

FOR ENERGY EFFICIENT INNOVATIONS

**THINK ON.**

[www.onsemi.com](http://www.onsemi.com)

# Digital Isolation Products

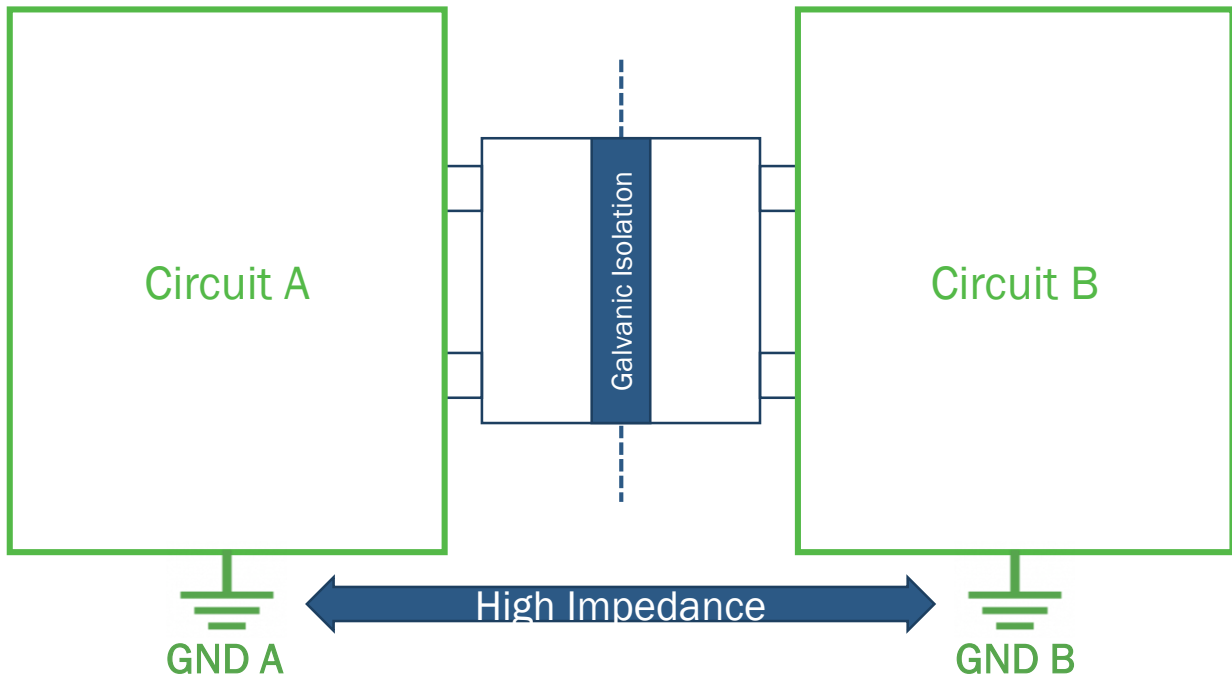
Customer Presentation

Public Information



# Introduction to Isolation

**Galvanic isolation** is a principle of isolating functional sections of electrical systems to prevent current flow.



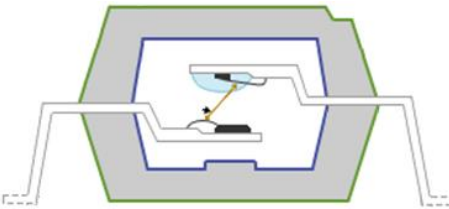
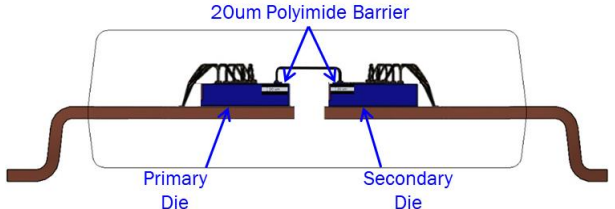
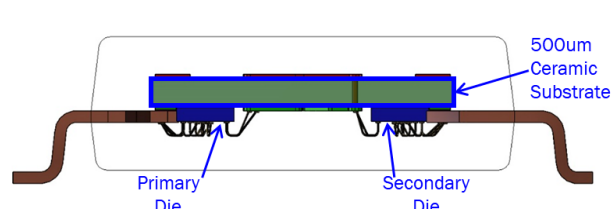



## Reasons for Galvanic Isolation

- Safety of End User
- Protecting LV circuits from HV Circuits
- Filtering of Common-Mode Noise
- Eliminating Ground Loop Noise
- Level-Shift between Power Domains

## Technologies used for Galvanic Isolation

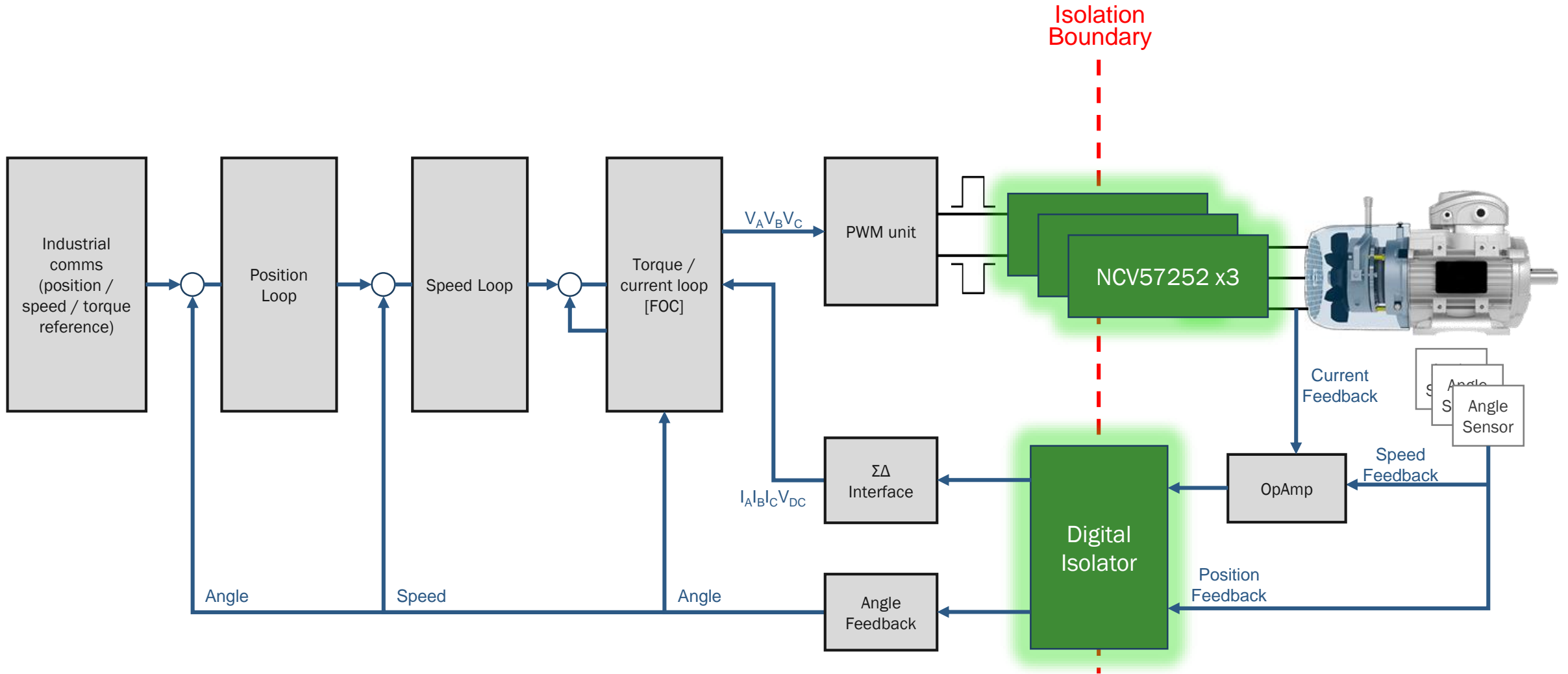
- Optically Isolated Devices
- Digitally Isolated Devices
  - Insulation with on-chip capacitors
  - Insulation with on-chip inductors
  - Insulation with off-chip capacitors

