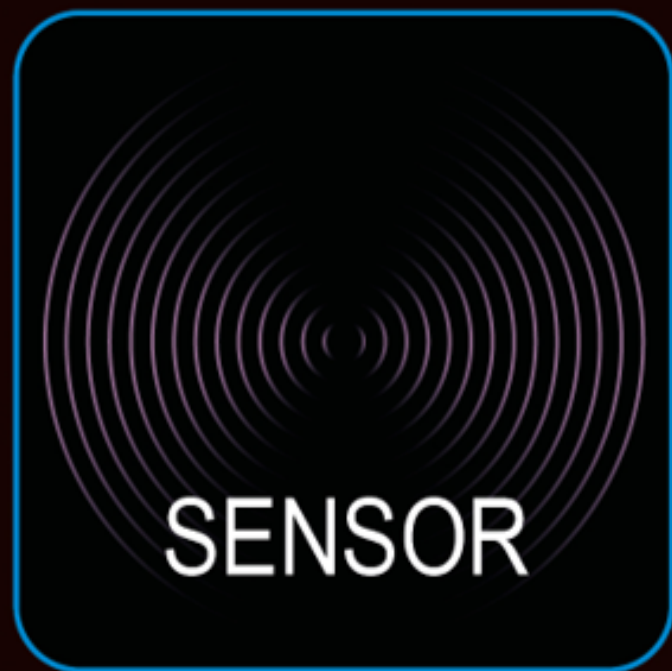


# RUTRONIK TECHTALK MEETS



08.06. - 10.06.2021 | **ONLINE**

Auxiliary power supplies in high power EV charging stations –  
with great power comes great responsibility

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Innovation Manager

**RECOM**

# 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:

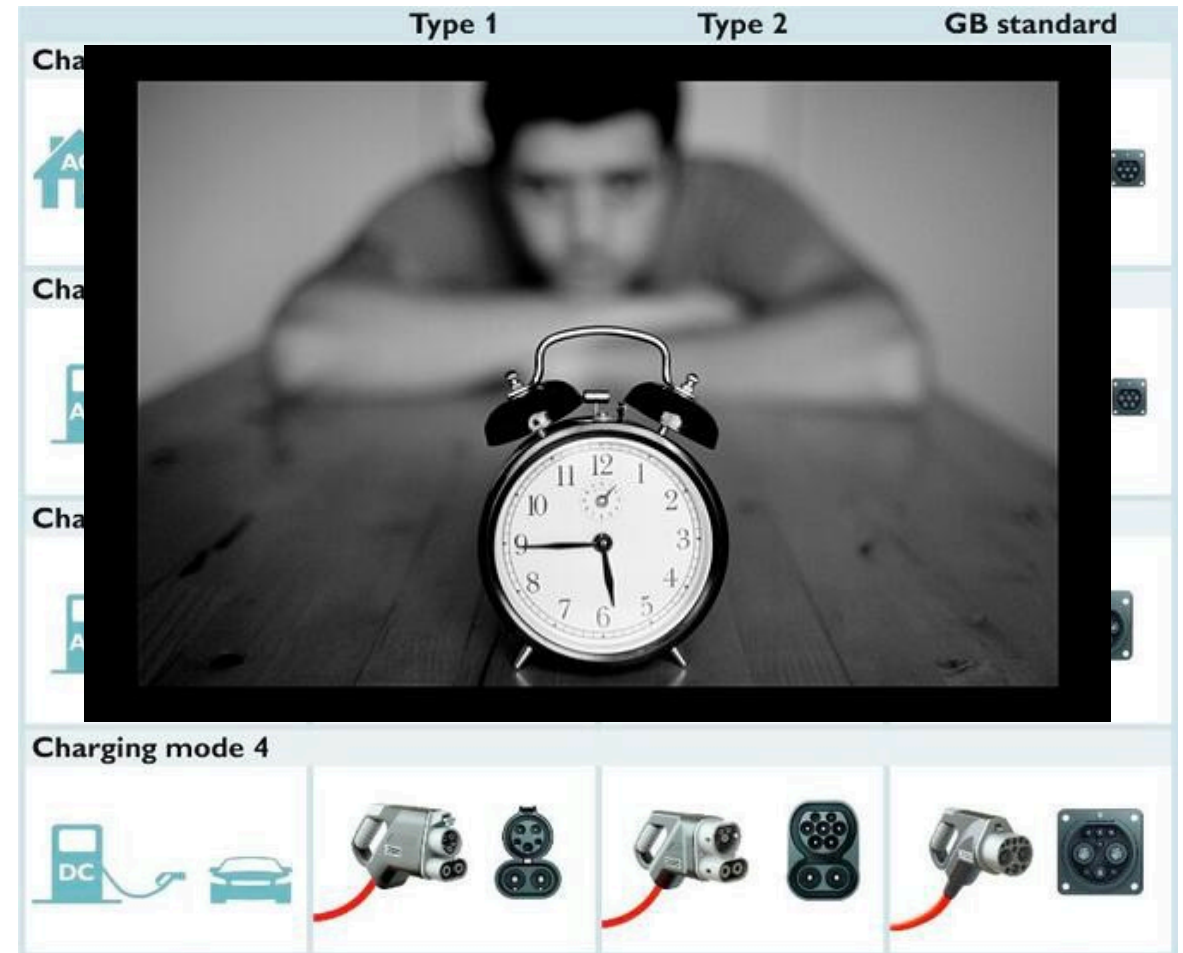
- *higher power for faster charging*
- *(cable) cooling system required*
- *increased safety measures*

