功能全面的光耦驱动并保护下一代功率器件

Broadcom Optocouplers – Driving and Protecting Next-generation Power Devices For Automotive Designs

Hong Lei Chen

November 23, 2017 • Tech Shanghai

Agenda

- Broadcom Optocouplers Overview
- Optocoupler Introduction
- Automotive-grade Optocouplers and Applications
- EV Charging Station Introduction and New Gate Driver Introduction
- Design Tools and Technical Support
- Summary

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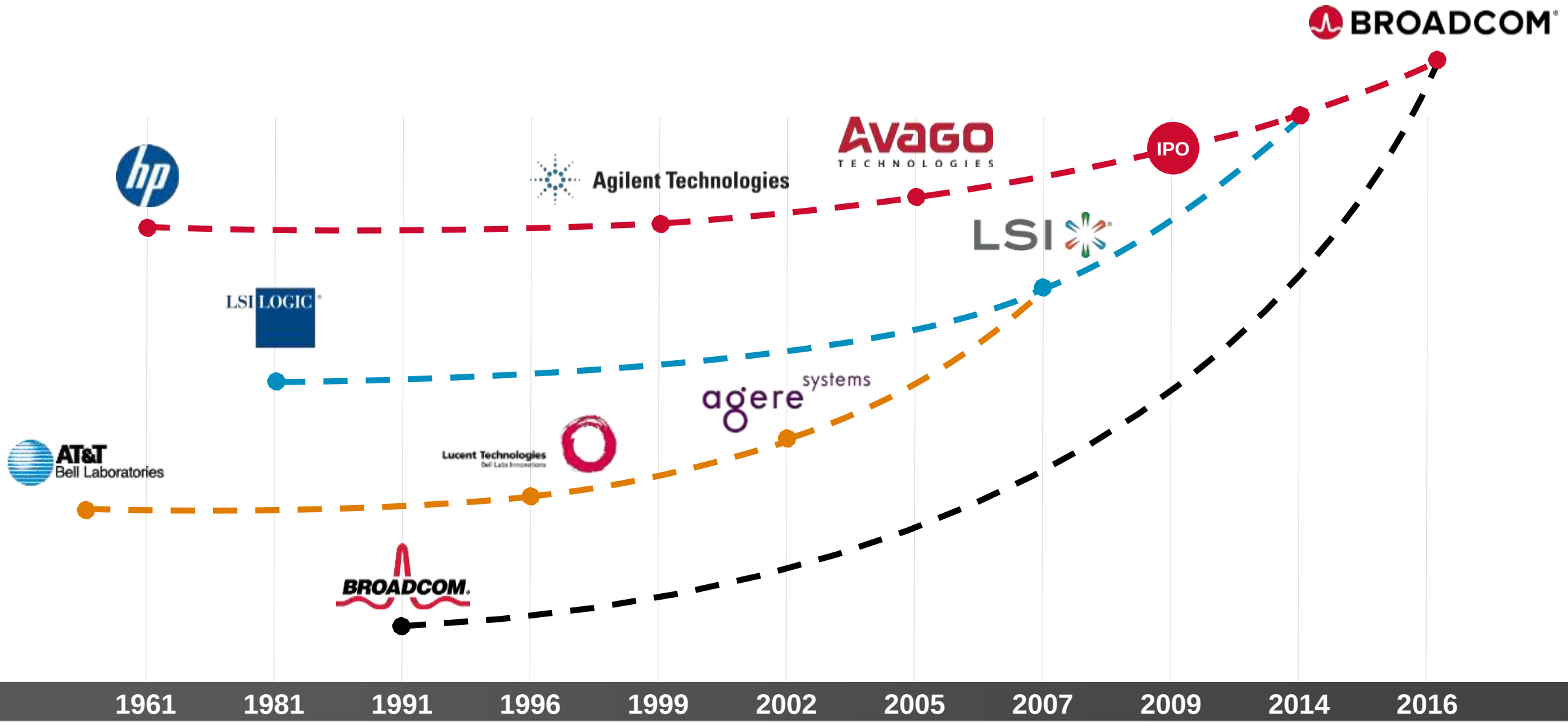
Heritage of Technology



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Broadcom Optocouplers – Market and Product Leadership

Company Name

Isolation Products Milestone

1968 — HP commercialized GaAsP LEDs

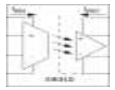
1970 — HP introduced Optocouplers

1989 — HS CMOS & Widebody Optocoulers (HCNW)

1992 — Flagship Gate Drive Optocoupler

HCPL-3120

1993 — Iso-Amp (Optically Isolated Current Sensor)



HCPL-7800

1997 — Industry's First Smart Gate Drive Optocoupler

HCPL-316J

1999 — Agilent spun off from Hewlett Packard

2000 — 3.3V/5V Optocouplers

ACSL-xxxx

2004 — Multi-Channel, Bi-Directional Optocouplers

2005 — Avago spun off from Agilent

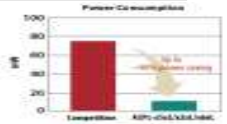
2007 — First Automotive Grade Optocoupler R²Coupler™ (ACPL-xxxT)

2009 — TS16949 Certified Test/Assembly Factory

2010 — Ultra-Low Power Optocoupler

2012 — TS16949 Certified Epi/Wafer Fab

2014 — Optically Isolated Voltage Sensor



2015 — 14mm C/C Package Optocouplers (ACNT-xxxx)

Fine-Pitch SSO12/20/24 Package (ACFL/ACFJ-xxxx)

2016 — Broadcom merged with Avago

>100M R²Couplers Shipped

Broadcom Optocouplers Overview

Product Families

Digital Optocouplers
Signal Isolation
- Digital Optocouplers (up to 50MBd)
- Digital Isolators (up to 100MBd)
- Analog Optocouplers & Special Functions

Gate Drivers
Power Device Gate Driving
- IPM Interface
- IGBT/MOSFET Gate drivers
  - Smart gate drivers
  - Basic gate drivers

Isolation Amplifiers
Current / Voltage Sensing
- Isolated ADC
- Analog Output Iso-Amp

Market Segments

Industrial

Automotive-grade Optocouplers
AEC-Q100 certification

Hermetic Optocouplers
MIL-PRF-38534

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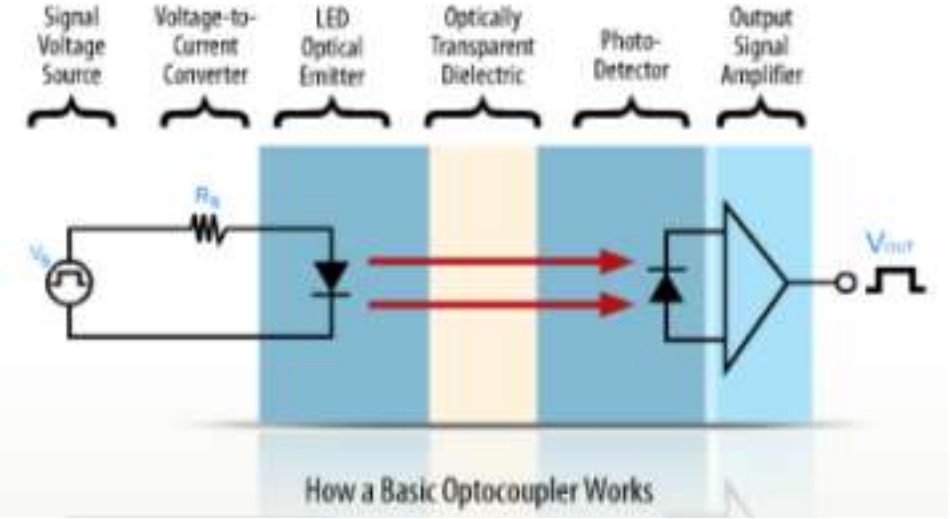
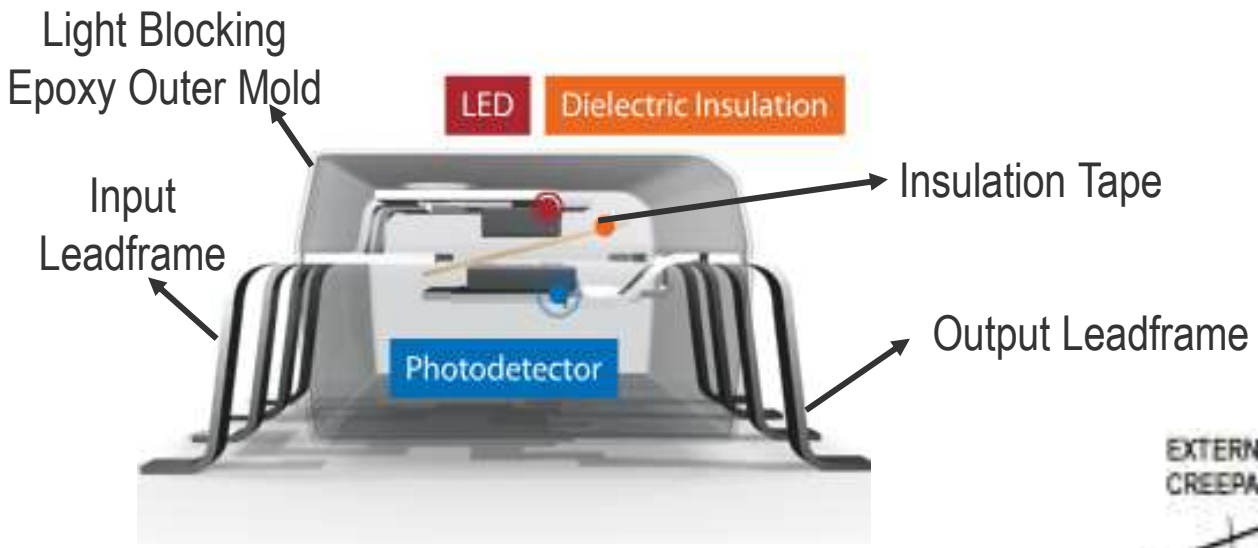
What is Optocoupler?

(also known as: Photocoupler, Opto-isolator, Optical isolator)





Optocoupler Selection Criteria

Basic Electrical Parameters:

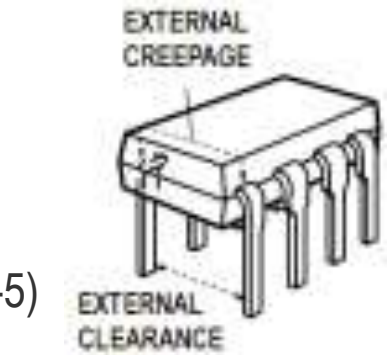
- CTR (= Io/If) range
- LED Vf, If
- Vcc power supply range
- Data rate (MBd) / tprop delay
- Operating temp. range
- CMRR kV/µs (noise immunity)

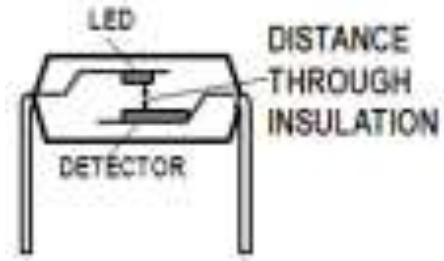
Other Parameters:

- Package: SO, SSO, DIP, ACNV, ACNW, ACNT
- Reliability / Operating Lifetime

Basic Safety Parameters:

- Viso : dielectric withstand voltage (UL1577)
- Viorm : max. working insulation voltage (IEC 60747-5-5)
- Clearance, creepage, DTI : insulation coordinates
- “Functional”, “Basic”, “Reinforced Insulation”
- Safety certificates (component level standards):
  UL1577, IEC 60747-5-5, CSA #5
- ESD: HBM, MM, CDM
- MSL=1 (most optocouplers)





