

POWER SOLUTIONS FOR EV CHARGING APPLICATIONS



Introduction

“With great power comes
great responsibility.”

Voltaire



Handling EV charger power levels in the kilowatts range requires safe, reliable and secure charger system design.

The majority of EV charger design effort is still being invested in developing new charger topologies and architectures or choosing optimal power components, but the main technical challenge is not the power stage!

Introduction

Different EV charging applications require different solutions:
Unidirectional Chargers:



- Slow (single phase AC/DC: 2.3kW)
- Fast, Super-fast or Rapid
(three-phase AC/DC: 11kW – 50kW)
- Supercharger, Ultra-fast or Ultra-rapid
(10-30kV AC/DC or DC/DC: 150kW–
350kW)

Introduction

Different EV charging applications require different solutions:
Unidirectional Chargers:



„About 5,500 chargers [in the UK] are categorised 'slow' (in other words, awful); 13,300 'fast' (really slow); and 3,400 'rapid' (slow). Just over 900 are 'ultra-rapid' (OK)“

Toby Walne, Mail on Sunday, UK

Fast Charging

The majority (64%*) of EV users say that charging times are too long:

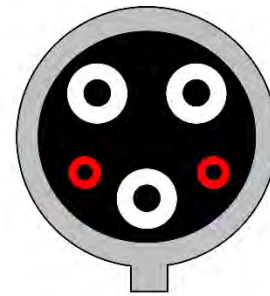
- *higher power for faster charging*
- *(cable) cooling system required*
- *increased safety measures*

e.g.

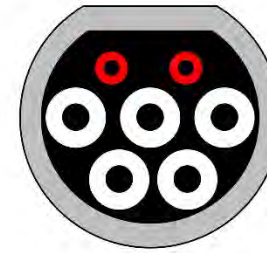
Plugs with power, data and aux. power connectors

EV interacts with EVSE over pilot-wire

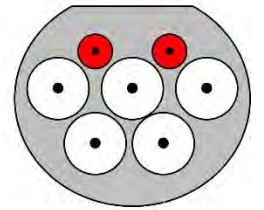
Increased protection (surge withstand, OVP, OCP, OTP, calibrated current/voltage sensors)



J1772 TYPE 1
USA/Japan/Korea



J1772 TYPE 2
Europe



GB/T
China

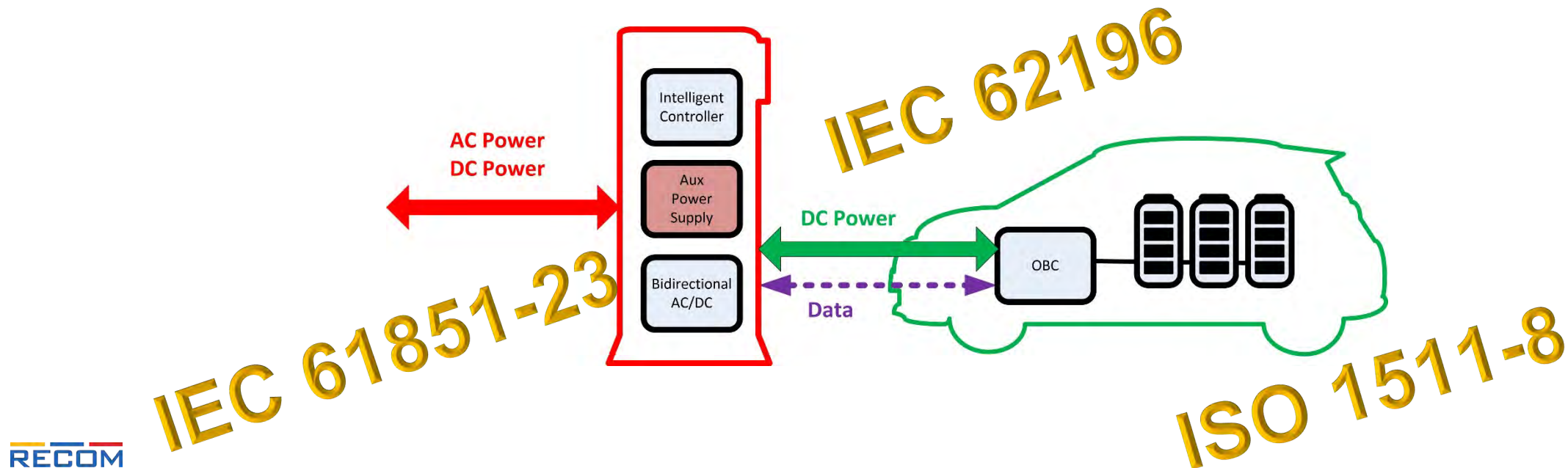
EVSE Standard Connectors
(Pilot-wire pins shown in red)

**OnePoll Survey, 2021*

Fast Charging

EV OBC 'handshakes' with the EVSE which negotiates with the supply to control power flow, according to the safety standards.

