Pulse
a YAGEO company

Specialized Power PBU

Product Guide

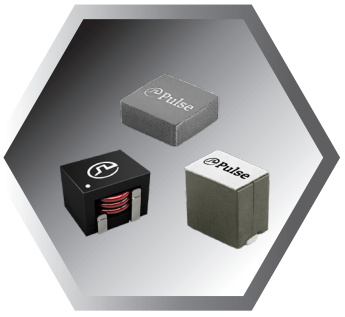
Q2 2024

Pulse

a YAGEO company

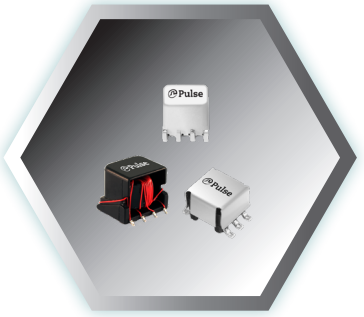
Our Products

from mW to kW,
we will help make your next great product a reality



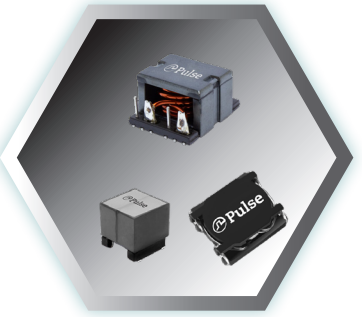
Power Inductors

- Power Bead, TLVR, Round Wire, Planar, Toroidal Constructions
- Over 100Apk



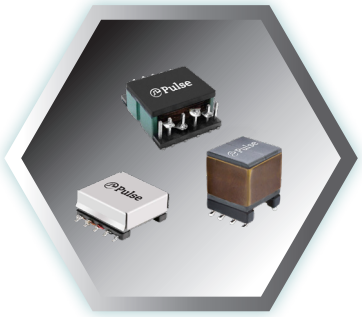
Isolation Transformers

- Push-pull, Flyback and H-Bridge topologies
- Functional, Basic and Reinforced Insulation
- Up to 5kVrms Hi-pot



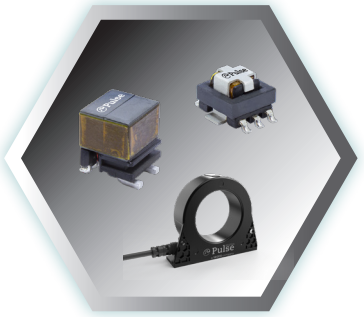
Common Mode Chokes

- NiZn, MnZn and Nanocrystaline Materials
- Up to 45Arms



Switch Mode Transformers

- Multiple Topologies
- Up to 800W
- Functional, Basic and Reinforced Insulation



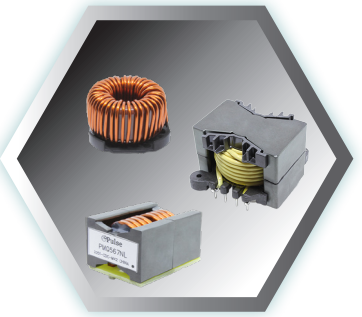
Current Sense Magnetics

Current Sense Transformers

- Functional, Basic and Reinforced Insulation
- Up to 50Arms

Rogowski Coils

- Round, Rectangular, Oval
- FLEXROGO
- Up to 450mV/KA



Custom Power Magnetics

- Small form factor and high power
- Modifications to exisitng catalog
- Full customs for unique solutions

Table of Contents

Pulse offers a complete range of magnetics for high-frequency switching power supply applications. Our experts also have the capacity to design and manufacture a wide array of custom and application specific magnetics.

SPECIALIZED POWER PRODUCTS

POWER PRODUCTS

BUSINESS UNIT

AEC-Q200 · MSL · ROHS COMPLIANT

Pulse Electronics Power PBU has been designing and manufacturing power magnetic components for more than 50yrs. We have a rich history of product and manufacturing innovation, a diverse patent portfolio and world class automated assembly and test which allows us to ramp quickly and produce cost-effective, high-quality, robust and reliable components.

We offer a complete line of catalog power magnetics for switch mode power applications including Power Inductors, Power Transformers, Isolation Transformers, Current Sense Magnetics and Common Mode Chokes in through-hole, surface mount and pin-in-paste terminations. In addition to our extensive catalog line we also design and manufacture custom and application specific magnetic solutions for our key OEM, EMS and Distribution partners.

OUR MARKETS

Pulse Power PBU strives to be a true design and production partner for our customers by utilizing our:

Communications

Industrial

Computing

Transportation

- Proven design and manufacturing expertise:
  - o 3D mechanical modelling and FEM
  - o Safety Agency Engineers
  - o Component level efficiency testing.
- In-house AEC-Q200 stress test qualification capabilities.
- ISO and IATF certified manufacturing sites.
- Localized technical support from experienced Product Marketing and Field Application Engineers.

From small consumer devices to large utility installations, power magnetics are everywhere

FEATURED PRODUCTS: NEW IN 2024

Dual Winding TLVR Inductor 70nH to 200nH, 145Apk

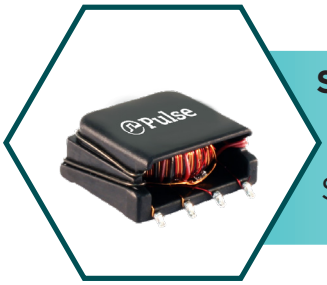
Series: PAL6373, PAL6374, PGL6380, PGL7250, PGL7195 & PGL7005

Compensation Choke Power beads for TLVR applications

Series: PGL6312 and PAL6364

High Frequency Flat Coil Inductors 2.2uH, up to 22A

Series: PGL6459 & PGL6704

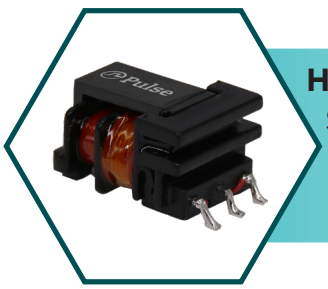


Sidecar Reinforced Insulation, 13.2mm creepage

Series: PGG6457 & PMG6457

EP7 Platform Functional & Basic Insulation for Automotive

Series: PM9572



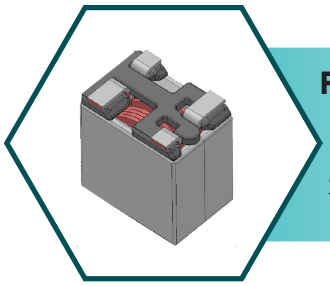
High Isolation UI5 2W LLC SiC & GaN drive Transformer

Series: PMT6709

FEATURED PRODUCTS: NEW IN 2023 CONT'D

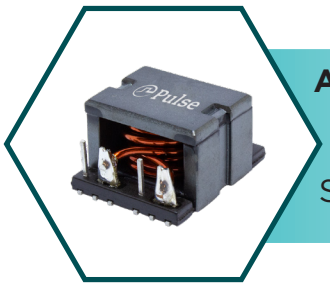
IATF SLIC & Shasta CMC's
94uH/1.1A to 380uH/20A

Series: PM274x & PM275x



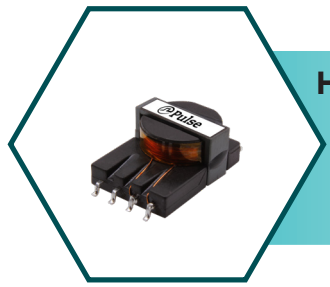
Flatcoil Common Mode Chokes
ER19, 225uH/25A/18A

Series: PGC6895



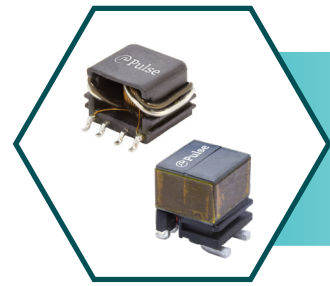
Automotive Grade Common Mode Chokes
Up to 39Arms in SMT Platform

Series: PM9407 & PM9408



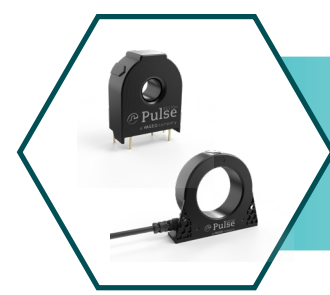
High Isolatation Current Sense Transformer
Up to 50 Arms, 5000 Vdc Isolation

Series: PAS/PMS6322



Compact, Safety Compliant, Current Sense
Transformers

Series: PH9500 & PH9505



Rogowski Coil Current Sensors
Dynamic Range from 1A to 2500A

Series: RC01/RC03/RC05

POWER INDUCTORS

OVERVIEW

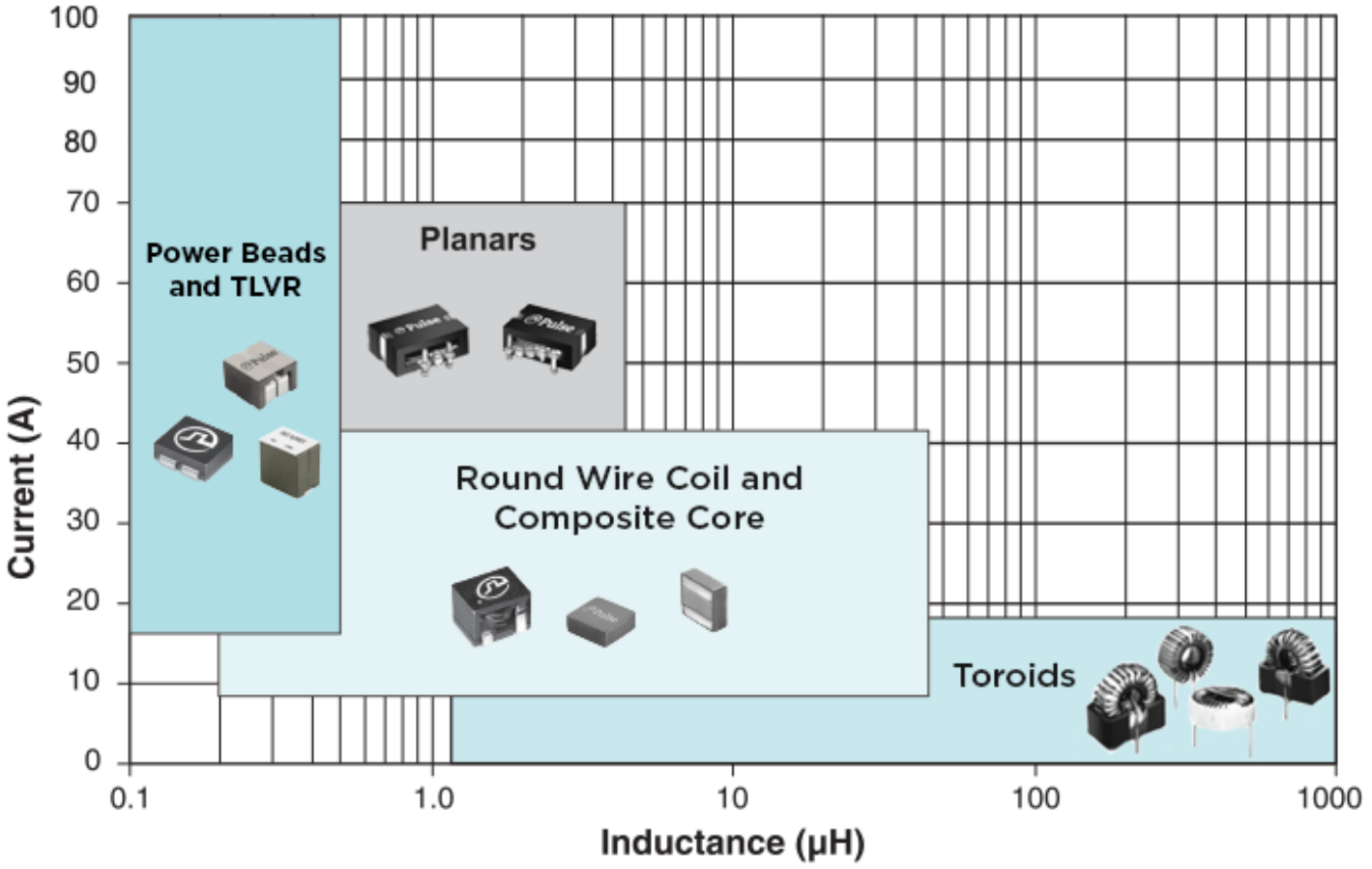
Power Inductors are used in virtually every electronic system and every market segment from small sub-watt wearable and hand-held devices to large kilowatt and megawatt industrial power installations. They can be used in a variety of functions including differential mode filtering, output chokes and as the main energy storage device in multiple power supply topologies.

The key parameters when selecting a power inductor are:

- Inductance value which will be based on the requirements of the circuit application.
- Current rating to ensure the part will not overheat and that is is compatible with the circuit requirements.
- Saturation current to ensure the component will not saturate at peak application current.
- AC core and AC conductor loss calculation to verify thermals and efficiency.

Pulse Power Inductors come in a wide-range of product technologies including power beads, molded, composite, round wire coils, drum cores, flat wire, planar and toroids. Offerings range from a few mA to 150Apk, from 20nH to 10mH in both surface mount and through-hole configurations.

PRODUCT OVERVIEW: SMT POWER INDUCTORS



Power Bead Inductors:
Low Inductance (<0.5uH), high current (>100Apk) applications for single and multi-phase applications.