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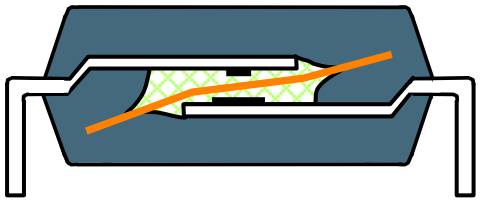
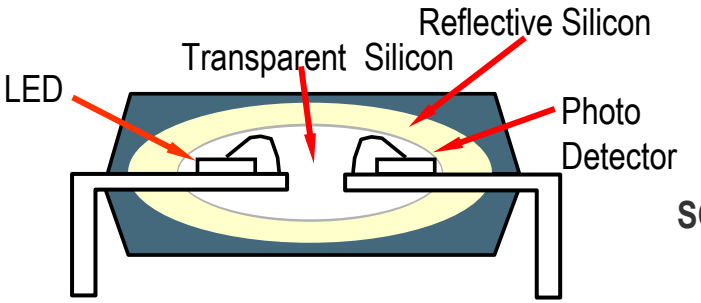
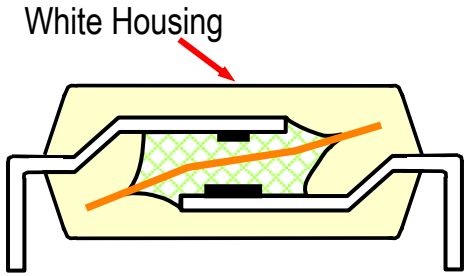
Broadcom Optocoupler Package Types



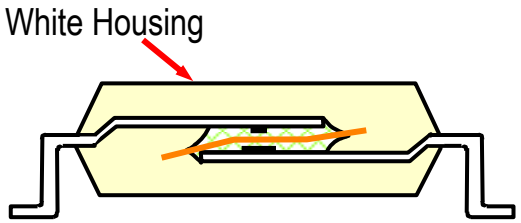
DIP-4, DIP-6, DIP-8
DIP-16



WIDEBODY

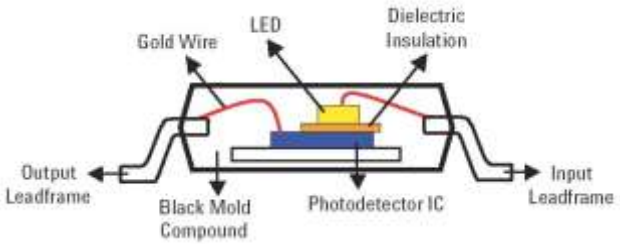


Jade DIP-8



Jade S0-16

SO-4, SO-5, SO-8
SSO-6 SSO-8



Stag SO-8, SO-16

	Package	Creepage (mm)	Clearance (mm)	Internal Clearance (mm)	IEC/EN/DIN EN 60747-5-5 V_{iorm} (V_{peak})	UL 1577 V_{iso} (V_{rms})
SO-5		5.0	5.0	0.08	567	3750
Stretched SO-6 (SSO-6)	ACPL-Pxxx	8.0	7.0	0.08	891	3750
	ACPL-Wxxx	8.0	8.0	0.08	1140	5000
SO-8		4.8	4.9	0.08	567	3750
Standard 300mil DIP8		7.4	7.1	0.08	630	3750
		8.0	7.4	0.5	891	3750/ 5000
Stretched SO-8 (SSO-8)	ACPL-Hxxx	8.0	7.0	0.08	891	3750
	ACPL-Kxxx	8.0	8.0	0.08	1140	5000
	ACPL-Cxxx	8.0	8.0	0.5	1414	5000
Stretched SO-12 (SSO-12)	ACFL-xxxxx	8.0	8.0	0.08	1140	5000
SO-16		8.3	8.3	0.5	1230	5000

	Package	Creepage (mm)	Clearance (mm)	Internal Clearance (mm)	IEC/EN/DIN EN 60747-5-5 V_{iorm} (V_{peak})	UL 1577 V_{iso} (V_{rms})
400mil DIP8 Widebody	ACNWxxxx	10.0	9.6	1.0	1414	5000
500mil DIP10 Widebody	ACNVxxxx	13.0	13.0	2.0	2262	7500
15mm SSO-8	ACNT-Hxxx	15	14.2	0.5	2262	7500
SO-8	ACSL-xxxx	4.5	4.9	0.08	567	2500/ 3750
SO-16 Narrow body		4.5	4.9	0.08	567	2500
SO-8		4.0	4.0	–	–	2500
SO-16 Narrow body		4.0	4.0	–	–	2500
SO-16		8.1	8.1	–	–	2500
	ACML-xxxx	8.1	8.1	–	–	5600

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Optocoupler Market Segments

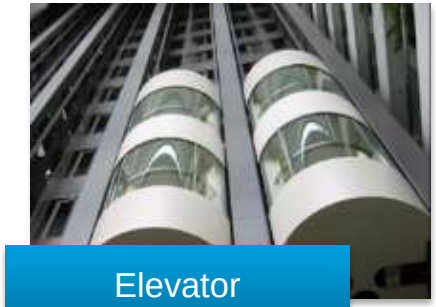

Locomotive


Medical


Power Supply


Motor Drives


Renewable Energy

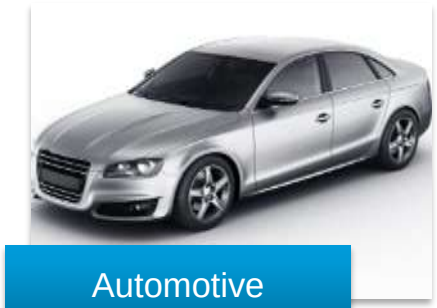

Elevator


Robotics


Factory Automation


Industrial Networking


Heating, Ventilation & Air-conditioning


Automotive


EV Charging Station

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Introduce R²Couplers™ – Broadcom Automotive-grade Optocouplers

Broadcom offers reliable isolation technology with a wide selection of products

Applications in xEV Systems

Different packages to meet different high voltage requirement

Charger & Converters
Gate Drive
- High Speed MOSFET Driver
- Smart IGBT/MOSFET Driver

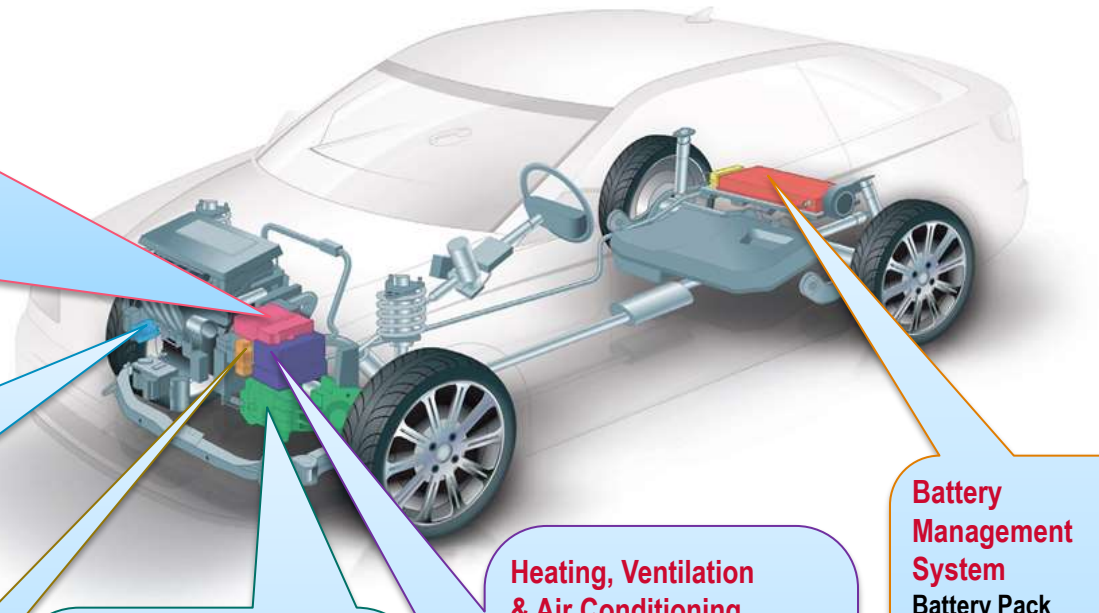
Analog Sensing
- Voltage Sensing
- Current Sensing
- Analog Feedback

Digital Interface
- Digital Communications
- Status Control / Wake-Up
- Fault Feedback

Oil Pump
Inverter
- IPM Drive Interface
- Integrated IGBT Gate Drive

CANBus Interface
- Digital Communications
- Status Control

Analog Sensing
- Temperature/ Voltage Sensing
- Current sensing



Traction Inverter System
Gate Drive
- High Speed MOSFET Driver
- Smart IGBT/MOSFET Driver

Analog Sensing
- Voltage Sensing
- Current Sensing
- Temperature Sensing

Digital Interface
- Digital Communications
- Status Control / Wake-Up
- Fault Feedback

Heating, Ventilation & Air Conditioning
Aircon Inverter
- IPM Digital Interface
- IGBT Gate Driver

Heater
- IPM Digital Interface
- Voltage Sensing
- Current Sensing

Digital Interface
- Digital Communications
- Status Control / Wake-Up
- Fault Feedback

Battery Management System
Battery Pack Monitoring
- Voltage sensing

Cell Management
- Digital Communications
- Status Control / Wake-Up
- Fault Feedback

Insulation Resistance Measurement
- Solid State Relay
- Voltage Sensing

	Gate Driver	IsoAmp	Digital	Relay
Part Numbers	ACPL-K33T/K34T	ACPL-782T	ACPL-M49T/K49T/ ACFL-5212T	ACPL-K30T
	ACPL-31JT/344JT	ACPL-C87AT/C87BT	ACPL-M43T/ K43T/K44T/ ACFL-5211T	ASSR-601JV*
	ACPL-32JT/33JT	ACPL-C797T/C799T*/ 0873T*	ACPL-M71T/ K71T/K74T/ ACFL-6211T	
	ACFJ-3540T*		ACPL-M72T/ K72T/K75T/ ACFL-6212T	
Traction Inverter	O	O	O	
Charger	O	O	O	
Converter	O	O	O	
BMS		O	O	O
HVAC		O	O	
Oil Pump			O	

* Advance information

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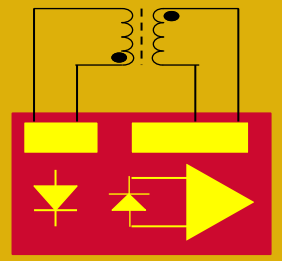
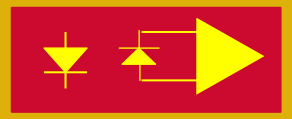
Gate Driver for Onboard Charger, DC-DC Converter and Inverter

Isolation / Power	Benefits	< 10kW	10kW – 100kW - 250kW
• **Flyback Converter** • **Isolation** • **Driver** 	•Distributed power architecture •**Better performance** and **lower cost**		ACPL-32JT 2A Gate Drive Desat Sensing Miller Clamp 2W Flyback Controller ACPL-33JT 2A Gate Drive Desat Sensing Miller Clamp > 4W Flyback Controller NEW ACFJ-3540T 2A Gate Drive **Emitter Sensing** Miller Clamp 2W Flyback Controller
• **Isolation** • **Driver** 	•**Fully compatible** to existing power architecture	ACPL-31JT Smart MOSFET Driver ACPL-K34T 200kHz MOSFET Driver ACPL-K33T SiC MOSFET Driver ACPL-312T 2A IGBT Gate Drive	ACPL-344JT 2A Gate Drive, Desat Sensing Miller Clamp, UVLO Feedback ACPL-38JT 2A Gate Drive, Desat Sensing, Fault Feedback
Application		**DC/DC, Charger**	**Drive Systems**