Therefore, an independent aux. power supply is required to enable the main power stages only when it is safe to do so.

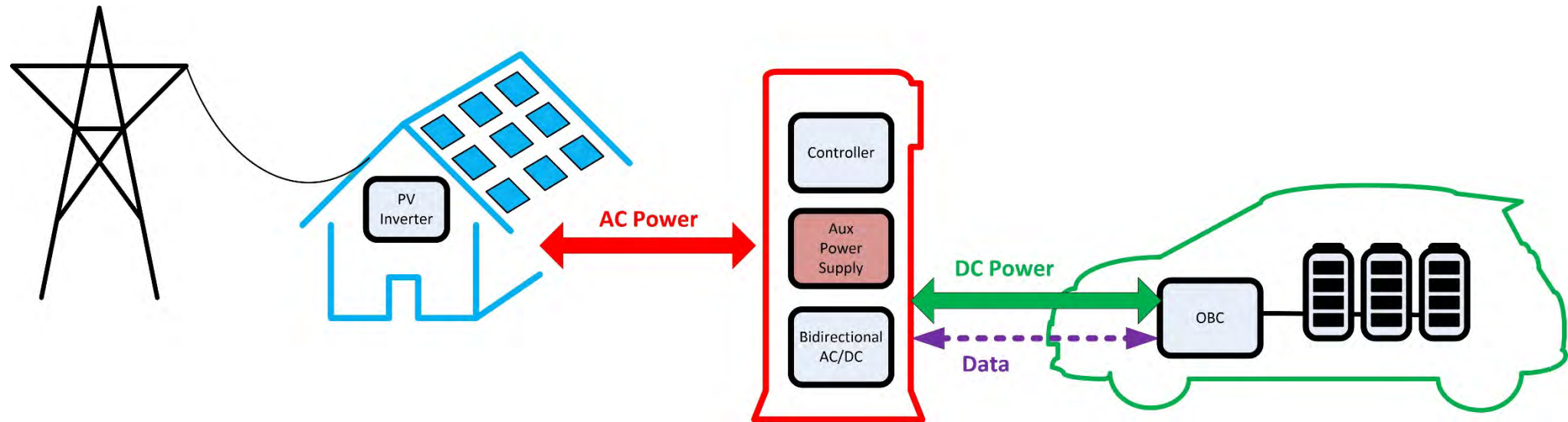


Home Charging

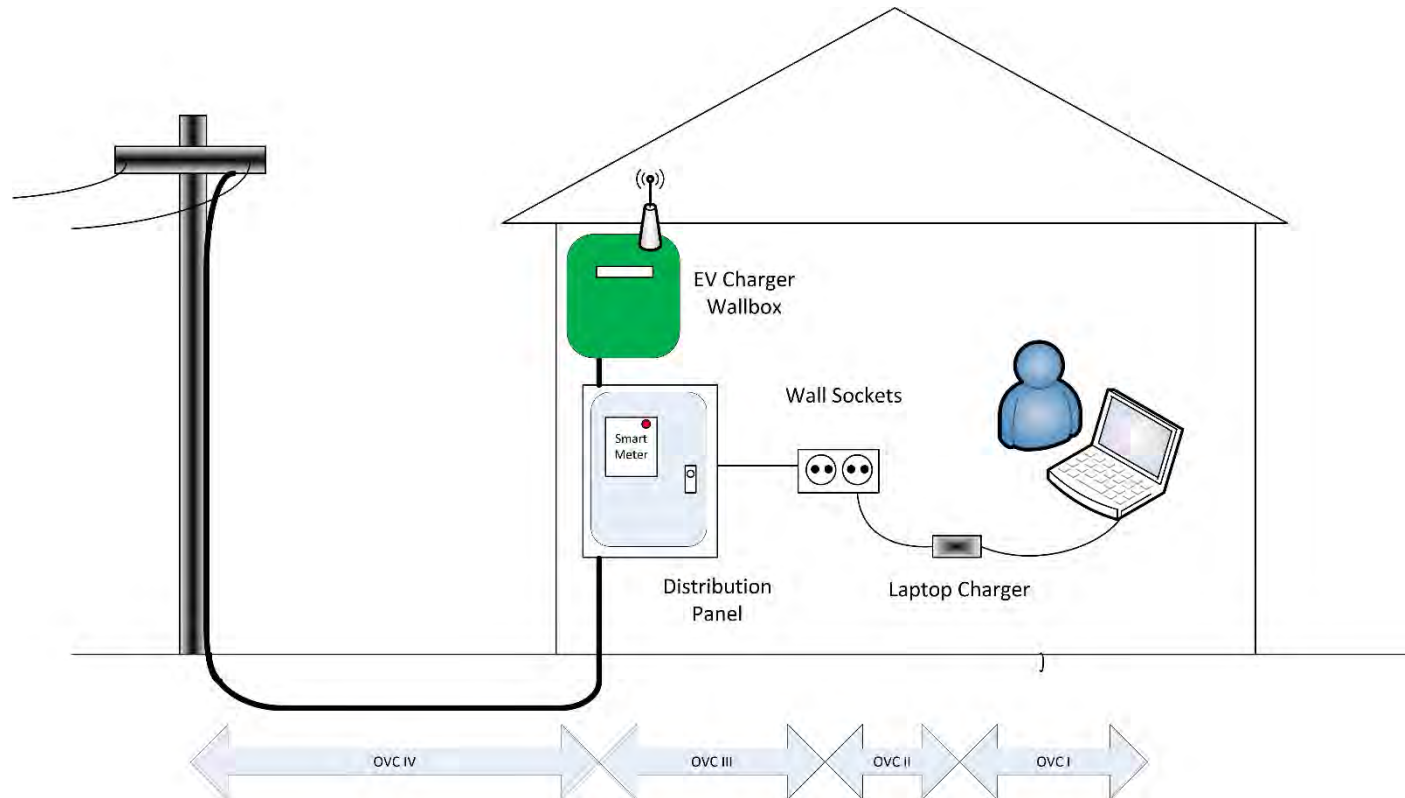
Intelligent bidirectional chargers (V2H and H2V) possible, but problematic:

- Legal hurdles (Auto-maker does not want responsibility for secondary use, Utility supplier does not want responsibility for secondary supply)
- ROI critical (*Low cost chargers use intelligence built-in inside the EV*)

Installation category: **OVCII (pluggable)** or **OVCIII (fixed installation)**

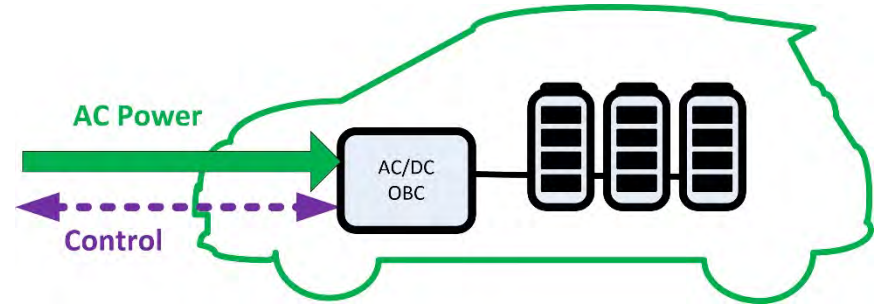
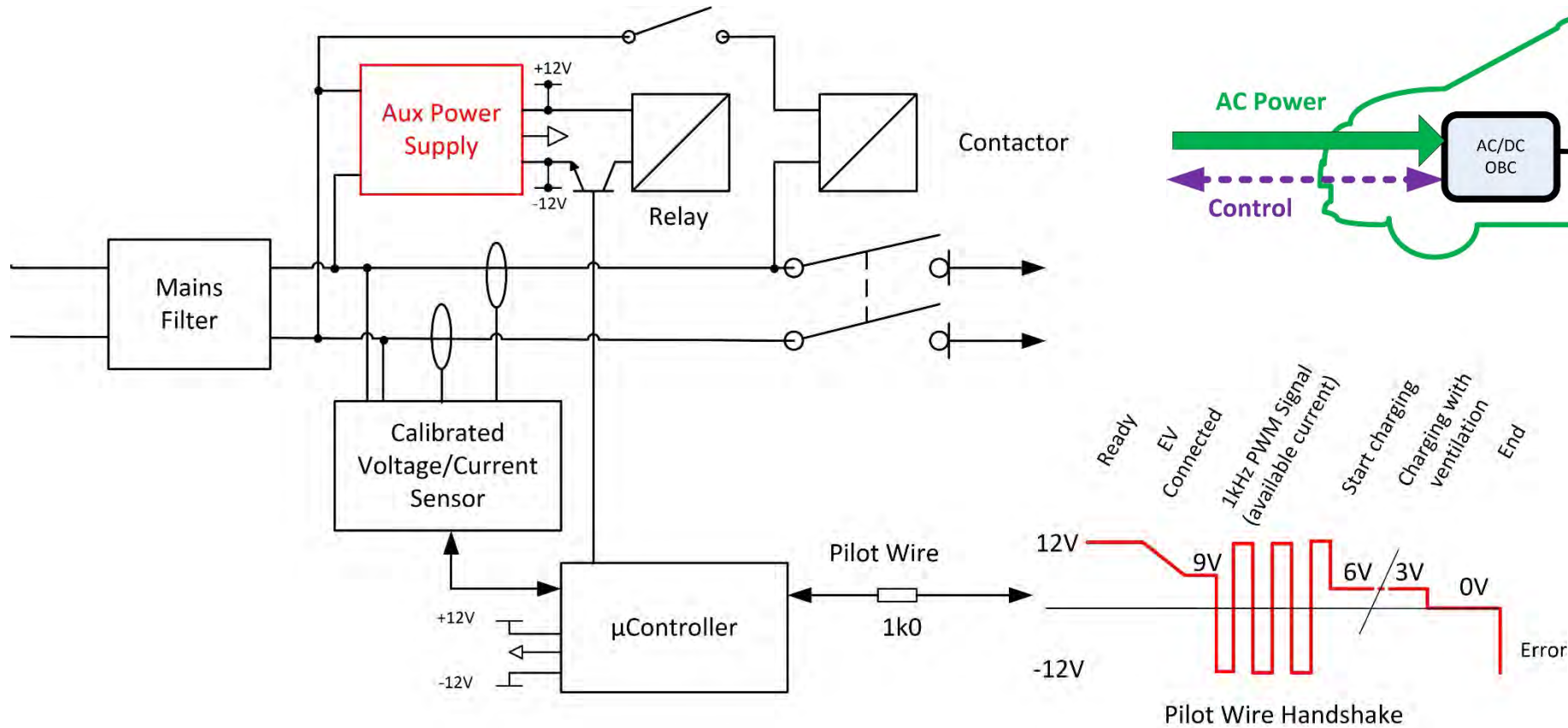