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)



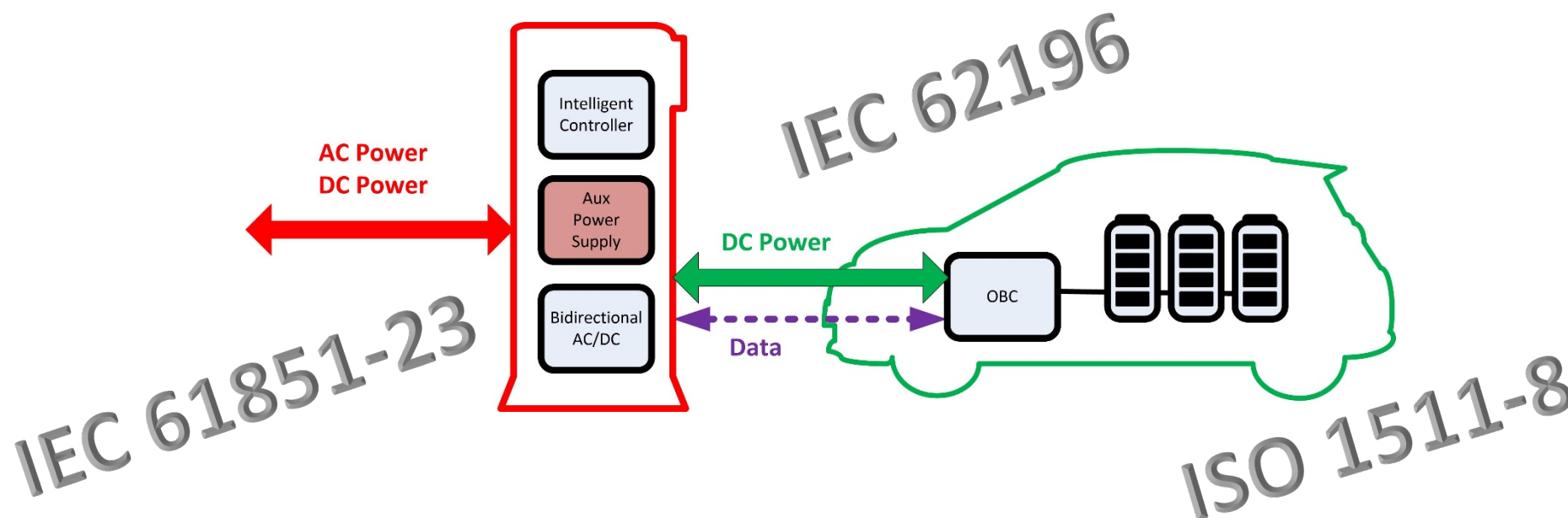
\*OnePoll Survey, 2021

IEC 61851 charging modes and types (Source: <https://blog.foxconn.com/waiting-for-a-charge>)