Dual Winding TLVR Inductors:
Low Inductance (<0.2uH), high Current (>44Apk) for quick transient response applications

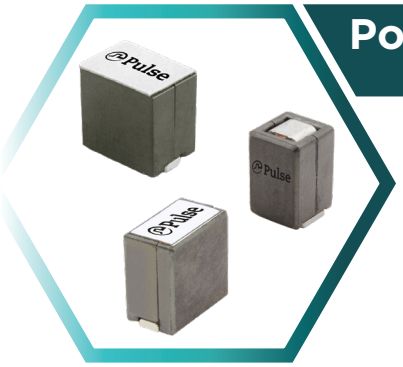
Planar Inductors:
Mid-Inductance (0.5 to 4uH), high current (>73A) applications.

Round Wire Coil Inductors:
Mid-Inductance, High-Efficiency Inductors (0.3 to 20uH) up to 50A.

Composite Core Inductors:
Mid-Inductance (0.1 to 20uH), wide current (0.5 to 32A) applications, high power density.

Toroid Inductors:
Versatile multi-use platforms for single and dual winding applications.

POWER INDUCTORS: PRODUCT TYPES

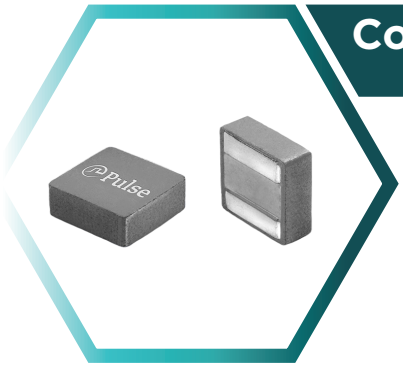


Power Bead Inductors

- Commonly used for high current multi-phase application for powering processors, memory modules, high current ASICs and FPGs
- 1T or 2T structure for ultra low DCR (<0.120uOhms)
- Ferrite core to minimize AC loss and maximize energy storage density
- 20nH to 1uH, >140Apk
- 30+ platforms sizes (4x4mm to 13x13mm)

Dual Winding TLVR Inductors

- Used in Multi-phase and Vcore regulators with fast transient requirements
- Dual winding to quick reaction to a sudden change in load
- 1000V isolation between windings
- 70nH to 200nH, up to 145Apk
- 9 platform sizes (10x5x6mm to 12x6x12mm)
- Range of matching compensation inductors available



Composite Inductors

- Commercial (130C) and Automotive Grade (155C)
- Highest Energy Storage and Low DCR
- 200nH to 50uH
- >120Apk
- 40+ platform sizes from 4x4x2.0mm to 16x16x13mm

POWER INDUCTORS: PRODUCT TYPES CONT'D

Round Wire Coil Inductors

- Ferrite Core for low AC Losses
- Designed to minimize PCB area
- 300nH to 100uH
- >80Apk
- 6 platforms from 7x7x6mm to 26x26x15mm

Alternate Constructions

- Planar Inductors: Typically, low profile, high current (>30Arms) utilizing a ferrite core and copper plate windings.
- Toroid Inductors: Round magnet wire wound on distributed gap powder material cores. Soft saturation and excellent shielding.
- Flat Coil Inductors: Utilize flat wire coil for the windings to create a low DCR and low profile high current solution
- Wire-wound Inductors: General purpose inductors wound with round magnet wire and using a gapped ferrite core.

POWER INDUCTORS

POWER BEAD INDUCTORS

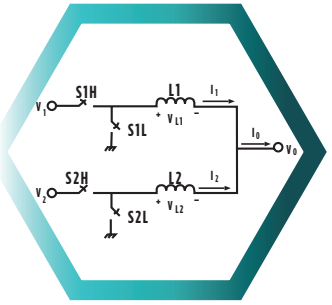
AEC-Q200 MSL 1 ROHS COMPLIANT

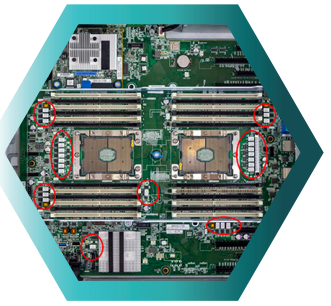
Power bead inductors are typically used in high current multi-phase voltage regulators that power processors, memory modules and high current ASICS and FPGAs in a wide range of applications including servers, graphic cards, storage and data centers. In a multiphase architecture the current is broken into parallel paths and the operation (turn on/off) of each path is staggered such that the combined ripple current at the output is much less than that of each individual path. This ripple cancellation allows for the use of very small inductance values (50-300nH) in each path which means the power supply can respond to changes in load (transient response) much faster than a single phase implementation.

Pulse has been a world leader in power bead inductors since their inception over twenty years ago. Our high volume automated manufacturing enables us to produce components that are cost-effective while maintaining exceptional quality and reliability. Our relationships with top OEMs and Power IC manufacturers ensures that we have a wide-range of high energy density solutions and the lowest power loss.

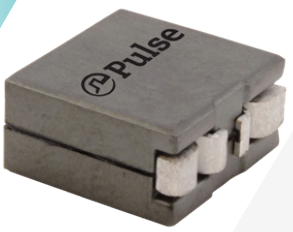
FEATURES & BENEFITS

- Single turn construction for ultra low DCR
- Ferrite core miånimizes AC loss
- Highest energy density (uJ/cm3)
- Inductance range from 20nH to 1uH
- Multiple footprints (4x4mm to 13x13mm)
- Flat inductance with frequency
- Fully automated assembly for low cost
- High reliability and exceptional quality





Part Number	DCR (mΩ nom)	Dimensions (mm Max)			0 100nH 200nH 300nH 400nH 500nH 600nH 700nH 800nH 900nH 1uH
		L	W	H	
PA5189	0.390	4.1	4.1	4.1	20.5Apk
PA2983	0.330	4.0	5.0	4.0	75Apk 29.5Apk
PA5190	0.290	5.3	5.1	6.6	78Apk
PA4059	0.200	5.7	5.5	4.6	50Apk
PG2110	0.220	8.0	5.0	8.0	75Apk 41Apk
PA5016	0.125	9.0	5.0	9.5	76Apk 23Apk
PAL6055	0.230	10.0	4.5	10.0	134Apk 107Apk
PA5587	0.200	7.5	6.2	8.5	114Apk
PA5041	0.290	7.2	6.7	11.2	89.4Apk 31Apk
PA0512	0.320	7.0	7.0	5.0	58Apk 30Apk
PA1682	0.500	8.0	7.0	4.0	63Apk 26Apk
PA2083	0.600	7.6	7.4	7.0	93Apk 32Apk
PA2509	0.350	7.0	8.5	8.0	107Apk 32Apk
PA5615	0.130	10.0	6.0	9.0	84Apk
PA4990 PAL6101	0.125	10.0	6.0	12.0	178Apk 40Apk
PA3288	0.290	9.6	6.4	8.0	70Apk 34Apk
PG1712	0.170	9.6	6.4	9.3	75Apk 33Apk
PA5040	0.150	10.0	6.5	11.0	144Apk 36Apk
PA4025	0.290	10.0	6.8	12.3	75Apk 35Apk
PA4390	0.185	10.0	7.0	10.0	75Apk 43Apk
PA4987	0.810	10.0	7.0	10.0	32Apk 17Apk
PA5034	0.400	10.0	7.0	10.0	40Apk 30Apk
PA0511	0.290	10.2	7.0	5.0	75Apk 33Apk
PA5191	0.150	11.4	7.5	11.0	144Apk 96Apk
PA3779	0.350	10.0	7.0	8.0	
PA3784	0.180	10.0	8.0	8.0	94Apk 67Apk
PA4499	0.170	10.4	8.0	10.0	120Apk 38Apk
PA2607	0.290	10.4	7.9	7.5	94Apk 32Apk
PA1320	0.480	10.4	8.0	6.5	74Apk 32Apk
PA4060	0.290	10.4	8.0	7.5	94Apk 35Apk
PA2982	0.350	11.0	8.0	5.0	93Apk 42Apk
PA5187	0.120	10.8	8.2	8.2	100Apk 55Apk
PA4085	0.180	11.0	8.2	9.2	94Apk 72Apk
PA4272	0.200	12.8	7.3	10.1	94Apk 80Apk
PA3790	0.290	12.5	8.0	8.0	98Apk 63Apk
PA4228	0.130	12.8	8.3	9.0	80Apk 64Apk
PA5300	0.100	11.0	10.0	15.5	144Apk 80Apk
PA3136	0.230	13.8	8.0	4.0	60Apk 26Apk
PA2202	0.480	12.1	10.0	6.0	84Apk 30Apk
PA0515	0.630	11.2	11.2	9.0	68Apk 30Apk
PA0513	0.320	13.5	13.0	8.0	71Apk 35Apk
PA2891	0.220	13.7	13.0	8.0	85Apk 38Apk
					0 100nH 200nH 300nH 400nH 500nH 600nH 700nH 800nH 900nH 1uH



POWER INDUCTORS

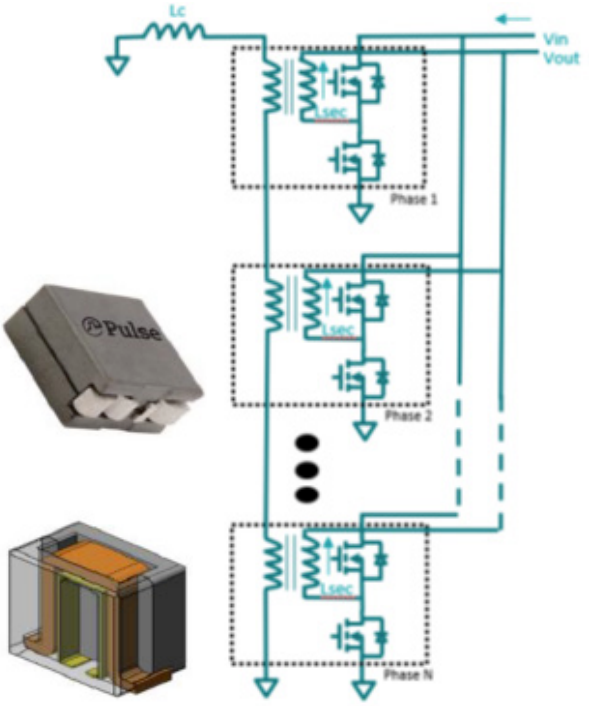
TRANS-INDUCTANCE VOLTAGE REGULATOR (TLVR) INDUCTORS

The TLVR has emerged as a promising topology for powering low-voltage, high-current, multi-phase applications such as data centres, storage systems, graphics cards, and personal computing. These systems require a reliable and efficient power delivery solution that can support processors, memory, and high-current ASICs and FPGAs.

Traditionally, non-TLVR multi-phase circuits have been used to meet these requirements. However, the increasing demands of these applications have led to the limitations of the traditional approach. When there is a sudden change is load current, each of the individual phases of the muti-phase buck regulator needs to adjust its duty cycle sequentially in order for the output current to react to the new requirement. This can result in a temporary but unacceptable droop of output voltage during this transition.

In May 2019, the TLVR circuit was introduced in the TD Commons, proposing a novel approach that replaces the traditional bead inductors with trans-inductors (1:1 ratio transformers). This change dramatically improves the transient response as the duty cycle of each phase can now be adjusted simultaneously via a sense winding that is coupled with the main winding in each TLVR inductor.

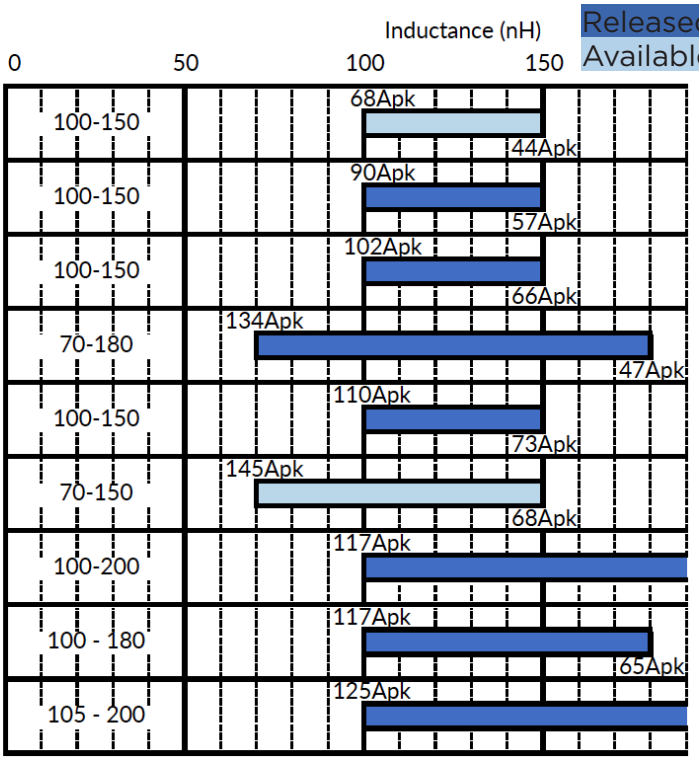
Building on our existing Power Bead manufacturing expertise and our 3rd party relationships with the Power IC suppliers that are driving these innovations, Pulse has developed dual winding TLVR inductors and is expanding its range of TLVR solutions for both the main and compensation inductors.