Home Charging: OVC



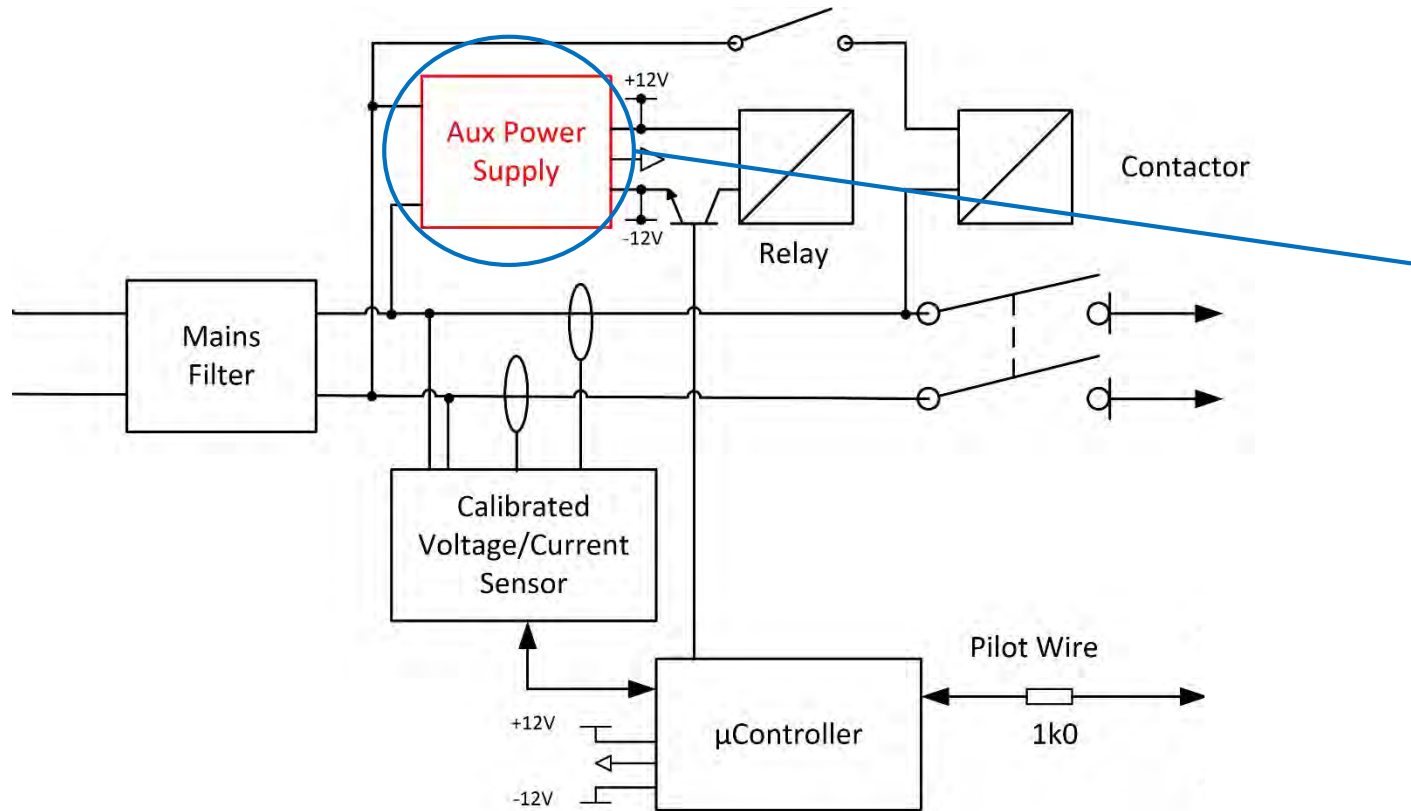
- Installation category
OVCIII (fixed installations)
- Reinforced isolation
 - 4k VAC surge / 6 kV peak dielectric withstand
 - 5.5 mm creepage/clearance
- applies to main power stage
AND to aux power supplies.*

Home Charging: (max. 11kW)



EV controls the EVSE charging rate, turns off charger when full.
(analog control)

Home Charging: Fixed installation



OVCIII isolated supplies for AC power monitoring circuit with 85 VAC to 305 VAC input to cope well with supply dips and surges, e.g.