# 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.*

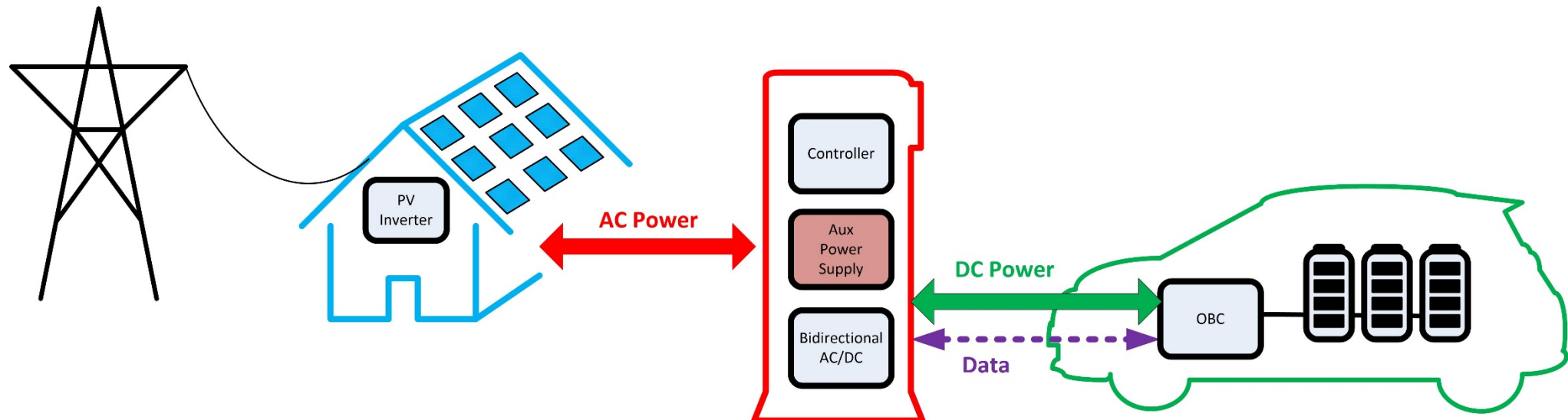


# Home Charging

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

