

APPLICATION NOTE

Switching & Protection for Level 2 Electric Vehicle Chargers

Electric Vehicle Supply Equipment (UL)



Are you involved in designing an EV charger as an original equipment manufacturer or contract manufacturer? ABB Applications provide a jumping-off point able to simplify and reduce design time and complexity thanks to application "bundles" and reference designs.

What is an EV Charger?

At its simplest, an EV charger is a gate for supplying power to an electric vehicle. There are many types of chargers, ranging from onboard Level 2 to dedicated Level 2 (external) and even Level 3 [DC] fast chargers. Size and cost vary, depending on the type of charger, rated power and charging time. While there are many varieties (commercial versus residential, for example), the most common EV chargers today are dedicated Level 2 for destination charging (take longer to charge) and Level 3 fastchargers for when you're on the go!

Why you need Switching & Protection solutions

Charging EVs requires significant power (10-100's kW), so there are accompanying risks related to circuit and user protection. Users must be protected from electric shocks, burns and arc flashes. Circuits also require protection:

- Overcurrent protection for devices and conductors (fuses and breakers)
- Disconnecting means for safe shutdown and servicing
- Circuit isolation and control (electrical switching)
- Ground fault protection (for fire and damage prevention)
- Surge protection to prevent damage to switching devices and electronics.

Main benefits



Smarter protection

Select from a comprehensive range of low voltage components to ensure interoperability and compliance in your next design.

Reduce Design Time

Speed up your process and reduce total design time by using ABB's application bundles and reference materials for faster component searches and overall engineering time.

Safety

Choose from stringently tested, globallycompatible product lines for all your protection needs:

- overcurrent protection
- surge protection
- disconnecting means
- switching / interrupting devices
- control
- monitoring

Smarter metering and monitoring Your system design can be enhanced with embedded monitoring and controls able to determine everything, from electrical parameters and conditions to product wear. These signals are optionally made available through specific ABB Ability-enabled devices, such as molded case circuit breakers.

Level 2 Chargers for Destination EV Charging

Fundamentals, main components & functionalities

Electric vehicle (EV) chargers vary in size, power and voltage, depending on their charging speed. Level 3 (L3) DC "fast chargers" use direct current for impressively quick charging but tend to be more expensive. On the other hand, AC Level 2 (L2) chargers (240V single phase or 208V three phase) offer respectable charging times and are cost-effective for both commercial and residential use.



Installation contactors for EV Charging

Level 2 chargers

The Level 2 (L2) charger is often used in "destination" type settings such as offices, hotels and residences; e.g. where the user will be stationary for several hours, allowing sufficient time for an electric vehicle to charge.

The L2 charger is essentially a power gate, with some accompanying communications to negotiate the charging cycle with the vehicle. Beyond the communication protocol between the charger and the vehicle, L2 chargers are primarily dedicated to switching and circuit protection. Most small-commercial and residential L2 chargers with dedicated wall outlet are typically single-phase 240V, rated up to 40A. Continuous charge current and power is therefore about 80% of this rating, i.e. 32A / 7.68 kW.

The charging mode described in this application note is called "Mode 3" in the IEC literature. Mode 3 charging is the most economical of all fixed charging installations (see table below).

	Level 2
Charging type	AC charging
Voltage	Single-phase or three-phase up to 240V AC
Power	3-19 kW
Amperage	16-80 A
Application	Residential, commercial, fleet
Charging time	4-20 hours
Range per hour	15-80 miles



Standard

UL 2594: AC Level 2 chargers are generally listed to UL 2594 for EV use. The standard introduces a required subsystem called charging circuit interrupting device (CCID) that provides protection to personnel. It measures and interrupts differential [leakage] current at one of two levels: 5mA, or 20mA; full requirements are specified in UL 2231-1 and UL 2231-2. At the 40A overcurrent device rating, most residual current circuit breakers (RCCB) are typically unable to protect against leakage currents less than 30 mA. Additionally, at 150-300Vrms, a 20mA CCID must interrupt the charging circuit if the grounding path (GM/I protection) becomes open-circuited or has an excessively high impedance. Consequently, an RCD or RCCB does not replace a CCID and may not be expressly required. However, it can provide redundant or supplemental protection against fire and property damage from differential fault currents.