# Isolation Market & Technologies

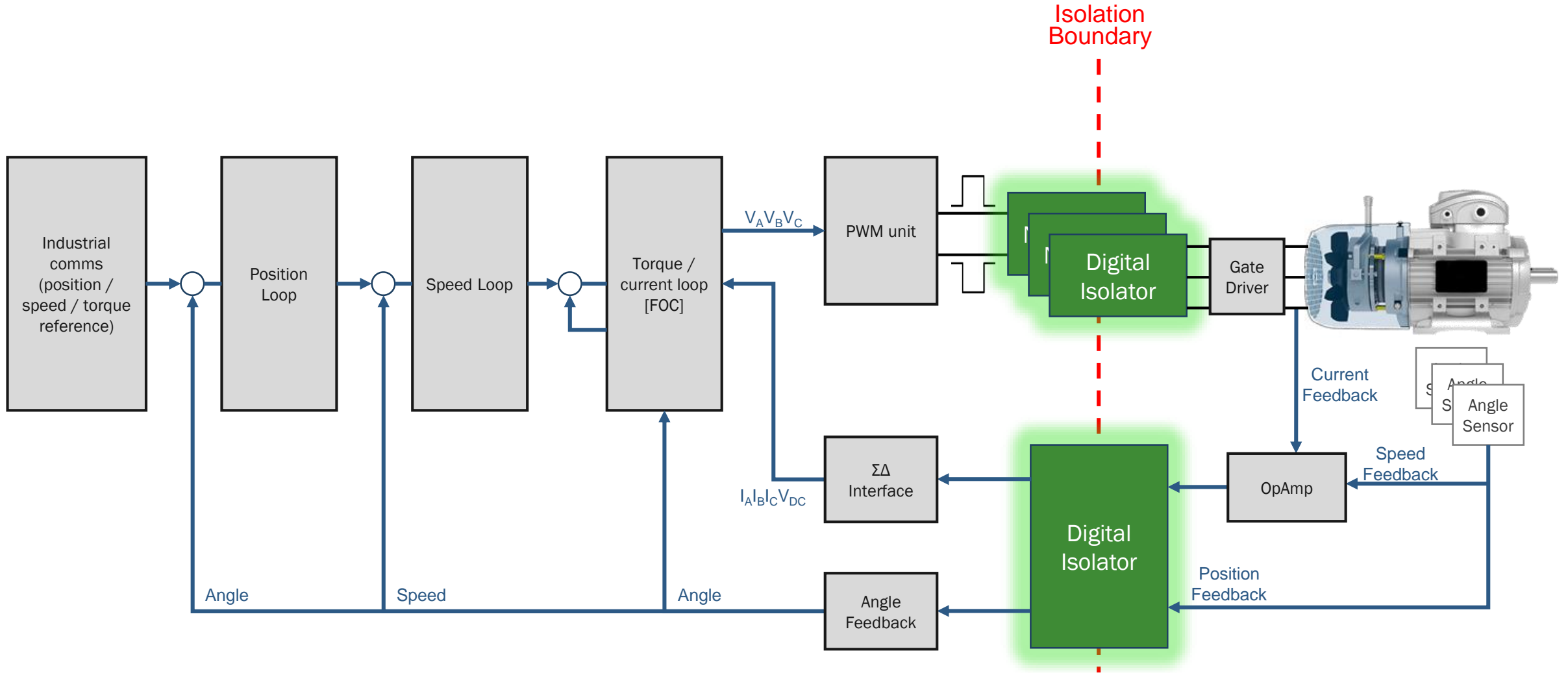
Optocouplers	Digital Isolators (DI)	Digi-Max™ (DM)
		
<b>Technology</b>		
Optical: LED + Photodiode	Digital: On-Chip	Digital: Off-chip with Ceramic Insulator
<b>Benefits</b>		
Lowest Cost EMI / EMC Immunity Isolation Reliability / Safety	Low Cost  Stable over Temp & Time	EMI / EMC Immunity Isolation Reliability / Safety Stable over Temp & Time
<b>Primary Markets</b>		
Power Supplies Industrial HP Drives	Automotive (EV/HEV) Telecom	Industrial HP Drives
<b>Lead Suppliers</b>		
		Unique to 



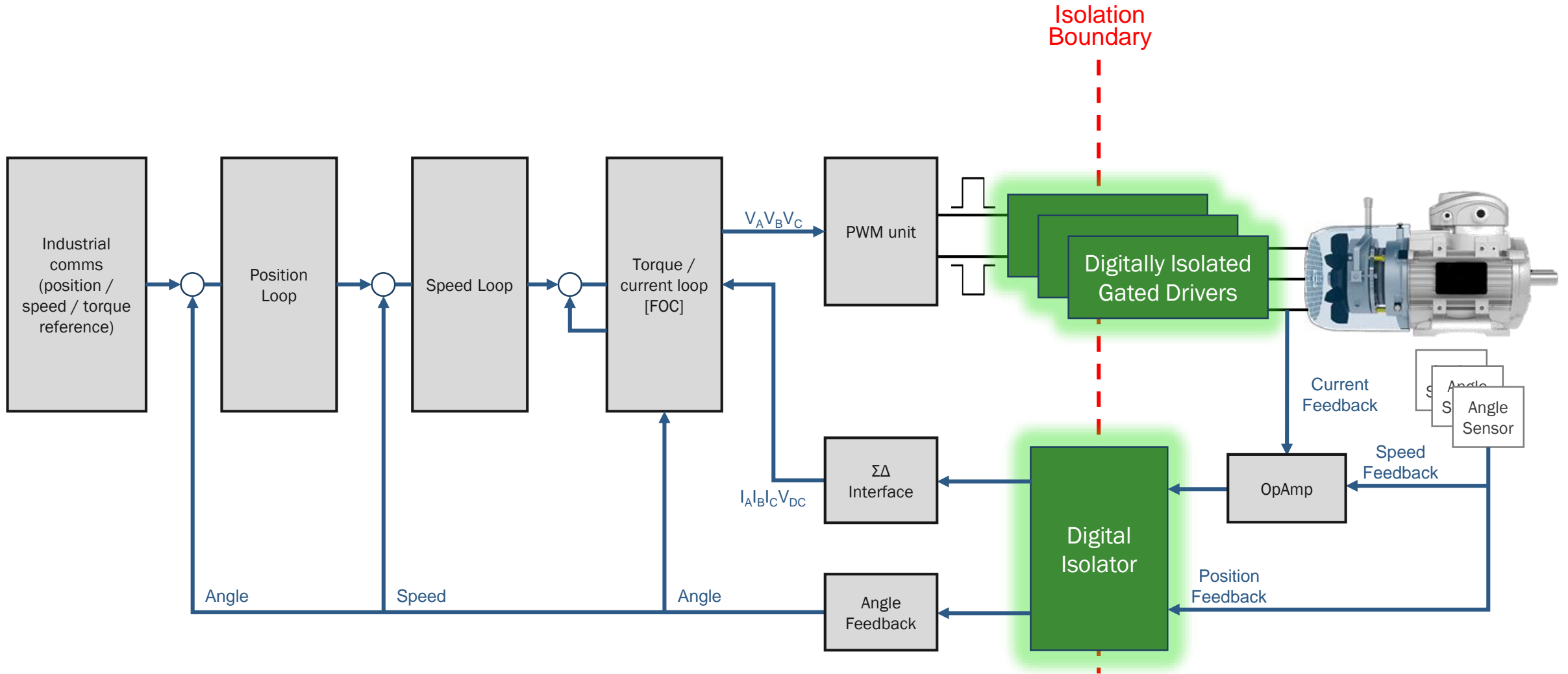
# 3-Phase Motor Control (Industrial Robotics / Etc...)



