRUMENT CLUSTER  
 ADVANCED DRIVER ASSISTANCE SYSTEM

HCMA1305 Inductors  
 HCMA1707 Inductors  
 DRA Inductors  
 CC12H Chip Fuses  
 ATC Blade Fuses  
 MAX Blade Fuses

# Partnership With IC Manufacturers



✓ Excellent partnership with IC houses  
✓ Thousands of reference designs





# Contact Info Eaton ELX

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