Charging Circuit Interrupting Device (15-300 Vrms; <150Vrms any conductor to ground). Pick One*:

Option	Insulation Type	Requirements
1	Basic Insulation	CCID5, <5mA (5MIU) earth leakage threshold
	0	r
2	Basic Insulation	CCID20, <20mA (20MIU) earth leakage threshold + ground monitor/interrupter (GM/I)
	0	r
3	Double Insulation	CCID20, <20mA (20MIU) earth leakage threshold
	0	r
4	Reinforced Insulation	CCID20, <20mA (20MIU) earth leakage threshold
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* Requirements excerpted from UL 2231-1 Table 2



Level 2 Chargers for Destination EV Charging

Charging sequence

This is the typical **charging sequence**:

- User plugs charger cable into vehicle
- Vehicle «handshake» with charger (communications)
- Ground continuity and insulation resistance safety checks (as required)
- Isolation power contactor closes
- Charging: EV on-board charge controller begins switching, power circuits conduct
- Charging is completed or interrupted by user: Charge controller stops switching, charger's isolation contactor opens
- Protective devices open if short circuit, ground fault or interrupted ground connection occur
- Manual isolation using circuit breaker of upstream distribution panel, external disconnect or safety switch (as required).



Main components

 SU200M or ST200M Miniature Circuit Breaker (MCB)
 F202 Series Residual Current Devices (RCD)

 ESB-series installation contactors
 OVR Series Surge Protective Device

Primary Functional Requirements

- Negotiating charging sequence with vehicle (charger-vehicle communication)
- Overcurrent Protection of charging circuit
- Electrical isolation of charging circuit
- Earth leakage / ground fault detection and interruption
- Providing the vehicle with an earthing conductor while charging
- [Generally] safety & testing in accordance with UL 2594 (Electric Vehicle Supply Equipment).

Secondary Optional Requirements

- Surge Protection to protect against voltage spikes, such as those from switching or lightning
- Monitoring: for collecting data on charge process, history and overall system health
 - Voltage, current, power or temperature monitoring
 - Communication: to communicate parameters to an HMI, point-of-sale, or centralized monitoring system
- Charge management and scheduling (if not done elsewhere, could be done within the charger)
- Remotely-operated: need for remote control (such as via cloud-based services or consumer-facing apps).

Switching & Protection for Level 2 Electric Vehicle Chargers

Discover our Switching & Protection solutions for easy L2 charger configuration considering a fixed unit rated for 40A at 240VAC (7.68 kW)



Specifications of electrical quantities for a 40A charger

2 EV Charger Data – Residential / Small Commercial			
Rated power	[kW,ac]	7.68	
Rated AC voltage	[V,ac]	240	
Rated current	[A,ac]	32	
Overcurrent protective device rating	[A,ac]	40	
Prospective AC short circuit current	[kA]	5	

ABB's offering (UL) - Level 2 Destination EV Charging

Distribution L2 EV Charger Contactor € €°€'€ CCID 6,6,66 ī. Œ RCD Panelboard/ Enclosed мсв rotary disconnect load center **Control board** Power circuit Control circuit – – – – Ground

L2 Destination EV Charger Single-Line Diagram

Charger Components

On each charger power circuit	Additional Components	
 SU200M (UL 489 MCCB) or ST200M (UL 1077 supplementary protector) for local overcurrent protection and circuit disconnection F202 series residual current devices for ground fault detection and interruption (equipment protection; not personnel protection) ESB installation contactor for charging circuit control; may be tested and included as part of a CCID for UL 2231 requirements. 	 Surge Protective Device (SPD) (External) enclosed rotary disconnect Aux contact, shunt trip, emergency stop, pilot devices. 	

Bill of materials

Reference Design Parameters

40A overcurrent protection / 32A cont. current	240Vac Single Phase Source (120V to ground, max)
Level 2 «destination» EV charger	Residential or light commercial setting

Description	Product ID	(US product code)	Total quantity
MCB, C-Char., 10kA (240VAC), 40A, 2P UL489	2CDS272337R0404	SU202M-C40	1
Residual Current Circuit Breaker 2P AC type 30 mA	2CSF202401R1400	F202 A-40/0.03 AP-R	1
ESB Contactor (NO) 40 A - 4 NO - 0 NC - 230 V Coil	1SAE341111R0640	ESB40-40N-06	1
OVR T2 2L 40-150 P TS U Surge Protective Device w/ aux contacts	2CTB802343R2100	OVR T2 2L 40-150 P TS U	1
Enclosed Switch, 600V/60A, 3p, UL 98. Type 3R/12 steel, lockable	1SCA022824R0150	EOT60U3M3-P	1

APPLICATION FINDER







Product offering

SU200M MCB:



ESB Contactors:



AF Contactors:



Enclosed Disconnects:





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ST200M Suppl. Protector:



F200 Series RCD / RCCB:



Definite Purpose Contactors:



OVR Series Type 2 SPD:



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