FEATURES & BENEFITS

- Dual winding to sense load changes
- 70nH - 200nH
- Up to 145Ap
- Better transient performance compared to multi-phase buck.
- Potential for lower switching frequency, reduced switching losses
- Less output capacitance for lower BOM cost

Part Number	Dimensions (mm Max)		
	L	W	H
PGL7195 (0.50mΩ)	10.2	5.0	6.0
PGL7250 (0.55mΩ)	13.0	8.0	5.0
PGL6520 (0.125mΩ)	9.6	6.4	12.0
PAL6374 (0.135mΩ)	10.0	5.0	12.0
PGL7005 (0.125mΩ)	10.0	6.0	12.0
PGL7093 (0.125mΩ)	12.0	5.0	12.0
PGL6380 (0.125mΩ)	12.0	6.0	11.2
PAL6373 (0.14mΩ)	12.0	6.0	12.0
PGL6215 (0.125mΩ)	12.0	6.0	12.0



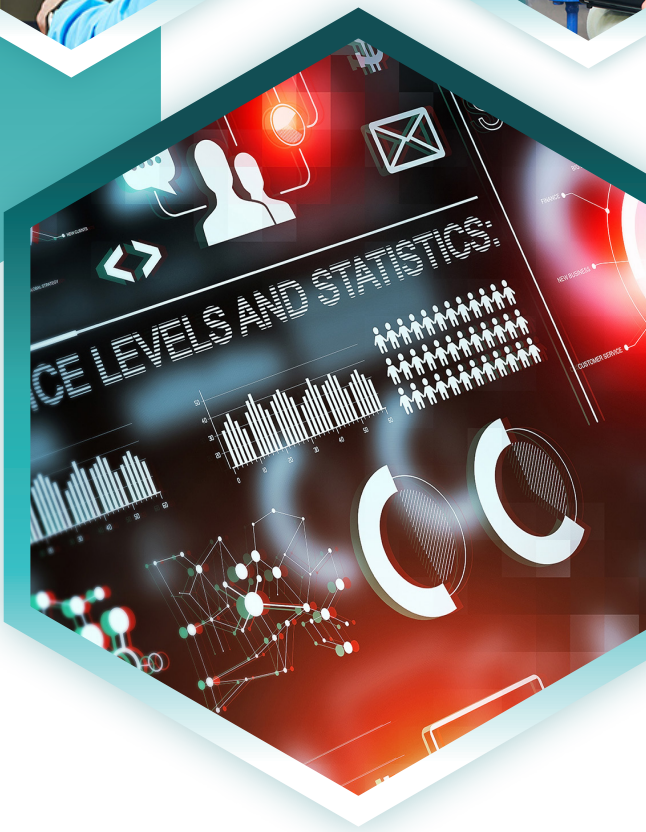
POWER INDUCTORS

ROUND WIRE COIL

AEC-Q200 MSL 1 ROHS COMPLIANT

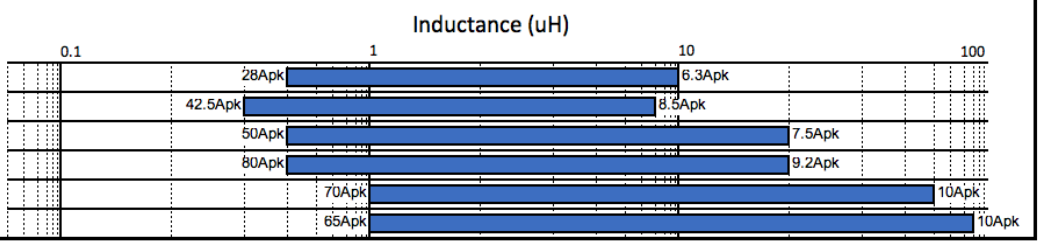
Our round wire coil (RWC) inductors come in six platform sizes and enable the highest efficiency of any SMT inductor through the use of a low loss ferrite core material which minimizes AC losses and also eliminates thermal ageing. The use of round magnetic wire instead of rectangular flat coils enables a lower cost while still maintaining a low DCR and small footprint. The platforms have passed the AEC-Q200 stress test qualification proving the designs robustness and suitability for difficult environments but the parts are not IATF certified. The six platforms range in size from 7.6x7.4x6.4mm to 26x26x15mm and are suitable for a wide range of applications and markets including communications, computing and industrial.

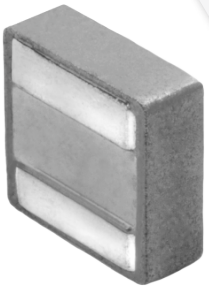
FEATURES & BENEFITS



- Higher profile to minimize PCB footprint
- Ferrite core to minimize AC losses
- AEC-Q200 Qualified
- Larger terminations for lower DCR and stronger solder joint
- Suitable for High Frequency Applications
- Computing, Communications and Inductrial Applications

Part Number	Industry Size Code	Dimensions (mm Max)		
		L	W	H
PG0871	-	7.6	7.4	6.4
PG0702	-	10.8	9.2	8.0
PG0926	-	13.4	13.4	8.0
PG0936	-	17.5	16.7	10.0
PG1083	-	21.7	21.5	12.5
PG1096	-	26.0	26.0	14.8





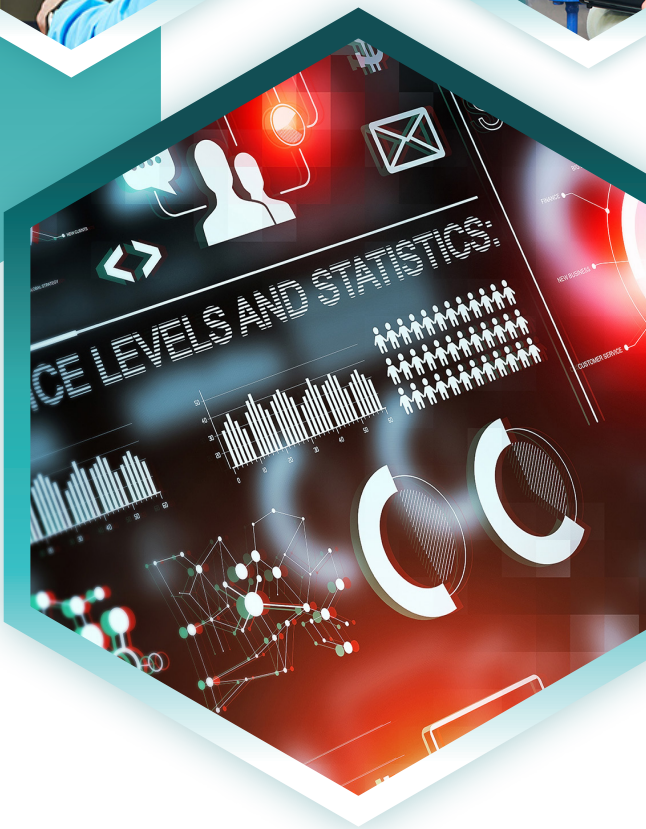
POWER INDUCTORS

HIGH CURRENT COMPOSITE CORE

AEC-Q200 MSL 1 ROHS COMPLIANT

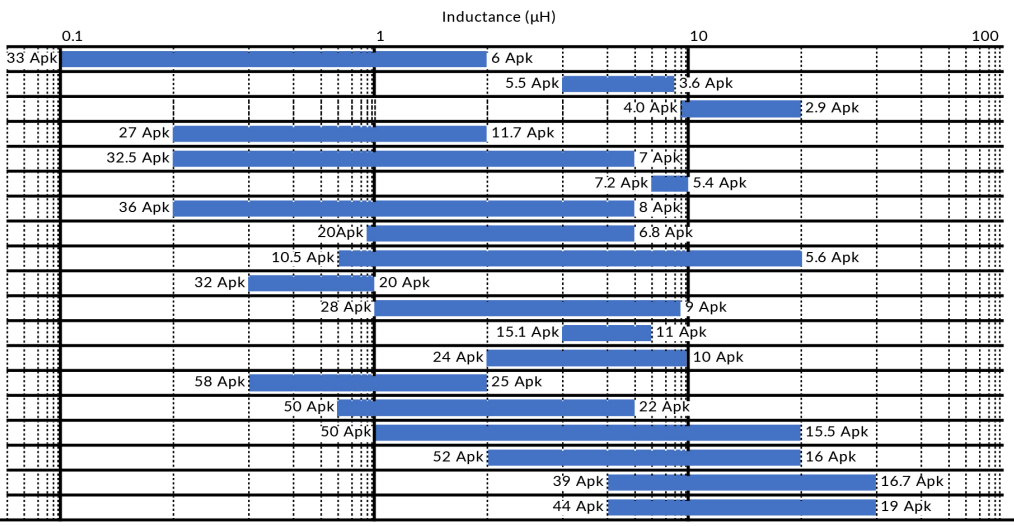
Our composite core inductors come in multiple platform sizes and provide a fully shielded, high energy storage, soft saturation solution for applications up to 120Apk current. The construction enables the highest energy density of any available SMT inductor and also minimizes acoustic noise. With commercial grade and automotive grade both offering a -55C to 155C operating temperature range, they cover a wide range of applications and markets including Datacom, Computing, Industrial and Automotive.

FEATURES & BENEFITS



- Low Profile, High Current Applications
- Composite core material for higher energy storage density
- Lowest DCR/mm3
- Soft saturation characteristics
- Larger terminations for lower DCR and stronger solder joint
- Computing, Communications, Industrial and Automotive Applications
- Excellent temperature stability
- Handles high transient current spikes without saturation
- Suitable for High Frequency Applications

Part Number	Industry Size Code	Dimensions (mm Max)		
		L	W	H
PA5001/PM2201	4020	4.3	4.3	2.1
PA5430/PM5430	4030	4.3	4.3	3.1
PA5431/PM5431	4040	4.3	4.3	4.1
PA5002/PM2202	5020	5.7	5.7	2.1
PA5003/PM2203	5030	5.7	5.7	3.1
PA5175/PM5175	5050	5.7	5.7	5.0
PA5004/PM2204	6030	6.8	6.6	3.1
PA5005/PM2205	6050	6.8	6.6	5.0
PA5432/PM5432	6060	6.8	6.6	6.1
PA5006/PM2206	7020	8.0	7.8	2.1
PA5007/PM2207	7030	8.0	7.8	3.1
PA2240/PM2240	7070	8.0	7.8	7.0
PA2241/PM2241	8080	8.6	8.3	8.0
PA2242/PM2242	1030	11.8	10.5	3.1
PA2243/PM2243	1060	11.8	10.5	6.0
PA2244/PM2244	1010	11.8	10.5	10.0
PA5433/PM5433	1580	16.8	15.8	8.0
PA2247/PM2247	1510	16.8	15.8	10.0
PA2248/PM2248	1513	16.8	15.8	13.0



POWER TRANSFORMERS

OVERVIEW

AEC-Q200 · IATF 16949 · MSL · ROHS COMPLIANT

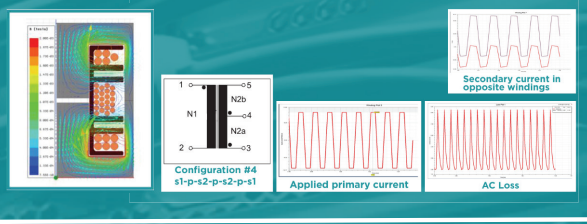
Power Transformers are used to convert voltages and isolate signals for functionality and safety. Our broad line of catalog (up to 800W) and custom (up to 22kW) solutions are used in multiple topologies including flyback, forward, push-pull, resonant, LLC and phase shifted full bridges. Typical operating frequencies are between 80-500kHz but solutions can be adapted for greater than 1MHz operation.

Our designs include surface mount, through hole and pin-in-paste terminations using a wide range of winding technologies including wire-wound, flat wire, foil, copper plate and PCB constructions. Our catalog and customer solutions include Class B (130C), Class F (155C) and Class H (180C) insulation systems for functional, basic and reinforced safety isolation requirements complying to the latest safety standards.

With local technical support in all regions, advance simulation tools and an experienced design team we can help to optimize your power solutions.

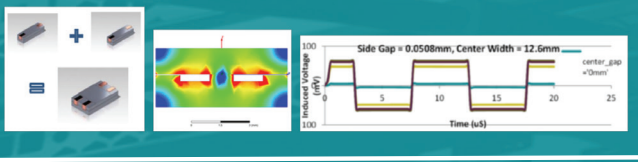
AC Proximity Analysis

❖ Simulate all AC losses associated with fringing and proximity and running optimization.



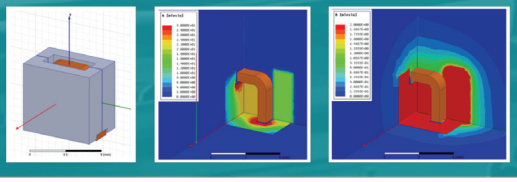
Component Integration Analysis

❖ Enables Integration while ensuring minimized coupling



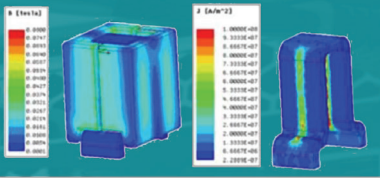
Radiated Field Analysis

❖ Ability to 'look' at the radiated field and make appropriate modifications during the design process.