[RAC03E-xxK/277](#): a very small (37x24mm), very low cost 3W AC/DC with -30°C to +75°C, no derating).

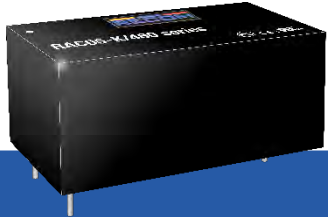
or

[RAC05-xxK/480](#): a 5W AC/DC in 2"x1" package with 85 VAC to 538 VAC for line-line connections (no neutral wire) or L-N connection.

or

[RAC20-xxK/277](#): a 20W AC/DC in 2"x1" package with extra power (10W @ +85°C).

OVCIII AC/DC Converters for Aux Power



5W



3W-20W



40W

[RAC05-xxK/480](#)

[RAC03E-xxK/277](#)
[RAC10-xxK/277](#)
[RAC20-xxK/277](#)

[RACM40-xxK](#)
 (Medical grade)

5, 12 or 15 VDC outputs

3.3 ,5, 12,15,18, 24, ±12, ±15 VDC outputs

5, 12, 15, 24 or 48 VDC outputs

85 VAC to 538 VAC (L-N or L-L)
 120 VDC to 745 VDC

85 VAC to 305 VAC (L-N)
 120 VDC to 430 VDC

85 VAC to 264 VAC (L-N)
 120 VDC to 370 VDC

Standby consumption <500 mW

Standby consumption ≈ 40 - 250 mW

Standby consumption ≈100 mW

-40°C to +60°C, full load, 230VAC.

-40°C up to +55°C, full load, 230VAC.

-40°C to +65°C, full load, 230VAC.

Features: SCP, OVP, OCP, OTP, built-in fuse, complies with EMC Class B (no FG), up to 140% peak power, 5000m

OVC III according to IEC62477-1 (4k VAC reinforced isolation)

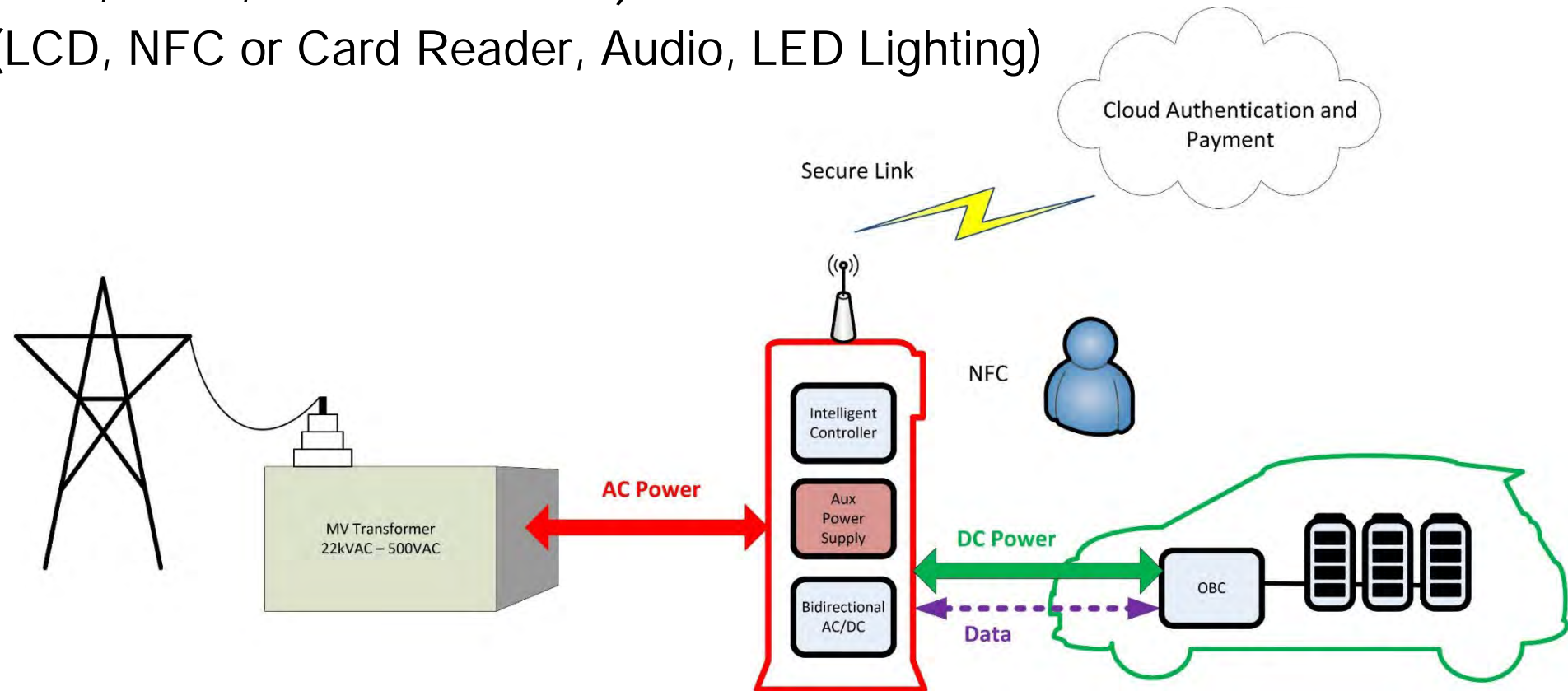
2" x 1", PCB mount (RAC03: 1.45" x 0.95")

