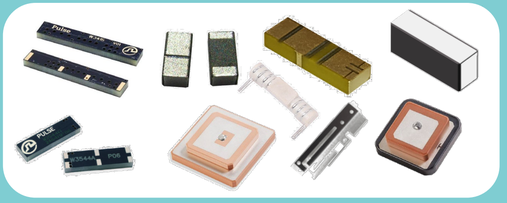
Pulse Electronics
Rutronik Tech Day 2021

Connecting 5G for Industry 4.0

Pulse
a YAGEO company

Wireless Connectivity for Industrial Automation – 5G

Pulse
a YAGEO company



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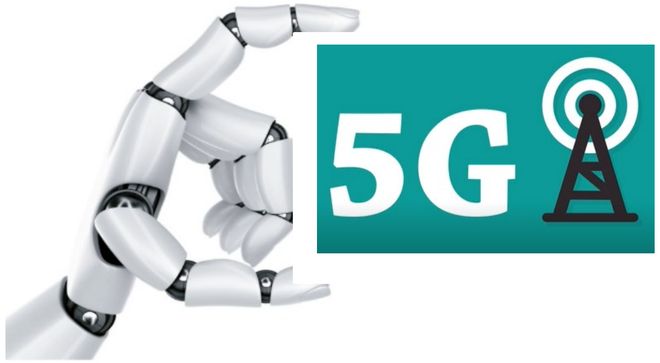


Internal

Outdoor

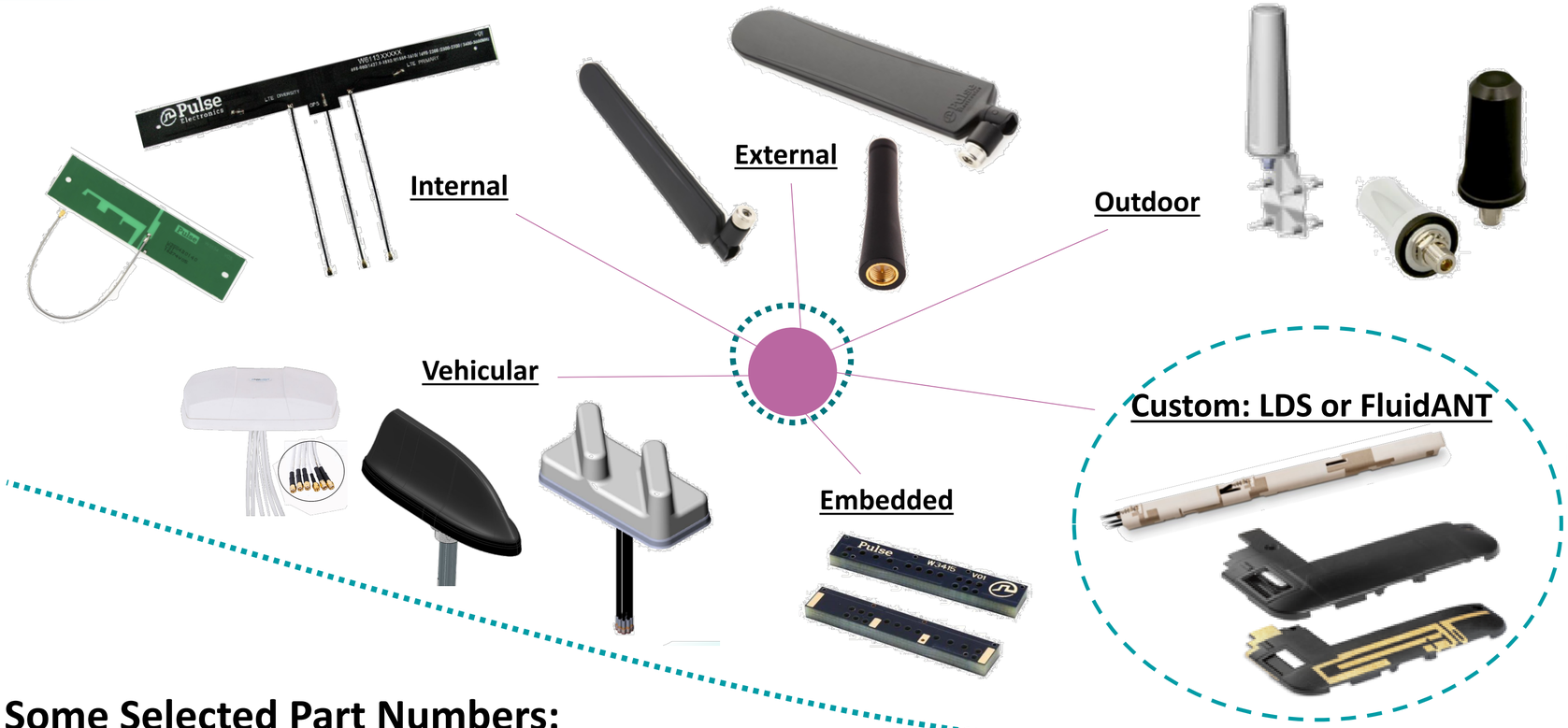
External
In-building

Custom Design
LDS/LAP, FluidANT, FPC

Antennas for all user case

Vehicular

Selected 5G Antennas



Some Selected Part Numbers:

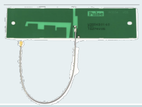
Internal	External	Outdoor	Vehicular	Embedded
W3435XXX	W5150	LPT600/71DMN	Armadillo	W3415
W3554XXX	W1096	RO600/71NFKIT	TWC	
W6114XXX	W1696XX	LPT600/71NMO	Shark FIN	

Datasheet: www.pulseelectronics.com

Pulse 5G-FR1 Antennas

- **Benefits:**
  - Covering 617-7125MHz
  - Wide selection
  - Cost competitive
  - ROHS and REACH
  - Fast delivery
  - LDS or FluidANT for 100% custom solutions
- **Applications:**
  - IoT, Smart Vehicles, Robotics, AR/VR, Security, AI, drones, automotive, EV, Medical etc..
- **Service:**
  - Technical support
  - PCB layout review
  - Tuning and optimization on final product, active/passive testing

New 5G Antennas – Now Available

P/N	Type	Freq [MHz]	Gain [dBi]	Eff. [%]	Radiation pattern	Connector	Size [mm]
W3415 	Embedded	617 - 6000	-1.0 to 2.5 dBi	55%-75%	Omni	SMT	40 x 7 x 3
W3554XX 	Internal	617 - 6000	1.9 to 3.5 dBi	37-66%	Omni	U.FL/SMA/MMCX	30 x 120 x 0.2
W5150 	External	617 – 6000	1.2 to 5.5 dBi	45-70%	Omni	SMA Male	229 x 30
LPT600/71 DMN 	Outdoor	617 - 7125	2 to 6.1 dBi	70-83%	Omni	N-Female/ DM	Ø41 x 95.9
TWC 	Vehicular	617 to 6000 MHz (4x 4G/5G-FR1, 4x WiFi 6E, 1x GNSS)	LTE/5G-FR1 = 2 to 5 dBi, WiFi 6E = 6.5 dBi	57-67%	Omni	Custom Connector Configurations	122.8 x 274.5 x 95.2