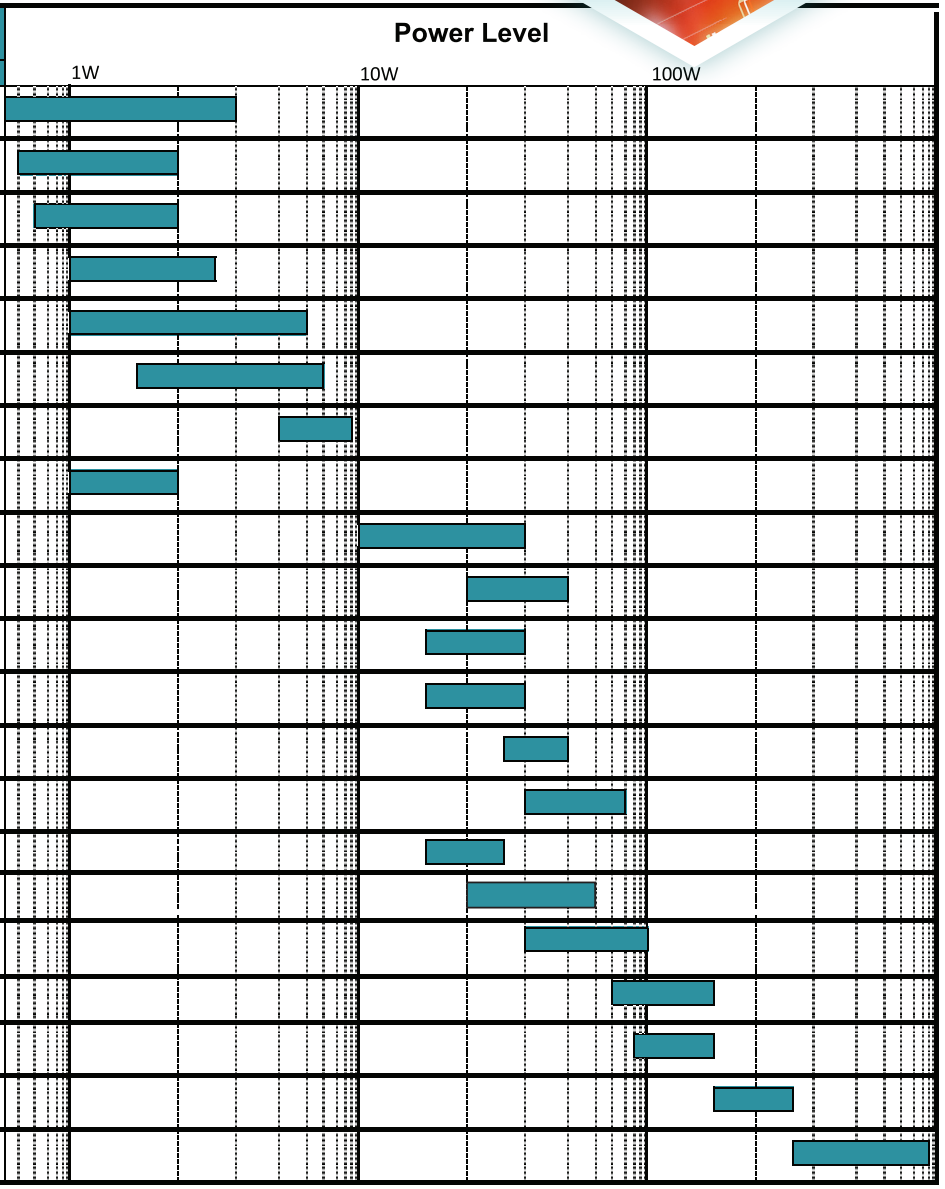
AC Gap Losses

❖ Ability to visualize and predict gap losses.



PRODUCT OVERVIEW SMT POWER TRANSFORMERS

Power Transformer Platform		Safety Insulation	Dimensions (mm Max) L	W	H
	Mini-Drum	Functional	6.4	6.2	3.6
	Shasta	Functional	9.0	8.6	7.6
	ER7.5	Functional	9.5	8.0	6.0
	ER9.5	Functional	12.1	10.7	6.6
	ER11	Functional	12.7	11.4	6.6
	ER14	Functional	16.5	15.5	7.6
	EP7	Functional	13.4	10.7	9.3
	EP9	Basic CR 2.9mm	10.3	10.5	12.5
	EP10	Functional	15.2	13.1	11.5
	EP13	Functional	17.7	14.0	12.7
	EP13R	Reinforced CR 8mm	17.7	13.5	16.0
	EP7+	Functional	13.6	11.0	13.5
	EP10+	Functional	15.5	13.0	15.5
	EP13+	Functional	17.7	14.5	14.0
	EFD15	Functional	22.2	17.2	8.4
	EFD15+	Functional	22.3	16.5	10.5
	EFD20	Functional	29.2	21.6	11.4
	EFD25	Functional	32.0	26.4	13.7
	ER19	Functional	24.7	21.6	9.1
	ER25	Functional	29.5	25.4	9.1
	ER25+	Functional	33.5	26.4	18.3



HIGH ISOLATION TRANSFORMER PLATFORM

OVERVIEW

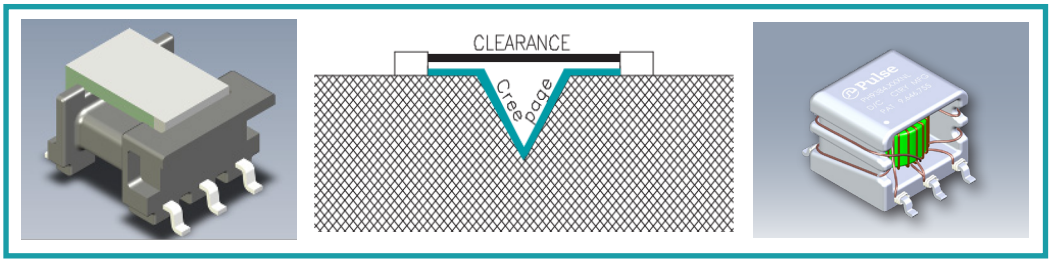
Pulse high isolation transformers use innovative mechanical design and enhanced wire insulation to maximize electrical isolation. While all transformers provide electrical isolation (the elimination of a conductive path) and functional insulation (the physical barrier that guarantees this electrical isolation), further requirements are introduced for safety standard compliance:

1) Safety Insulation – A higher level for insulation than required for purely functional operation that accounts for the micro-environment of the transformer and other influencing stresses. Basic and Reinforced insulation compliance imposes requirements for withstand voltage measurement, wire insulation selection and physical separation of non- insulated conductive materials.

2) Working Voltage – The highest voltage differential across the insulation barrier during normal operation. This is a safety standard input parameter. Along with the inputs of insulation material type and level of air pollution, separation requirements for non-insulated conducted elements are defined.

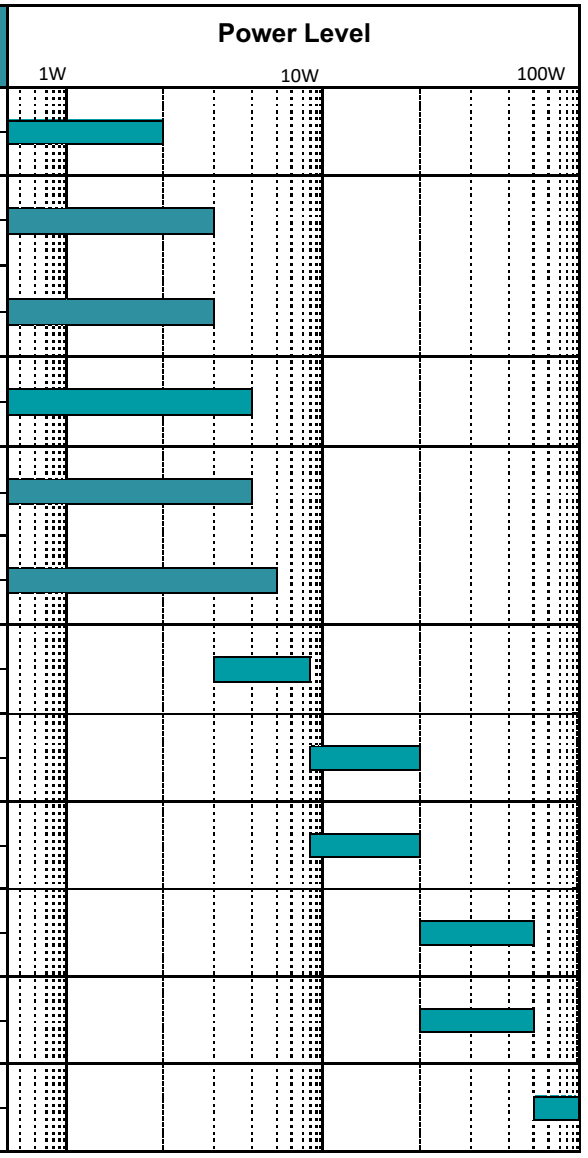
3) Creepage and Clearance Distance – Clearance is the shortest distance through air, creepage is shortage distance along the surface of insulation between non-insulated conductive elements within the transformer. The safety standard defines minimum separation distances for both. The creepage/clearance/withstand voltage capabilities of the Pulse isolation transformer platforms are summarized in the following chart.

4) Withstand Voltage – The test voltage that is applied without insulation breakdown or flash over across the insulation barrier. This is the measure of electrical isolation capability, the requirement increasing for higher levels of safety insulation and working voltage. Withstand voltage is commonly referred to as dielectric strength or hi-pot.

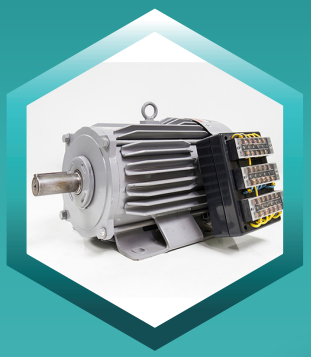


HIGH ISOLATION PLATFORM OVERVIEW

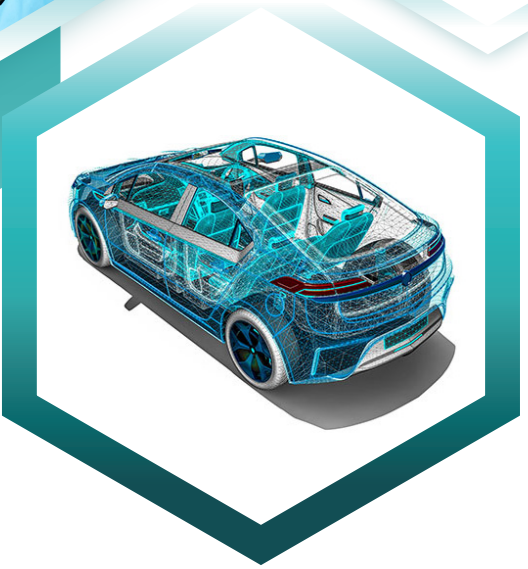
Isolation Transformer Platform	Dimensions LxWxH (mm Max)	Creepage & Clearance Distance (mm Min)	Safety Insulation	Isolation Voltage (Vrms)	Working Voltage (Vrms)
UI5 1	11x8.5x6.3	6.0 4.5	Basic	3000	600
			Reinforced	3000	300
UI5 2	17 x 11 x 8.5	9.1 7.0	Basic	3000	850
			Reinforced	4000	600
Sidecar 1	12.5x9.2x7.6	11 9.5	Basic	4000	1000
			Reinforced	4000	470
Sidecar 2	17 x 16 x 7.5	13 13	Basic	3000	1300
			Reinforced	4000	650
Encapuslated Toroid	15.3x12x9.7	8.0 8.0	Basic	3000	800
			Reinforced	5000	400
Open Frame Toroid	29 x 20 x 12.5	24 24	Basic	3000	1500
			Reinforced	5000	1250
EP7R	13x10x12.5	8.3 8.3	Basic	4000	830
			Reinforced	5000	415
EP13R	17.5x13.5x16.5	8.0 8.0	Basic	4000	800
			Reinforced	5000	400
EFD15R	21.85x16.5x11	9.6 4.8	Basic	4000	880
			Reinforced	6000	480
EP17R	24.6x19x18.5	18 9.0	Basic	4000	1000
			Reinforced	6000	900
EFD20R	30.8x21.8x13.5	11 8.0	Basic	4000	1000
			Reinforced	6000	500
EFD30R	40.6x31.8x16.2	16.6 5.2	Basic	4000	952
			Reinforced	6000	800



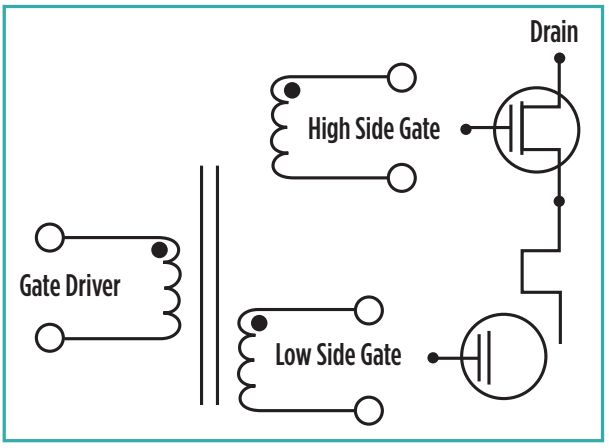
The IEC61558-1 safety standard is referenced for the corresponding working voltage for basic and reinformed insulation compliance, based on insulation material group III and pollution degree 2 and the selected wire insulation. Please contact Pulse Electronics for your next isolation transformer need for a safety compliant solution based on one of these platforms.