# 3-Phase Motor Control (Auto / Industrial Robotics / Etc...)

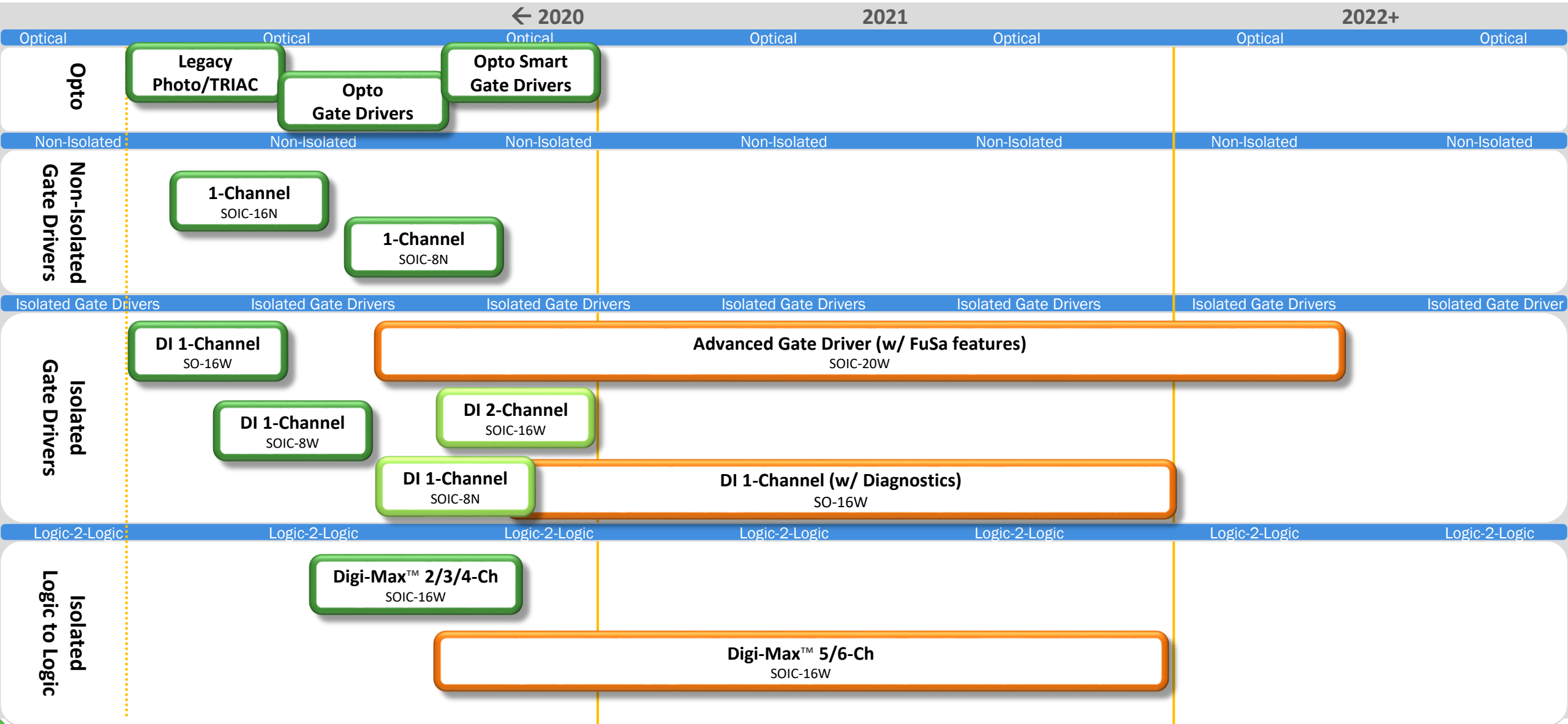


# 3-Phase Motor Control (Auto / Industrial Robotics / Etc...)



# Isolation Products Development Roadmap

Released    Sampling    Develop



# Isolated Gate Drivers





# High Voltage IGBT Gate Drivers

	Non-Isolated	High side & Low side	Internally Isolated
PRODUCTS	<p>NCD5700/02 NCD5701/03(A/B/C) S016 &amp; S08</p>	<p>NCD57200/01 S08 P2P with IR/IFX &amp; ST</p>	<p>NCD57000/01 Single channel S016 wide body P2P w/ TI &amp; IFX</p> <p>NCD57080/84/85/90 Single channel S08 narrow &amp; wide body P2P w/ TI, IFX, Analog</p> <p>NCD57252 Dual channel S016 wide body P2P w/ TI, SiLabs</p>
APPLICATIONS	<p>HVAC PFC UPS Motor Control 1-Switch PTC Heater</p>	<p>IPMs Motor Control White Goods 2-Switch PTC Heater</p>	<p>UPS Solar Inverter Motor control EV Chargers</p> <p>PTC Heaters BSG Inverter OBC Traction Inverter</p>
HIGHLIGHTS	<p>High Drive Current Low Propagation Delay Full Features: DESAT, Clamp, UVLO, TSD, Vee</p>	<p>High Drive Current Dead time control Low Propagation Delay</p>	<p>High Drive Current Low Propagation Delay Full Features: DESAT, Clamp, UVLO, Vee, STO Isolation Certification: UL/VDE/IEC</p>



# Gate Drivers OPN Selection Guide

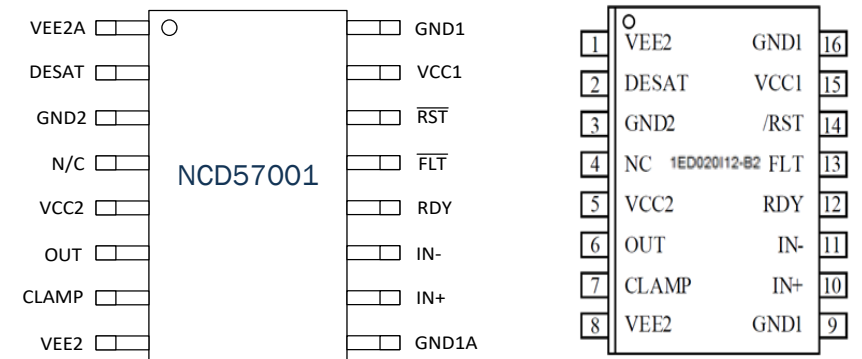
	Specs/Features							Target Applications								
								Automotive				Industrial/Consumer				
	No. of channels	Isolation	Differential Input	DESAT w/ FLT	Miller Clamp	VEE	Split output	Traction	PTC	OBC	HV DC-DC	IH	UPS	Solar	Motor Control	HVAC
NCDV)5700/2	1			V	V	V	V	V	V							
NCD(V)5701/3A	1			V	V			V	V	V	V	V	V		V	
NCD(V)5701/3B	1			V		V		V	V	V	V	V	V		V	
NCD(V)5701/3C	1			V			V	V	V	V	V	V	V		V	
NCD(V)57000/1	1	V	V	V	V			V	V					V	V	V
NCD(V)57080A	1	V	V		V					V	V	V	V			V
NCD(V)57080B	1	V	V			V				V	V	V	V			V
NCD(V)57080C	1	V	V				V			V	V	V	V			V
NCD(V)57090A	1	V	V		V								V	V	V	
NCD(V)57090B	1	V	V			V							V	V	V	
NCD(V)57090C	1	V	V				V						V	V	V	
NCD(V)57084	1	V		V					V				V			
NCD(V)57085	1	V		CS w/FLT					V				V			
NCD(V)57252	2	V								V	V			V		V
NCD(V)57200/1	2									V	V	V	V			V



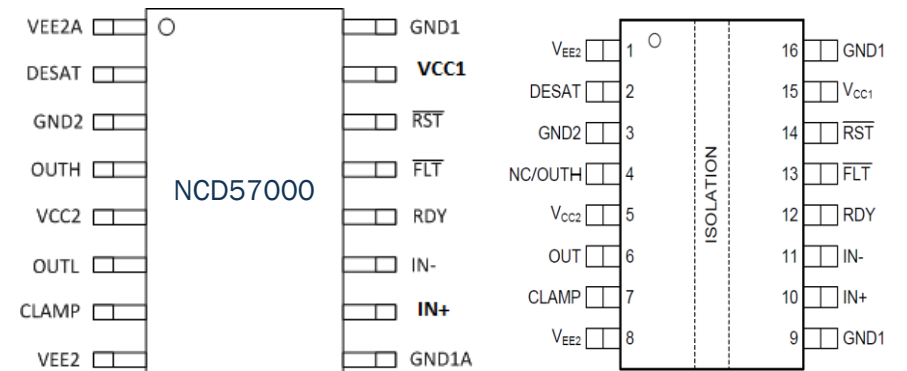
# 16 pin wide body isolated drivers – Specs & Pin-out

Parameter	Digital Isolated Drivers				Opto-Drivers
	ON NCD57000	Infineon 1ED020I12	TI ISO5852S	Analog ADuM4135	Avago ACPL-333J
Source Current	7.8A <sub>pk</sub>	2A <sub>pk</sub>	2.5A <sub>pk</sub>	4A <sub>pk</sub>	2.5A <sub>pk</sub>
Sink Current	7.1A <sub>pk</sub>	2A <sub>pk</sub>	5A <sub>pk</sub>	4A <sub>pk</sub>	2.5A <sub>pk</sub>
Prop. Delay	66ns	170ns	76ns	55ns	180ns
Delay Distortion (tpdoff-tpdon)	15ns	25ns	20ns	15ns	150ns
Isolation Voltage	5 KV	4.5 KV	5.7 KV	5 KV	5 KV
CMTI	100kV/us	50kV/us	100kV/us	100kV/us	50kV/us
Operating Temp	+125	+105	+125	+125	+105