Network PBU – Application overview

Network PBU
Supports all wireline networking topologies

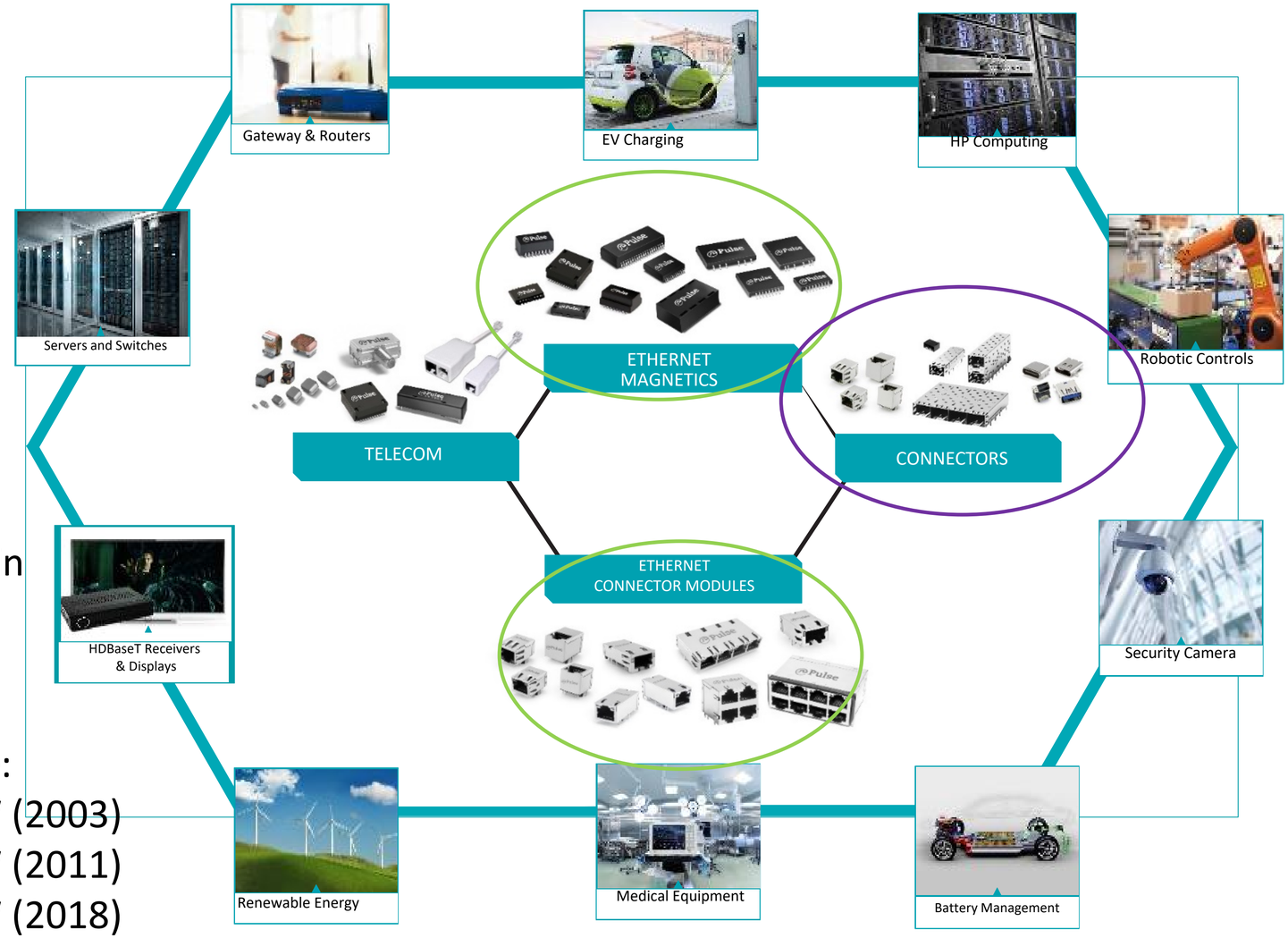
Focus - Ethernet based Communications

10Mb to 10Gbps on Copper
1Gbps to 400Gbps over Fibre Optic

Governed by IEEE802.3xx Standard
Covers ALL these data rates :
seamless – moving across the digital domain
scalable – moving between Data rates
interoperable – moving form device to device

Supports power feeding low voltage DC on the cable:

Power over Ethernet:	PoE	IEEE802.3af	15W (2003)
	PoE+	IEEE802.3at	30W (2011)
	PoE++	IEEE802.3bt	90W (2018)
Power over Data lines:	PoDL	IEEE802.3bu	65W (2016)



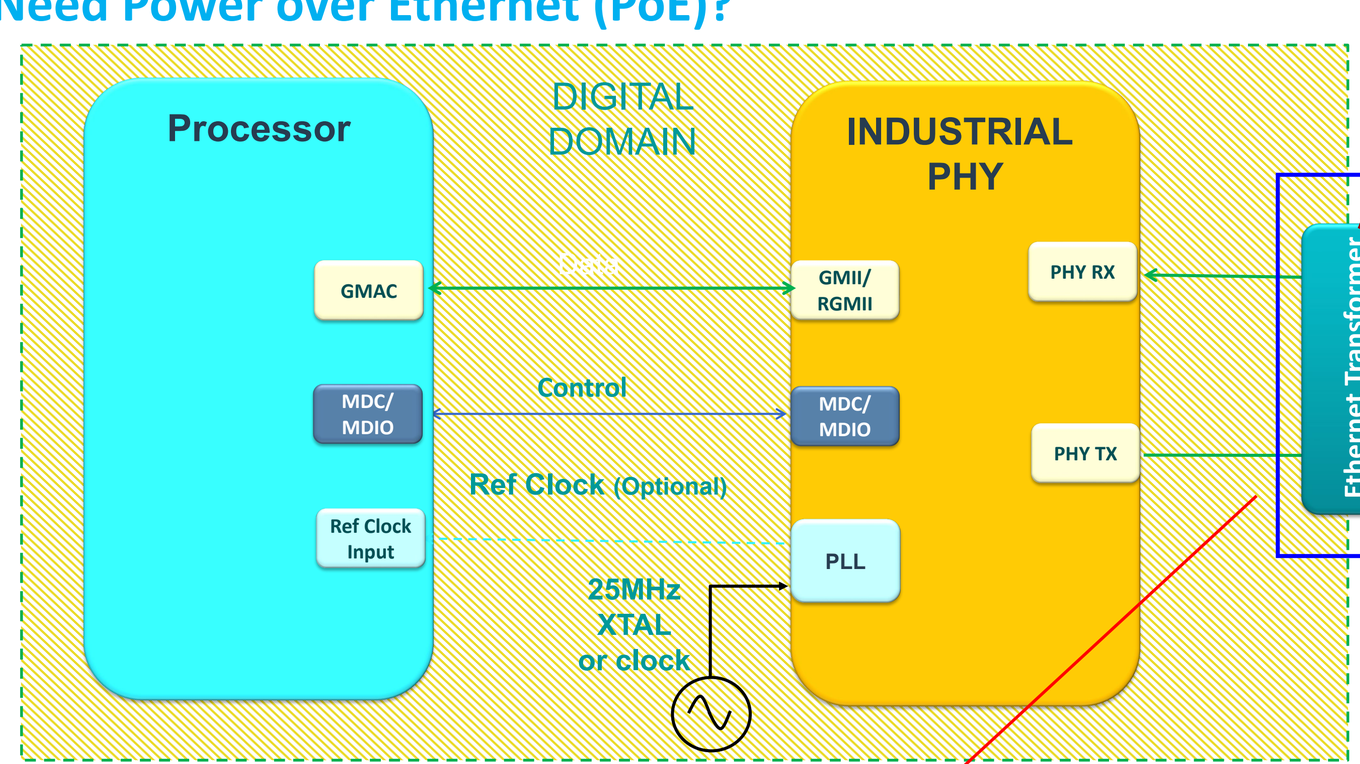
Industrial Design Steps

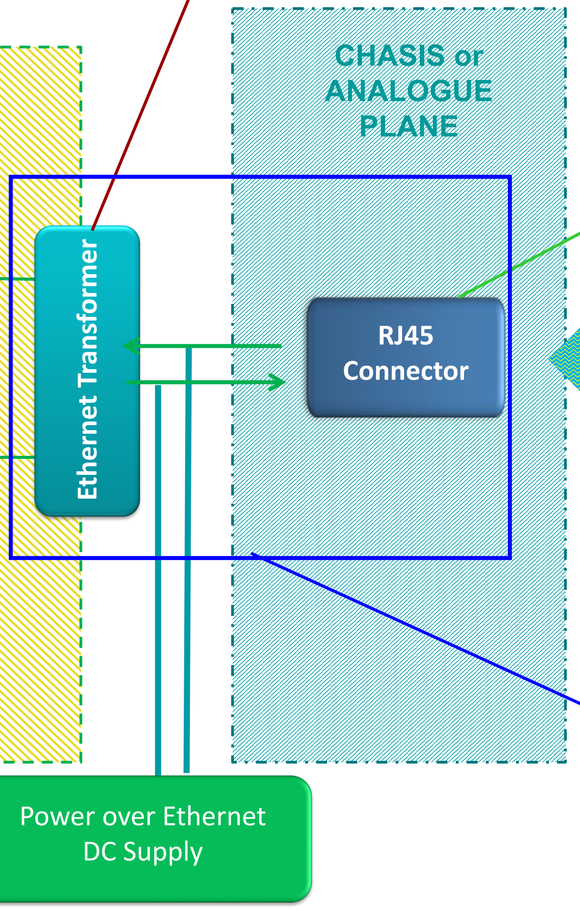
STEP #1 - Select the Processor

STEP #2 - Select the PHY

STEP #3 - find a magnetic solution

Need Power over Ethernet (PoE)?