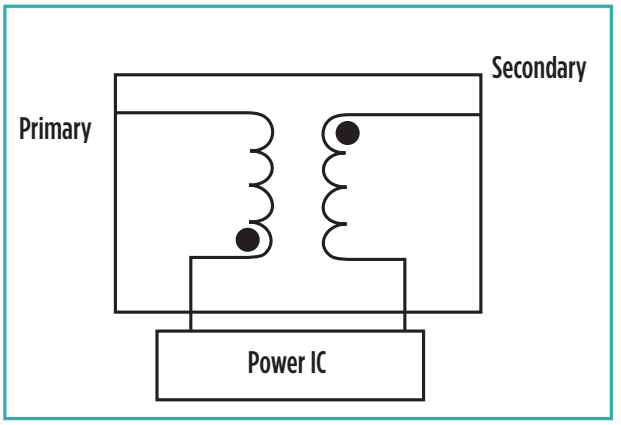
SMT ISOLATION TRANSFORMERS



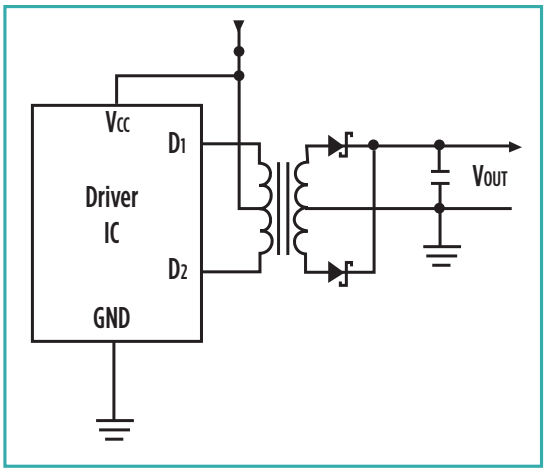
High Side, Low Side H-Bridge



Flyback Isolation Transformer



Push-pull Isolation Transformer

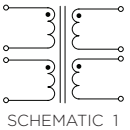


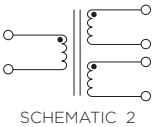
SMT Isolation Transformer Solutions

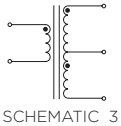
	Dimensions			Series	Isolation Voltage (Hi-pot)	Insulation Type	UL Creepage Distance (Pri-Sec)	Volt-usec Rating (V-usec)	Topology	IATF
	L	W	H							
	6.6	5.8	5.3	PH9084	1500Vrms	Functional	-	28-37	Energy Transfer (schematic 1)	-
	7.1	6.1	5.5	PA2777	1500Vrms	Basic	1.4mm	9.3	Energy Transfer (schematic 4)	-
	8.0	6.6	5.3	P0926	1500Vdc	Functional	-	23	Energy Transfer (schematic 2)	-
	8.3	6.9	3.0	PG1427, PAG6658	2700Vdc	Functional Basic	2.8mm	21-30	Energy Transfer (schematic 3)	-
	8.6	6.7	2.5	PE-68386, PA2001	1500Vrms	Basic Functional	-	21-30	Energy Transfer (schematic 4)	-
	8.6	6.7	3.6	PA0264, PA2004	1000Vrms 1500Vrms"	Functional	-	12-20	Energy Transfer (schematic 2)	-
	9.5	7.1	5.3	PA1323	1500Vrms	Functional	-	21.7	Energy Transfer (schematic 4)	-
	10.2	7.5	11.0	PH9572, PH9572A PM9572, PM9572A	1500Vrms 2500Vrms	Functional Basic	12.0	42-84	Energy Transfer (schematic 1)	Yes
	9.5	8.1	5.1	PH9085, PM2180	2500Vrms	Functional		22-24	Energy Transfer (schematic 1)	Yes*
	10.5	9.0	6.5	PMT9085	3000Vrms	Reinforced	6.4mm	15-23	Energy Transfer (schematic 4)	Yes
	11.8	8.8	4.0	P0544, PA2002	"1500Vdc	Functional	1.4mm	45-60	Energy Transfer (schematic 2)	-
	11.8	8.8	4.0	PA0184, PA0297, PA0510, PA2007, PA2008, PA2009	1500Vrms	Basic	1.4mm	27-53	Energy Transfer (schematic 2)	-
	11.8	8.8	4.0	PA0173, PA0185 PA2005, PA2006	1500Vrms	Basic	1.4mm	17-26	Energy Transfer (schematic 2)	-
	10.9	9.7	2.7	PA3493	1650Vrms	Basic	1.4mm	21.7	Energy Transfer (schematic 4)	-
	10.0	10.0	12.5	PH9184	4000Vrms	Basic	4.0mm	200-296	Energy Transfer (schematic 1)	-
	10.0	10.0	12.5	PH9185, PM2190	5000Vrms	Reinforced	8.0mm	36-110	Energy Transfer (schematic 1)	Yes*
	10.5	10.3	12.5	PH9496	2500Vrms	Basic	6.2mm	-	Energy Transfer (schematic 4)	-
	9.2	12.5	7.6	PH9384, PM2185	4000Vrms	Reinforced	8.3mm	-	Energy Transfer (schematic 1)	Yes*
	13.0	10.0	12.5	PH0416, PM0416	5000Vrms	Reinforced	8.3mm	-	Energy Transfer (schematic 4)	Yes
	13.0	12.0	7.1	PH9363	2500Vrms	Basic	2.8mm	-	Energy Transfer (schematic 4)	-
	16.5	15.6	7.1	PH9385, PM2155 PAG6547, PMG6547	4000Vrms	Basic Reinforced	12.0mm	70-109	Energy Transfer (schematic 1)	Yes*
	16.7	16.5	14.2	PH9400, PH9400A	4000Vrms 5000Vrms	Basic Reinforced	12.0mm	125-375	Energy Transfer (schematic 1)	-

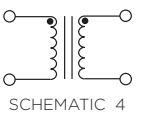
*See specific datasheeet for details

Available Schematics
(multiple turns ratios available)


SCHEMATIC 1


SCHEMATIC 2


SCHEMATIC 3


SCHEMATIC 4

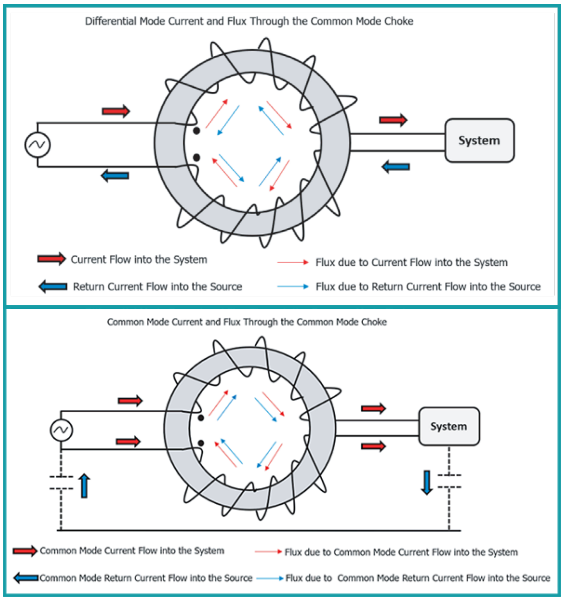
COMMON MODE CHOKES

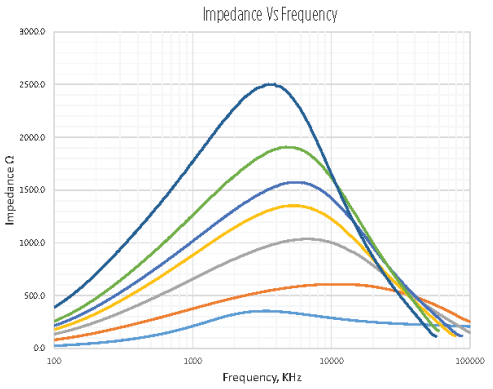
OVERVIEW

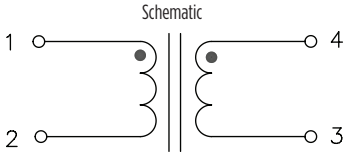
AEC-Q200 IATF 16949 MSL 1 ROHS COMPLIANT

Common Mode Chokes, are designed to attenuate and filter common mode noise within an electric system. The key parameters for a common mode choke are the current rating (to ensure the part does not overheat within the application), the impedance versus frequency (to ensure it is optimized to attenuate the desired frequencies), the isolation voltage (to ensure it meets board level requirements between the line and neutral phases) and safety isolation (to ensure it meets the safety requirements of the end-application). It is important to remember that common mode chokes cannot saturate in the application (under normal use) as they are designed to ensure that the line and return currents are balanced.

Pulse catalog parts are available with SMT terminations and toroid and shape core constructions for currents ranging from mA to 40Arms. Catalog automotive grade solutions are also available.



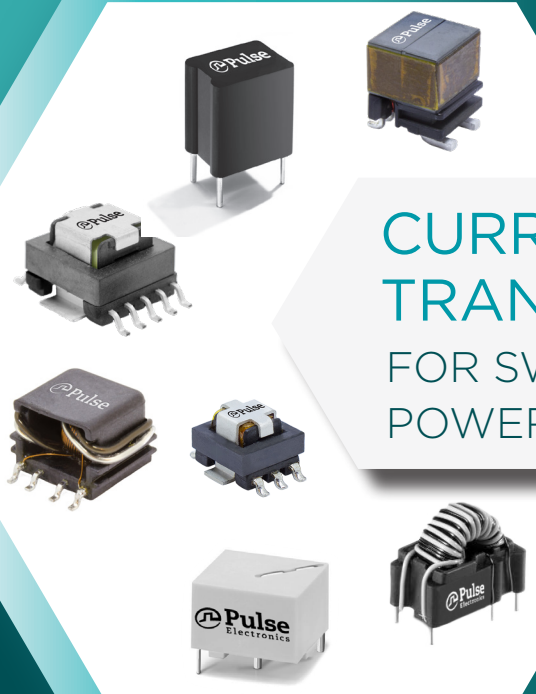




COMMON MODE CHOKES

SMT PRODUCT OFFERING

Reference Part Number		Platform Size (Max) L (mm)	W (mm)	H (mm)	SRF (typical)	Impedance @ SRF (typical)	Current Rating (Arms) 0A 5A 10A 15A 20A 25A 30A 35A 40A
	PA2742NL	9.1	8.9	7.9	6 MHz to 15 MHz	0.45 kΩ to 1.5 kΩ	
	PA2741NL			3.8			
	PM0354	13	13	5.6	2 MHz to 20 MHz	0.20 kΩ to 8.2 kΩ	
				8.6			
	PAC6006	15.5	13.5	13.5	3.4 MHz to 11 MHz	0.4 kΩ to 2.5 kΩ	
	PM53913NL	16.4	14.2	8.9	0.2 MHz to 3 MHz	1.4 kΩ to 6.5 kΩ	
	PM2750NL	18.2	15	7.6	2 MHz to 9 MHz	0.90 kΩ to 1.8 kΩ	
				10.0			
	PM0351NL	19.6	17	9.9	2.0 MHz to 18 MHz	0.20 kΩ to 27.5 kΩ	
	PA5140	19.5	19.8	19.2	2.8 MHz to 3.7 MHz	2.2 kΩ to 5.5 kΩ	
	PM2754NL	21.1	19.1	11.2	4.0 MHz to 6 MHz	0.25 kΩ to 0.6 kΩ	
	PM9407	24.9	21.6	16.9	1.4 MHz to 1.8 MHz	0.7 kΩ to 2.4 kΩ	
	PA5141	23.5	24.3	22.7	2.1 MHz to 3.4 MHz	1.1 kΩ to 4.2 kΩ	
	PM0429NL	28	25.4	10	4.0 MHz	3.1 kΩ	
	PM0502NL	31	25.4	12.7	2.5 MHz to 4 MHz	0.9 kΩ to 6.4 kΩ	
	PH9408	30.5	27	18	1.1 MHz to 1.3 MHz	0.5 kΩ to 5.5 kΩ	



CURRENT SENSE TRANSFOMERS

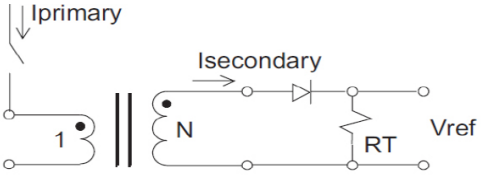
FOR SWITCH MODE POWER APPLICATIONS

AEC-Q200 · IATF 16949 · MSL · ROHS COMPLIANT

With the increased focus on end-product efficiency the need to accurately monitor current in electronic circuits is paramount. By accurately knowing the current in the system it is possible to identify issues, optimize efficiency and re-direct current flow as required. Broadly speaking current sense applications can be broken up into DC current applications (battery monitoring), low frequency sinusoidal applications (50/60Hz electrical transmission, distribution and storage systems) and high frequency applications (switch mode power supply circuits operating >40kHz). Within these broad groups there are a variety of current sense technologies available (basic shunt resistors, Hall Effect, magnetic transformer and AMR) and each has trade-offs in terms of complexity, size, cost, efficiency, accuracy and isolation. Perhaps the most versatile solution, for non-DC applications, is the use of a transformer and Pulse Electronics is a leader in market lead in both low frequency (https://egston.com/) and high frequency switch mode power solutions (https://www.pulseelectronics.com/current-sense-magnetics/). Transformer solutions are inherently electrically isolated and can be designed to easily comply with relevant safety standards, they offer very low loss, excellent accuracy over temperature and time and the cost and complexity are quite low.

When selecting a current sense transformer it is important to know:
* The maximum rms current that is going to be measured so that a thermally appropriate transformer can be identified.
* The isolation voltage required
* The insulation level (functional, basic, reinforced)
* Specific mechanical constraints.

In any practical application the only real 'limit' to the current sense operation is thermal. If too much current is applied to the primary it (and the secondary winding) may overheat so it is important to make the correct selection and test the transformer at maximum current and ambient temperature. Although users often worry about saturating the transformer it is almost impossible, in any realistic application, to do so as the saturation current is not related to large primary current (as this energy is not stored in the core) but rather the relatively low sensed voltage divided by the secondary turns and frequency. As long as the frequency is not too low (<kHz) then saturation is not an issue. However, this does highlight that switch mode power current sense magnetics cannot be used in 50/60/400Hz type applications.