P2P w/ Infineon



P2P w/ TI

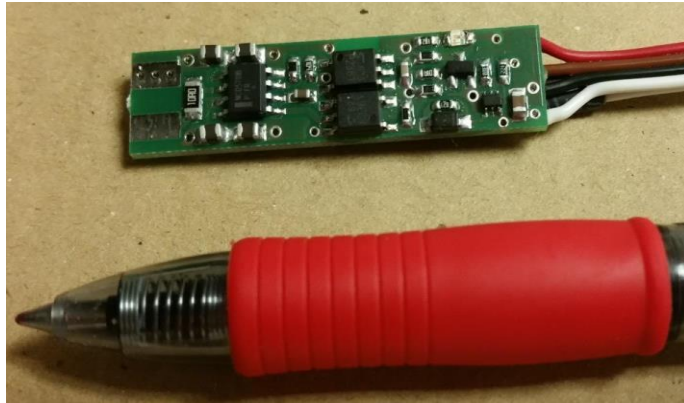


ISO5852S/ISO5851/ISO5452/ISO5451

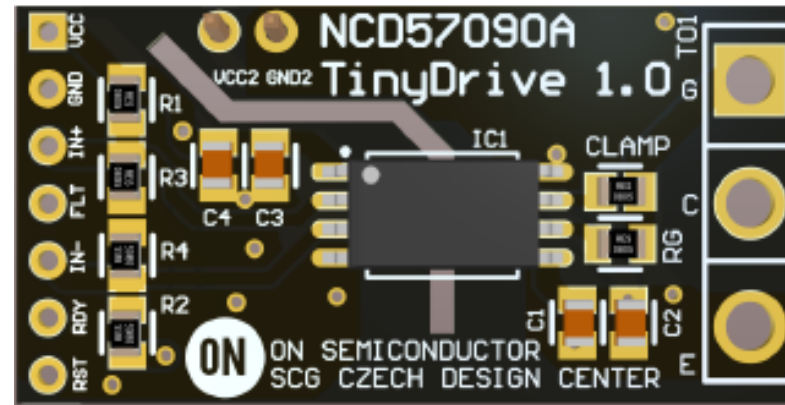


# Reference Boards

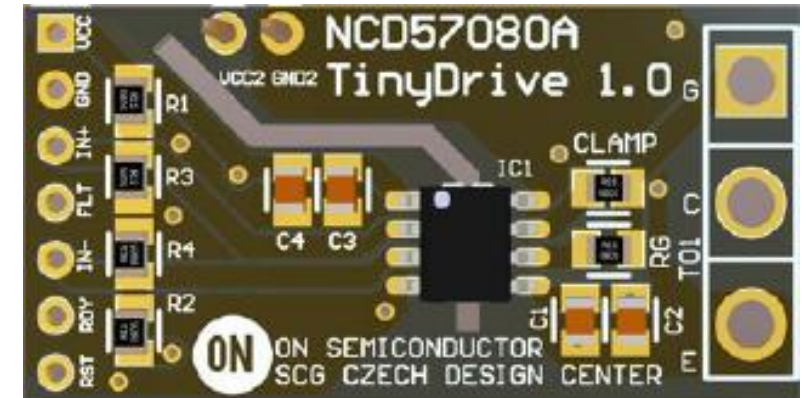
## TinyDrive Board for NCD5701B



## Eval board for NCD57090



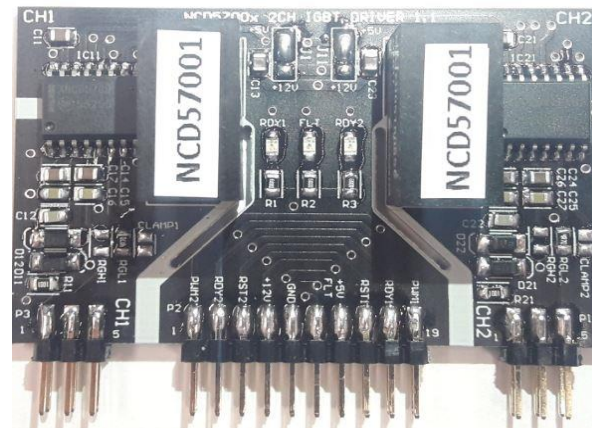
## Eval Board for NCD57080



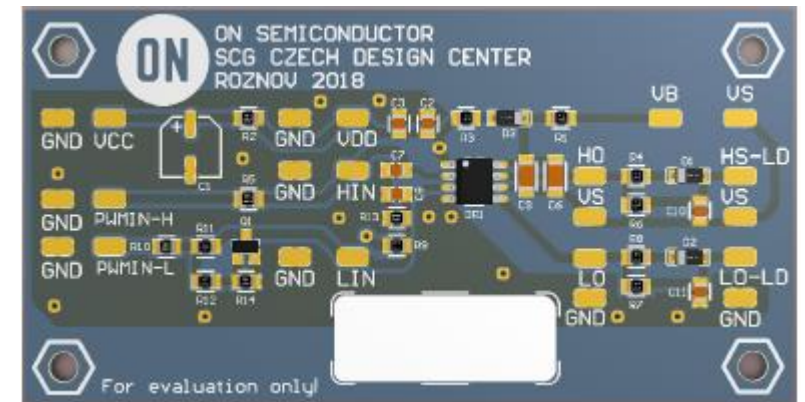
## TinyDrive Board for NCD5700x



## 2-Ch Board for NCD5700x



## Eval Board for NCV57200



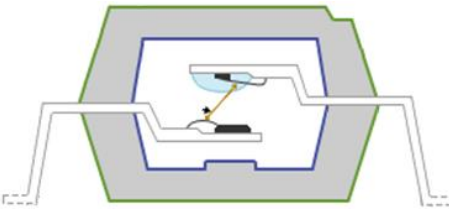
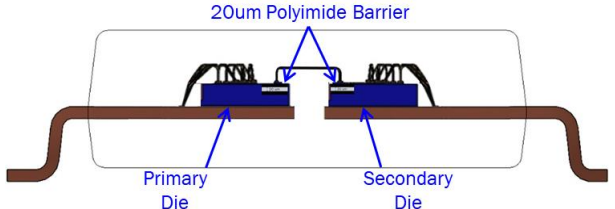
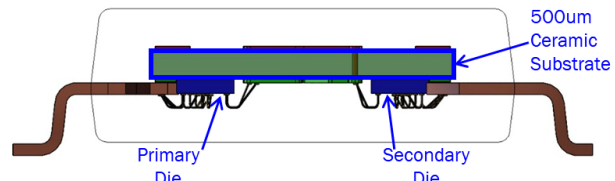



# Digi-Max™

---

Logic-2-Logic Digital Isolators



# Isolation Market & Technologies

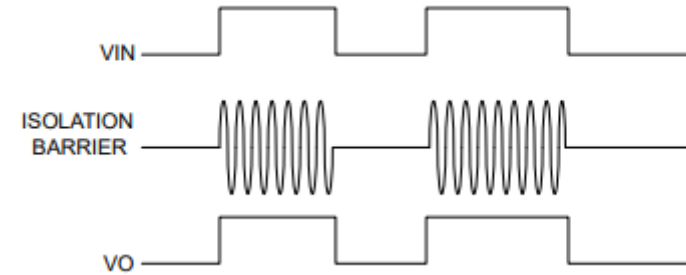
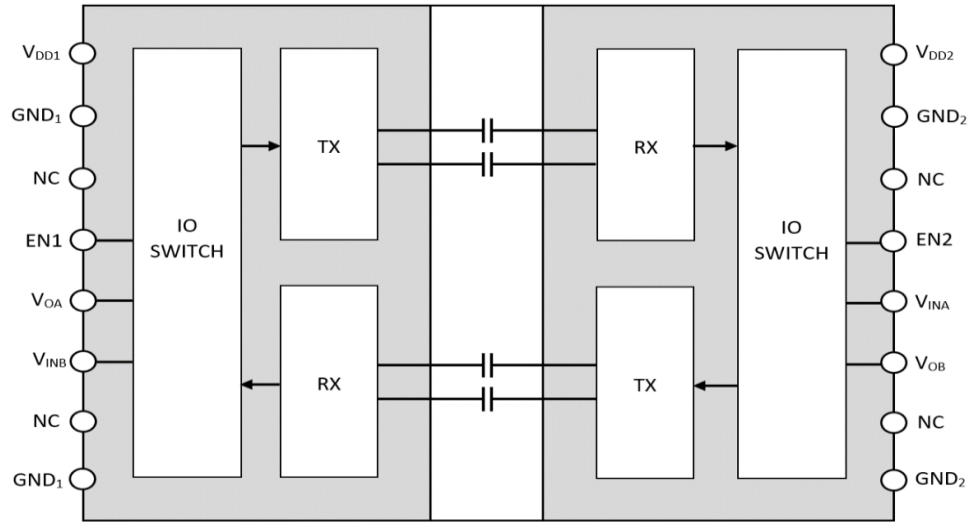
Optocouplers	Digital Isolators (DI)	Digi-Max™ (DM)
		