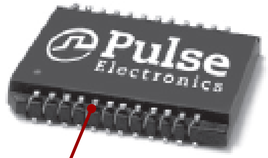




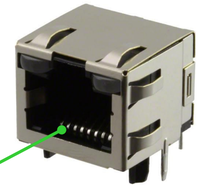
DISCRETE PRODUCT

HxxxNL

HXxxxxNL



RJ45 CONNETORS Cat3 / Cat5 / CAT6



E5J88-xxXXxx-L

E6588-xxXXxx-L

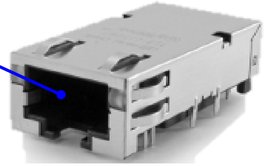
CAT5e/CAT6 DATA CABLE

UTP = Unshielded Twisted Pair

STP = Shielded Twisted Pair

INTEGRATED CONNECTORS

(PULSEJACK®) CAT5e/CAT6



Jx/JXx series

ISOLATION BARRIER

Separates unknown Ground Planes

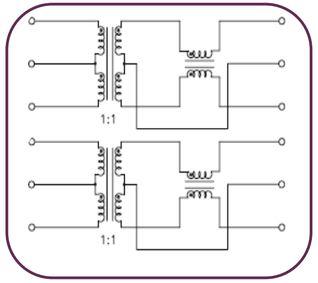
Isolates Analogue from Digital

Simple 10/100 Design

IEEE802.3u

10/100Base-TX - 100Mbps Data rate over UTP

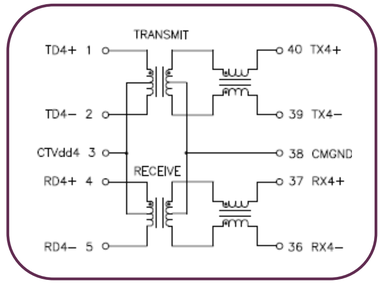
- Communication over two twisted Pairs of wire - TX and RX
- Requires Two Separate Transformers for Isolation



Common Schematic:

- Symmetrical TX / RX – AutoMDIX
- 2 wire Choke on Cable Side
- Support low level PoE (>8W)
- NEW Isolation parts up to 4.5KV

H1102NL	**->**	**H1260NL**	**~20%**
HX1188NL	**->**	**HX1341NL**	**~25%**

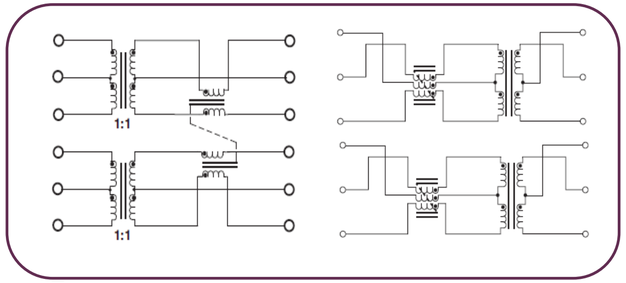


Shared Central Tap:

- Symmetrical TX / RX – AutoMDIX
- Reduces Pin Count – Smaller footprint

CANNOT Support PoE

H1164NL(MSL3)	**->**	**HX1344NL(MSL1)**	**~30%**
HX1234NL(MSL3)	**->**	**HX1344NL**	**~40%**



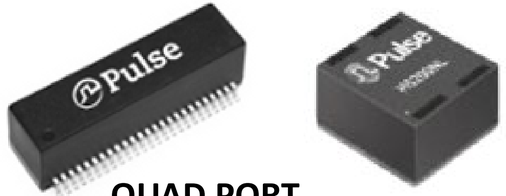
Power over Ethernet design:

- Symmetrical TX / RX - AutoMDIX
- 2 wire shared Choke on Cable side or 3 wire Choke PHY Side.
- High Current/ Low Saturation Risk <70W

HX2019NL - PoE **HX2326NL – PoE+**

SINGLE PORT

DUAL PORT



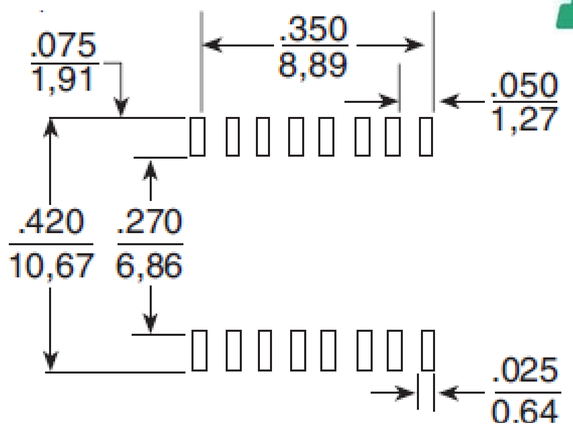
QUAD PORT

Network PBU - Focus Products

Industrial 100Mb with Power over Ethernet
Discrete SMD Transformer Modules

Features and Benefits:

- Compliant to IEEE802.3at/bt
- Support power rating from ~8W up to 40W on 2 pair
- Industry standard 16pin SOIC footprint
- Rugged Design for -40 to +85°C operations
- Support all Voltage and Current driven Phys.



Applications:

Industrial / Outdoor:

Remote Switches and Routers.

Motor Control, Sensing and Remote Metering

Building Control:

Lifts, escalators, HVAC, LED Lighting, CCTV Security, Keypad/Video entry, Access control

Part Number	PoE IEE802.3xx STD	OCL @ DC BIAS (3% of max current)	PoE Power Level 2 pair (PSE)	DC Current Max Per Pair (mA)	Package size W x L x H (mm)	Continuous working Load at 70°C
HX1188NL	Pseudo	350uH @ 8mA	<10W	200mA	12.7 x 9.40 x 5.97	350mA / 57Vdc
HX1198NL	Pseudo	350uH @ 8mA	<10W	200mA	12.7 x 9.40 x 5.97	615mA / 57Vdc
HX2019NL*	IEEE802.3af (plus)	350uH @ 8mA	15W	350mA	12.7 x 9.40 x 5.97	280mA / 57Vdc
HX2326NL**	IEEE802.3at (plus)	135uH @ 19mA	40W	720A	12.7 x 9.40 x 5.97	600mA / 57Vdc

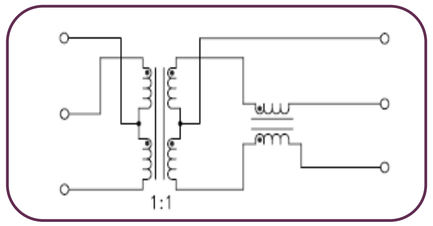
* Temperature rise +45°C at 1Amp above ambient

** Low Winding DCR – improve Temperature rise when under load +35°C at 1Amp

Simple 1Gb Design

IEEE802.3ab 10/100/1000Base-TX – 1Gb Data rate – (250Mbps full duplex x 4 channels)

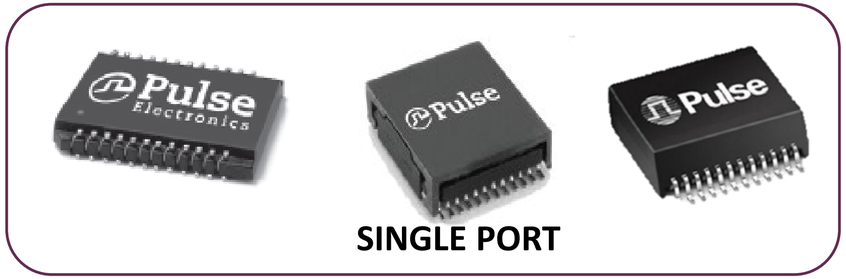
- Communication over four twisted Pairs of wire - 4x TX or RX Channels
- Requires one Isolation Transformer on each channel – (4 Coils/4 Chokes)
- Chokes assist with Common/Differential Noise reduction at low frequencies



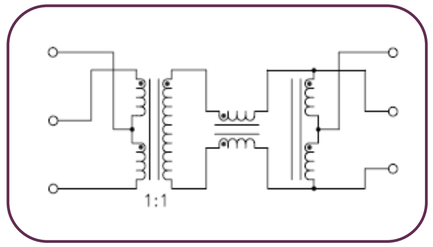
Most widespread schematic: (8 Core)

- 2 wire Choke on Cable Side of Transformer
- Supports Vdr and Idr PHYs
- Lowest Cost approach – Sim-To Fast Ethernet
- New High Isolaiton Parts up to 5KV

H/HX5004NL (MSL3) -> **H/HX5004ENL** (MSL1) **~20%**



SINGLE PORT

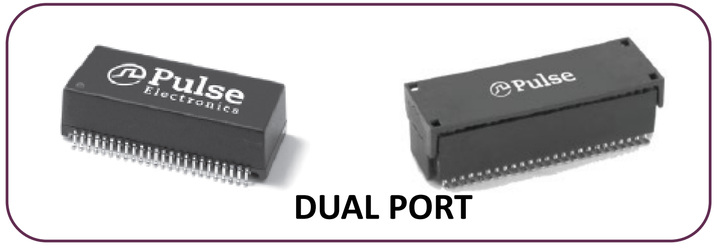


OLD schematic with Shunt Inductor: (12 Core)

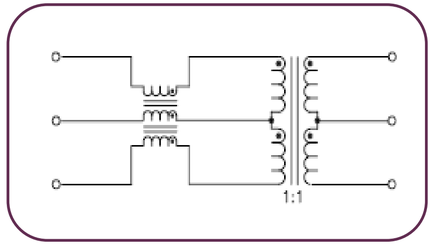
- Shunt Coil is added to above design -
- Supports Idr PHYs best