1.8" x 3.2", PCB mount (threaded inserts)

Industrial, household and ITE certified (e.g. 62368-1, 60335-1, 61558-1, 61558-2-16)

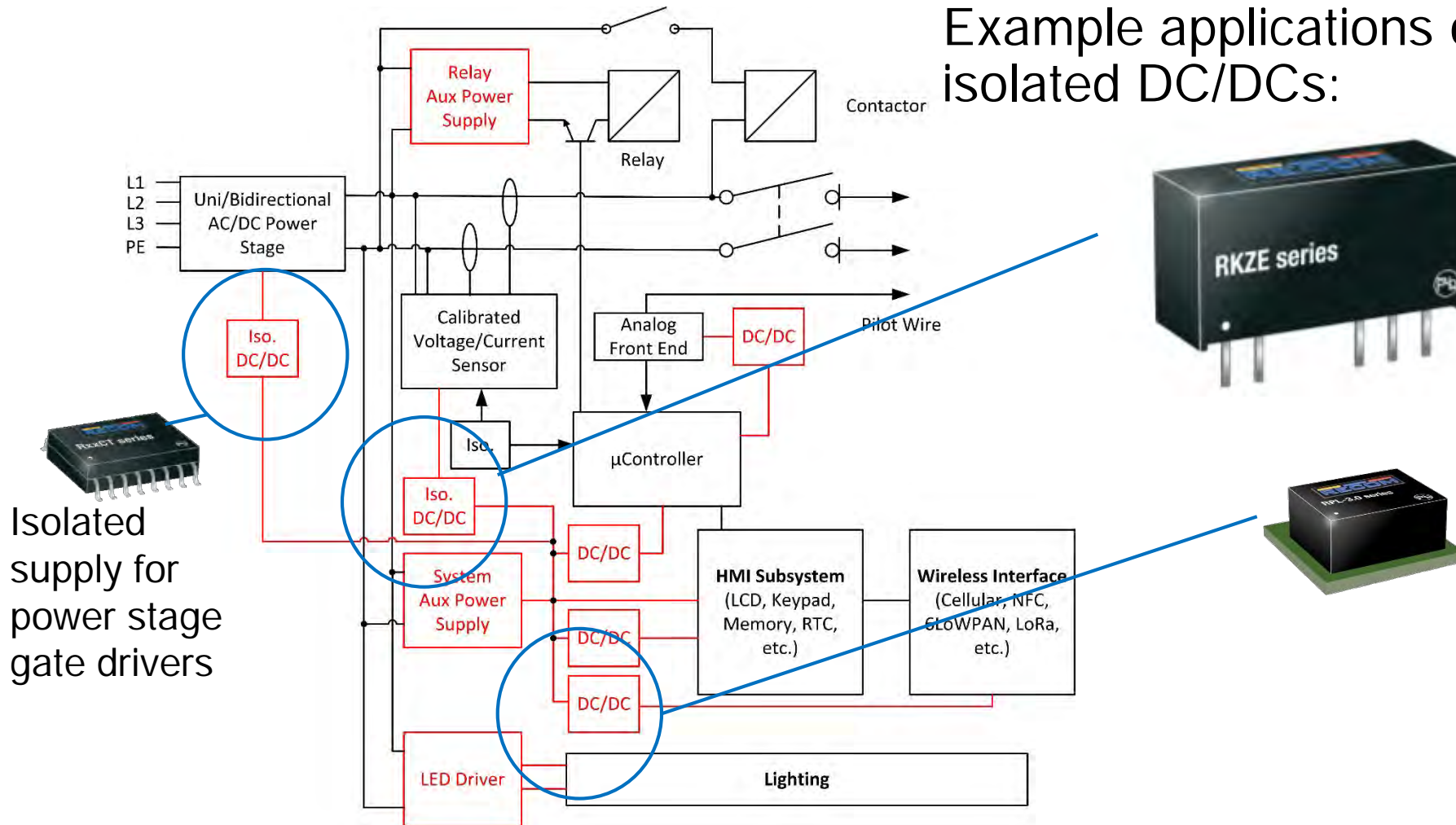
Public Charging: HPC (AC or DC)