<b>Technology</b>		
Optical: LED + Photodiode	Digital: On-Chip	Digital: Off-chip with Ceramic Insulator
<b>Benefits</b>		
Lowest Cost EMI / EMC Immunity Isolation Reliability / Safety	Low Cost  Stable over Temp & Time	EMI / EMC Immunity Isolation Reliability / Safety Stable over Temp & Time
<b>Primary Markets</b>		
Power Supplies Industrial HP Drives	Automotive (EV/HEV) Telecom	Industrial HP Drives
<b>Lead Suppliers</b>		
		Unique to 



# Comparison of Isolation Techniques

Attribute		Opto-Coupler	On-chip Magnetic	On-chip Capacitive	Digi-Max™ Off-chip Capacitive
Isolation Materials		Epoxy/Silicone gel	Polyimide	SiO <sub>2</sub> or equivalent	Ceramic Substrate/ Epoxy
Signal Coupling		Optical (LED +diode)	Magnetic field	Electric field	Electric field
Performance Across Temp & Time		Varies	Consistent	Consistent	Consistent
Life Expectancy		~10 Yrs	~ 20 Yrs	~ 20 Years	~20 Years
Speed		Slow	Fast	Fast	Fast
Distance Through Insulation (DTI)		> 400 μm	~20 μm	~20 μm	> 500 μm
Meets EN60950 >0.4mm DTI		Yes	No	No	Yes
Common Mode Transient Immunity (CMTI)		~25 kV/μs	> 100 kV/μs	> 100 kV/μs	> 100 kV/μs
EMI EMC	Susceptibility	Non-issue – too slow	Design techniques	Signal level dependent	Signal level dependent
	Radiation	Non-issue (light transmission)	Design techniques	Design techniques	Design techniques
Junction Temperature		Up to 125°C	Wide range (150 °C)	Wide range (150 °C)	Wide range (150 °C)
Standards		UL1577 IEC60747-5-5	UL1577 VDE0884-11	UL1577 VDE0884-11	UL1577 VDE0884-11
Modulation Method for Internal Signal Xfer		No modulation required	On-Off Keying	On-Off Keying	On-Off Keying
AEC Qualified Portfolio		Limited	Yes	Yes	Yes

# Working Principles of Bi-Directional Ceramic Isolator



- Bi-Directional communication between two isolated circuits.
- Off-chip ceramic capacitors that serve both as the isolation barrier and as the medium of transmission for signal switching using on-off keying (OOK) technique,
- Tx, modulates the VIN input logic state with a high frequency carrier signal.
- Rx detects the barrier signal and demodulates it using an envelope detection technique.





FOR ENERGY EFFICIENT INNOVATIONS

**THINK ON.**

[www.onsemi.com](http://www.onsemi.com)

**Digi-Max™ Family  
Logic-to-Logic Digital Isolator  
Using Ceramic, Off-Chip Galvanic Isolation**

**September 2020**

Public Information



## Digi-Max Isolator – Safety Advantages



# Optocouplers

---

# Optoelectronics Portfolio

More than 1,000 active Optocouplers part numbers!!

## Phototransistor

- 4PB, 6PW, SO8, MFP, SO-4

### Application Segments

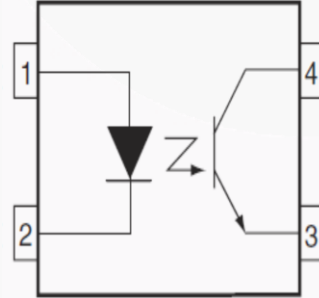
- All

### Key Features

- CTR (gain), VISO, T(OFF), I(F)
- Low cost, all-purpose optocoupler

### ON Advantage

- FODM8801 (OptoHiT) – Better CTR vs. Temp



## IGBT/MOSFET Gate Drivers

- 8PW, SO16, SO-5, SO-6

### Application Segments

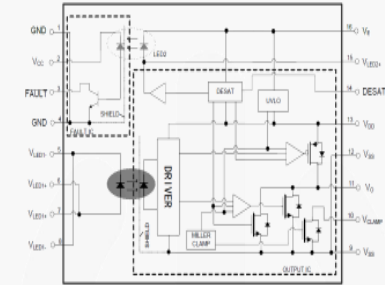
- Motor drives, Solar, IH,
- Welding

### Key Features

- Basic and smart MOSFET/IGBT gate drive
- UVLO, CMTi, I(O), PWD, Skew, Vdesat, VDD-VSS

### ON Advantage

- Lower RDSON (Faster ON/ON), better noise immunity



## Photo TRIAC Drivers

- 6PW, 6PB, MFP

### Application Segments

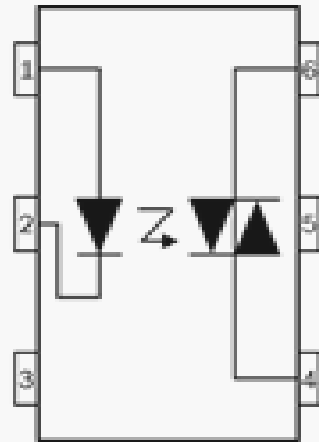
- White goods
- Welding

### Key Features

- AC Mains control
- IDRM, VDRM, IFT, VINH, dv/dt

### ON Advantage

- Better quality (competitors have known reliability issues)



## High Performance

- MFP-5, SO-5, SO-6, SO-8, 8PW

### Application Segments

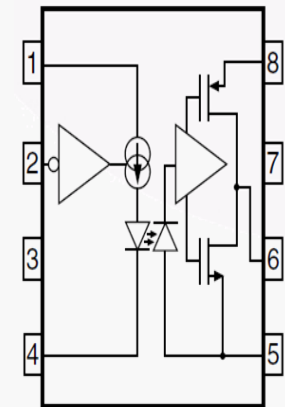
- PLC, Industrial field bus, consumer

### Key Features

- High bandwidth or very high gain
- TPHL/TPLH, IFT, CMTi, PWD

### ON Advantage

- Compete on price vs. Broadcom/Avago



# Where are they Used?

## End Products

- Power inverters (Solar Inverter, motor drive, UPS, Automotive traction inverter)



## Focus

- IGBT/MOSFET Gate Drivers
- High Performance Optocouplers

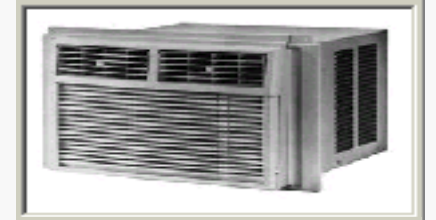
## Recent New Products

- NCD(V)57080

FOCUS

## End Products

- Air Conditioner, Consumer Appliances, Office equipment



## Opto Focus

- TRIAC Driver Optocouplers

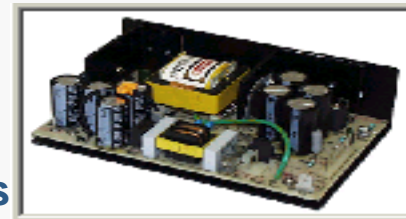
## Focus Products

- FOD4xx Snubberless driver
- FODM3053\_NF098



## End Products

- SMPS, Adaptors, Chargers



## Focus

- Phototransistor Optocouplers

## Recent New Products

- CTR Customization
- FODM8801 OptoHit

## End Products

- Industrial Process Control

## Opto Focus








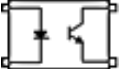
- High Performance Optocouplers

## Focus Products

- Digi-Max Isolators – NCID9xxx
- High speed – FOD07xx







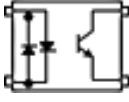

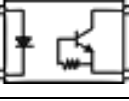


# On Semiconductor Phototransistor Portfolio






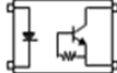

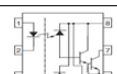

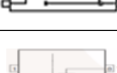


ON_Semi PhotoTransistor Optocoupler Portfolio (1)										
Functional Diagram	Creepage & Clearance Distance		5 mm	5 mm	8 mm	4 mm		7 or 8 mm	7 or 8 mm	
	Package Type		MFP4(HP)	MFP4(FP)	LSOP4	SO8 1-Ch	SO8 2-Ch	DIP4	DIP6	DIP8 2-Ch
	Features	Isolation Voltage (Vrms)								
	General Purpose	3,750	FODM217x	FODM121x, FODM124, FODM2701						
		4,170							CNY17FxM, MOC8106M	
		5,000			FODM1007, FODM1008, FODM1009			FOD817		MCT6x, MCT9001
	Low Input Current, High Temp	3,750	FODM8801x							
	With/Without Base Pin	2,500				MOC20xM, MOC21xM	MOC20xM, MOC21xM			
	With Base Pin	4,170							4N2xM, 4N3xM, CNY17xM, H11AV1M, MCT2EM, TIL111M, TIL117M	
	Low Input Current With Base Pin	2,500				MOC216M, MOC217M	MOC217M (no base)			
		4,170							H11AG1M, MCTS210M, MCTS211M	
	High Vceo With Base Pin	4,170							4N38M, H11D1M, H11D3M, MOC8204M	