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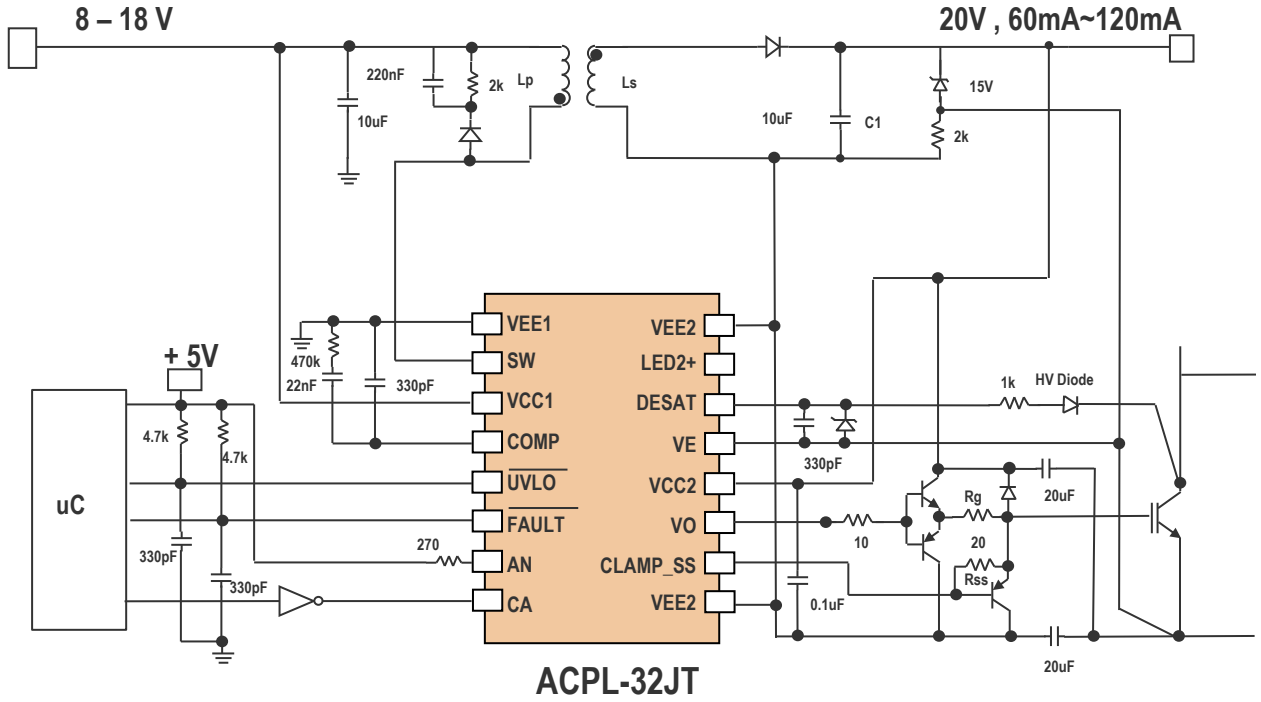
ACPL-32JT Compact Design with Integrated Flyback Controller

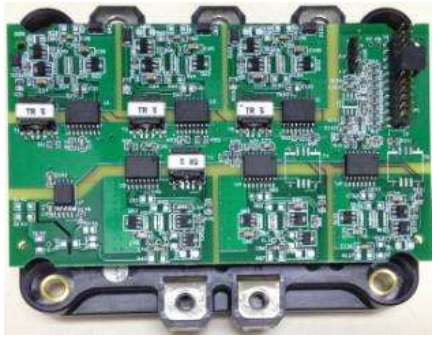
Features

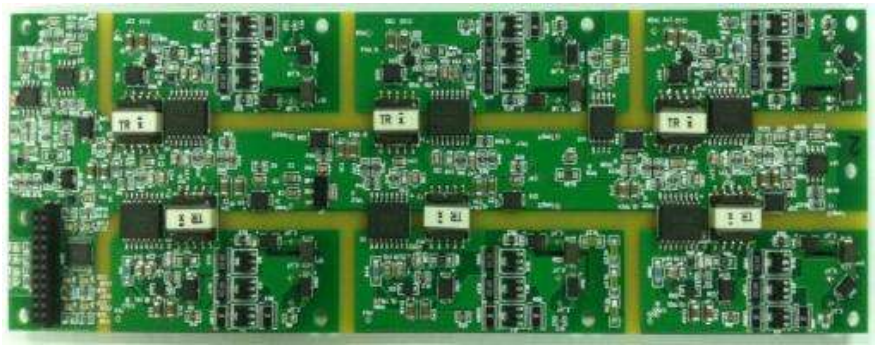
- Integrated flyback controller
- Rail to rail driving output
- Negative Gate Biasing and Miller Clamp for gate noise rejection
- Adjustable Desat Sensing threshold through additional Desat Diode
- Soft shutdown timing can be adjusted by Rss
- Direct low impedance LED input, high dV/dt noise immunity
- Over current blanking time can be controlled through blanking capacitor



Evaluation Board Available

Single Channel





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ACFJ-3540T - Gate Driver with Flyback DC-DC Controller, Emitter Sensing, Miller Clamping and UVLO Feedback

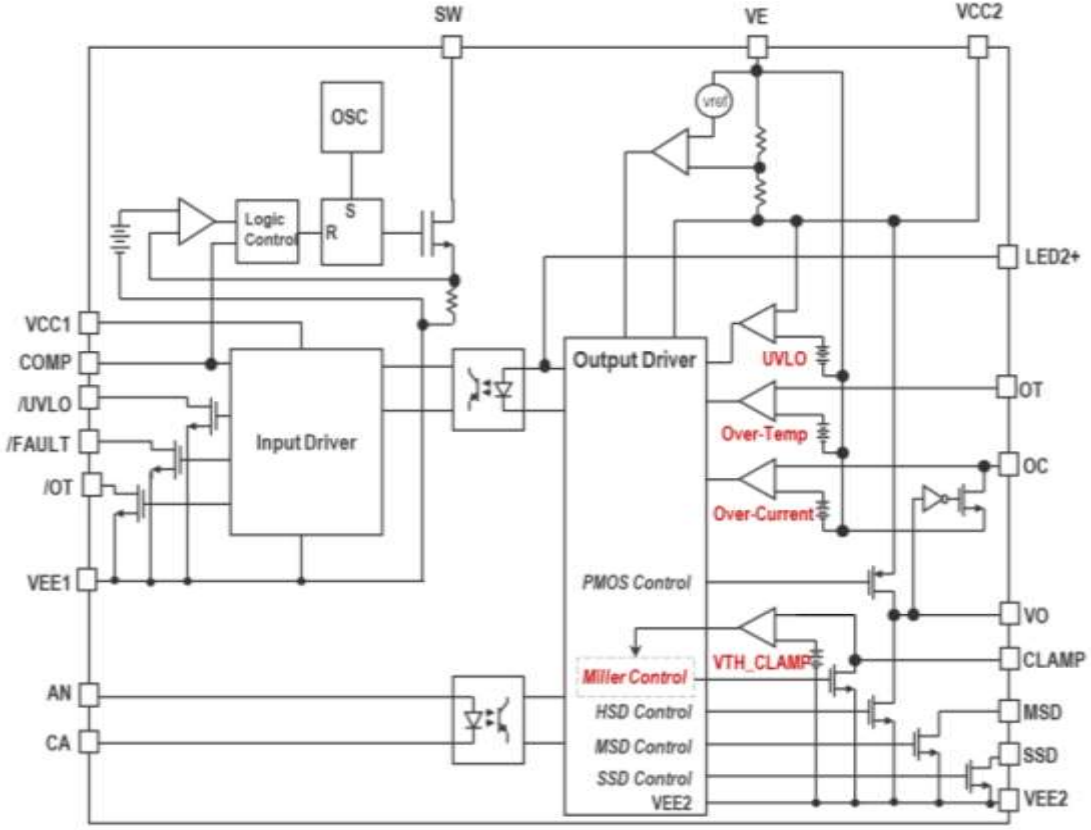
Key Features

- **Qualified to AEC-Q100 Grade 1 Test Guidelines**
- Automotive temperature range : -40ºC to +125ºC
- **Integrated flyback controller for isolated DC-DC converter**
  - Regulated output voltage (V_{CC}-V_E): 15V +/- 5%
  - Configuration negative supply (V_E-V_{EE})
- 1A / 2.5A minimum peak output drive / sink current
- Miller clamp sinking current : 2.5A
- Propagation delay: 150ns max.
- **Integrated fail-safe IGBT protection**
  - Emitter over-current sensing, “Soft” IGBT turn-off and fault feedback
  - Under Voltage Lock-Out protection (UVLO) with feedback
  - Over temperature detection, with auto shutdown and feedback
- High noise immunity
  - Direct LED input with low input impedance and low noise sensitivity
  - Common Mode Rejection(CMR): 50kV/µs at V_{CM} = 1500 V
- SO-24 package with 8mm creepage and clearance
- Regulatory approvals:
  - UL1577, CSA (5kV_{RMS} / 1 minute)
  - IEC 60747-5-5 (Continuous working voltage, V_{IOTM}, of 1230V_{PEAK})

Applications

- IGBT Gate Driver for Traction Inverter, Charger and HVAC

- **Status Update**
- Datasheet : **Available**
- Engineering Samples: **Available**



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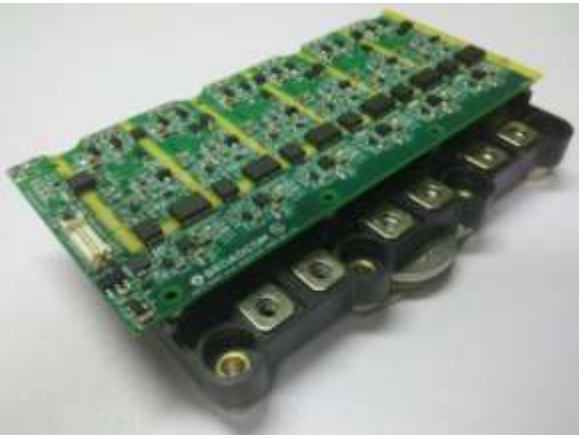
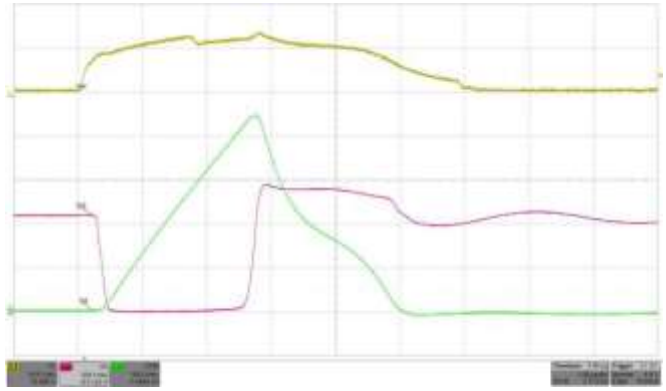
Driver Board using ACFJ-3540T and ACPL-C87AT for Fuji M653 IGBT Module

About the driver board:

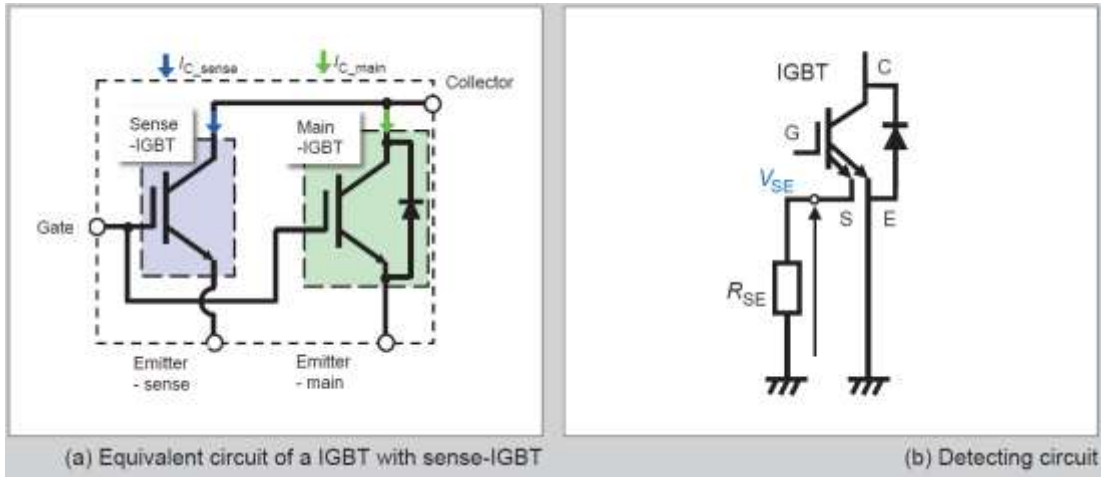
- Direct mount to IGBT module
- **Driver IC: ACFJ-3540T with integrated flyback DC/DC controller**
  - **Over current and short circuit protection (emitter sense) with soft shutdown capability and fault feedback**
  - **UVLO protection and feedback**
  - **Over temperature protection and feedback**
- +15.5/0V Distributed 2W Power Supply
- 5A peak buffer output for gate driving
- Temperature feedback for each channel
- Buffer driven PWM gate driver input





Short Circuit Event Waveform

- About the Fuji M653 Series Automobile IGBT Module
  - 800A/750V emitter current sensing IGBT module
  - 6 switch elements
- About emitter sensing IGBT:



Source: Fuji Electric M653 Series Application Manual

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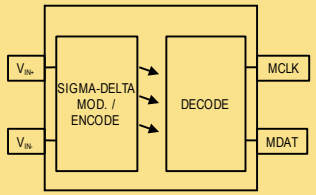
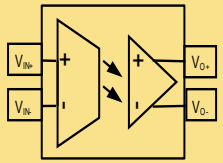
Isolation Amplifier Selection

	50A – 500A	< 50A	AC Voltage	DC Voltage	Temperature Sensing
Digital Outputs 	Sample **ACPL-C799T** Sigma Delta Output +/-50mV Current Sensor 1%		**ACPL-C797T** Sigma Delta Output +/-200mV Voltage Sensor 1%		
Differential Analog Outputs 		**ACPL-782T** +/-200mV Input Range 2%		**ACPL-C87BT / C87AT** 2V Input Range 0.5% / 1%	
Interface	**Current sensing**		**Voltage Sensing**		

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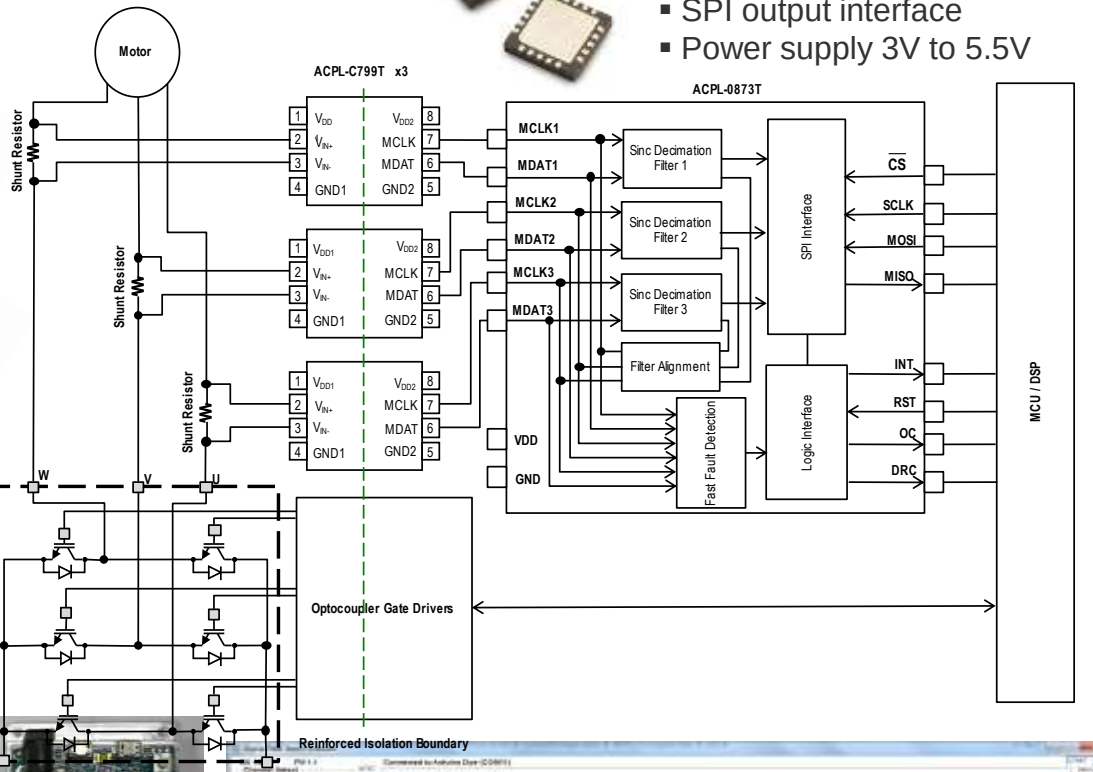
3-Phase Motor Current Sensing

ACPL-C799T Sigma-Delta Modulator:

- Full input range +/-80mV, Linear input range: +/-50mV
- ENOB: 12 bits
- V_{REF} error @ 25ºC max: ±1%
- Input offset voltage typ: 0.3mV
- SNR typ: 78dB
- Clock frequency over temp: 9MHz min, 10MHz max
- High CMR (15 kV/µs at V_{CM} = 1000 V)
- Stretched SO-8 package (8 mm Creepage)
- Reinforced insulation with worldwide safety approvals:
  - IEC/DIN EN 60747-5-5: V_{IORM} = 1414 V_{PEAK}
  - UL 1577: 5000 V_{RMS}/1 minute

ACPL-0873T 3 Channel Digital Filter:

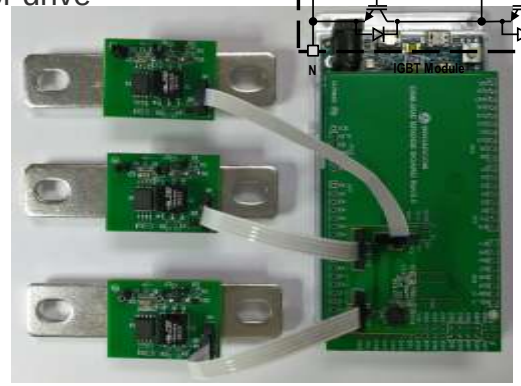
- Automotive AEC Q-100 Grade 1 (-40ºC to +125ºC)
- 3 Programmable individual Sinc filters
- Fast fault detection, programmable over-current threshold
- SPI output interface
- Power supply 3V to 5.5V

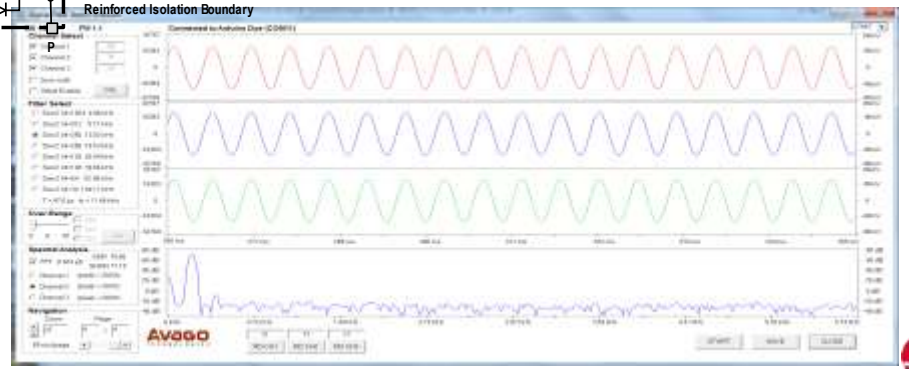


Evaluation Board:

- Sensing up to 500A current together with selected 0.1mΩ Shunt
- SPI source code available
- GUI Demo Software available for Arduino DUE board
- Specialized for 3-phase current sensing in motor drive

Manufacturer	TT Electronics	KOA	Isabellenhutte	Vishay
Part Number	EBW-387-38-049	2017-c-0424	BAS-M-R0001	WSBS8518
Resistance	0.1mΩ	0.1mΩ	0.1mΩ	0.1mΩ
Worldwide Contact	www.ttelectronicsresistors.com	www.koaglobal.com	www.isabellenhutte.de	www.vishay.com





Digital Optocoupler Selection

Up to 1414Vdc (BUS/Truck) 	Dual Channel Uni / Bi-Directional **ACFL-5212T** Wide Supply Range 4 pin, Linear Response SSO12 Bi-direction	**ACPL-K44T** Wide Supply Range Linear Response Zero Off state power SSO8 Dual **ACFL-5211T** Wide Supply Range Linear Response Zero Off state power SSO12 Bi-direction	**ACPL-K75T** Supply Current < 1.5mA SSO8 Dual **ACPL-K74T** Supply Current < 1.5mA SSO8 Dual **ACFL-6212T** Supply Current < 1.5mA SSO12 Bi-direction **ACFL-6211T** Supply Current < 1.5mA SSO12 Bi-direction
	ACPL-K49T Wide Supply Range 20kBd 4 pin configuration Linear Response Zero off state power SSO8 Single	**ACPL-K43T** Wide Supply Range 1MBd Prop Delay < 1us Linear Response Zero Off state power SSO8 Single	**ACPL-K72T** 10MBd CMOS Output SSO8 Single **ACPL-K71T** 15MBd CMOS Output Prop Delay < 32ns SSO8 Single
Up to 560Vdc (Passenger Cars) 	**ACPL-M49T** Wide Supply Range 20kBd 4 pin configuration Linear Response Zero off state power SO5 Single	**ACPL-M43T** Wide Supply Range 1MBd Prop Delay < 1us Linear Response Zero Off state power SO5 Single **ACPL-M46T** Wide Supply Range 1MBd Prop Delay < 0.5us SO5 Single	**ACPL-M72T** 10MBd CMOS Output Supply Current < 1.5mA SO5 Single **ACPL-M71T** 15MBd CMOS Output Supply Current < 1.5mA Prop Delay < 32ns SO5 Single **ACPL-M61T** 10MBd Open Collector Output SO5 Single
Isolation Voltages	**Up to 100kBd**	**100kBd – 1MBd**	**1MB – 15MBd**

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A Complete Safety Isolation Solution for Electric Vehicle Charging Station Designs

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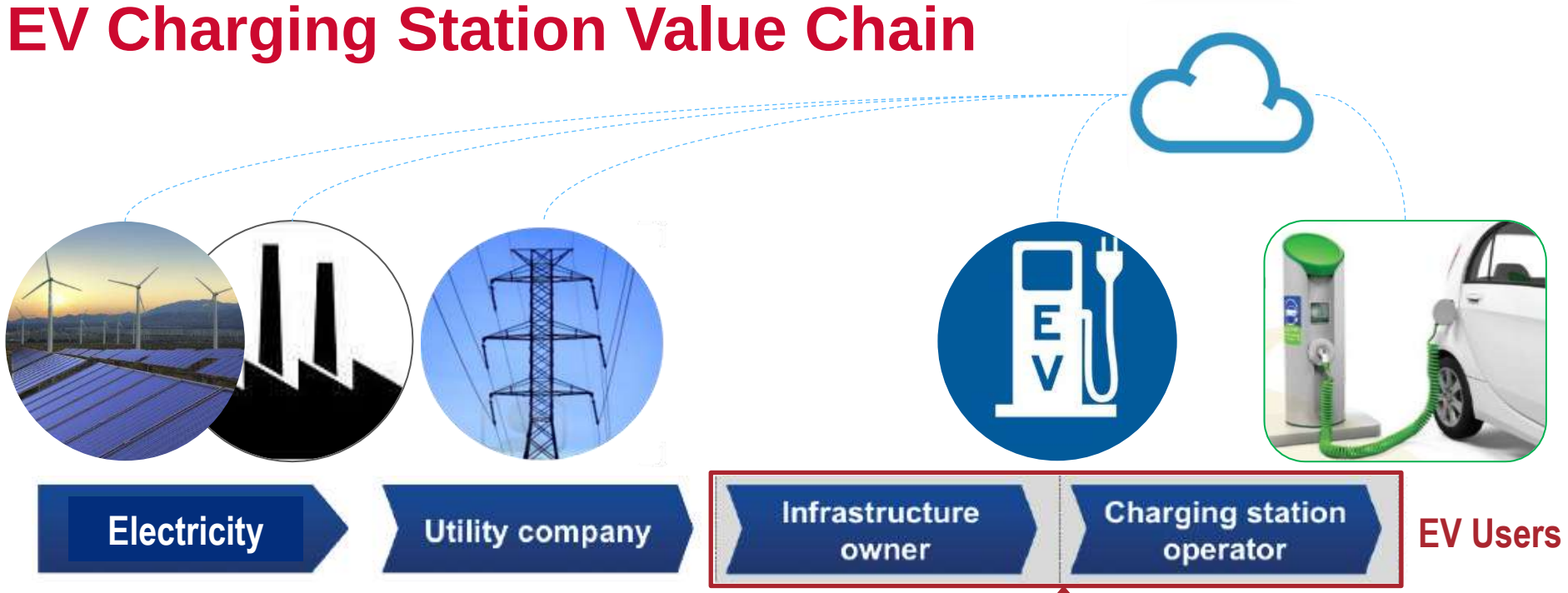
EV Charging Station Value Chain



- Charging station suppliers fulfills an important supportive activity.
- The EV user can choose products and services according to his needs and preferences; which energy source, who to produce it, who to distribute it, etc.