TYPICAL APPLICATION CIRCUIT

CURRENT SENSE TRANSFORMERS

HIGH FREQUENCY PRODUCT OFFERING

	Dimensions (mm)			Series	Isolation Voltage (Hi-pot)	Insulation Type	UL Creepage Distance (Pri-Sec)	Current Rating	Primary DCR (MAX)	Available Turns Ratios	IATF
	L	W	H								
	8.4	7.2	5.5	P820x	500Vrms	Functional	-	10Arms	6.0 mOhms	1:20 to 1:125	-
	8.4	7.2	5.5	PA1005, PM2165	500Vrms	Functional	-	20Arms	0.75 mOhms	1:20 to 1:125	Yes*
	8.4	8.4	3.3	PA0368	500Vrms	Functional	-	4Arms	4.0 mOhms	1:50 to 1:125	-
	12.8	9.7	7.2	PH9494	2250Vdc	Functional	-	30Arms	0.35 mOhms	1:50 to 1:200	-
	13.6	12.8	14.4	PH9505	3000Vrms	Reinforced	6.5mm	30Arms	0.5 mOhms	1:50 to 1:180	-
	14.0	13.0	8.8	PH9500	4400Vdc	Basic	8.2mm	10Arms	3.0 mOhms	1:65 to 1:100	-
	14.6	12.6	7.1	PE-682xx	500Vrms	Functional	-	15Arms	1.15 mOhms	1:1:50 to 1:1:200	-
	19.9	14.5	10.0	PB002x	1000Vdc	Functional	-	35Arms	0.42 mOhms	1:50 to 1:200	-
	20.5	12.8	14.4	PAS6322, PMS6322	3500Vrms	Reinforced	10mm	50Arms	0.5mOhms	1:30 to 1:200	Yes
	THT Solutions										
	19.0	14.0	19.0	PE-67xxx	4250Vrms	Reinforced	8mm	20Arms	1.0 mOhms	1:50 to 1:300	-
	20.6	14.7	19.0	P058x	3000Vrms	Reinforced	8mm	20Arms	1.7 mOhms	1:1:50 to 1:1:200	-
	17.2	9.5	20.4	FIS1x1	2500Vrms	Reinforced	8mm	15Arms	-	x:50 to x:200	-
	17.6	15.2	12.0	FIS1xx5	4000Vdc	Reinforced	8mm	25Arms	1.2 mOhms	1:50 to 1:1000	-
	17.2	9.9	20.4	PE-5168x PE-5171x	3000Vrms	Reinforced	8mm	25Arms	-	1:50 to 1:200 1:50CT to 1:200CT	-
	22.9	17.8	17.8	PE-6358x PE-6361x PE-64xxx	3000Vdc	Reinforced	8mm	20Arms	1.1 mOhms	1:50 to 1:200 1:50CT to 1:200CT 1:1:50 to 1:1:200	-

ROGOWSKI COIL

OVERVIEW

The Rogowski coil is a toroid-shaped air-core coil.
It has a non-ferromagnetic core (usually plastic core) used to measure alternating current.

Types:
Most ring, oval or other shapes are possible with:
Round, rectangular or oval cross section

Rogowski coils are constructed without ferromagnetic core, which results in several advantages:

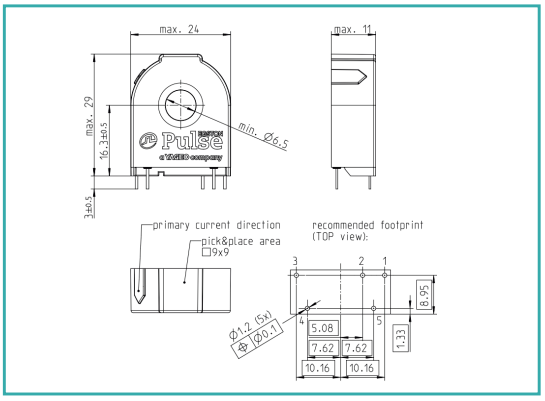
- Robust design
- Wide dynamic range
- High bandwidth
- No nonlinear effects (as in conventional current transformers by the iron core)
- Can be used without load (in contrast to the current transformer)
- Low temperature dependency
- For versions with open core, the measurement can be done without disconnecting the circuit

ROGOWSKI - CURRENT SENSOR

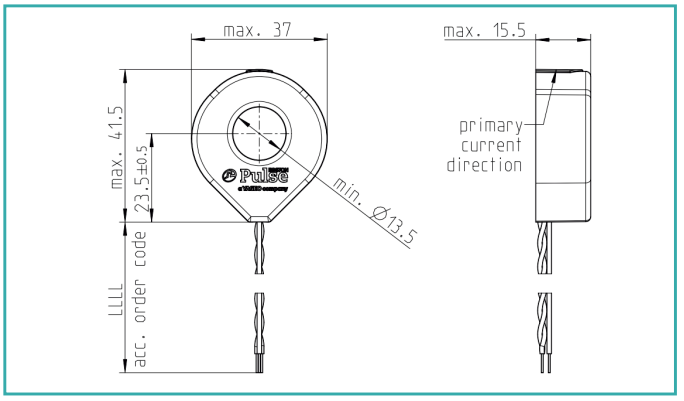
RC01-SSS-0 Series | RC03-SSS-LLL-0 Series | RC05-SSS-LLLL-0 Series

Electrical Specifications @ 25°C – Operating Temperature -20°C to 80°C									
Description	Part Number	Sensitiity			Wire Length	Typ Resonance Frequence	typ Temperature coefficient	Typ external electromagnetic field	Typ external electricla voltage potential
		50Hz	60Hz	Tolerance	mm	kHz	ppm/K	%	mA (@230VAC/50Hz)
RC01-SSS-0									
Rogowski Coil Size 01 - 100mV/kA	RC01-100	100	120	±1%	n.A	370	30	0,2	60
Rogowski Coil Size 01 - 100mV/kA- Shielded	RC01-100-S								25
Rogowski Coil Size 01 - 200mV/kA	RC01-200	200	240	±1%	n.A	200	25	0,2	40
Rogowski Coil Size01 - 200mV/kA-Shielded	RC01-200-S								25
Rogowski Coil Size 01 - 300mV/kA	RC01-300	300	360	±1%	n.A	150	25	0,2	35
Rogowski Coil Size 01 - 300mV/kA-Shielded	RC01-300-S								25
RC03-SSS-LLLL-0									
Rogowski Coil Size 03 - 200mV/kA	RC03-200-0250	200	240	±1%	250± 10	170	25	0,2	125
Rogowski Coil Size 03 - 200mV/kA- Shielded	RC03-200-0250-S								50
Rogowski Coil Size 03 - 400mV/kA	RC03-400-0250	400	480	±1%	250± 10	90	6	0,2	85
Rogowski Coil Size 03 - 400mV/kA- Shielded	RC03-400-0250-S								45
Rogowski Coil Size03- 600mV/kA	RC03-600-0250	600	720	±1%	250± 10	70	3	0,2	80
Rogowski Coil Size 03 - 600mV/kA- Shielded	RC03-600-0250-S								45
RC05-SSS-LLLL-0									
Rogowski Coil Size 05 - 150mV/kA	RC05-150-1000	150	180	±1%	1000± 20	110	28	0,2	140
Rogowski Coil Size 05 - 150mV/kA- Shielded	RC05-150-1000-S								20
Rogowski Coil Size 05 - 300mV/kA	RC05-300-1000	300	360	±1%	1000± 20	60	25	0,2	110
Rogowski Coil Size 05 - 300mV/kA- Shielded	RC05-300-1000-S								40
Rogowski Coil Size 05 - 450mV /kA	RC05-450-1000	450	540	±1%	1000± 20	45	21	0,2	80
Rogowski Coil Size 05 - 450mV/kA- Shielded	RC05-450-1000-S								20

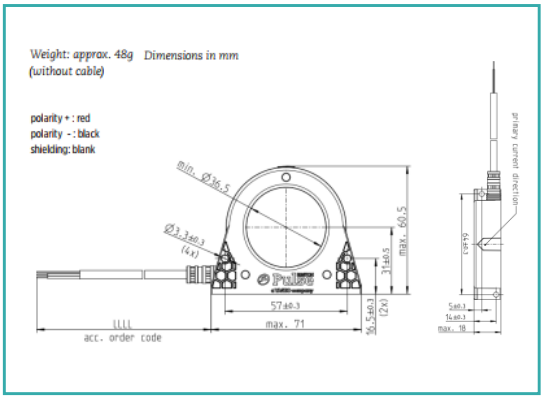
RC01-SSS-0



RC03-SSS-LLLL-0



RC05-SSS-LLLL-0

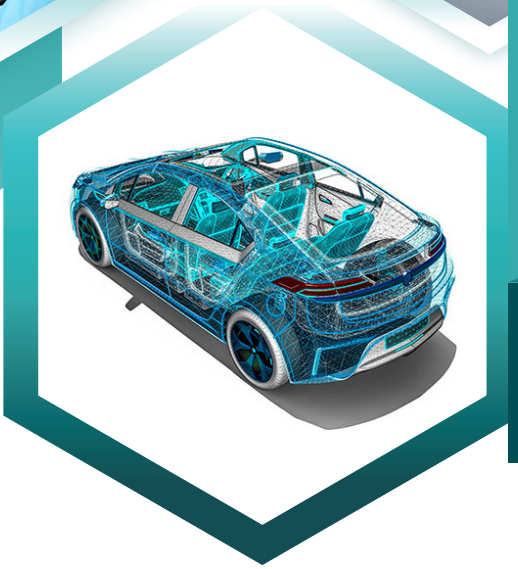


Codification

RCXX-SSS-LLL-0

- RC: Rogowski Coil
- SSS: Sensitivityin mV/kA/50Hz
- O: (Options) S: with Shielding
- XX: 01: SIZE 01 03: SIZE 03 05: SIZE 05
- LLLL: optional Wire length in mm

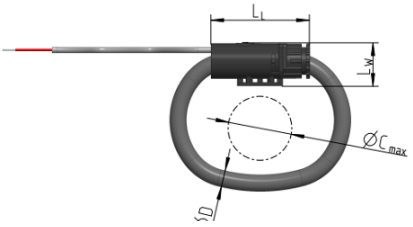
ROGOWSKI CURRENT SENSOR

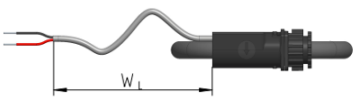


FLEXROGO

FLRC.S040 | FLRC.S100

Description	Sensitivty [mV/kA]	Resistance [Ω]	Self Inductance [uH]	Ø C_{max}	Ø D	L_L [mm]	L_W [mm]	W_L [mm]
FLRC.S040								
FLRC.S040	40	38±5%	270 ± 5%	75	10	65	26	500
FLRC.S040	40	38±5%	270 ± 5%	75	10	65	26	1000
FLRC.S040	40	38±5%	270 ± 5%	75	10	65	26	1500
FLRC.S040	40	38±5%	270 ± 5%	100	10	65	26	500
FLRC.S040	40	38±5%	270 ± 5%	100	10	65	26	1000
FLRC.S040	40	38±5%	270 ± 5%	100	10	65	26	1500
FLRC.S040	40	38±5%	270 ± 5%	125	10	65	26	500
FLRC.S040	40	38±5%	270 ± 5%	125	10	65	26	1000
FLRC.S040	40	38±5%	270 ± 5%	125	10	65	26	1500
FLRC.S100								
FLRC.S100	100	95 ± 5%	270 ± 5%	75	10	65	26	500
FLRC.S100	100	95 ± 5%	270 ± 5%	75	10	65	26	1000
FLRC.S100	100	95 ± 5%	270 ± 5%	75	10	65	26	1500
FLRC.S100	100	95 ± 5%	270 ± 5%	100	10	65	26	500
FLRC.S100	100	95 ± 5%	270 ± 5%	100	10	65	26	1000
FLRC.S100	100	95 ± 5%	270 ± 5%	100	10	65	26	1500
FLRC.S100	100	95 ± 5%	270 ± 5%	125	10	65	26	500
FLRC.S100	100	95 ± 5%	270 ± 5%	125	10	65	26	1000
FLRC.S100	100	95 ± 5%	270 ± 5%	125	10	65	26	1500





MOTOR COILS

DRIVETRAIN ELECTRIFICATION

Current Applications:

- Electric Turbocharger
- Hybrid Car
- Hybrid Bus
- E-Bike

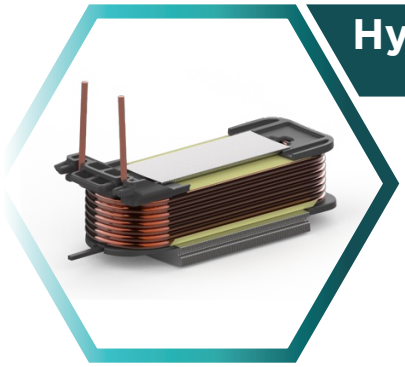
General Information:

- Single tooth motor coils and fully assembled stators
- Focus on concentrated/segmented winding > no hairpin winding
- Self-bonding wire with thermal compacting process
- High compact layer winding (conical shape) > max. power efficiency
- Insulation through foil or overmoulding
- Optionally varnished or potted
- Multiple coil group-winding (e.g. 4 coils interconnected)
- 2-8 wires can be wound in parallel
- Power range: 300W up to 160kW
- Wire diameter between 0,25mm and 2,0mm

MOTOR COILS : PRODUCT TYPES

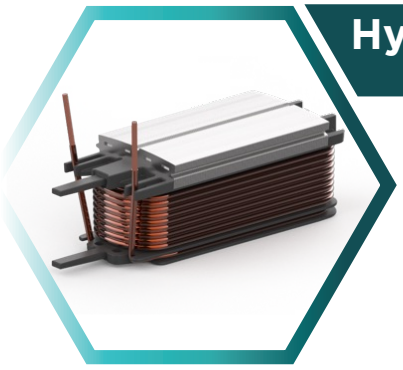
Electric Turbocharger

- Designed for 12V and 48V system
- Peak output 7kW
- Max. speed 70.000rpm
- Response time less than 250ms
- Reduces fuel consumption by up to 7%
- Up to 27% boost improvement
- Up to -10% CO2 emission