# On Semiconductor Phototransistor Portfolio (Cont)

ON_Semi PhotoTransistor Optocoupler Portfolio (2)								
Functional Diagram	Creepage & Clearance Distance		5 mm	5 mm	4 mm		7 or 8 mm	
	Package Type		MFP4(HP)	MFP4(FP)	SO8 1-Ch	SO8 2-Ch	DIP4	DIP6
	Features	Isolation Voltage (Vrms)						
 AC input General Purpose	2,500				MOC256M			
	3,750	FODM214	FODM2705					
	4,170						H11AA1M, H11AA4M	
	5,000					FOD814, FOD814A,		
 High CTR%	2,500				MOC223M	MOCD223M		
	3,750		FODM352					
	4,170						4N29M, 4N30M, 4N32M, 4N33M, H11B1M, TIL113M, MOC8021M, MOC8050M	
Darlington	Low Input Current With High CTR%	4,170					H11G1M, H11G2M	
	Low Input Current With High CTR%	5,000					FOD852	
 On-chip RBE High-Speed, Low Input Current	5,000						FOD819	







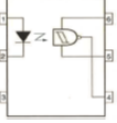
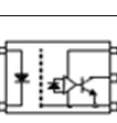
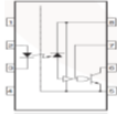
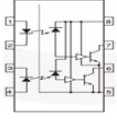
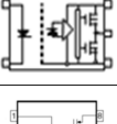
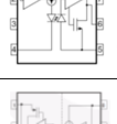
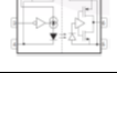

# ON Semiconductor® High Speed Optocoupler Portfolio(1)

Clearance/Creepage Distance			10 mm	4 mm	4 mm		7 or 8 mm	7 or 8 mm			
Package Type			SO5L	SO5	SO8 1-Ch	SO8 2-Ch	SDIP6	DIP4	DIP6	DIP8 1-Ch	DIP8 2-Ch
Data Rate (Typ.)	Output Configuration	Function Diagram									
< 20 kbps	Transistor							FOD819			
					HCPL0700, HCPL0701					6N138M, 6N139M	
< 100 kbps	Split Darlington					HCPL0731					HCPL2731M
				FODM452, FODM453							
< 1 Mbps	Open collector				HCPL0453, HCPL0500, HCPL0501, FOD050L					HCPL4503M*, 6N135M, 6N136M	
						HCPL0534, HCPL0531, FOD053L					HCPL2530M, HCPL2531M
	Totem Pole						FOD8480, FOD8483 (Non-Inverting)				




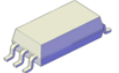
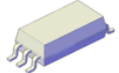
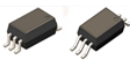

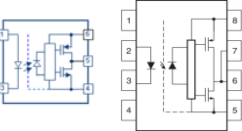
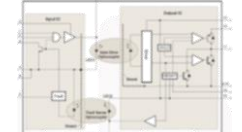
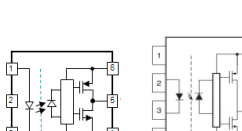
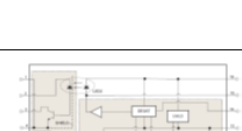
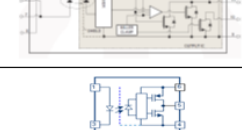




# ON Semiconductor® High Speed Optocoupler Portfolio(2)

Clearance/Creepage Distance			10 mm	4 mm	4 mm		7 or 8 mm	7 or 8 mm			
Package Type			SO5L	SO5	SO8 1-Ch	SO8 2-Ch	SDIP6	DIP6	DIP8 1-Ch	DIP8 2-Ch	
Data Rate (Typ.)	Output Configuration	Function Diagram									
< 1 Mbps								H11L1M, H11L2M, H11L3M			
								H11N1M, H11N2M			
< 10 ~ 20 Mbps	Open collector		FOD8160	FODM611, FODM8061			FOD8163, FOD8163T				
					HCPL0600, HCPL0601, HCPL0611, FOD060L			6N137M, HCPL2611M, FOD260L			
						HCPL0637, HCPL0638, HCPL0639, HCPL062N			HCPL2630M, HCPL2631M		
	Totem pole			FODM8071				FOD8173, FOD8173T			
					FOD8001, FOD0710, FOD0720, FOD0721						
						FOD8012A					



# Isolated Gate Driver Optocouplers Portfolio Table

Clearance & Creepage Distance			8 mm	8 mm	10 mm	7 or 8 mm	7 or 8 mm
Package Type			SO16L	SO5L	SO5L	SDIP6	DIP8
Peak Output Current, $I_{OP}$	Prop Delay, $t_{PHL}$ , $t_{PLH}$	Function Diagram					
0.6 A	500 ns						FOD3150
2.5 A	500 ns			FOD8321		FOD8314	FOD3150A
	500 ns		FOD8316, FOD8318				
	400 ns				FOD8320		FOD3120/5
	200 ns			FOD8384	FOD8383	FOD8342	FOD3180, FOD3182, FOD3184
	200 ns		FOD8332, FOD8333				
4.0 A	200 ns					FOD8343	
4.0 A	200 ns		FOD8334				