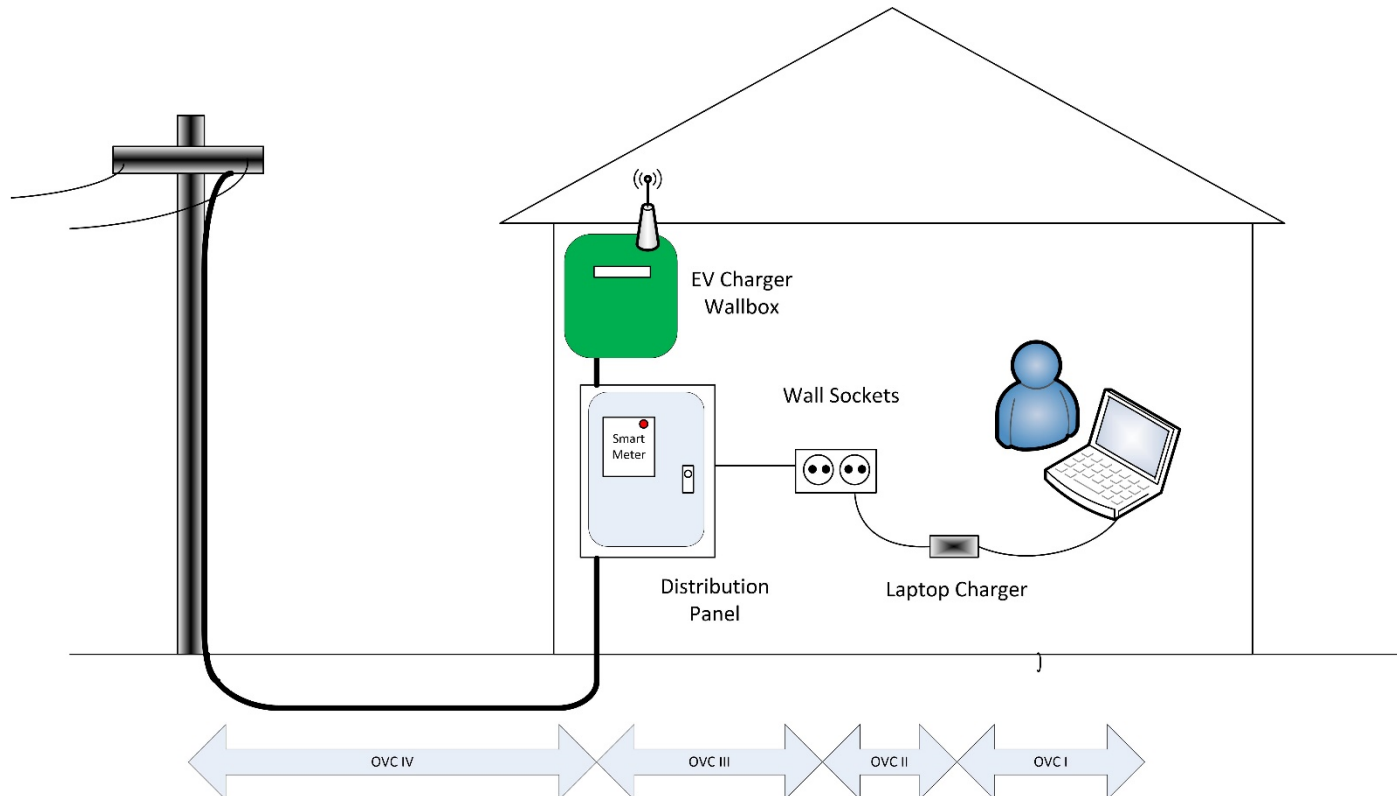


Installation category

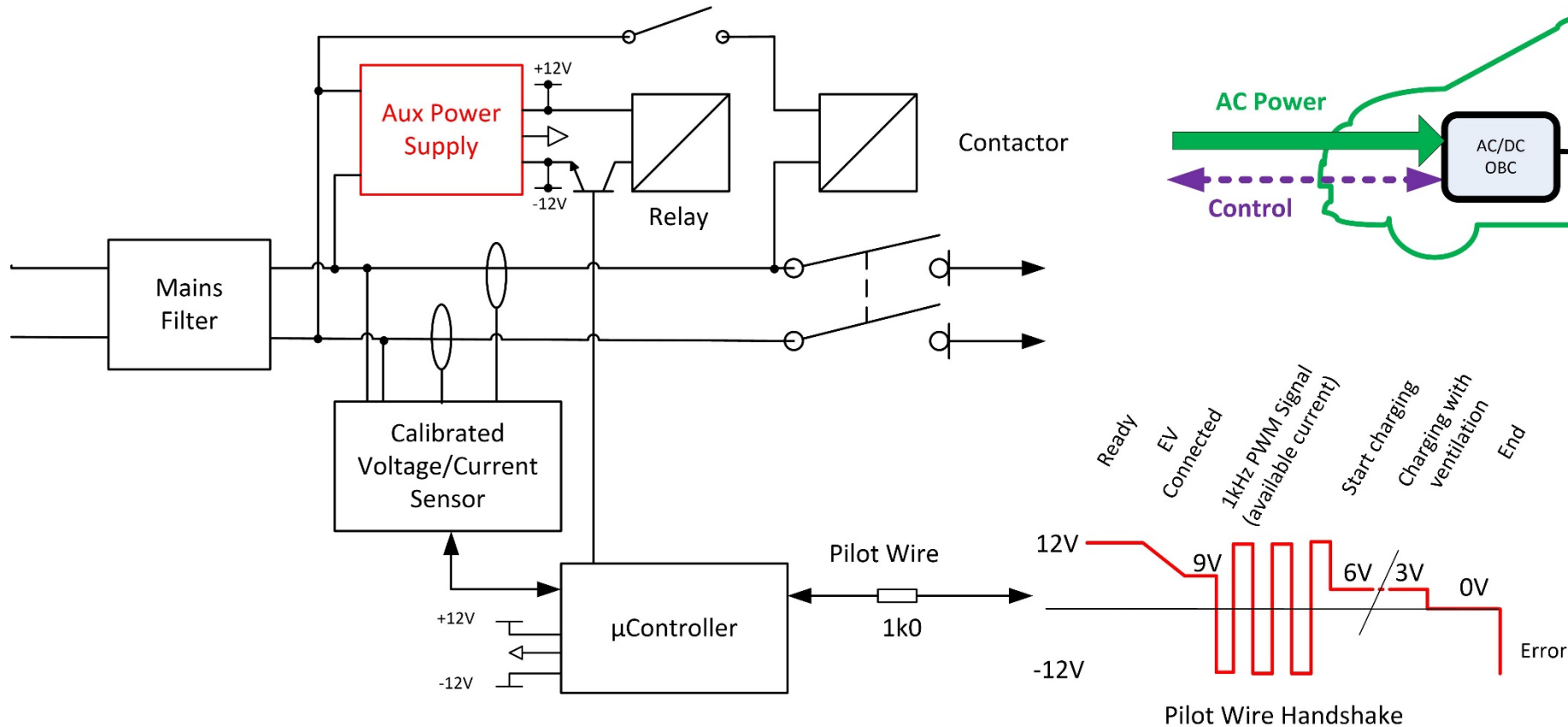
OVCIII (fixed installations)