H5007NL (MSL1) -> **H5007ENL** (MSL1) **~20%**

H5014NL (Dual,MSL3) -> **HC5003NL** (MSL1) **~40%**



DUAL PORT

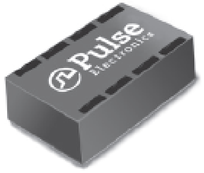


NEWER preferred schematic: (8 Core)

- 3 wire Choke (PhySide) replaces Shunt on Cable Side
- Supports PoE <140W – low winding error and imbalance
- Small Compact design - Drives NEW small footprints

H6062NL -> **HX5181NL** **~10% (~25% on HX5004NL)**

H6096NL -> **HX6096NL** **~10%**



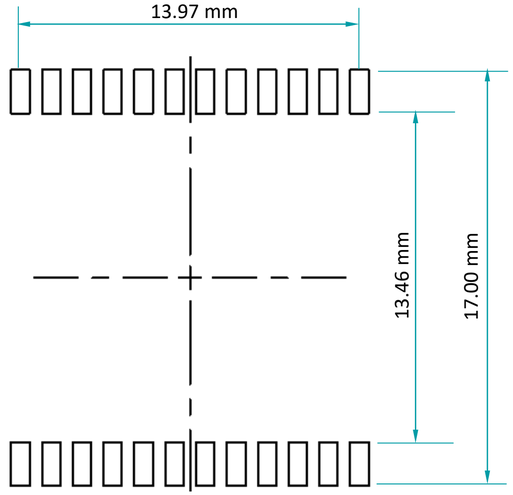
QUAD BGA PORT

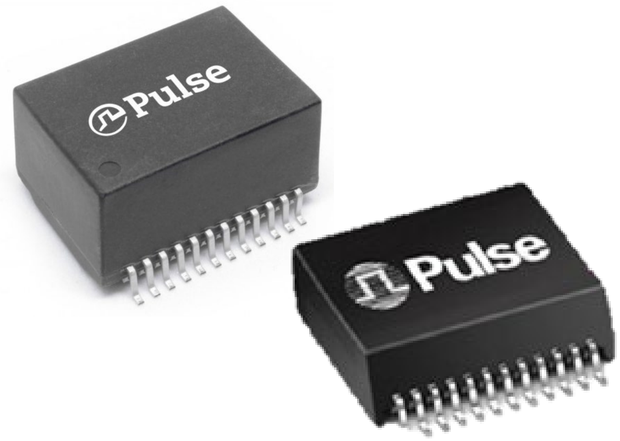
Network PBU - Focus Products

Industrial 1G Power over Ethernet
Discrete SMD Transformer Modules

Features and Benefits:

- Compliant to IEEE802.3at/bt and above
- Support power rating from 15W up to 120W
- Industry standard or reduced footprint!
- Rugged Design for -40 to +85°C operations
- Support all Voltage and Current driven Phys.





PAD LAYOUT SUGGESTION
(Pin Pitch 050” / 1.27mm)

Applications:

Industrial / Outdoor:

WiFi and wireless access points (WAPs)
Remote Switches and Routers.
Motor Control, Sensing and Remote Metering

Building Control:

Lifts, escalators, HVAC, LED Lighting, CCTV Security, Keypad/Video entry, Access control

Part Number	PoE IEE802.3xx STD	OCL @ DC BIAS (3% of max current)	PoE Power Level (PSE)	DC Current Max Per Pair (mA)	Package size W x L x H (mm)	Continuous working Load at 70°C
HX6062NL	IEEE802.3at	350uH @ 8mA	40W	400mA	16.0 x17.5 x 5.72	350mA / 57Vdc
HX6096NL	IEEE802.3bt	300uH @ 24mA	70W	720mA	16.0 x18.1 x 6.60	615mA / 57Vdc
HX6098NL*	IEEE802.3bt (plus)	120uH @ 28mA	140W	1.35A	16.0 x18.1 x 6.60	1.25mA / 57Vdc
HX6188NL**	IEEE802.3bt (plus)	135uH @ 35mA	130W	1.25A	16.1 x 18.1 x 10.2	1.15mA / 57Vdc

* Temperature rise +45°C at 1Amp above ambient
** Low Winding DCR – improve Temperature rise when under load +35°C at 1Amp

Network PBU - Focus Products

Mini Industrial 1G Power over Ethernet Discrete SMD Transformer Modules

Features and Benefits:

- Compliant to IEEE802.3at/bt for PSE/PD devices
- Support power rating from 15W up to 70W
- 40% smaller footprint!
- Rugged Design for -40 to +85°C operations
- Reflow 245°C pk
- Support all Voltage and Current driven Phys.

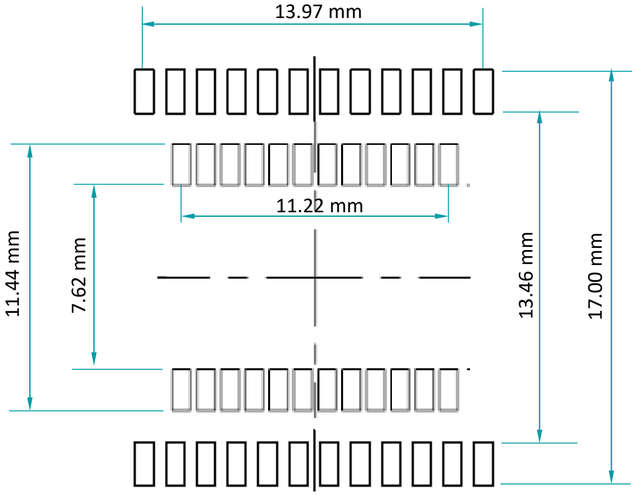
Applications:

Industrial / Outdoor:

WiFi and wireless access points (WAPs)
Remote Switches and Routers.
Motor Control, Sensing and Remote Metering

Building Control:

Lifts, escalators, HVAC, LED Lighting, CCTV
Security, Keypad/Video entry, Access control



PAD LAYOUT COMPARISON
(pin pitch 040” / 1.02mm

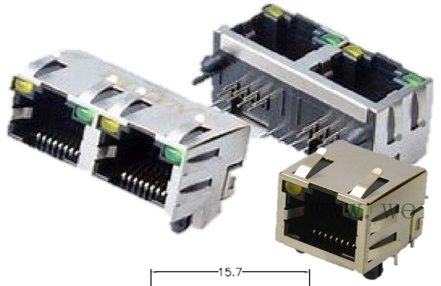
Part Number	PoE IEE802.3xx STD	OCL @ DC BIAS (3% of max current)	PoE Power Level (PSE)	DC Current Per Pair (mA)	Package size W x L x H (mm)	Continuous working Load at 70°C
HX5164NL	IEEE802.3at	350uH @ 8mA	40W	350	10.9 x 15.2 x 8.40	320mA / 57Vdc
HX6164NL*	IEEE802.3bt	120uH @ 18.5mA	70W	620	10.9 x 15.2 x 8.40	600mA / 57Vdc

*The Schematics are not the same – so please select the PoE level for the design – if you or the Customer is unsure use the higher HX6164NL for future proofing the design.

Network PBU - Focus Products

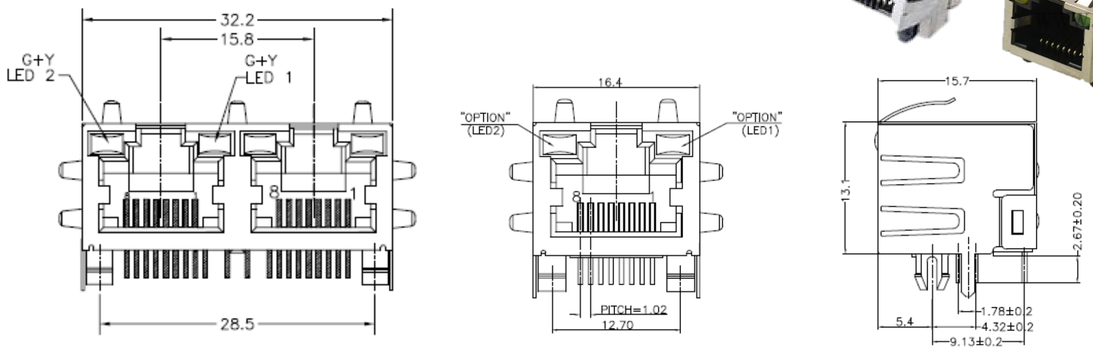
Pin-in-Paste Side Entry RJ45 for Industrial markets

•UL file E3317116



Features and Benefits:

- Small footprint – increase PCB real estate.
- 1x1 and 1x2 design for Ethernet 100/1000 or RS232/485
- Support PoE currents up to 1.2Amp per channel
- Bi-Colour LEDs for indicating operating mode
- Rugged Design for -40 to +85°C operations
- Tape and Reel option for automatic PnP processing
- Wave 260°C pk or Reflow solderable 245°C pk



Applications:

Industrial / Outdoor:

Motor / Servo and power supply control boards
Remote Master and slave daisy-chains
Embedded Industrial Ethernet switches
Instrumentation, Sensing and Remote Metering