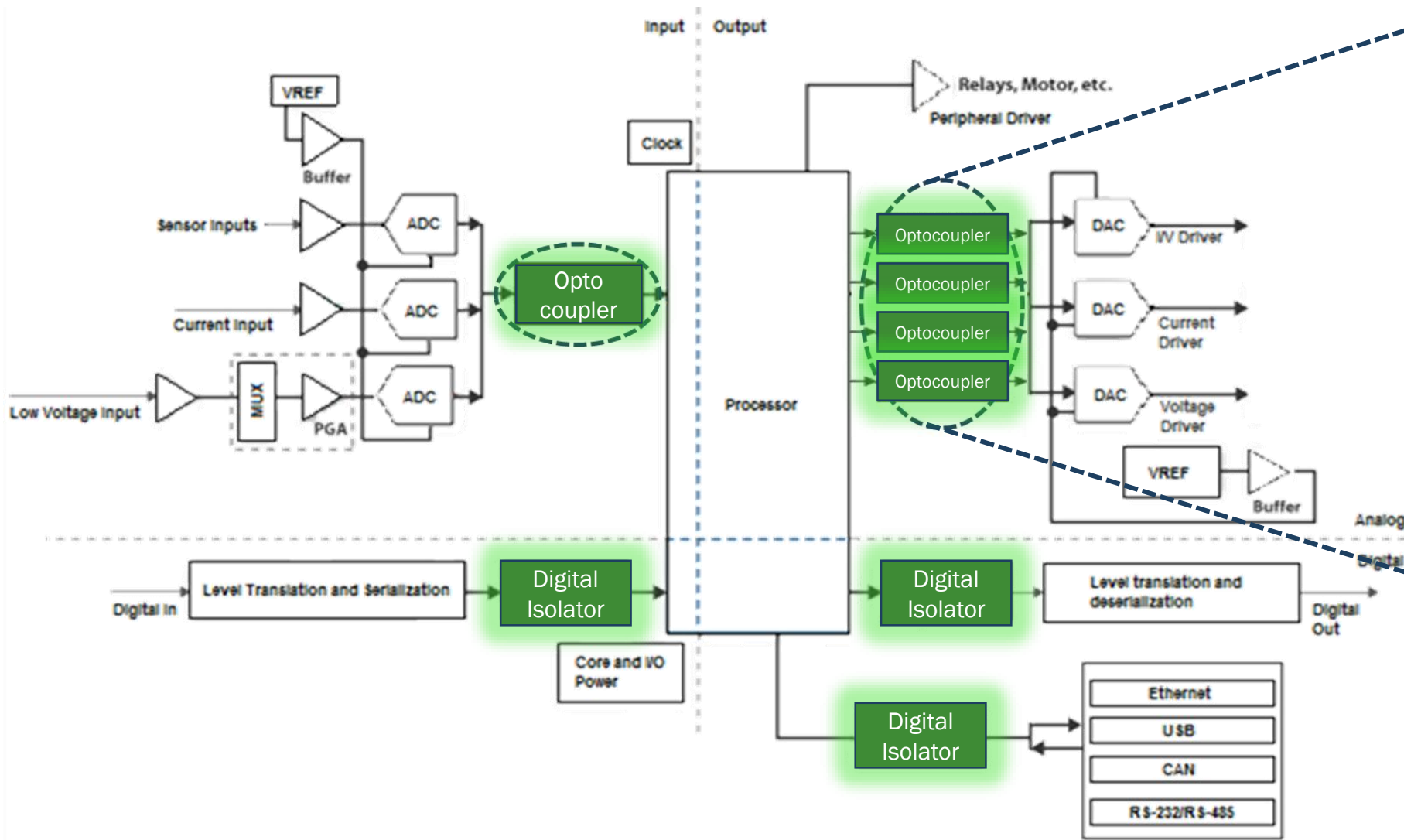
Public Information



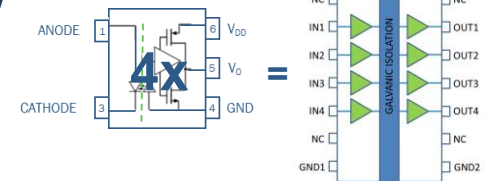
# Block Diagrams

---

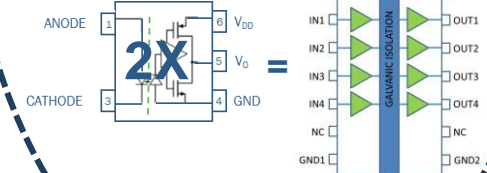
# Network Communications



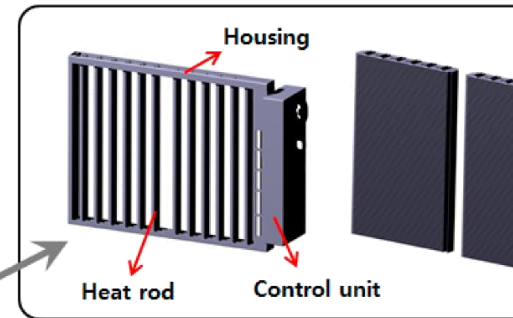
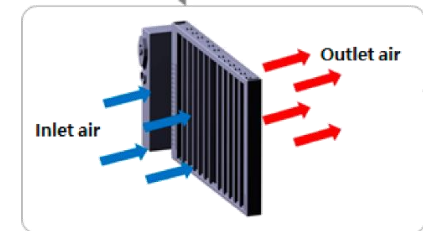
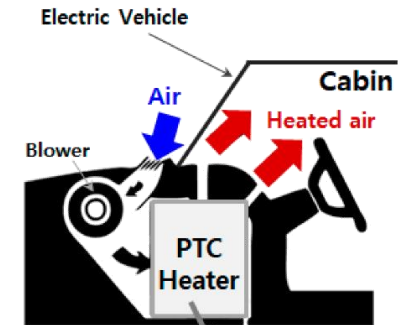
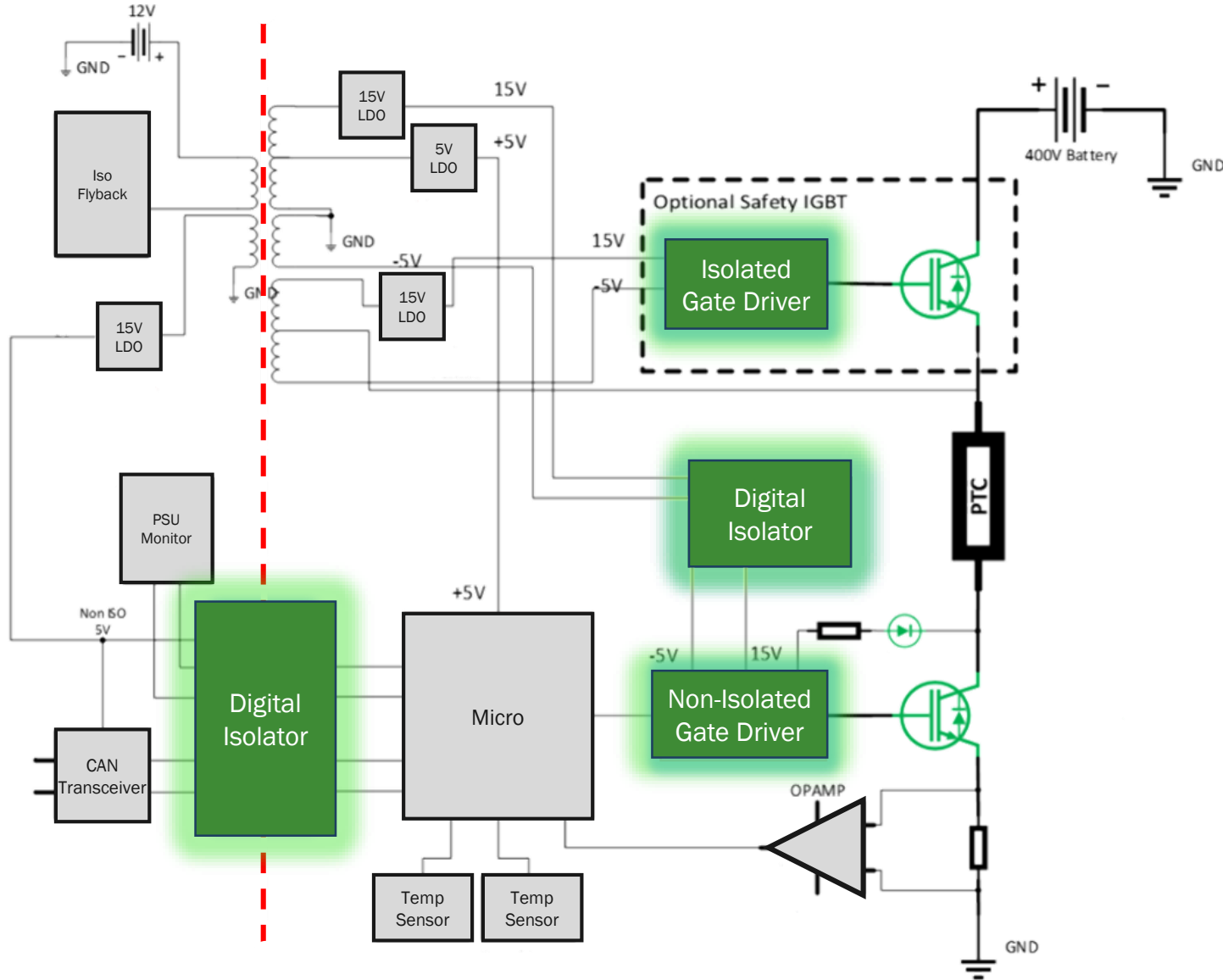
1-Ch Optocoupler Digi-Max™