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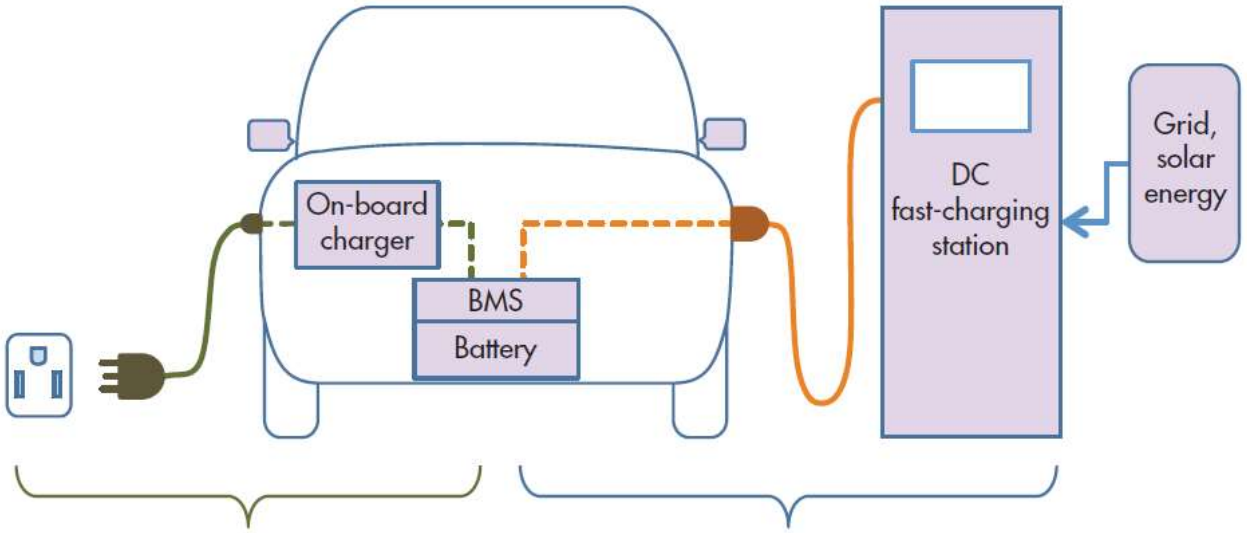
On-board Charger and Charging Station



AC charging

- Every vehicle has an on-board charger.
- Limited power rating, slow charging.
- Requires Automotive-grade components

DC charging

- Infrastructure investment is shared with hundreds of users.
- Large power rating, fast charging.
- Industrial-grade components suffice

AC/DC Charging Electrical Ratings

Charge Method	Nominal Supply Voltage	Maximum Continuous Current	Output Power	Estimated Charge Time[1]
AC Level 1	120 V AC Supply, 1-phase	12 A 16 A	1.4 kW 1.9 kW	17 Hrs (OBC, SOC[2] – 20% to full)
AC Level 2	208-240 V AC Supply, 1-phase	80 A	Up to 19.2 kW	SOC – 20% to full: 7 Hrs (3.3 kW OBC); 3.5 Hrs (7 kW OBC); 1.2 Hrs (20 kW OBC).
DC Level 1	200-500 V DC (EVSE Output)	80 A	Up to 40 kW	1.2 Hrs (SOC – 20% to 100%, 20 kW off-board charger)
DC Level 2	200-500 V DC (EVSE Output)	200 A	Up to 100 kW	20 min (SOC – 20% to 80%, 45 kW off-board charger)

Notes:

1) For ease of discussion, only BEV (battery electric vehicle) examples are listed.
2) SOC (state of charge) is the equivalent of a fuel gauge for the battery pack in a BEV. 0% SOC means the battery pack is completely discharged; and 100% SOC means it's fully charged.
3) Rated Power is at nominal configuration operating voltage and coupler rated current
4) Ideal charge times assume 90% efficient chargers, 150W to 12V loads and no balancing of Traction Battery Pack.
5) BEV (25 kWh usable pack size) charging always starts at 20% SOC, faster than a 1C rate (total capacity charged in one hour) will also stop at 80% SOC instead of 100%.

Reference: ABB White Paper; SAE International.

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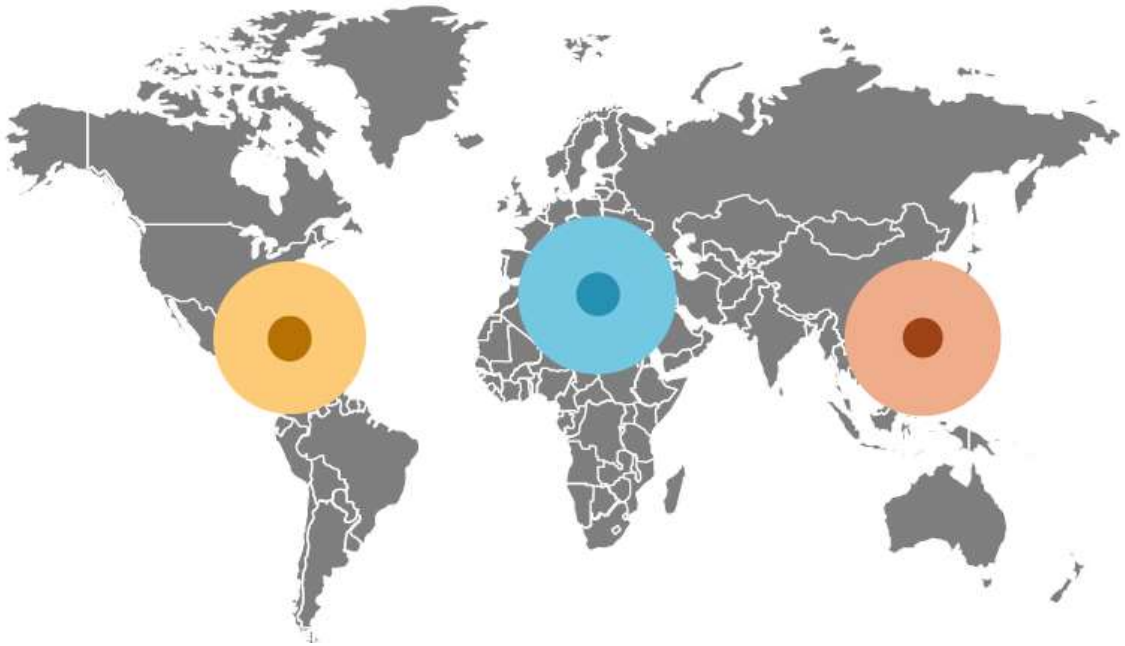
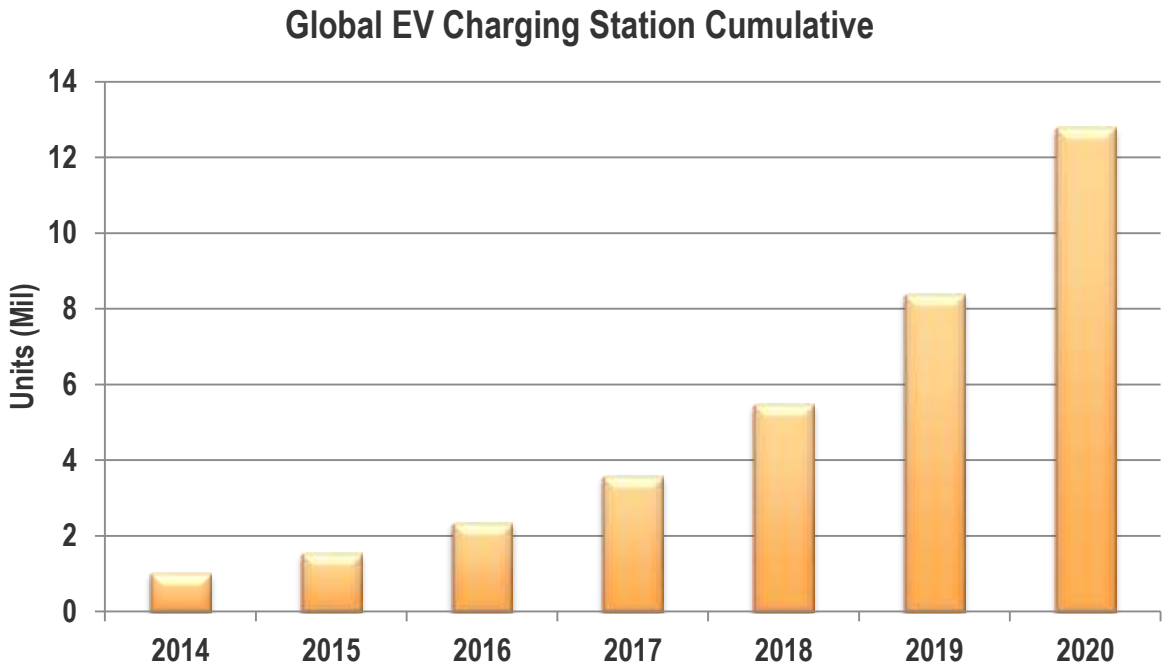
Global EV Charging Station Market to Grow to 12.8 Million Units in 2020





2014 439k + 338k + 278k = 1M

Americas EMEA Asia

2020 4.2m + 4.4m + 4.3m = 12.8M

Source: IHS.

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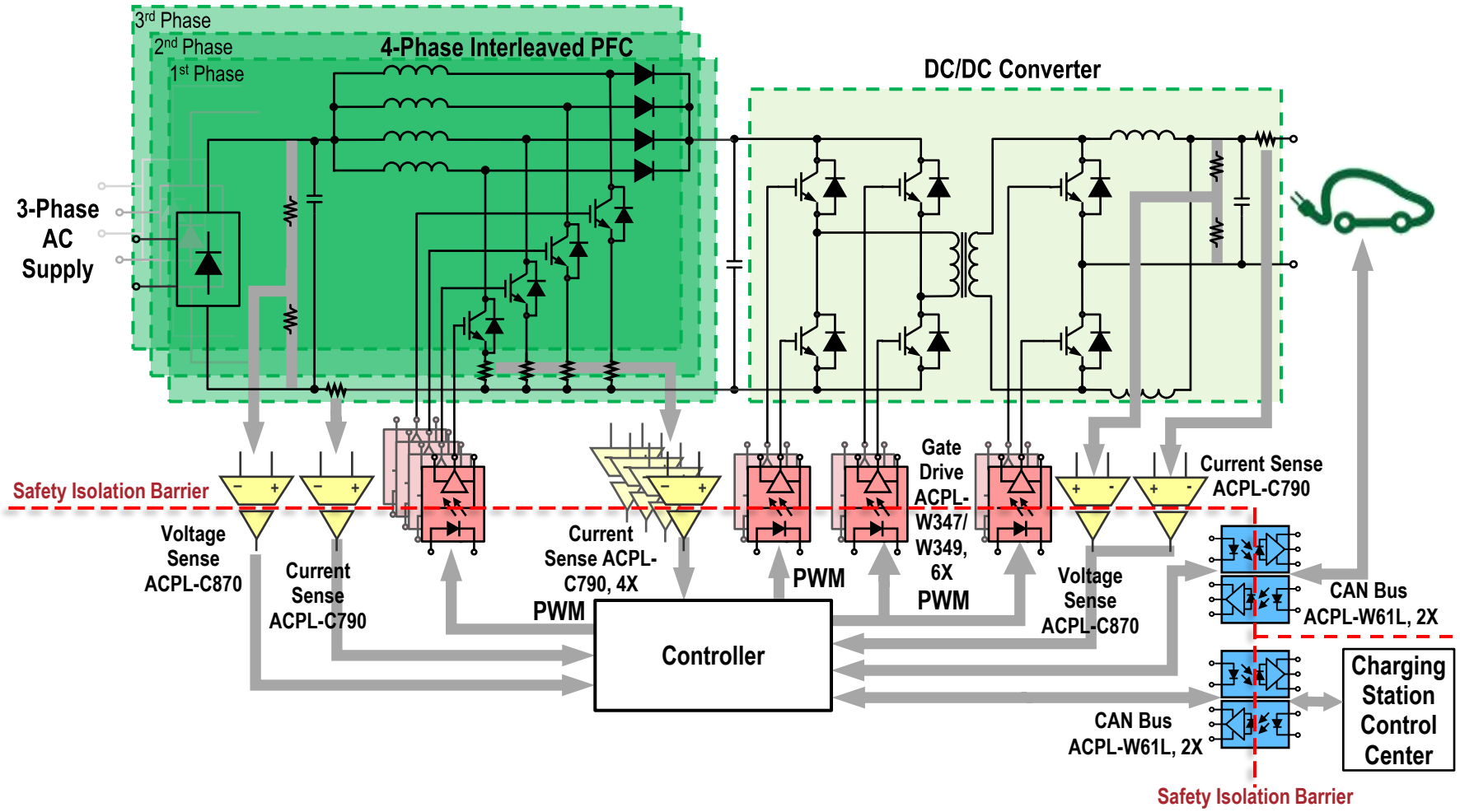
DC Fast Electric Vehicle Charging Station –
Broadcom provides complete isolation solution to ensure safety