- 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.*

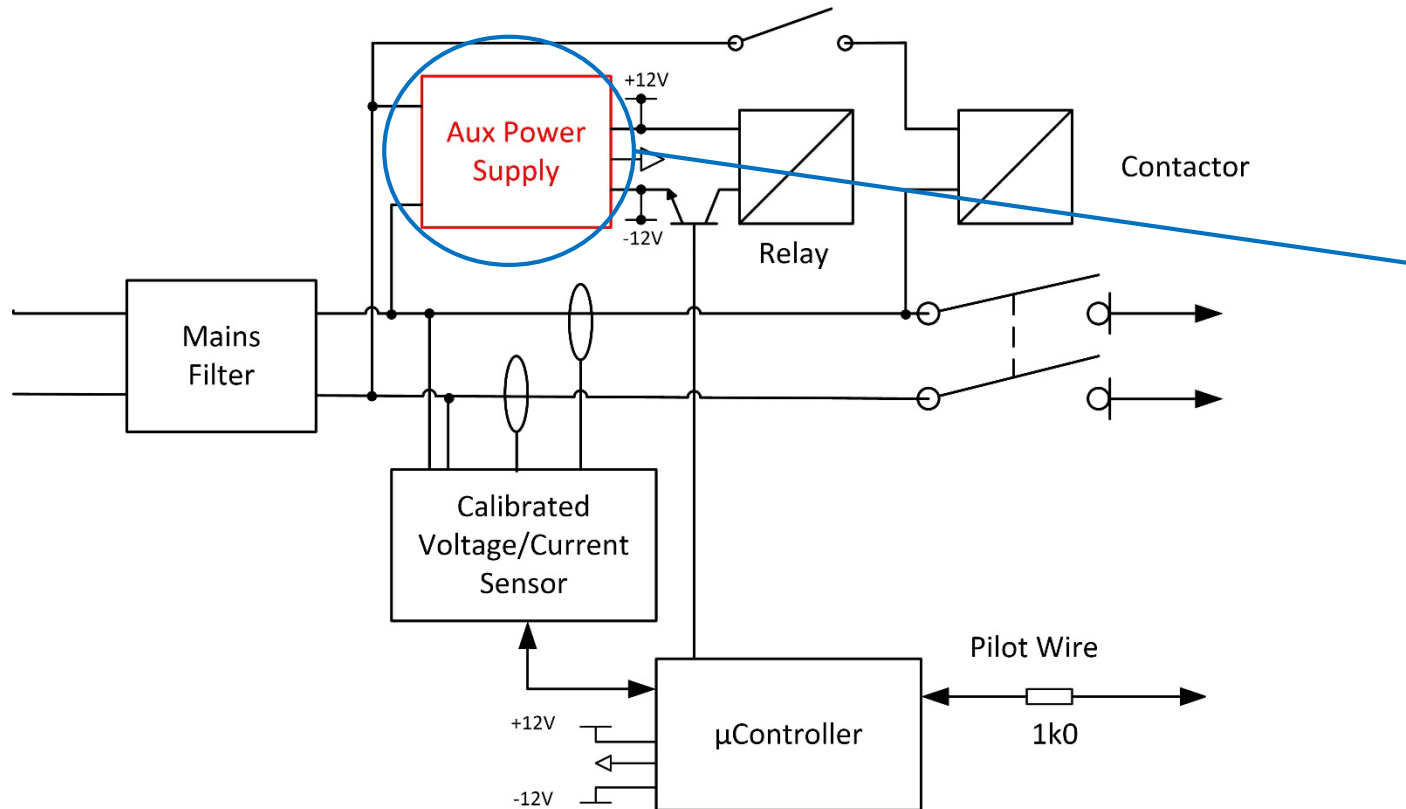


# Home Charging: (max. 11kW)



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

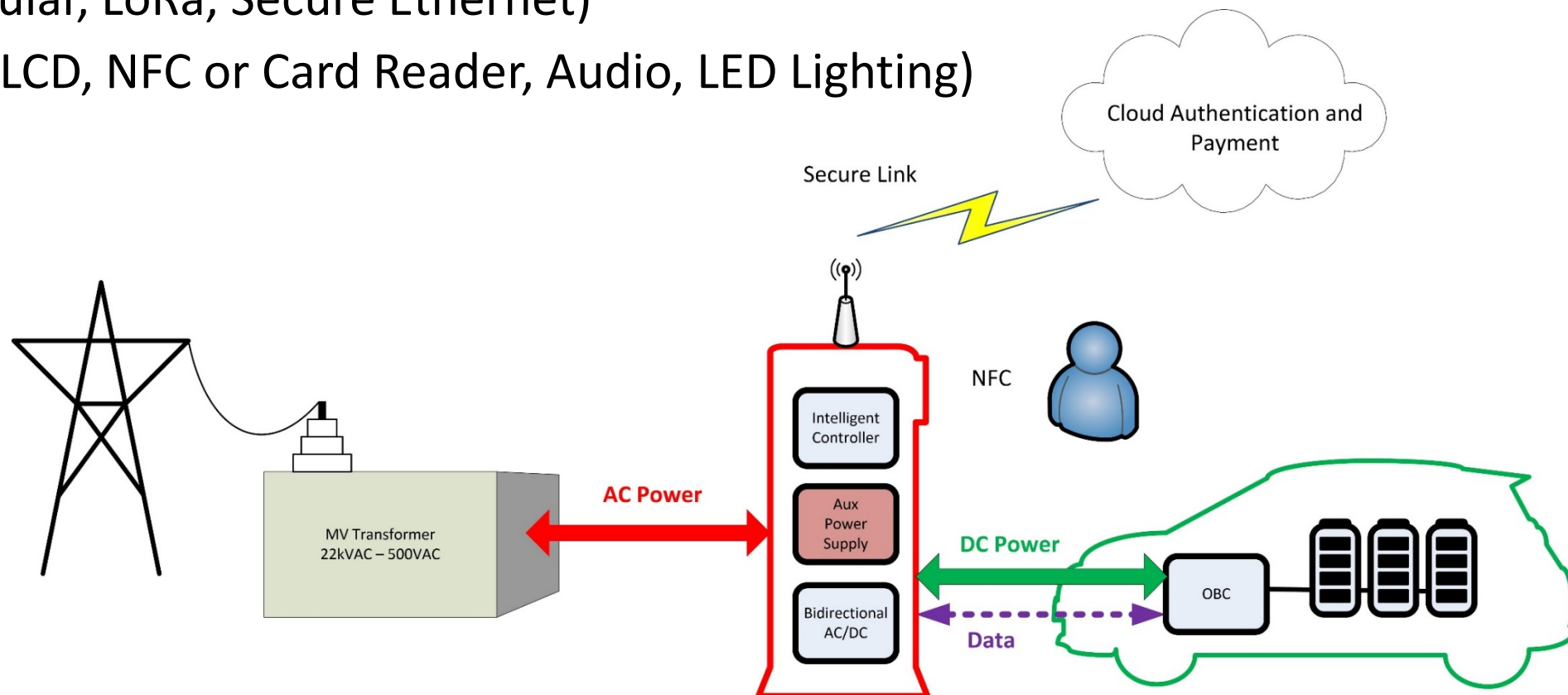


40W

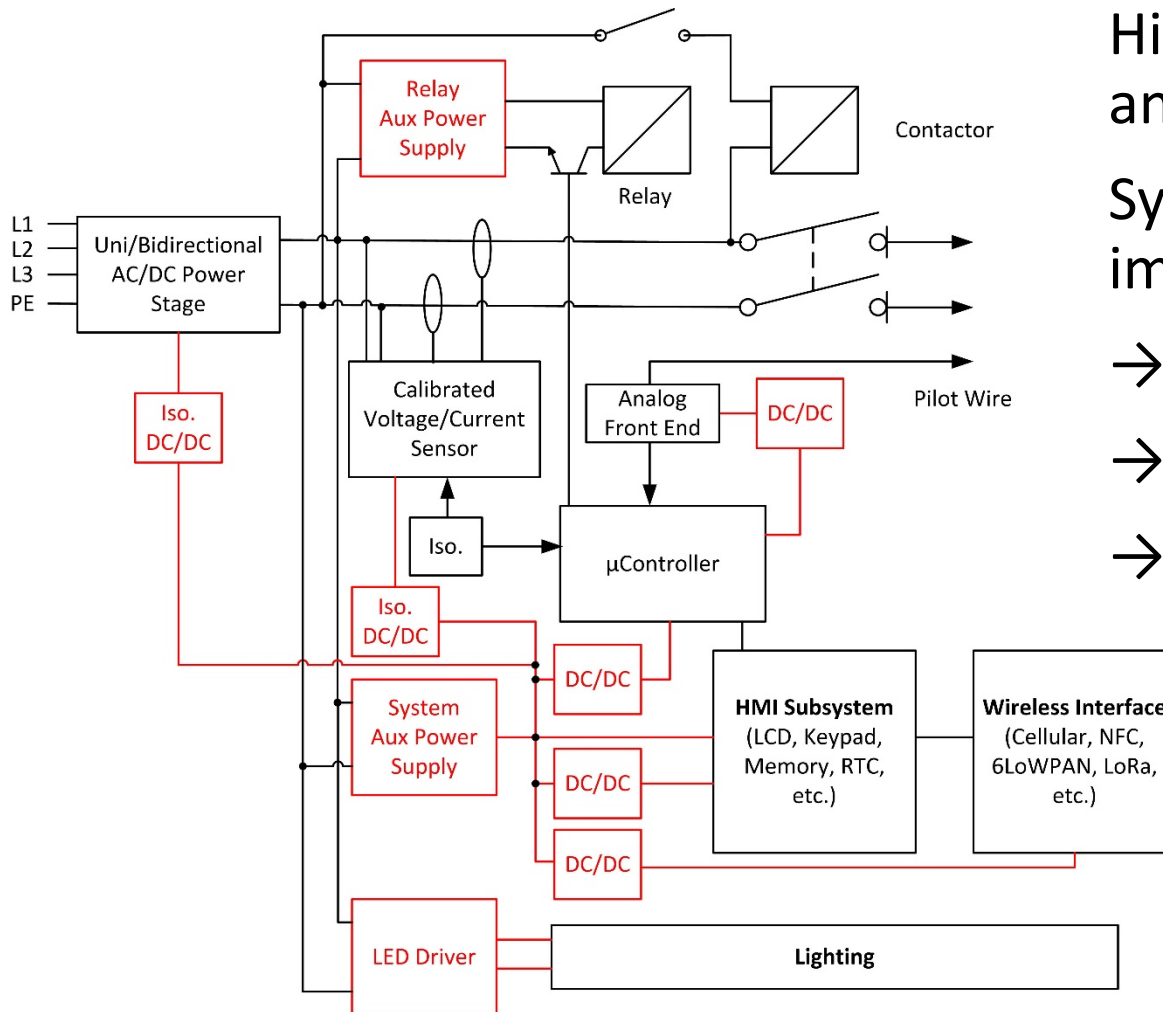
RAC05-xxK/480	RAC03-xxK/277 RAC10-xxK/277 RAC20-xxK/277	RACM40-xxK (Medical grade)
5, 12 or 15 VDC outputs	3.3 ,5, 12,15,18, 24, ±12, ±15 VDC outputs	5, 12, 15, 24 or 48 VDC outputs
85 VAC to 538 VAC (L-N or L-L) 120 VDC to 745 VDC	85 VAC to 305 VAC (L-N) 120 VDC to 430 VDC	85 VAC to 264 VAC (L-N) 120 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



High Power Charging: EVCS is more complex and smarter than domestic version.

System overall security and reliability more important than lowest possible cost.