Building Control:

Lifts, escalators, HVAC, Lighting, CCTV
Security, Keypad/Video entry, Access control

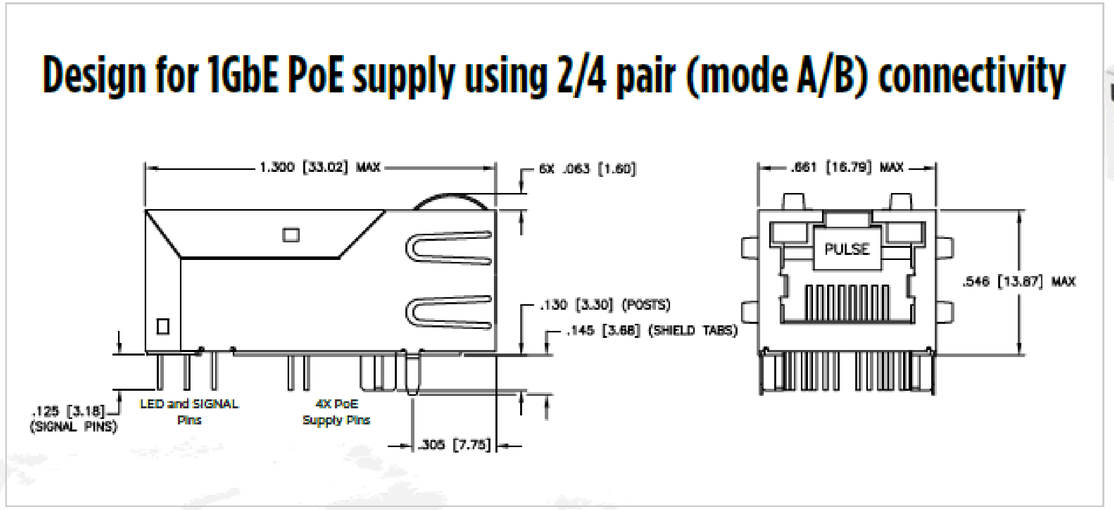
Part Number	Date Rate	EMI Fingers	LED Option (Left/Right)	Contact Gold thickness	PoE	Temp. Rating
E5J88-31LHS4-L	Single	None	Yellow/Green	30u”	YES	-40°C to +85°C
E5J88-41LHS4-L	Single	None	Yellow/Green	30u”	YES	-40°C to +85°C
E5J88-44LHS4-L	Single	Top/Side	Yellow/Green	30u”	YES	-40°C to +85°C
E5J88-41AHS4-L	Dual (1x2)	None	Yellow/Green	30u”	YES	-40°C to +85°C
E5J88-44AHS4-L	Dual (1x2)	Top/Side	Yellow/Green	30u”	YES	-40°C to +85°C

Network PBU - Focus Products

PulseJacks® Integrated PoE ICM for Industrial and Outdoor use

Features and Benefits:

- Ethernet Data rate for 1Gb and 2.5Gigabit
- Support power rating from 15W up to 90W
- Bi-Colour LEDs for indicating operating mode
- Rugged Design for -40 to +85°C operations
- Single Component solution with excellent EMC
- 8mm separation between PoE and Signal Pins
- Support all Voltage and Current driven Phys.



Applications:

Industrial / Outdoor:

WiFi and wireless access points (WAPs)

Remote Switches and Routers.

Motor Control, Sensing and Remote Metering

Building Control:

Lifts, escalators, HVAC, Lighting, CCTV

Security, Keypad/Video entry, Access control

Part Number	Date Rate	LED Option (Left/Right)	PoE Power Rating (Watts)	PoE Supported	Application site	Temp. Rating
JXK0-0136NL	1Gigabit	Yellow-Green Green	Non PoE	N/A	PSU/PD	-40°C to +85°C
JXK0-0161NL	1Gigabit	None	35W	4 pair Mode B	PSU/PD	-40°C to +85°C
JXK0-0190NL	1Gigabit	Yellow-Green Green	75W	4 pair Mode B	PSU/PD	-40°C to +85°C
JXK0-0203NL	1Gigabit	Orange-Green Yellow	75W	4 pair Mode B	PSU/PD	-40°C to +85°C
JXK0-2500NL	2.5Gigabit	Yellow-Green Green	90W	4 pair Mode B	PSU/PD	-40°C to +85°C

Network PBU – Product summary

Ethernet Discrete Transformers

Ports: **Single, Dual,** and **Quad**
Data Rate: **100/1G/2.5G/5G/10GBase-T** and **HDBaseT** (for 4K video application)
Power over Ethernet:

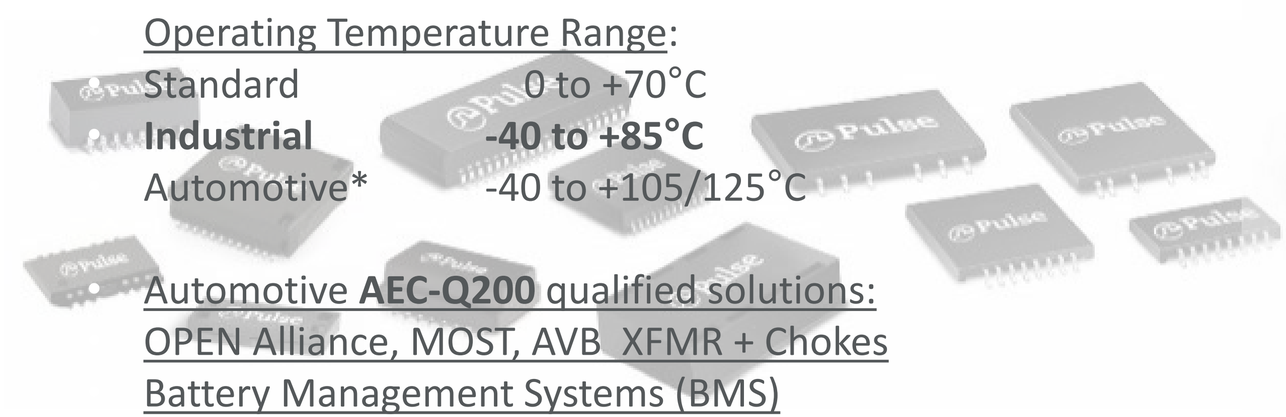
- IEEE 802.3af **PoE** **3-15W**
- IEEE 802.3at **PoE+** **10-30W**
- IEEE 802.3bt(4Pair) **PoE++** **60-140W**

Isolation: 1500Vrms to 6kVDC
Package Style: **SMD,** THT, BGA

Operating Temperature Range:

- Standard 0 to +70°C
- **Industrial** **-40 to +85°C**
- Automotive* -40 to +105/125°C

- Automotive **AEC-Q200** qualified solutions:
  OPEN Alliance, MOST, AVB XFMR + Chokes
  Battery Management Systems (BMS)



Ethernet Connector Module (ICM) – PulseJack®

Ports: **Single, Gang (1xn),** and **Stack (2xn)**
Data Rate: **100/1G/2.5G/5G/10GBase-T**

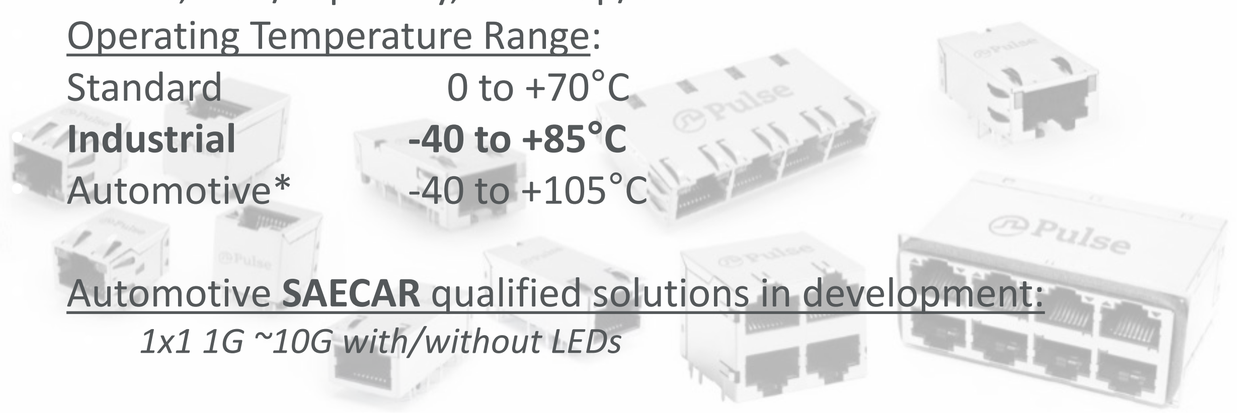
Power over Ethernet:

- IEEE 802.3af **PoE** **3-15W**
- IEEE 802.3at **PoE+** **10-30W**
- IEEE 802.3bt(4Pair) **PoE++** **60-140W**