Recommended Optocouplers

- Voltage sensor – ACPL-C87B/C87A/C870
- Current sensor – Analog output ACPL-C79B/C79A/C790; digital output ACPL-C797/796J/798J
- MOSFET gate drivers – ACPL-W345/346; IGBT/SiC/GaN MOSFET gate drivers – ACPL-W347/349
- Smart IGBT gate drivers for large power charging stations – ACPL-339J/336J/337J
- CAN Bus isolation – 5/10 MBd ACPL-W21L/W61L, 2X; 25 MBd ACSL-7210, 1X
- Insulation Resistance Detection – ASSR-601J/601JV

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Recommended Optocouplers for EV Charging Stations

The needs of Optocouplers in EV Charging system:

- Need gate drive optocoupler to drive IGBT/MOSFET
  - ✓ **Power MOSFET gate drivers ACPL-W346/345, ACPL-W347/349**
  - ✓ **IGBT gate drivers ACPL-339J/336J/337J**
  - ✓ **SiC MOSFET / GaN device gate driver ACPL-352J [NEW]**
- Need voltage, current and temperature sensor in inverters, DCDC converters
  - ✓ **Voltage/Temperature Sensor ACPL-C87B/C87A/C870**
  - ✓ **Current Sensor ACPL-C79B/C79A/C790**
- CAN bus communication requires high CMR Digital Optocouplers
  - ✓ **CAN Bus isolation 5/10 MBd ACPL-W21L/W61L**
  - ✓ **High speed communication 25 MBd ACSL-7210**
- Insulation resistance detection
  - ✓ **Solid state relay ASSR-601J/601JV [NEW]**

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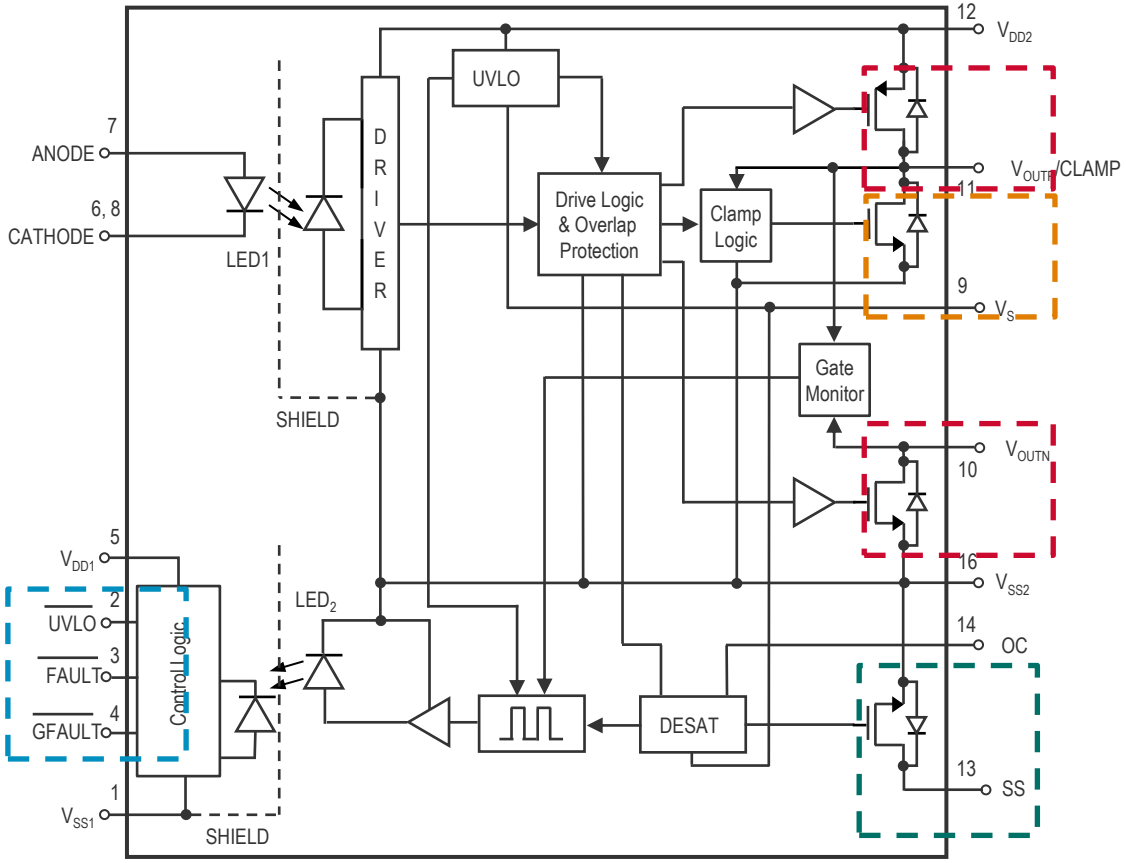
ACPL-352J – 5A Gate Drive Optocoupler with Over Current Protection and Isolated FAULT feedbacks

Key Features

- **5A(max)/4.5A(min)** Peak Output Current
- **Rail-to-rail** Dual Output
- **Features** for Functional Safety
  - IGBT/MOSFET **Over Current Fault**
  - **UVLO Fault**
  - IGBT/MOSFET **Gate Status Fault**
- **Adjustable Soft Shut**
- Integrated **Miller Clamping**
- **SiC/GaN MOSFET** ready
  - **150ns** max. Propagation Delay
  - **75ns** max. Propagation Delay Difference
  - **10ns** typ. Rise and Fall Time
  - 150kHz Data Rate
- **1mA** Blanking Capacitor Charging Current
- Isolation Voltage: 5kV$_{RMS}$ 1 minute
- Working Voltage: 1414V$_{PEAK}$ continuous
- Wide Operating Temperature: -40ºC – 105ºC
- **Worldwide Safety Approval:**
  - UL 1577
  - CSA notice #5
  - IEC60747-5-5

Schematic Block Diagram



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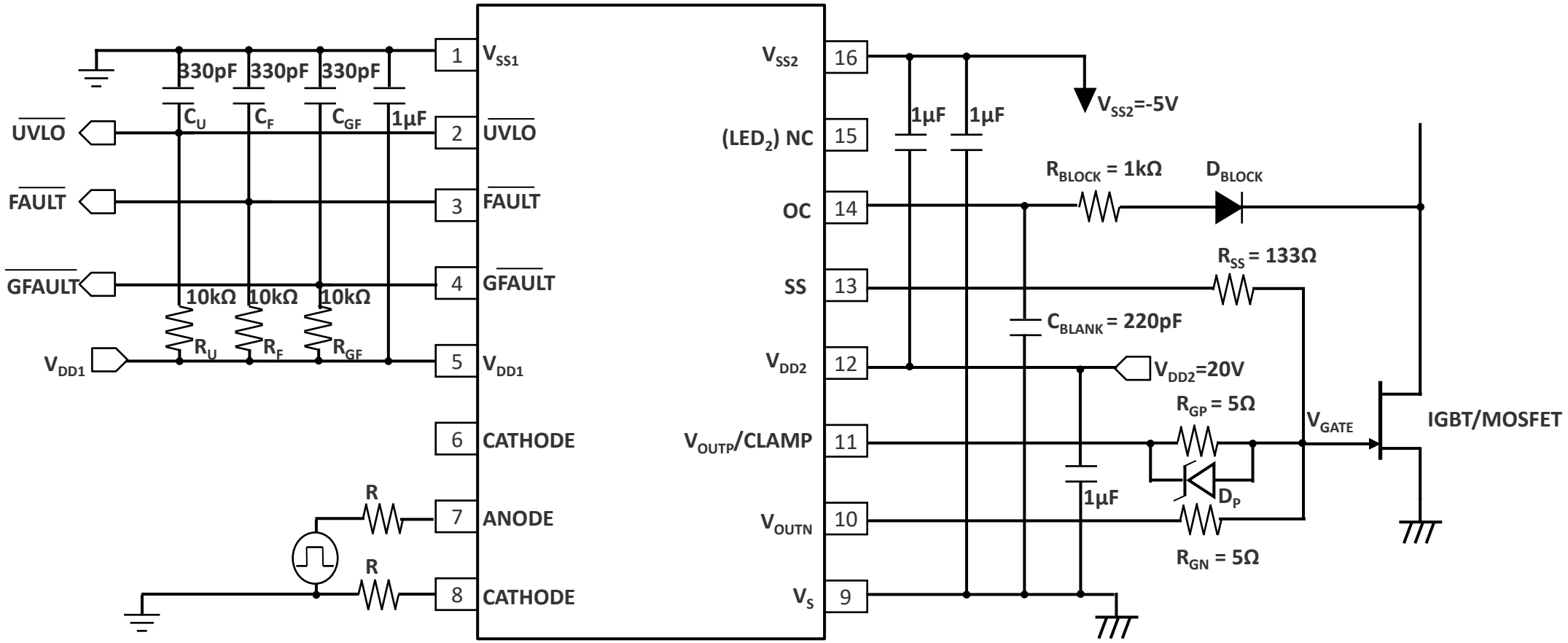
Application Circuit



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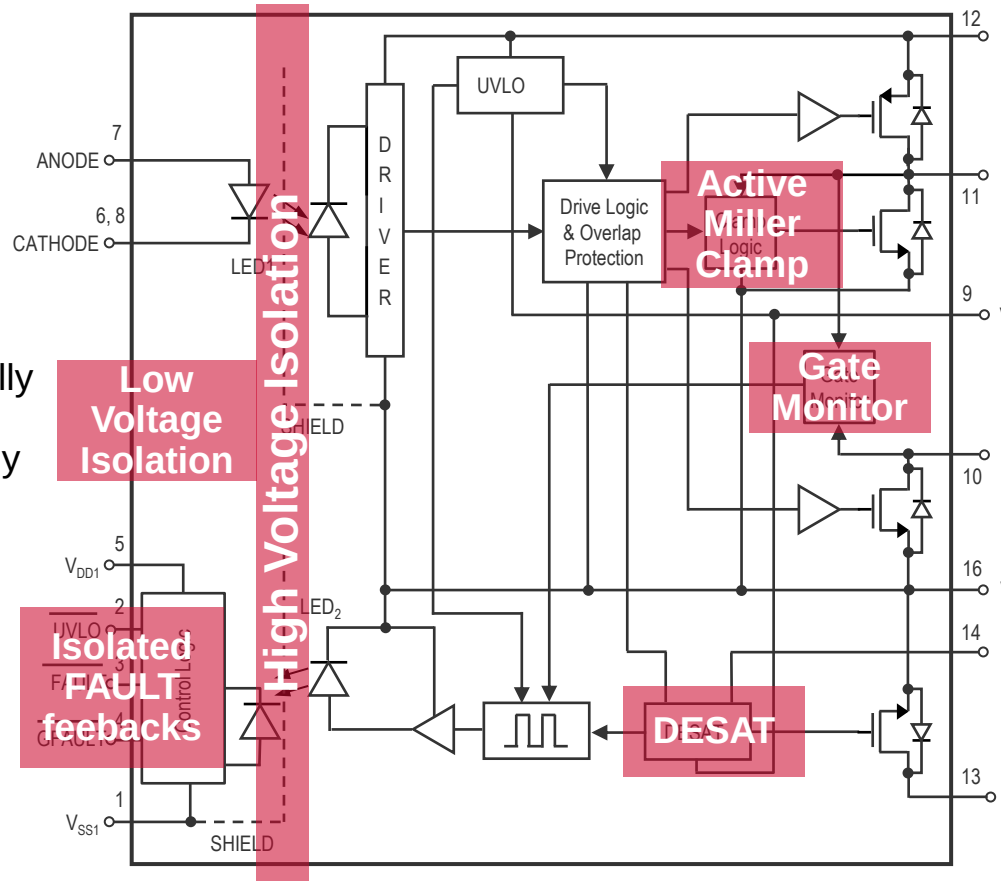
Features for Functional Safety

Reinforced galvanic isolation separates input LED from high voltage secondary side