→ multiple power supplies

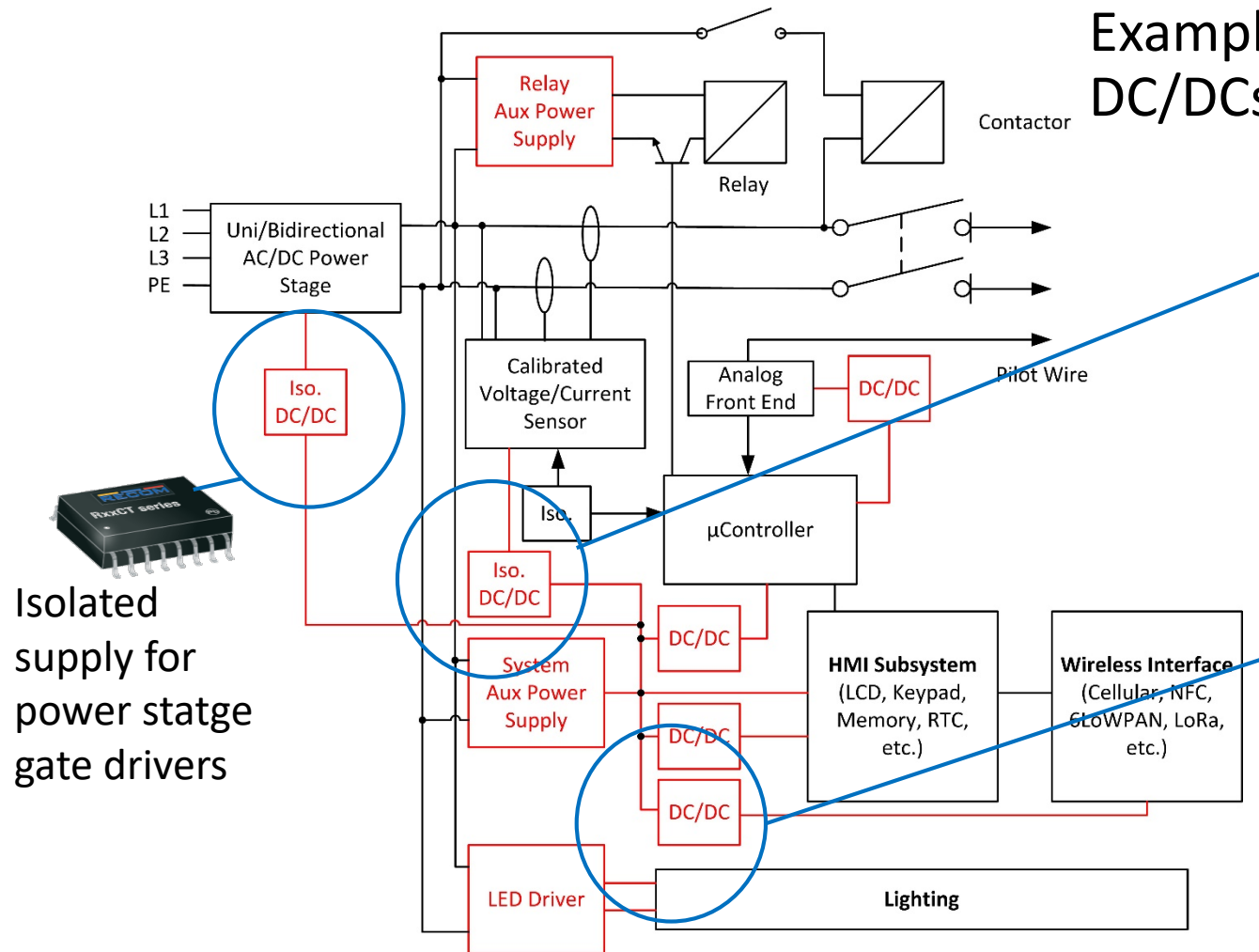
→ multiple bus voltages

→ mix of isolated and non-isolated DC/DCs

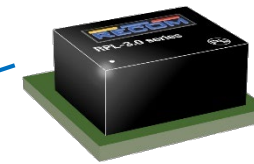
# Public Charging: HPC



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






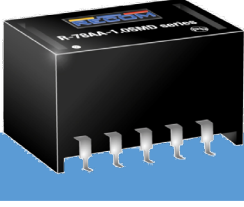
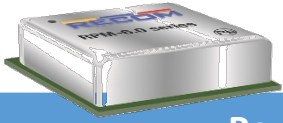
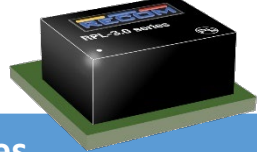
Isolated supply for AC power monitoring circuit using **RKZE-1212S/H2**: a low cost 2W DC/DC with 4kVDC isolation and operation from -40°C to +80°C, no derating



Non-isolated 3.8VDC/3A supply for data modem using **RPL-3.0**: a tiny 3mm<sup>2</sup> integrated inductor buck converter with adjustable output and full protection (SCP, OLP, OVP, OTP, UVLO).

# DC/DC Converters for Distributed Power Architecture



 <b>Isolated</b> 		 <b>Non-Isolated</b> 	  <b>Power Modules</b>
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](http://www.recom-power.com/gate-drivers)

# V2x Charging



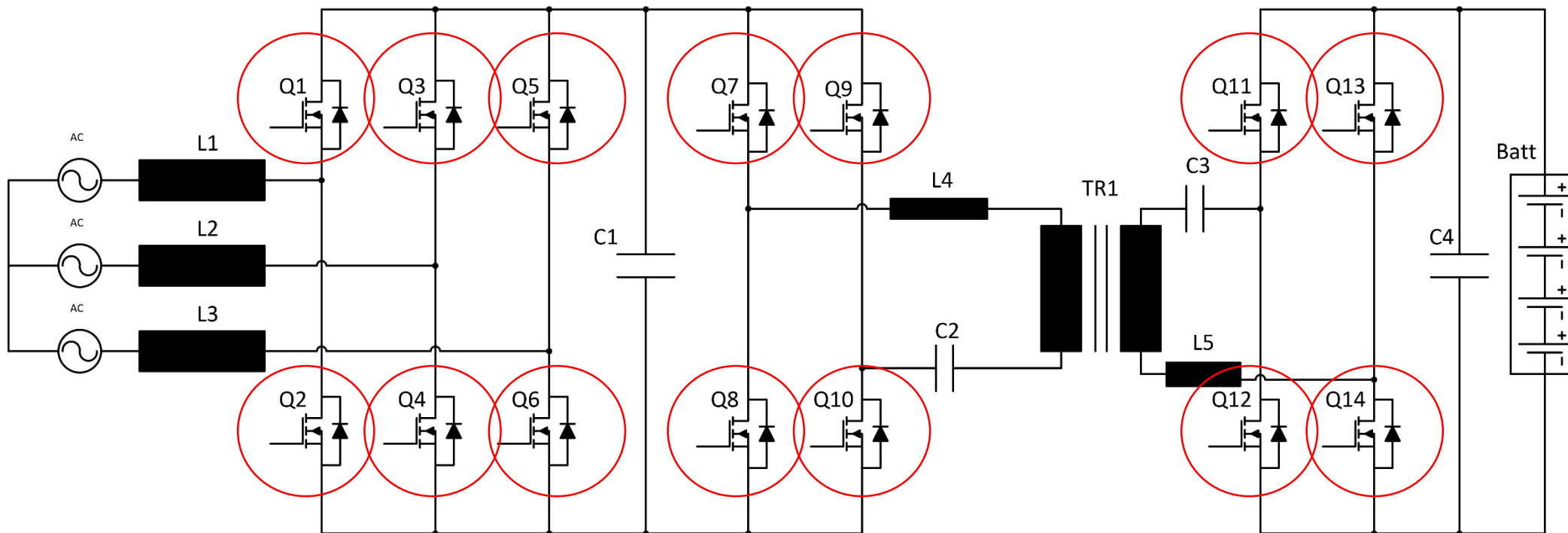
Different EV charging applications require different solutions:

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)

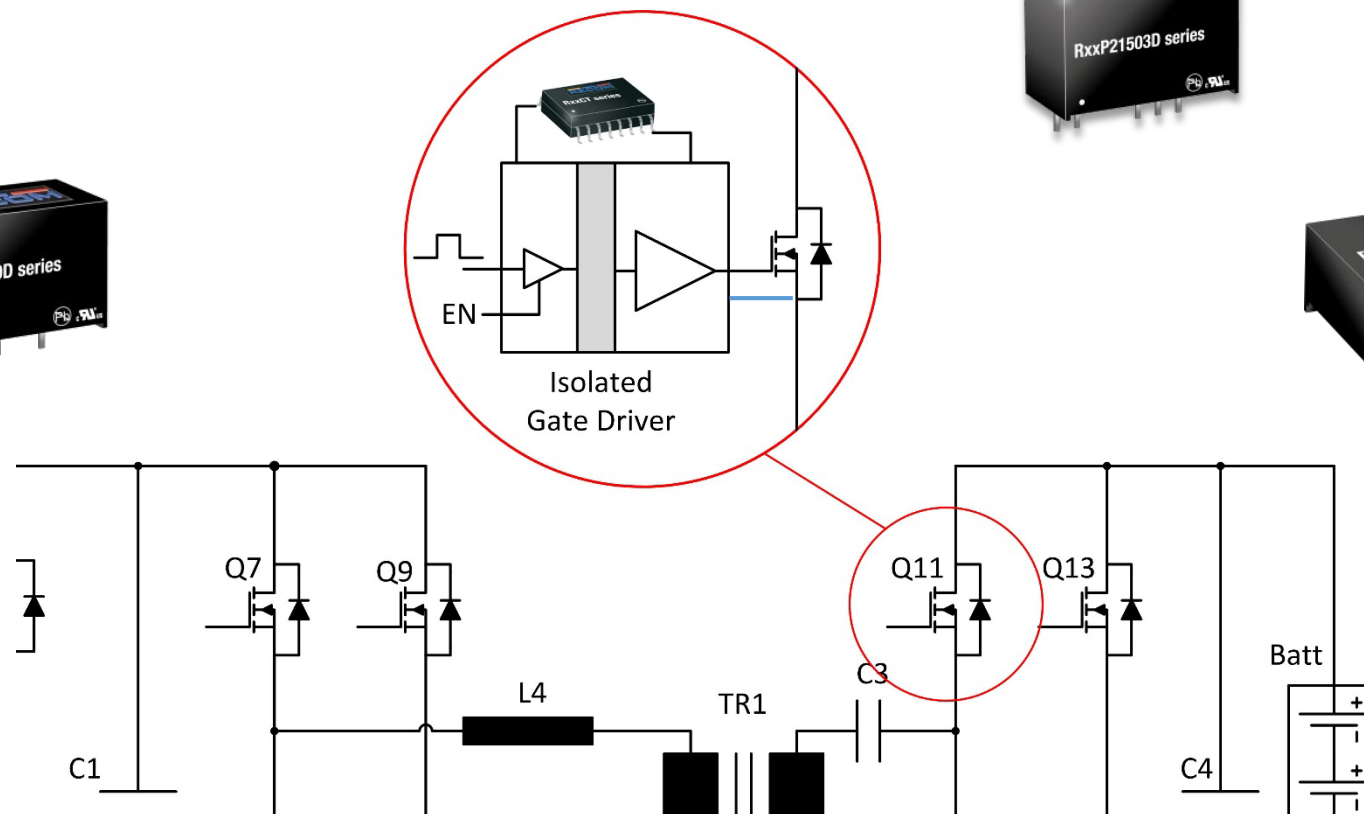


# Power Stage



*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	
RxxP2xx, RxxPxx, RP, RH & RKZ series in a compact SIP7 case. RV & RGZ series in DIP14 and DIP24		RxxP21503D, RxxP22005D, RKZ-xx2005D, and RA3 series in compact SIP7 or DIP16 cases		RxxCTxx, RxxPxx, RxxP2xx, RK, RP and RA3 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](http://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 and Rutronik help you bring your EV charger design to life.