Isolation: 1500Vrms (2250Vdc)
Package Style: **THT**, SMD, **THR, Press-fit**, Mid-mount, Low Profile, Side/Top Entry, Latch up/down
Operating Temperature Range:

- Standard 0 to +70°C
- **Industrial** **-40 to +85°C**
- Automotive* -40 to +105°C

Automotive **SAECAR** qualified solutions in development:
1x1 1G ~10G with/without LEDs

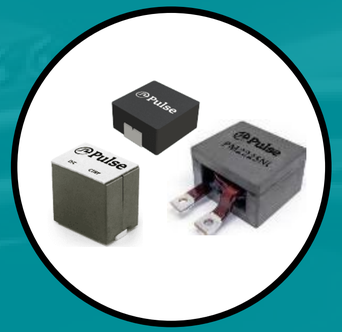


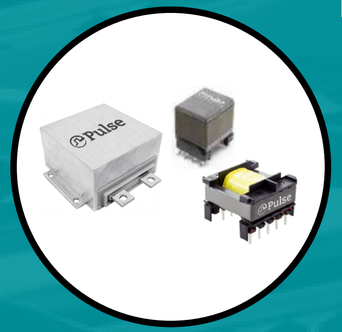
Powering 5G

Power magnetics are a critical part which include

Power Inductors

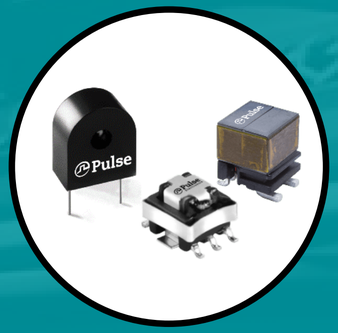
- Power Bead Inductors (Up to 120Apk)
- Molded Powder Inductors (Up to 118Apk)
- Composite Core Inductors (Up to 38Apk)
- Shielded & Unshielded Drum (Up to 30Apk)
- Toroid Inductors (Up to 40Apk)
- High Power Inductors (Up to 220Apk)





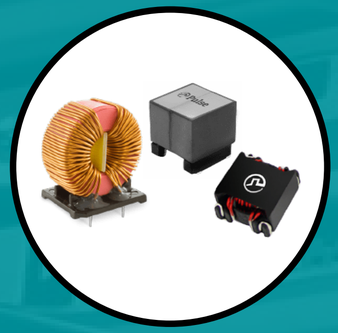
Power Transformers

- Multiple Topologies
- Wirewound Transformers (2W to 1KW)
- Planar Transformers (30W to 3.3kW)
- High Isolation Transformers (up to 5kVrms)
- Custom transformers available



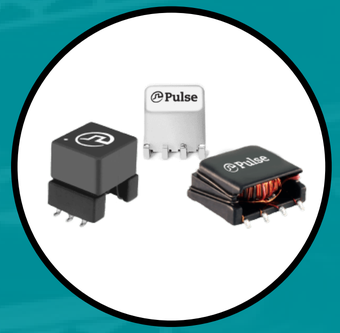
Current Sense Magnetics

- Functional, Basic and Reinforced Insulation (Up to 4000Vrms Isolation)
- Multiple platforms from 4A to 38A



Common Mode Chokes

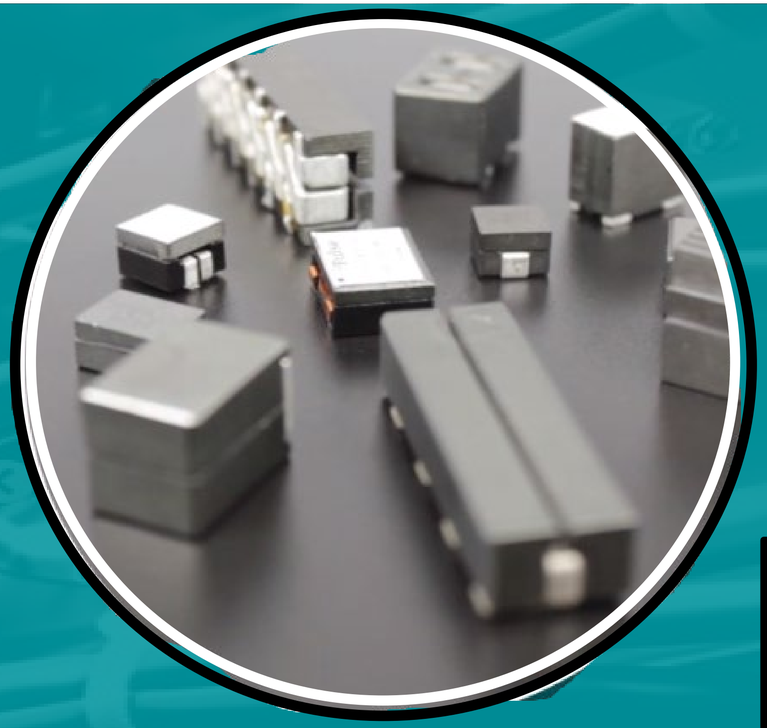
- Up to 38Arms
- Up to 2500 Vrms Isolation
- Multiple package sizes available

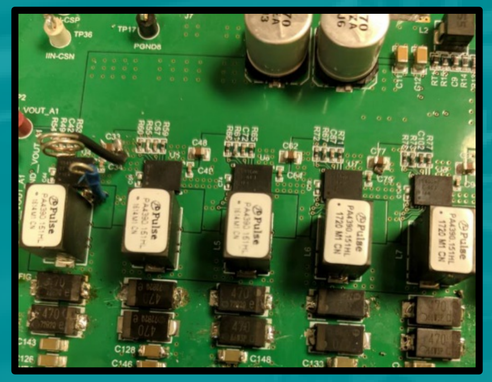


Isolation Transformers

- Functional, Basic and Reinforced Insulation (Up to 5000Vrms)
- Multiple turns ratios and volt-usec ratings