Input LED functionally isolated from low voltage power supply

Feedback LED is always switching to ensure ALL fault conditions are not lost

Holds IGBT/MOSET gate low during “OFF” state

Monitors IGBT/MOSET gate “ON/OFF” status vs input LED signal

Monitors if IGBT/MOSET goes in over current or short circuit

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SiC MOSFET / GaN Device Ready Gate Drivers

Reference Designs

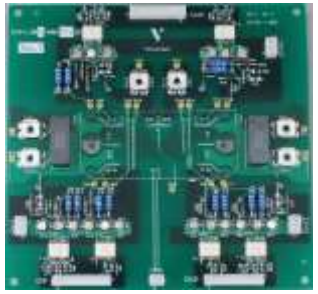
- Fuji Electric, Gate Drive for SiC MOSFET

  1200V 100A SiC MOSFET 2CSI100AM-120-50

Fuji Electric

- Vincotech, *H6.5 3-Level* IGBT

  10-FY07HVA0x0S5– 650V/50A-100A IGBT



Vincotech

- Panasonic, Gate Drive for X-GaN

  PGA26E19BA – 600V/10A GaN Transistor

Panasonic

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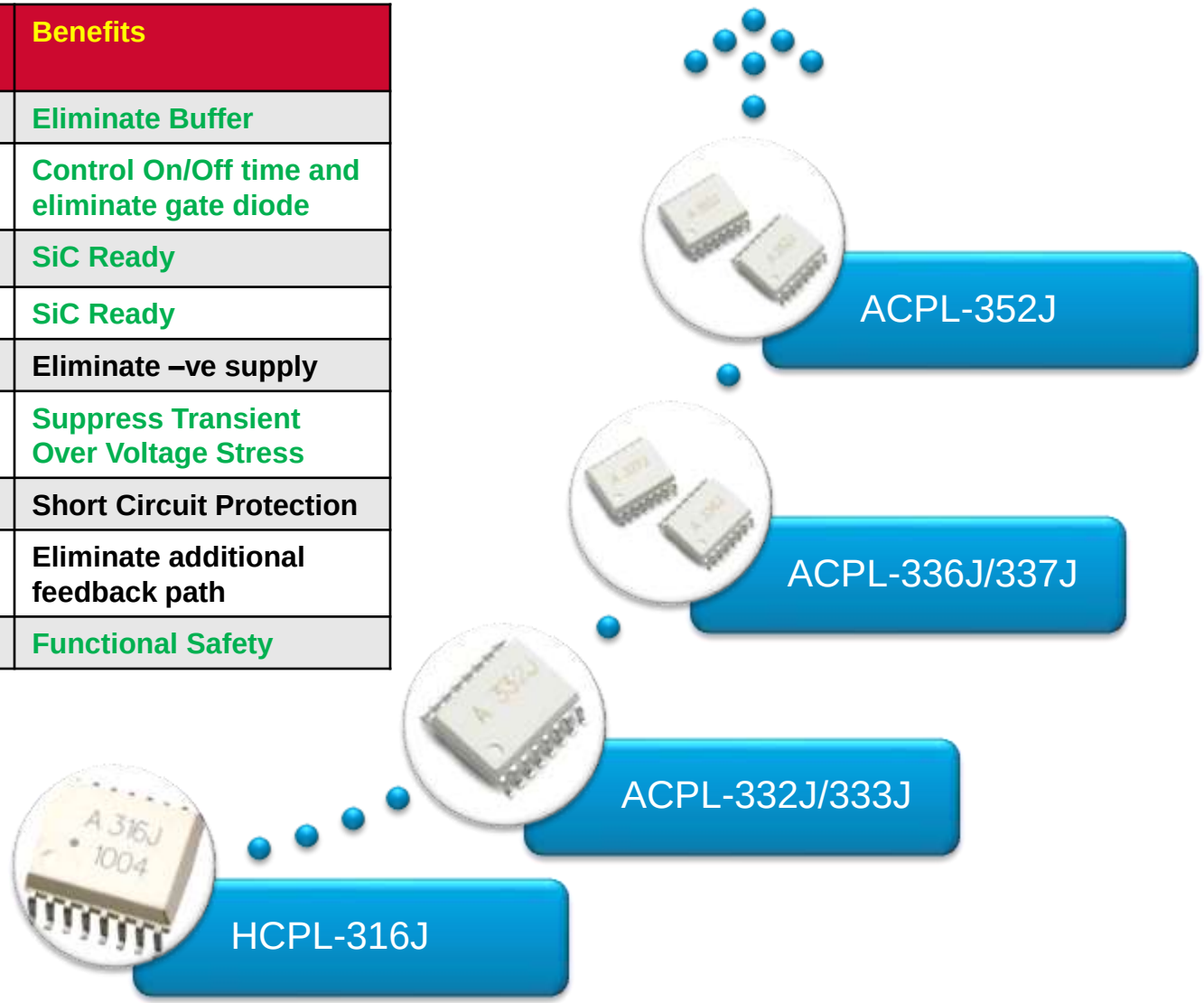
Smart Gate Drive Upgrades

Specification	HCPL-316J	ACPL-332J/333J	ACPL-337J	ACPL-352J	Benefits
I_{OUT} Max	2.5 A	2.5 A	4.0 A	5.0 A	Eliminate Buffer
Rail2Rail	No (Single)	No (Single)	Yes (Single)	Yes (Dual)	Control On/Off time and eliminate gate diode
t_{PLH}/t_{PHL} Max.	500 ns	250 ns	250 ns	150 ns	SiC Ready
tR/tF Typ.	100ns	50ns	80ns	10ns	SiC Ready
Miller Clamp	No	1.7 A	2 A	2.5 A	Eliminate –ve supply
Soft Shut Slew Rate	Fixed	Fixed	Fixed	Adjustable	Suppress Transient Over Voltage Stress
DESAT Protection	Yes	Yes	Yes	Yes	Short Circuit Protection
UVLO Feedback	No	No	Yes	Yes	Eliminate additional feedback path
Gate Status Feedback	No	No	No	Yes	Functional Safety



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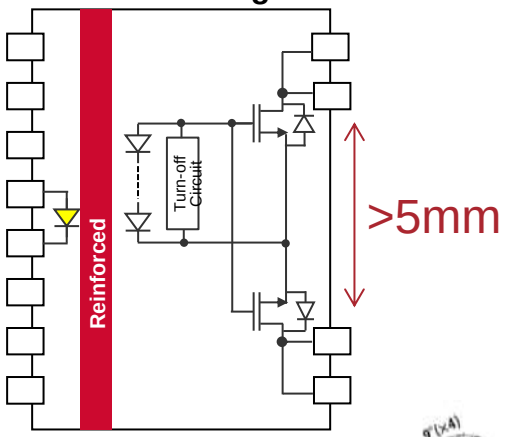
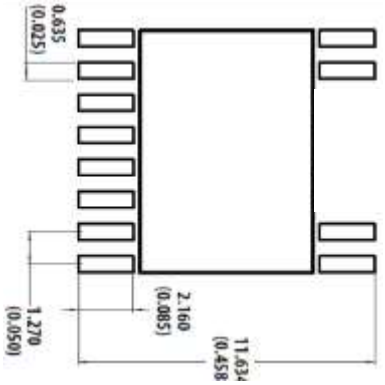
Industrial Photo Mosfet – ASSR-601J Overview

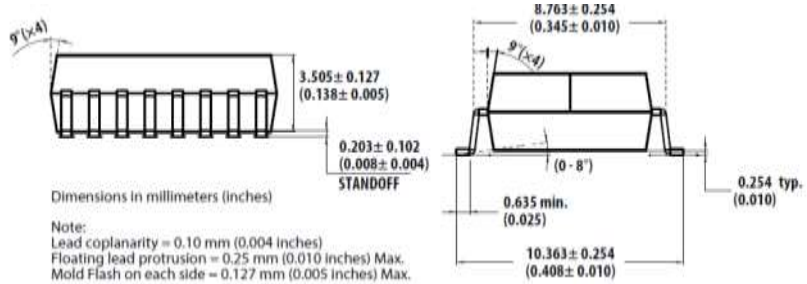
Key Features

- Industrial Grade Operating Temperature **-40°C to +110°C**
- Breakdown Voltage, **BV_{OFF}: 1500V** typ. @ I_{OFF}=0.25mA
- Avalanche rated MOSFETs
- Off-State Leakage, **I_{OFF} ≤ 1µA @ V_O=1000V, T_A=25°C**
- On-resistance, **$R_{DS(ON)}$ ≤ 250Ω @ I_{LOAD} =50mA**
- Turn On Time: T_{ON} ≤ 1ms
- Turn Off Time: T_{OFF} ≤ 0.5ms
- Package: 300mil SO-16
- Creepage & Clearance ≥ 8mm (Input-Output)
- V_{ISO} = **$5000V_{RMS}$** (UL 1min Rating)
- Working voltage = **$1414V_{PEAK}$** (Reinforced)
- $MOS_{drain\text{-}to\text{-}drain}$ Creepage > **5mm**
- CTI >600V Mold compound

Block Diagram







Applications

- Insulation resistance measurement for Motor-Earth leakage current
- Inrush Current Limiter for Inverter and Servo Drives

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Insulation Resistance Detection for EV and DC Charging Station

- **GB/T 20243.3-2015 requires insulation detection for both DC Charging Equipment and EV.**

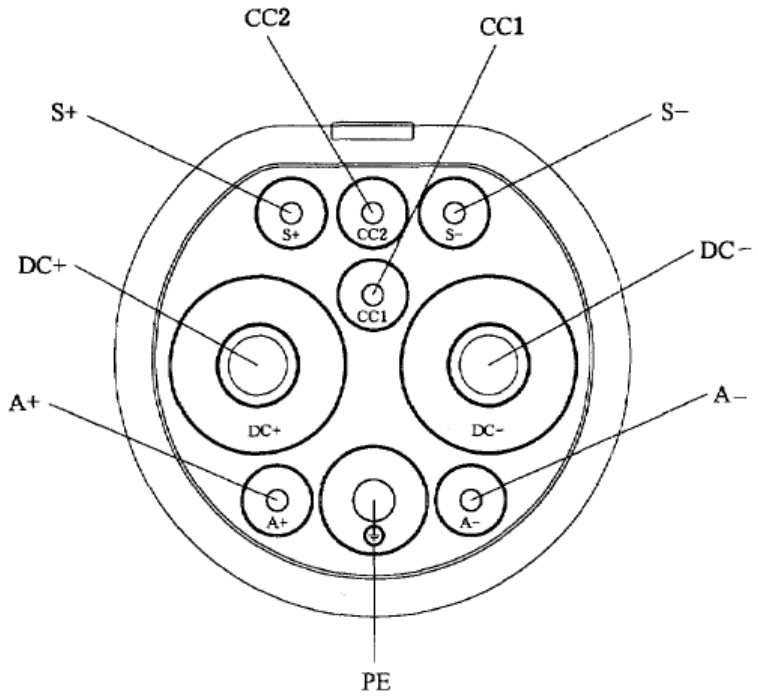
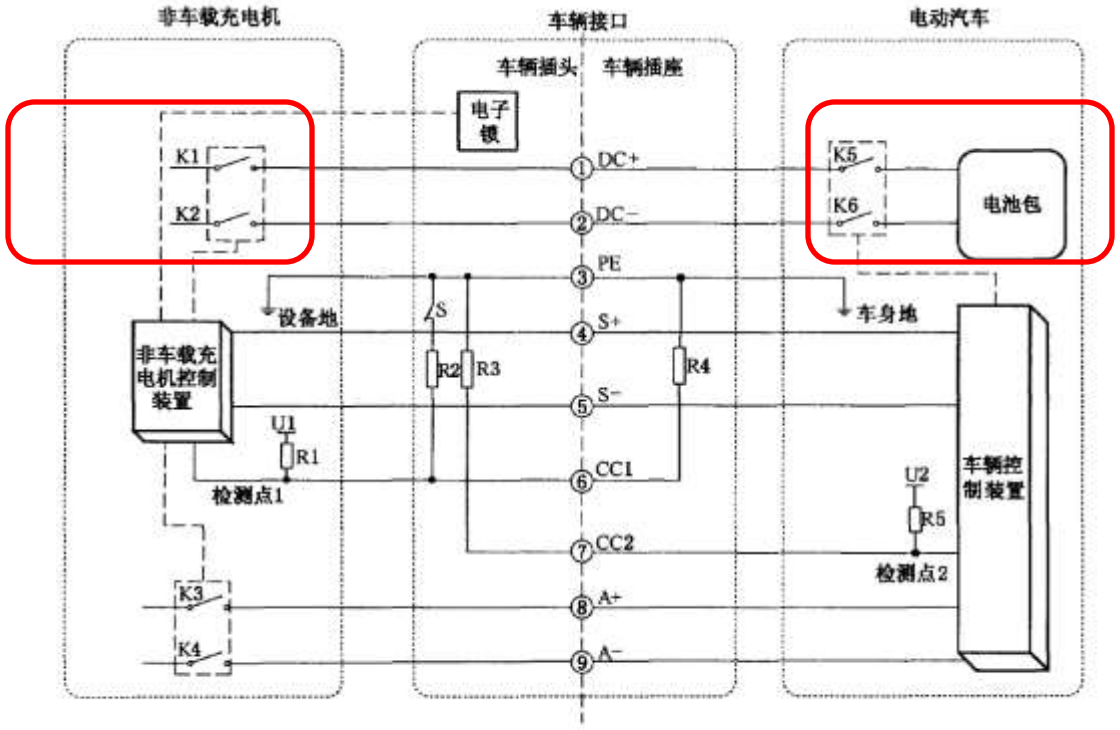