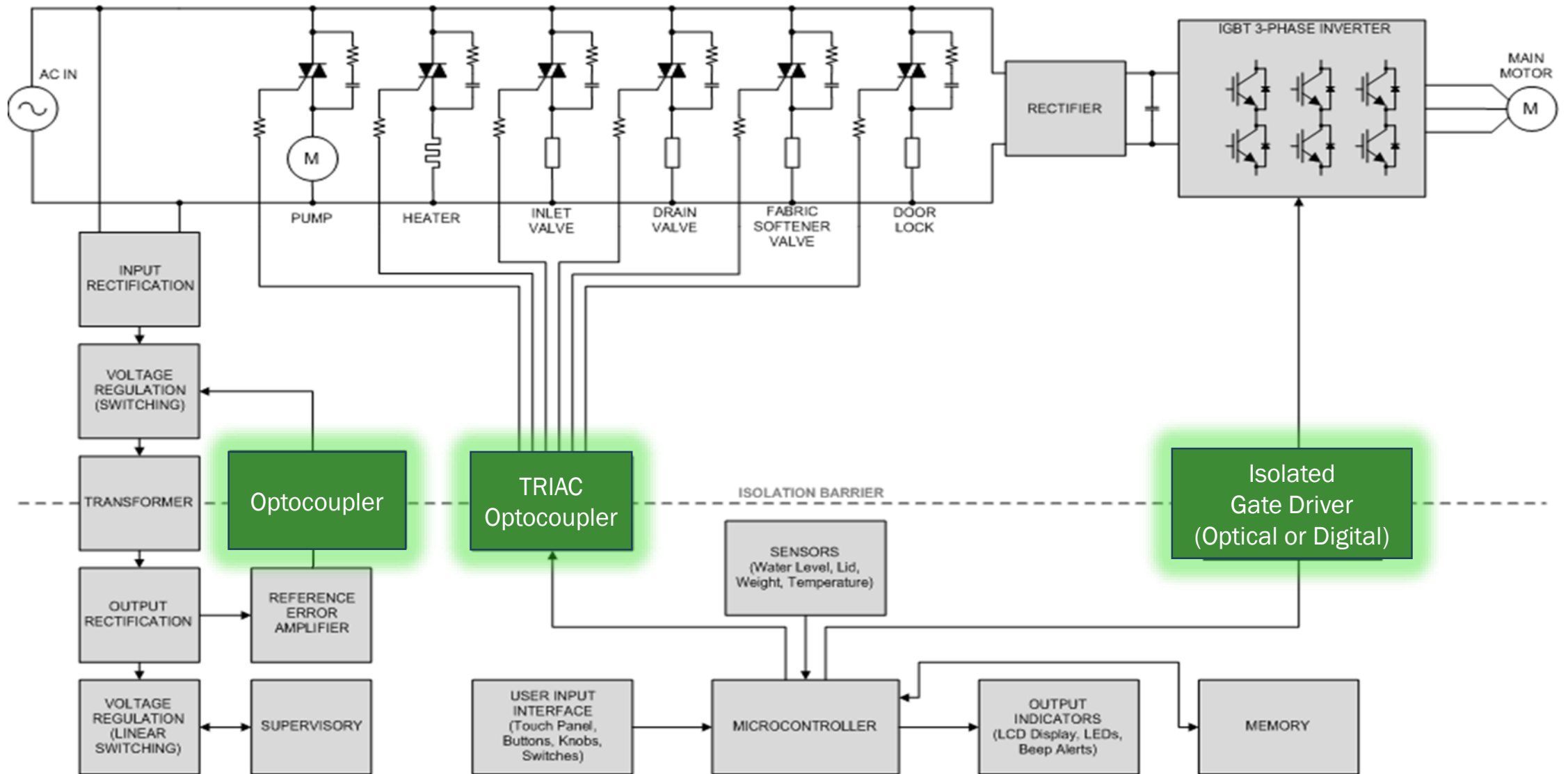
2-Ch Optocoupler Digi-Max™



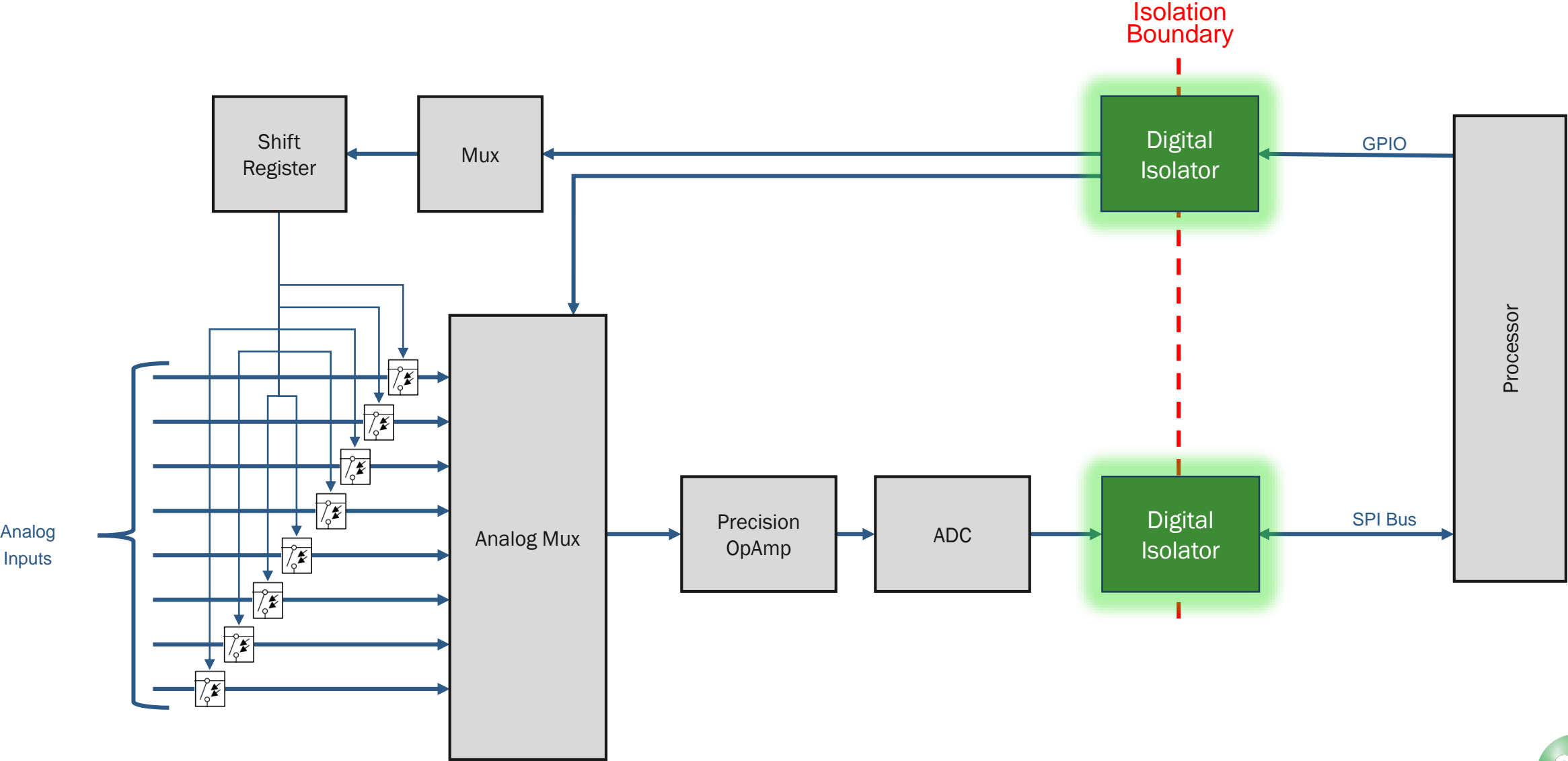
# Automotive Electrification – PTC Heaters



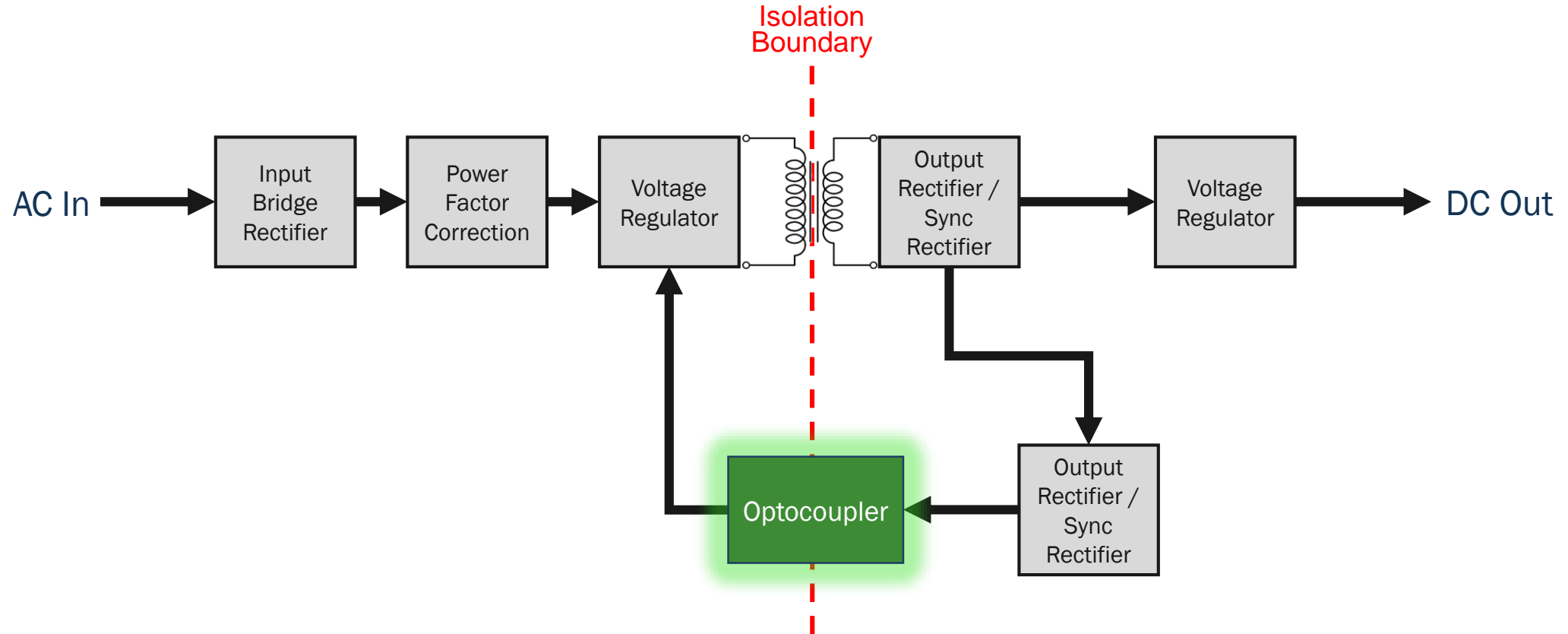
# Industrial Washing Machine



# Analog Input Modules



# Power Supply





# Thank You