- Intelligence in the charger for interoperability, security, and safety (Communication bus, Smart Controller with OTA, Alarm System)
- Secure (cloud-based) communication, authentication and payment system (5G Cellular, LoRa, Secure Ethernet)
- User interface (LCD, NFC or Card Reader, Audio, LED Lighting)



Public Charging: HPC

Example applications of isolated and non-isolated DC/DCs:



DC/DC Converters for Distributed Power Architecture



Isolated



Non-Isolated



Power Modules



[RSx](#) (1W, 2W, 3W, 6W, 12W) in SIP8
[R1SX](#), [R1DX](#), [R1ZX](#) (1W) in SMD
[R2SX](#), [R2DX](#), [R2ZX](#) (2W) in SMD

[R-78](#) (0.3A, 0.5A, 1A) in SIP3
[R-78B](#) (1A, 1.5A, 2A) in SIP3
[R-78AA](#) (0.5A, 1A) in SMD

[RPM](#) (1A, 2A, 3A, 6A) in 25 pad LGA
[RPX](#) (1A, 1.5A, 2.5A) in QFN
[RPL](#) (3A) in 10 pad LGA

Regulated or Unregulated Output

Regulated outputs

Regulated outputs

1kVDC, 2kVDC or 3kVDC Isolation

Non-isolated

Non-isolated

1:1, 2:1 or 4:1 input voltage range

Wide input voltage range (7:1)

Extra-wide input and output voltage range

-40°C up to +100°C, full load

-40°C up to +60°C, full load

-40°C up to +85°C, full load

Simple EMC Filtering

Up to 97% efficiency

Up to 99% efficiency

Through-hole or SMD PCB mount

SMD PCB mount

Features: UVLO, SCP as standard or as option, low profile, very high power density (3DPP®)

IEC/EN/UL certified

www.recom-power.com/gate-drivers

V2x Charging

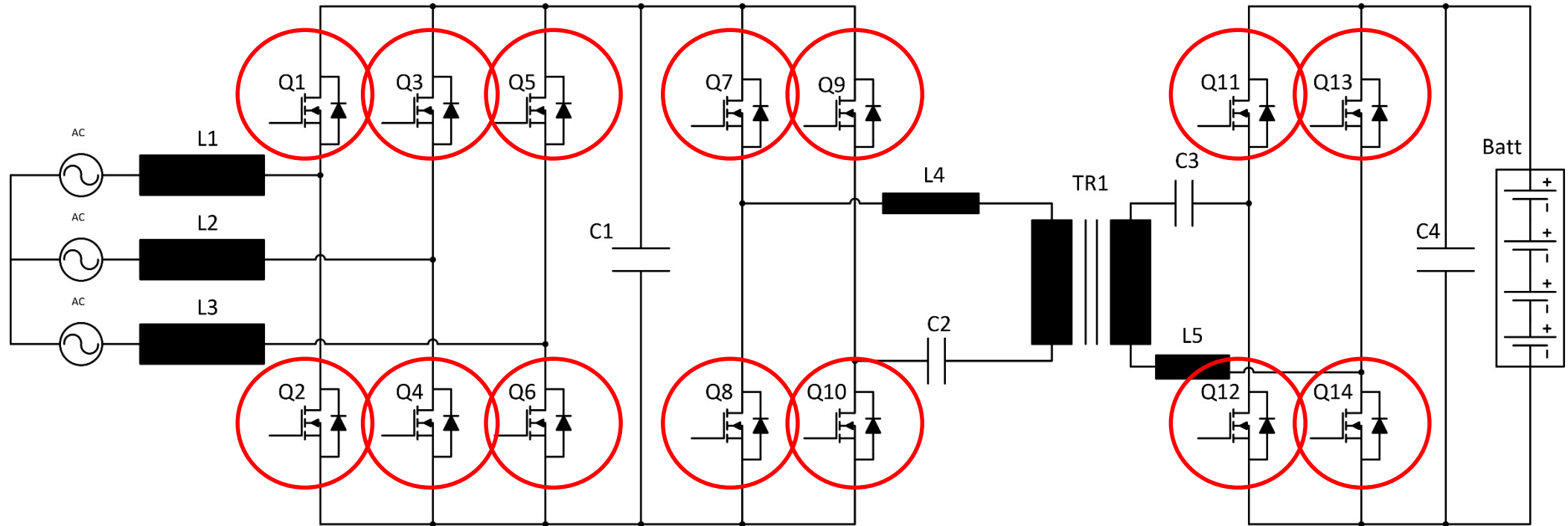
Different EV charging applications require different solutions:

V2x – Vehicle-to-Everything:

- **V2L** (Vehicle2Load) – DC/DC or DC/AC to charge e-bikes and scooters, power camping equipment.
- **V2G** (Vehicle2Grid) – AC/DC/AC for grid balancing/energy shaving, On-Board Chargers.
- **V2H** (Vehicle2Home) – AC/DC/DC for Smart home (self-sufficiency: mains + solar + battery + EV).
- **V2V** (Vehicle2Vehicle) – DC/DC for Fleet battery balancing/conditioning : cascadable)

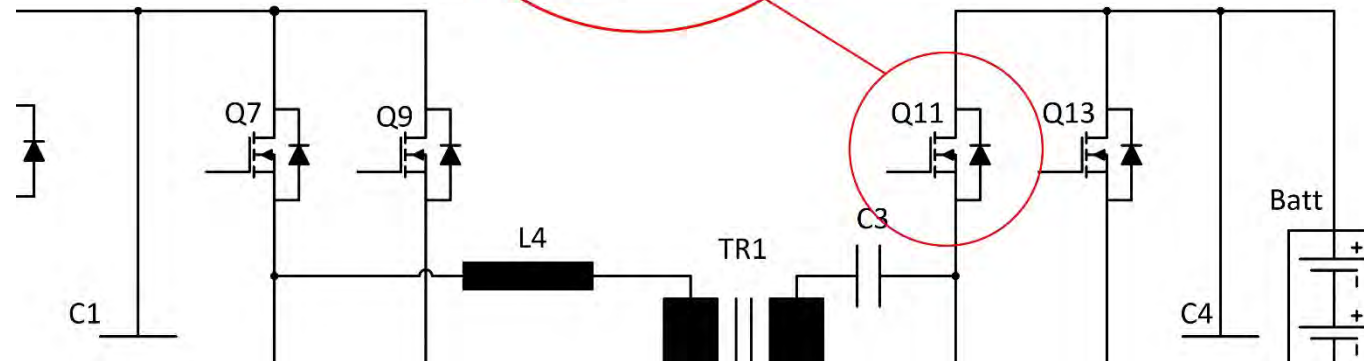
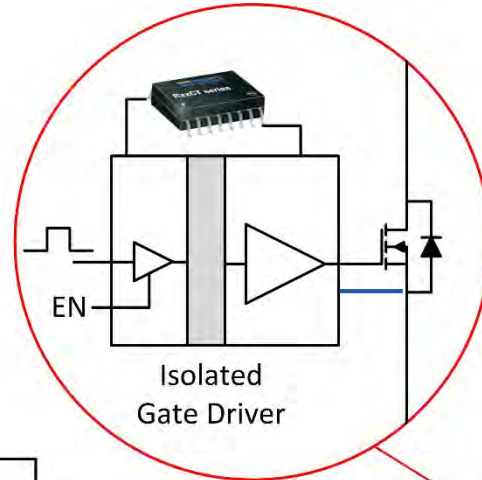


Power Stage






Power stage has 14 transistors

Power Stage



Power stage has 14 transistors – each with its own isolated driver + power supply

High Isolation DC/DC Converters for Gate Drivers

 IGBT	 SiC	 GaN
<u>RxxP2xx</u> , <u>RxxPxx</u> , <u>RP</u> , <u>RH</u> & <u>RKZ</u> series in a compact SIP7 case. <u>RV</u> & <u>RGZ</u> series in DIP14 and DIP24	<u>RxxP21503D</u> , <u>RxxP22005D</u> , <u>RKZ-xx2005D</u> , and <u>RA3</u> series in compact SIP7 or DIP16 cases	<u>RxxCTxx</u> , <u>RxxPxx</u> , <u>RxxP2xx</u> , <u>RK</u> , <u>RP</u> and <u>RA3</u> in compact SMD, SIP8 or SIP7 cases
+15V and -9V outputs	+15/-3V and +20/-5V outputs	+5V, +6V, +8, +9V, and +7/-1V outputs
1W or 2W total outputs	2W or 3W total output	1W, 2W, or 3W output power
5V, 12V or 24V inputs	5V, 12V, 15V or 24V inputs	5V, 12V, 15V, or 24V inputs
Up to 86% efficiency	Up to 87% efficiency	Up to 83% efficiency
Symmetric power	Symmetric power or symmetric current output	
Up to 6.4kVDC isolation (20kVDC for RHV2/RHV3 series)		
Up to +140°C operating temperature		
IEC/EN/UL certified		

www.recom-power.com/gate-drivers

Conclusion

Even high power EV chargers need multiple low power internal power supplies to create a fault-tolerant, safe and reliable power infrastructure.



- AC/DC for Aux. power, safety interlocks and control circuits with OVCIII.
- Isolated DC/DC for gate drivers, sensors and input isolation.
- Non-Isolated DC/DC for the internal distributed power architecture and dual-rail analog circuits.

RECOM offers over 30,000 AC/DC and DC/DC products with proven reliability, so let us help you bring your EV charger design to life.



www.recom-power.com/ev-charging