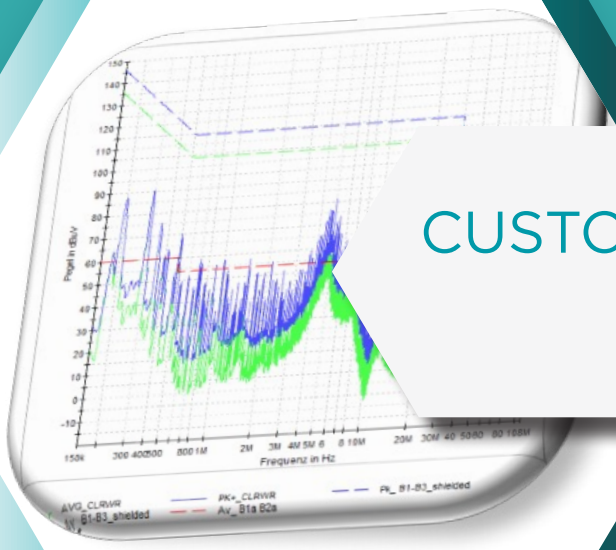
Hybrid Bus

- Mild-Hybrid 25kW/48V
- Recuperates braking energy
- Reduces fuel consumption by up to 16%
- Reduces air and noise pollution



Hybrid Car

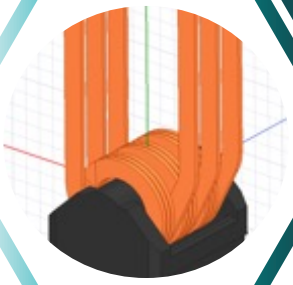
- 8-speed automatic transmission
- Mild and plug-in hybrids
- 24kW – 160kW
- Maximum torque 450Nm
- Reduces fuel consumption by up to 13%
- Reduces emission to a level of 136g/km



CUSTOM FILTER DESIGN

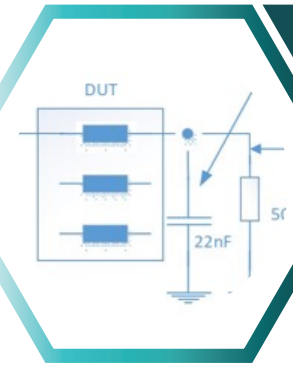
Possible input Data:

•CMC/DMC -Damping
• Impedance/Damping
•Topology



Dimensioning of the Inductance

- Copper cross section
- Core cross section
- Core material
- Determine parasitic properties:
- R_{DC}, R_{AC}, C_{Cpl}

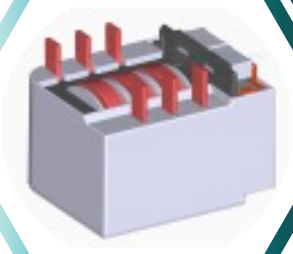


Circuit Calculation

- Determining the real component properties:

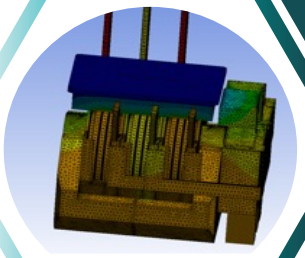
  $Z_L(f)$,;$Z_C(f)$
- Cosimulation with inductance
- Simulation of common and differential mode

Mechanical Design



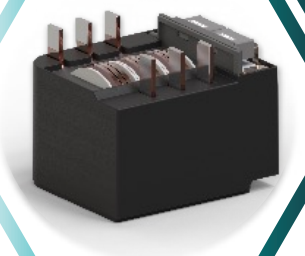
- Check normative requirements
- Define fixation
- Define materials for housing, potting, etc

Thermal Design and Calculation

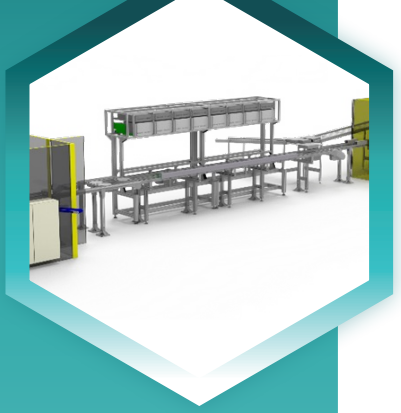


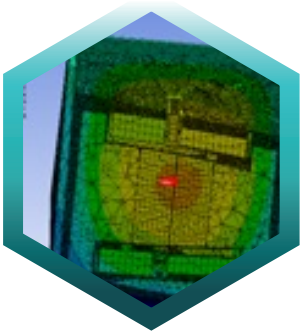
- Calculation of losses
- Determine connection to external cooling
- Definition of thermal properties of materials (insulation, potting...)

Verification



- Production of prototypes
- Electrical tests
- Thermal measurements





CUSTOM FILTER DESIGN

AEC-Q200

One Stop Shop

Design Support (Top down focus on key markets like e-Mobility)
- Electrical design
- Mechanical design (Creo)

Extended R&D support
- Magnetic Analysis
- Thermal Analysis (Outstanding cooling concepts)

Rapid Prototyping

Qualification (AEC-Q200)

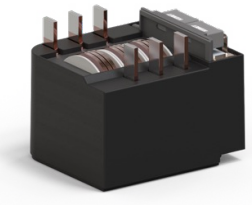
Inhouse production of equipment and automation

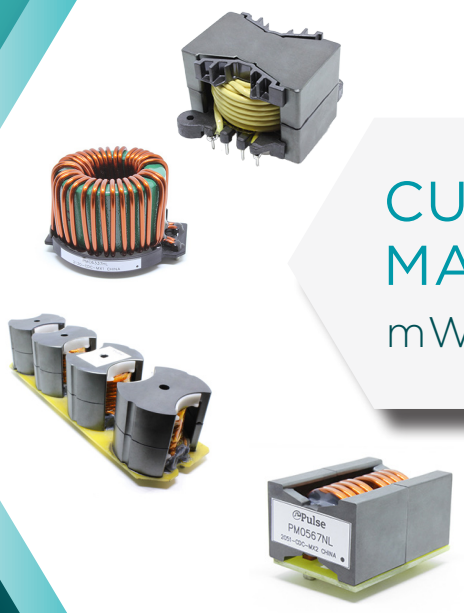
Development of production process & technology

Mass production
- Competitive automotive plants in Europe and Asia
- All automotive plants IATF certified
- Realized projects with the market leaders
- Technology leader (Market overview and several patents)

EMC-DC-Line Filter
48V/360A

Common Mode Filter
905V/350A





CUSTOM POWER MAGNETICS

mW to Kw

A significant portion of Pulse's Power PBU business is derived from developing unique magnetic solutions for our end-customer's applications. In fact, many of our catalog parts began as projects for a specific customer and then were expanded into a broader offering. Often customers are reluctant to engage on a custom design as they anticipate higher costs, NRE charges or longer lead times but in reality most projects leverage existing materials and platforms and therefore lead time, cost and NRE are not affected. Although we do have a wide selection of catalog power magnetics it is still often necessary to create custom or application specific designs due to variations in:

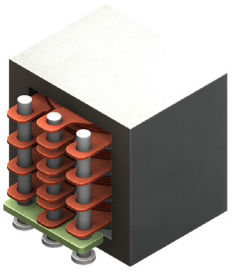
- Power supply topologies
- Input voltage ranges
- Operating frequency
- Output voltage and power requirements
- Mechanical and thermal constraints.

These custom or application specific designs are often simple tweaks to existing catalog solutions and although customers are concerned that 'custom' means higher costs, longer lead times and NRE this is not the case when leveraging existing platforms and material. However, some designs may require completely new designs utilizing custom materials (cores, windings and plastics) and in these cases any NRE, price or lead-time impacts will communicated up front to our customers. By leveraging our material knowledge, design expertise and finite element analysis simulation tools Pulse can quickly evaluate your requirements, determine if a project is feasible and design and manufacture parts that meet your exact requirements.

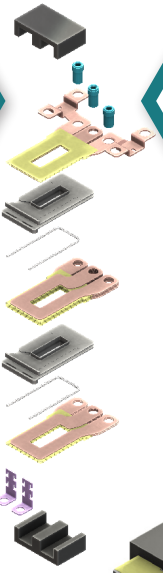
Please follow the link and fill out the form below and we will review your projects fit within our manufacturing capabilities and business model. We will typically respond to your inquiry within 24 hours.

High Power Custom Power Transformers

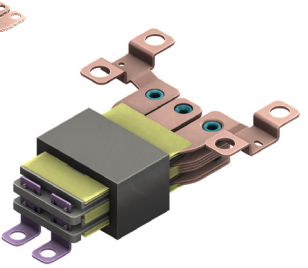
LLC Transformer
- 200-425v input
- 27v/3kW output
- 45x37x29mm

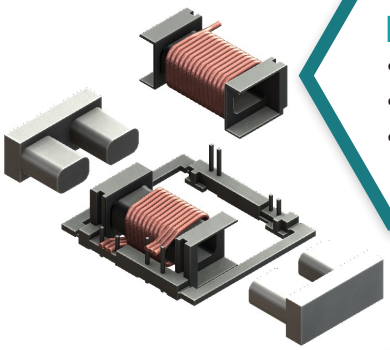


H-Bridge Transformer
- 340-435v input
- 220-470v/2.6kW output
- 63x50x43mm

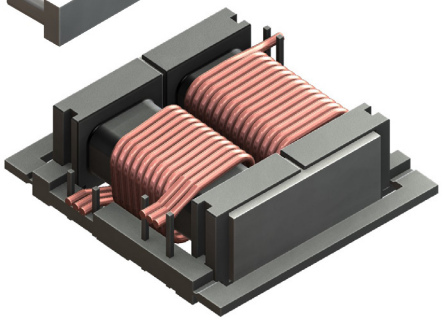


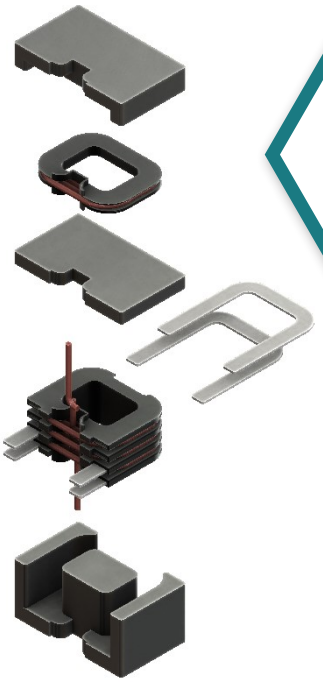
PSFB Transformer
- 253-468v
- 12v/3.3kW
- 109x79x28mm



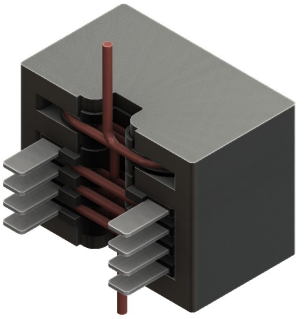


LLC Transformer
- 300-450v input
- 56v/1kW output
- 57x48x19mm



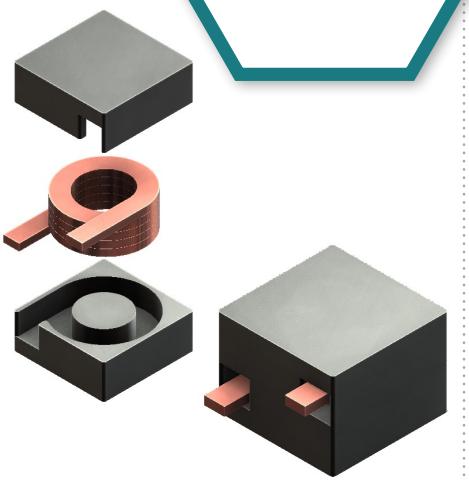


LLC Transformer
- 380-420v input
- 48v/3.9kW output
- 49x37x32mm

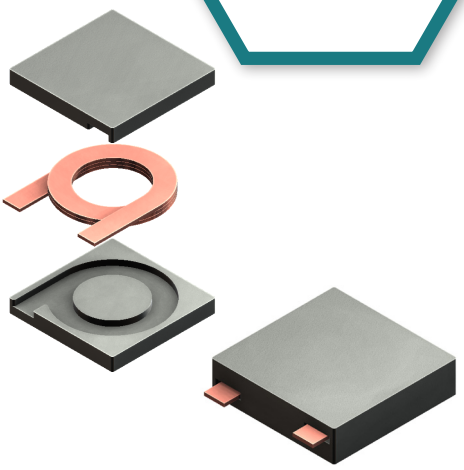


High Current Custom Inductors and CM Chokes

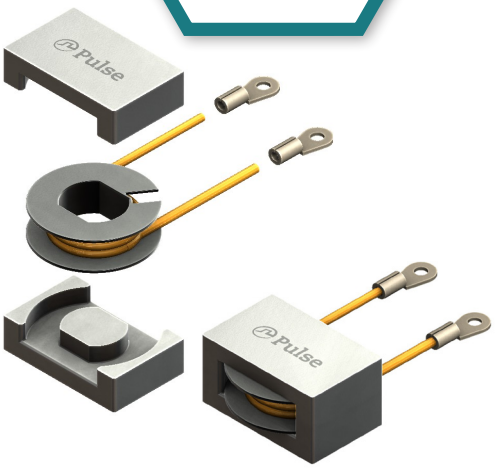
Output Inductor
- 3.9uH, 68Apk
- 3.9kW DC/DC
- 22x16x22mm



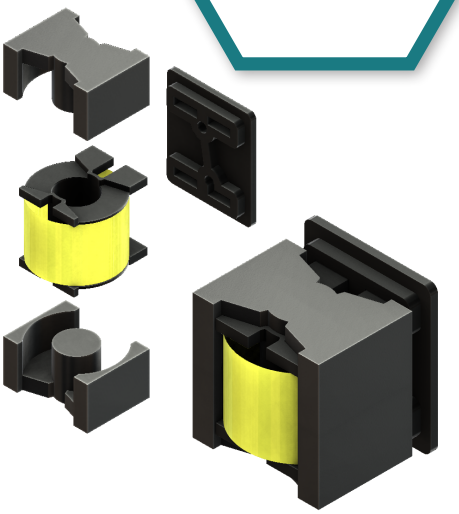
Output Inductor
- 3.9uH, 68Apk
- 3.9kW DC/DC
- 31x8x31mm