Power Beads

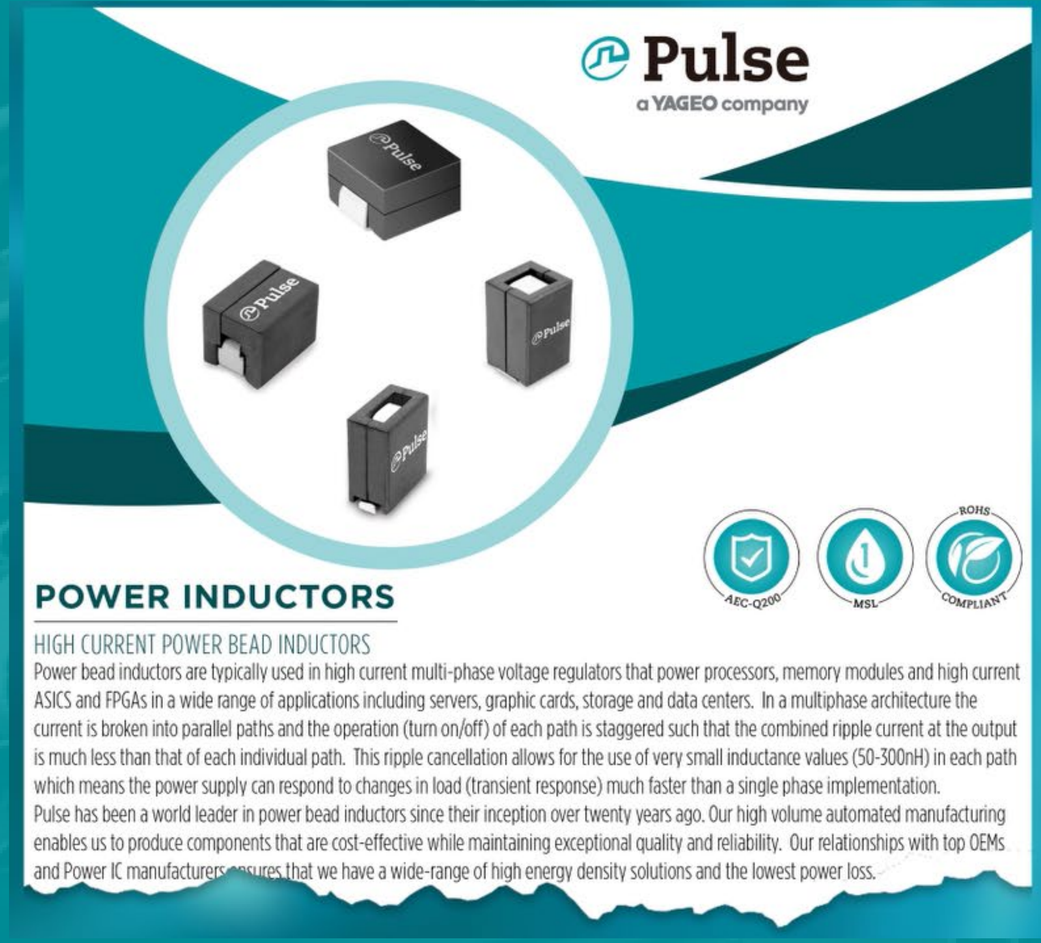


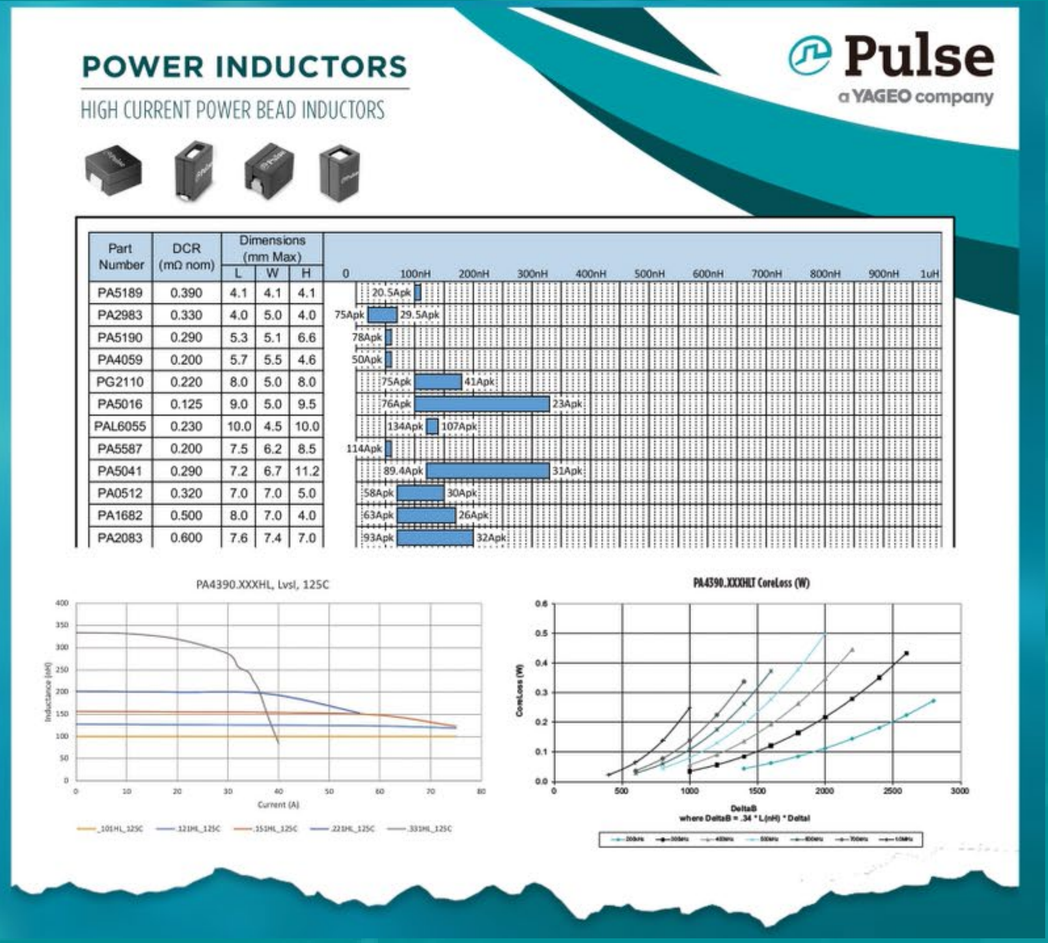


- 5G servers
- Edge servers
- High current multi-phase
- Power processors
- Memory modules
- High current ASICs and FPGAs

Power Beads

Over 40+ Catalog Platform Size Available, Datasheets and Technical Information available at PulseElectronics.com





Low Profile (U-I core) and Minimized Footprint (E-E) Core Platforms Available

Round Wire coils

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

Round Wire coils

Pulse a YAGEO company

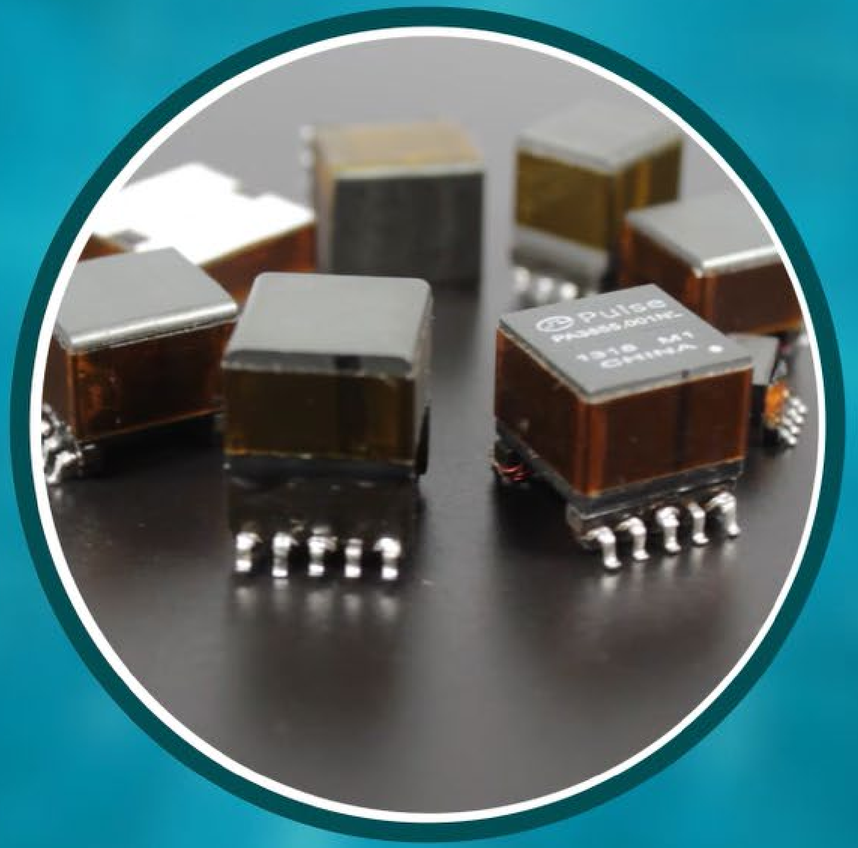
Over 6 Catalog Platform Size Available, Datasheets and Technical Information available at PulseElectronics.com

Power Transformers

Power Transformers are used in isolated circuits to convert voltages and provide safety isolation.
Designs Available for Flyback, Forward, Push-pull, Bridges, LLC and Resonant Mode

Through Hole

Surface Mount



Planar

Functional, Basic and Reinforced Insulation
Class B (130C), Class F (155C) and Class H (180C) Insulation Systems.

Power Transformers

2D and 3D FEA optimization allows us to Double the Power Density of industry standard platforms

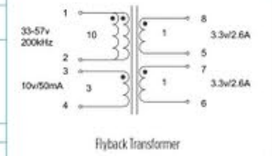
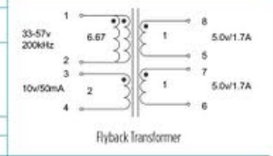
DC/DC (<75v input) PoE type applications allows us to double the through-power

High Frequency Wire Wound Transformers

EP7+ Platforms - SMT - PA5099.XXXNL AND PA5100.XXXNL

Pulse a YAGEO company

- *Industry standard footprint, 2X more power handling*
- **Power Range:** PA5099.XXXNL up to 17W; PA5100.XXXNL up to 27W
- **Height:** 15.5mm Max
- **Footprint:** 13.6mm x 11.0mm Max
- **Topology:** Forward and Flyback

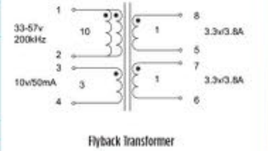
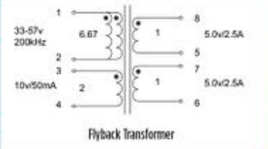
Pulse PN	Electrical Specifications @25°C – Operating Temperature -40°C to 125°C [1]				Schematic
PA5099.001NL	Pri. Inductance	(1-2)	80	uH ± 10%	
	Lk. Inductance	(1-2) w/ (5,6,7,8) shorted	1.0	uH Max	
	DCR	(1-2)	180	mΩ Max	
		(3-4)	130		
		(8-5)	12		
		(7-6)	12		
	Hi-Pot	Pri-Sec	2250	Vdc	
	KI Factor		1563		
PA5099.002NL	Pri. Inductance	(1-2)	80	uH ± 10%	
	Lk. Inductance	(1-2) w/ (5,6,7,8) shorted	1.0	uH Max	
	DCR	(1-2)	180	mΩ Max	
		(3-4)	130		
		(8-5)	24		
		(7-6)	24		
	Hi-Pot	Pri-Sec	2250	Vdc	
	KI Factor		1563		
	Pri. Inductance	(1-2)	80	uH ± 10%	
	Lk. Inductance	(1-2) w/ (5,6,7,8) shorted	1.0	uH Max	