图 1　车辆插头触头布置图

To add insulation resistance detection circuit



To add insulation resistance detection circuit

图 A.1　直流充电安全保护系统基本方案示意图

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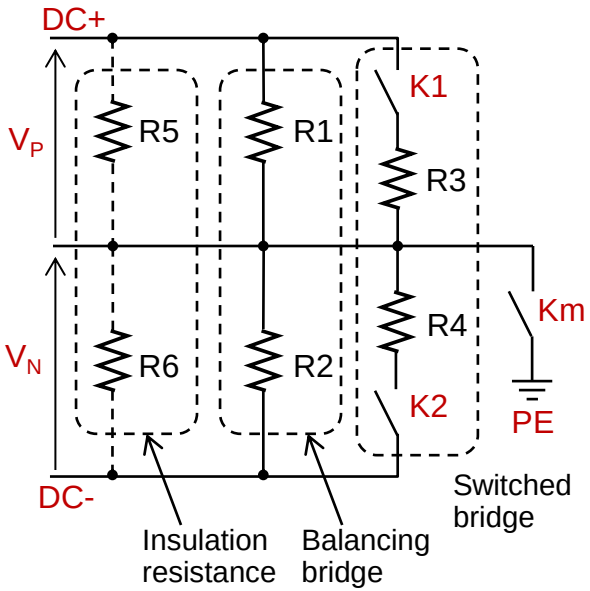
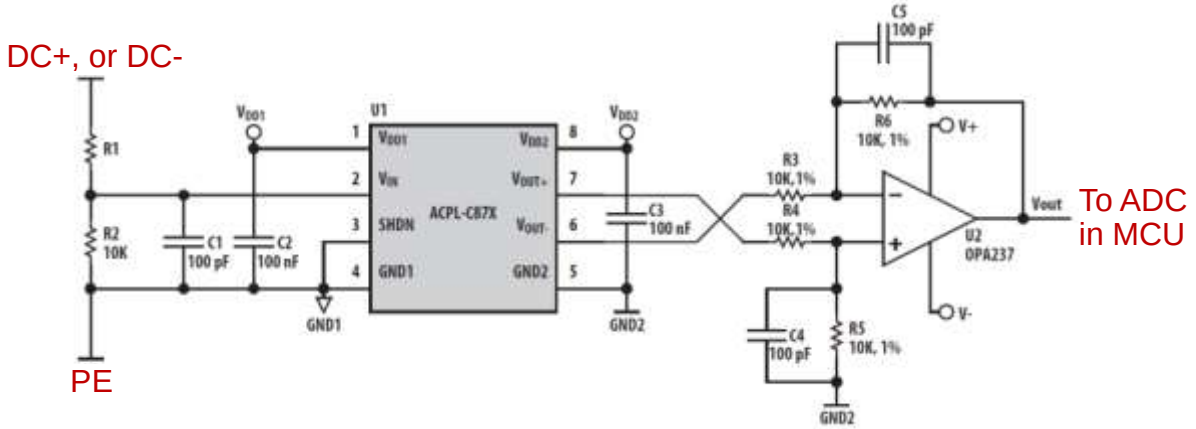
Using C87x Voltage Sensor, 601J/601JV SSR Switch

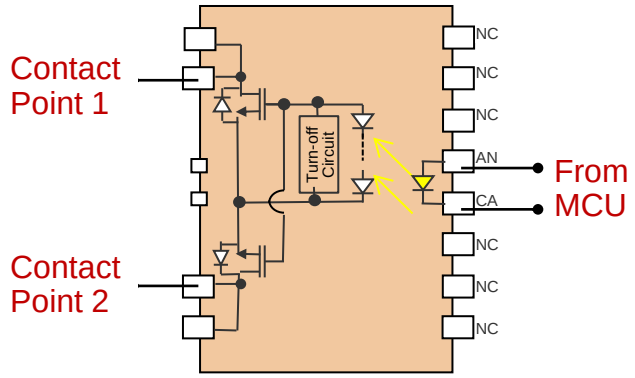


- EV charging station side and Automotive side use the same design.

- Using C87x to measure DC voltage across DC+ and COM, and DC- and COM.



- Using ASSR-601J/601JV SSR as the K1, K2, Km switches.



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Evaluation Boards

Basic Gate Drive Optocoupler

ACPL-H342/K342 Gate Driver with Active Miller Clamp

ACPL-P343/W343 IGBT Gate Driver

ACPL-P346/W3436 MOSFET Gate Driver

ACNT-H313 High Creepage/Clearance/Insulation Voltage Gate Driver

Smart Gate Drive Optocoupler

ACPL-339J MOSFET Buffer Interface Gate Driver

ACPL-337J Highly Integrated Gate Driver

ACPL-302J Gate Driver with DC-DC controller

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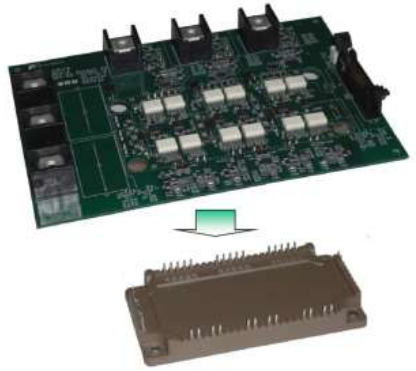
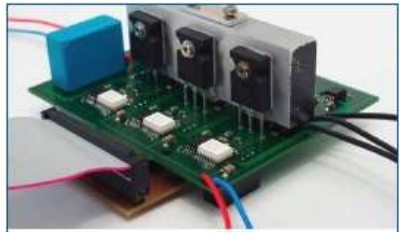
Reference Designs

- **Fuji Electric** AT-NPC **3 Level** 4-in-1/12-in-1 IGBT Modules**. ACPL-339J/332J** Gate Driver with DESAT Protection
- **Mitsubishi "Mega Power Dual"** Series IGBT modules**.** CM1800DY **1800A/1700V. ACPL-339J** Gate Driver with DESAT Protection
- **Cree 2nd Gen SiC MOSFET** C2M0080120D. **ACPL-W346** High Speed Basic Gate Driver and **ACPL-339J** Gate Driver with DESAT Protection
- **ST SiC MOSFET** SCT30N120. **ACPL-H342** Gate Driver and **ACPL-C797/796J** Sigma-Delta Modulator
- **Altera Multi-Axis Motor Control** Series. **ACPL-798J** Sigma-Delta Modulator with LVDS interface. **ACPL-W61L** 10MBd Digital I/O logic isolation





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Tutorial Webinars

光电耦合隔离放大器在光伏发电系统中的灵活应用

双路输出的智能IGBT驱动光耦 ACPL-339J

碳化硅功率器件(SiC MOSFET)门驱动光耦

设计完整和极具成本效益的门驱动方案

车规级光耦ACPL-32JT驱动三相全桥IGBT模块

http://www.broadcom.com/support/resources/video-webinar-library#webinars

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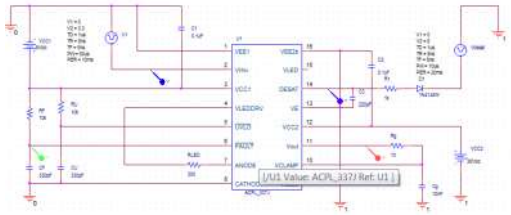
More Technical Evaluation Tools

- **Spice Models**



Download: http://www.avagotech.com/products/optocouplers/spicemodels/

- **Power and Thermal Modeling**

ACPL-337J			User inputs per application requirements Datasheet specifications Calculated outputs	
Parameters	**Symbol**	**Unit**	**Value**	**Comments**
LED Driving Current	ILED	mA	16	
LED Forward Voltage	VF	V	1.95	Datasheet Max
Average LED Switching Duty Cycle	Duty	%	80%	Application Average
LED Power Dissipation	**Pe**	**W**	**0.02496**	**= ILED * VF * Duty**
Maximum Input IC Supply Current	ICC1	mA	6	Application
Input IC Supply Voltage	VCC1	V	5.5	Datasheet recommended Max
Input IC Power Dissipation	**Pi**	**W**	**0.033**	**= ICC1 * VCC1**
Output IC Supply Voltage	VCC2	V	30	Datasheet
Maximum Output IC Supply Current	ICC2max	mA	7.5	Datasheet Max
MOSFET Gate Charge at Supply Voltage	Qg	uC	1	IGBT Datasheet per application or = VCC2 * Cg
LED Switching Frequency	fpwm	KHz	10	Application
Absolute Maximum Output Current	Iomax	A	4	Datasheet
Minimum High Side Output Impedance	Rds,ohmin	Ohm	0.5	Datasheet
Minimum Low Side Output Impedance	Rds,olmin	Ohm	0.2	Datasheet
Minimum Gate Resistance charging	Rghmin	Ohm	7	= (VCC2 - VEE) / Iomax - Rd,soh(min)
Minimum Gate Resistance charging	Rglmin	Ohm	7.3	= (VCC2 - VEE) / Iomax - Rd,sol(min)
Gate Charging/Discharging Resistance	Rg	Ohm	7.3	>= Rghmin || Rglmin
Maximum High Side Output Impedance	Rds,ohmax	Ohm	4.50	Datasheet Max
Maximum Low Side Output Impedance	Rds,olmax	Ohm	3.60	Datasheet Max
High Side Switching Power Dissipation	Phs	mW	57.20	= (VCC2*Qg*fpwm) * Rds,ohmax / (Rds,ohmax + Rg
Low Side Switching Power Dissipation	Pls	mW	49.54	= (VCC2*Qg*fpwm) * Rds,olmax / (Rds,olmax + Rg)
Output IC Power Dissipation	**Po**	**W**	**0.3317**	**=VCC2*ICC2max + Phs+Pls**
Thermal Coefficient Between				
LED and Input IC	Aei	°C/W	35.4	
LED and Output IC	Aeo	°C/W	33.1	
Input and Output IC	Aio	°C/W	25.6	
LED and Ambient	Aea	°C/W	176.1	
Input IC and Ambient	Aia	°C/W	92	
Output IC and Ambient	Aoa	°C/W	76.7	
Ambient temperature	Ta	°C	95	Application measurement
LED Junction Temperature	**Te**	**°C**	**111.5**	**Te = AeaPe + AeiPi + Aeo Po + Ta**
Input IC Junction Temperature	**Ti**	**°C**	**107.4**	**Ti = AeiPe + AiaPi + Aio Po + Ta**
Output IC Junction Temperature	**To**	**°C**	**122.1**	**To = AeoPe + AioPi + Aoa Po + Ta**
Absolute Max. Junction Temperature for LED and IC	**Tj**	**°C**	**125**	Datasheet

Contact Broadcom FAE for this tool.

- **IGBT Gate Current Calculator**

1. Bus Voltage, VB	V
2. Gate-Emitter Voltage, $V_{G(GE)}$	V
3. Turn-on Delay Time, $t_{d(on)}$	ns
4. Rise Time, t_r	ns
5. Reverse Transfer Capacitance, $C_{res} = C_{GC}$	pF
6. Input Capacitance, C_{ies}	pF

Contact Broadcom FAE for this tool.

For more info, visit:

OPTOCOUPLERS

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REFERENCE DESIGNS

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