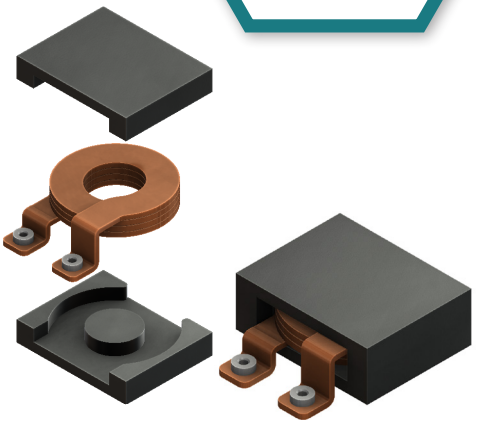
Resonant Inductor
- 14uH, 30Apk
- 53x44x26mm



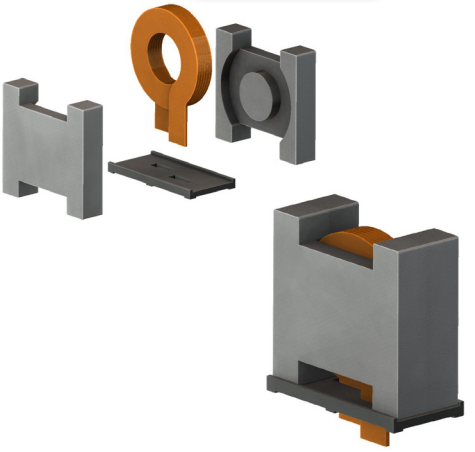
Resonant Choke
- 11kW
- 2uH, 40A
- 41x36x35mm



Output Inductor
- 1.8uH
- 340A
- 71x64x26mm

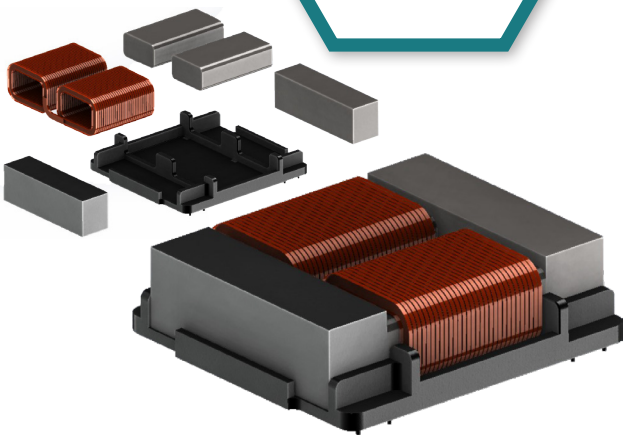


Output Inductor
- 1uH, 150Apk
- 46x23x46mm

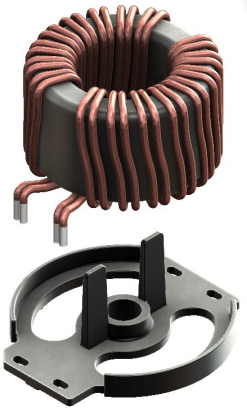


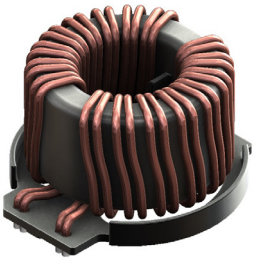
High Current Custom Inductors and CM Chokes (cont.)

PFC Inductor
- 300uH, 20Apk
- 2kW DC/DC
- 67x61x19mm



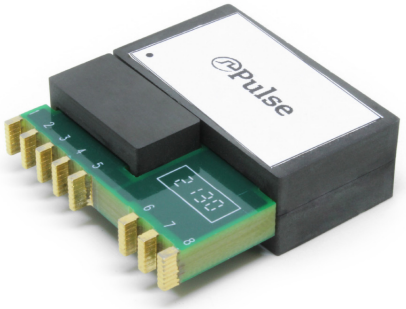
CM Choke
- 1.4mH, 36A
- 11kW
- 57x54x36mm



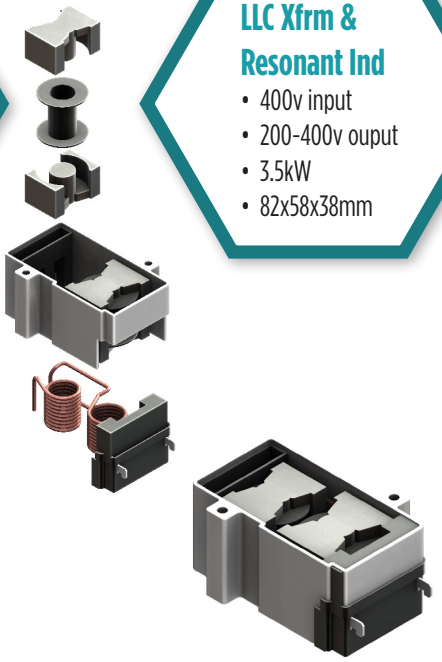


Integrated Custom Power Magnetic Assemblies

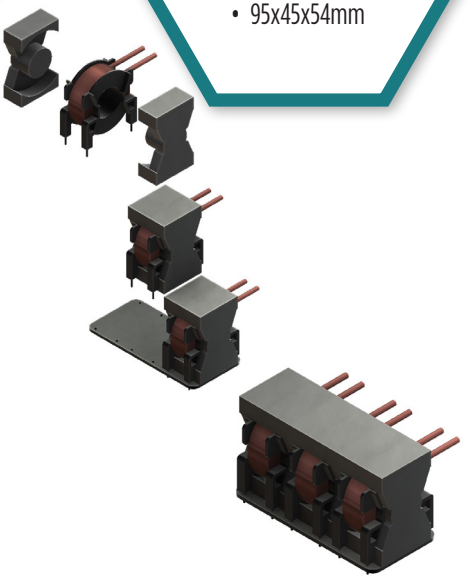
Integrated LLC
- 400v input
- 20v/330W output
- 36x36x13mm



LLC Xfrm & Resonant Ind
- 400v input
- 200-400v ouput
- 3.5kW
- 82x58x38mm



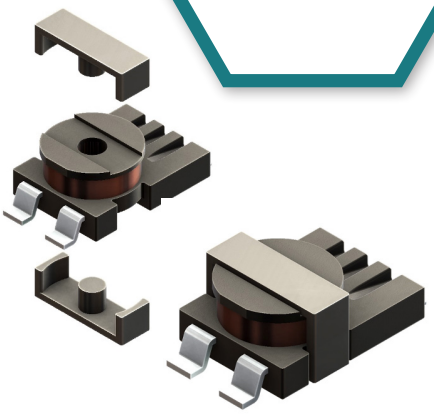
PFC Choke
- 95uH/30Apk
- 11kW 3-Phase
- 95x45x54mm



Small Form Factor Custom Solutions

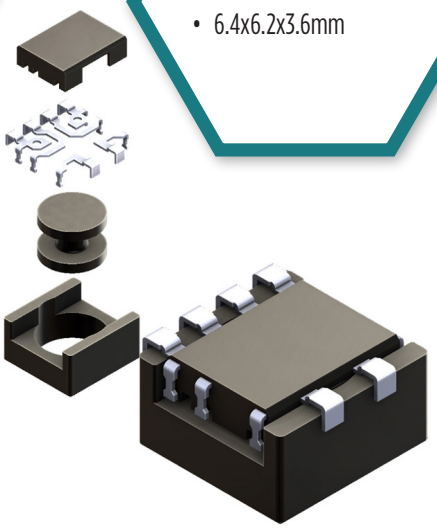
Current Sense Magnetic

- 50A, 5000Vrms
- 21x13x7mm



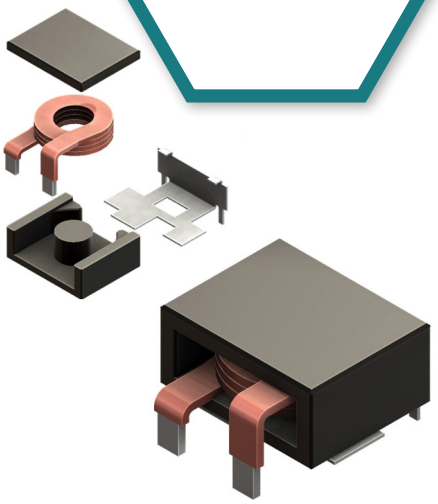
Flyback Transformer

- 2W
- 6.4x6.2x3.6mm



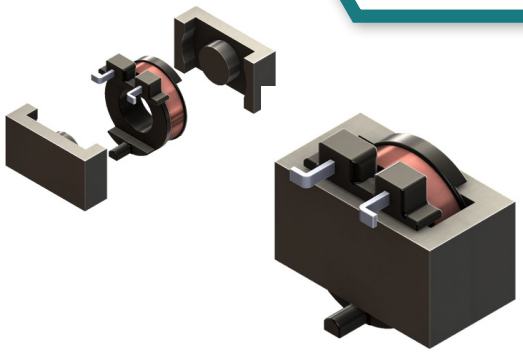
Straddle Inductor

- 0.8, 22Apk
- 11.4x11.3x6.8mm



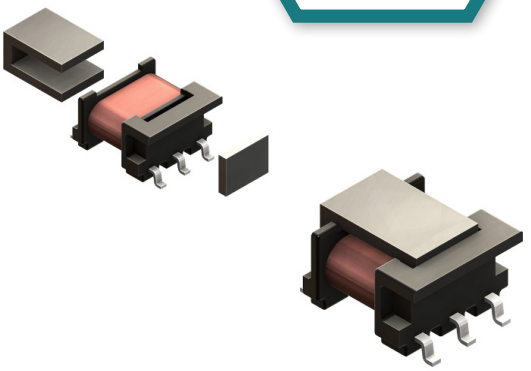
Straddle Inductor

- 1uH, 20A
- 11.2x9.8x7.4mm



Isolation Transformer

- 2500Vrms, Functional Insulation
- Small Form Factor
- 9.5x8.1x5.1mm



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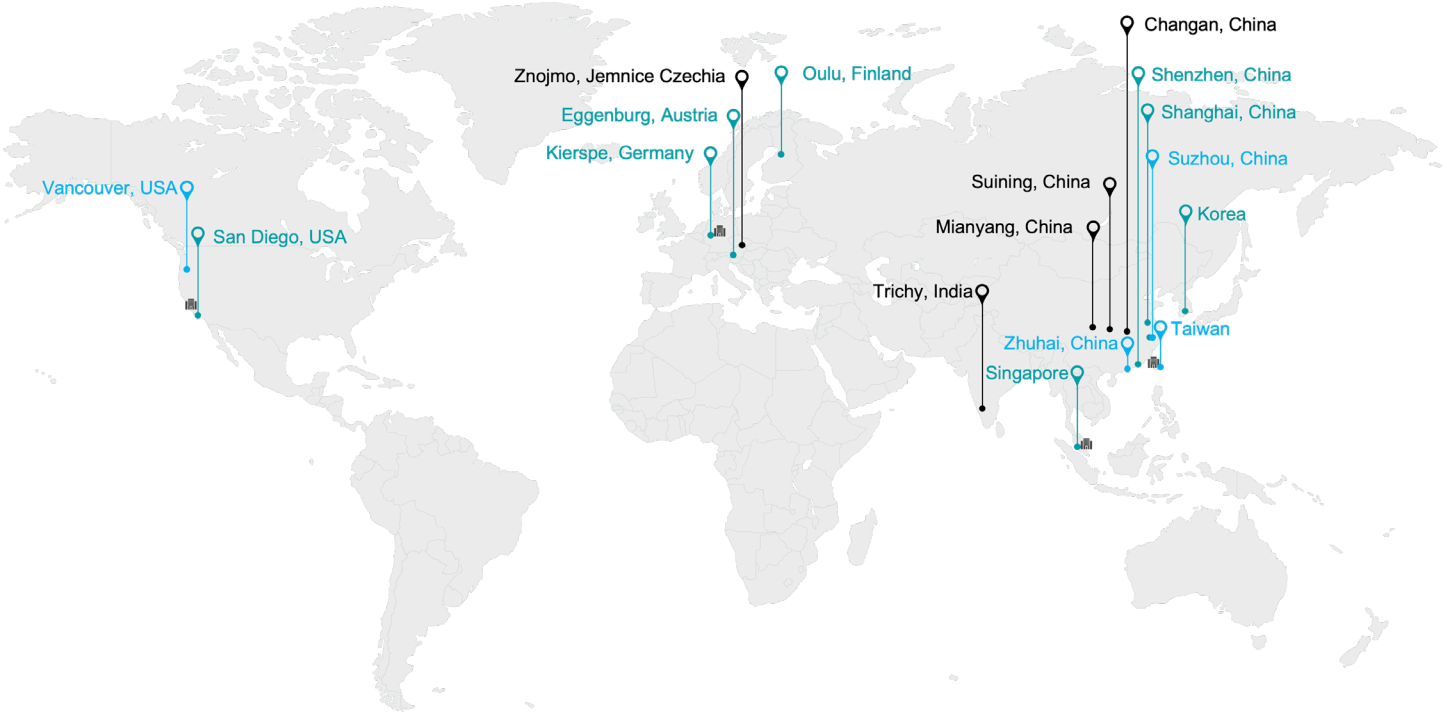
- Design Centers / Customer Support Centers
- Volume Production Plants and Design Centers
- Production Plants



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- Experienced core engineering team
  - Leverages global footprint to provide "globally local" design solutions with 173 engineers and 112 sales and marketing personnel

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