High Frequency Wire Wound Transformers

EP10+ Platforms - SMT - PA5130.XXXNL AND PA5131.XXXNL

Pulse a YAGEO company

- *Industry standard footprint, 2X more power handling*
- **Power Range:** PA5130.XXXNL up to 25W; PA5131.XXXNL up to 35W
- **Height:** 15.5mm Max
- **Footprint:** 15.5mm x 13.0mm Max
- **Topology:** Forward and Flyback

Pulse PN	Electrical Specifications @25°C – Operating Temperature -40°C to 125°C [1]				Schematic
PA5130.001NL	Pri. Inductance	(1-2)	80	uH ± 10%	
	Lk. Inductance	(1-2) w/ (5,6,7,8) shorted	1.2	uH Max	
	DCR	(1-2)	130	mΩ Max	
		(3-4)	90		
		(8-5)	8		
		(7-6)	8		
	Hi-Pot	Pri-Sec	2250	Vdc	
	KI Factor		1250		
PA5130.002NL	Pri. Inductance	(1-2)	80	uH ± 10%	
	Lk. Inductance	(1-2) w/ (5,6,7,8) shorted	1.2	uH Max	
	DCR	(1-2)	130	mΩ Max	
		(3-4)	90		
		(8-5)	17		
		(7-6)	17		
	Hi-Pot	Pri-Sec	2250	Vdc	
	KI Factor		1250		
	Pri. Inductance	(1-2)	80	uH ± 10%	
	Lk. Inductance	(1-2) w/ (5,6,7,8) shorted	1.2	uH Max	

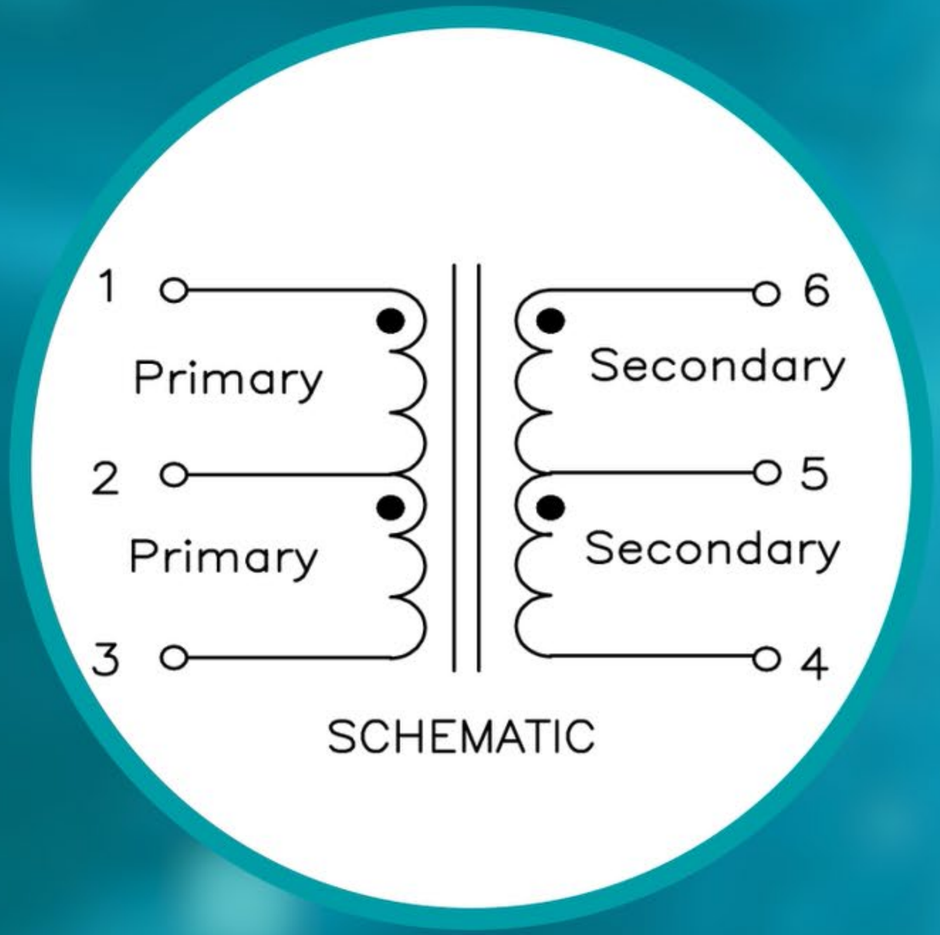
EP7+, EP10+ and EP13+, PA5099/5100, PA5130/PA5131, PA3855/3856

Common mode chokes

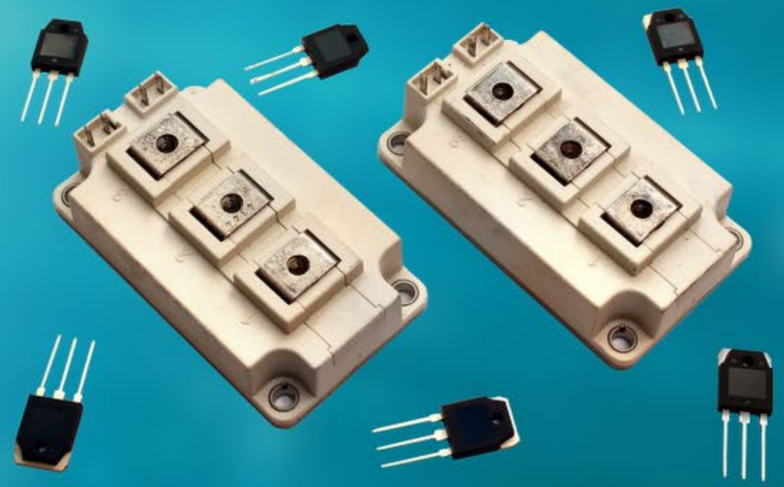
Used to reduce EMI within the power supplies used within 5G.
Critical to ensure noise does not couple to communication channels

Catalogue parts exceeding 40A; custom solutions exceeding 100A

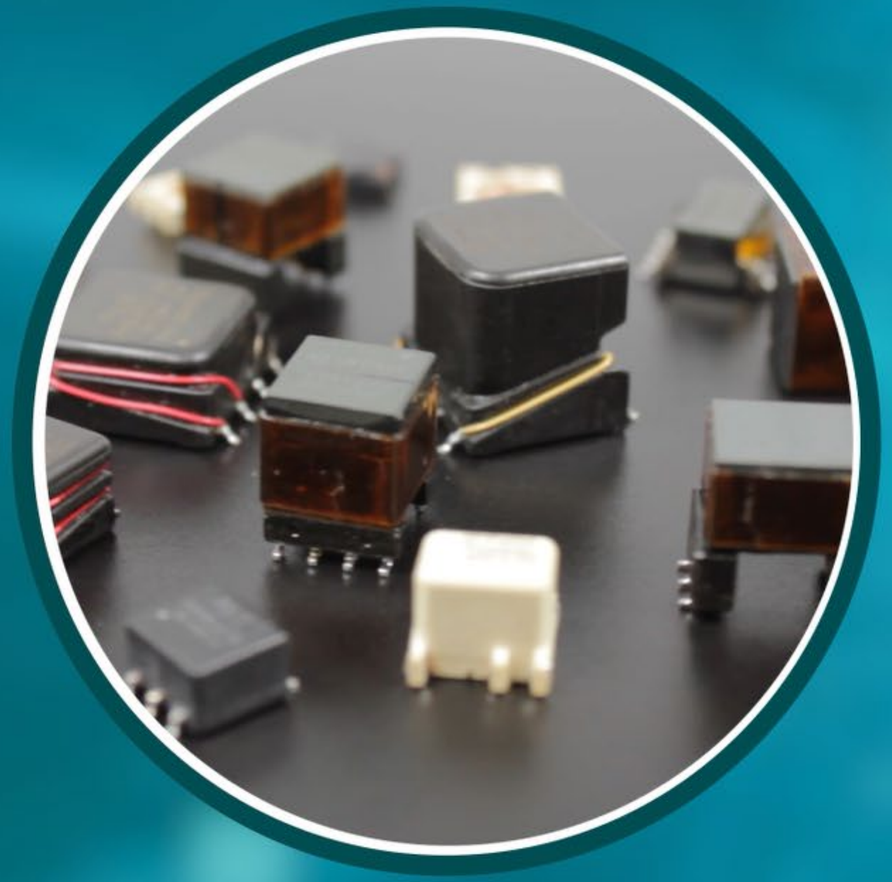
Isolation Transformers



Used to drive IGBTs, FETs and other switches



Isolation Transformers



Pulse offers parts from
1500 volts, up to 5000 volts

Functional, Basic, Reinforced

Current sense magnetics

Current Sense Magnetics are used to Sense Application Current and Provide Isolation

Pulse's catalog offering is up to 40Arms, 5000Vrms

Catalog Solutions for Functional, Basic and Reinforced Insulation Systems

Thank You