Powering an Electric Vehicle Charging Station

Electric Vehicles have proven to be quite a disruptive force for the automotive industry. This new mode of transportation is overtaking internal combustion equivalents due to the many benefits it offers over its counterpart such as lowering emissions, cheaper operating costs and significantly reduced maintenance requirements.

The electric vehicle in its current form still faces several challenges before it can be adopted as a preferred choice of transportation by the masses. The foremost challenge is the accessibility to an electric vehicle charging network that is both reliable and readily available.
Various countries around the globe have identified the need for an enhanced public charging network and have set up aggressive targets to meet them. The EU, for example, has estimated a need for 2 million EV chargers by 2025.

These high demands for a public electric charging network are in direct response to the current and future volume of electric vehicles sold. Looking at the USA, just in the state of California, a goal has been set to have 5 million electric vehicles on the roads by 2030. China, which is turning out to be one of the largest electric car markets has seen sales of over 2 million electric cars in 2018. These numbers indicate a strong need for an Electric vehicle charging network which is expected to keep rising as more electric vehicles are sold.

These chargers have been classified in many ways, but to make things simple we will broadly classify them into the following 3 main categories based on charging rate and output voltage type:

1] Portable AC chargers: These electric vehicle chargers are designed to be small, lightweight and draw power directly from the wall socket. These portable chargers are widely used as it provides a cost-effective solution that is a necessity due to the current unavailability of faster public charging stations.

2] AC charging stations: These charging stations can charge an electric vehicle faster than the portable AC chargers by delivering higher current with more protective safety features and complicated UI, making them safer and cheaper to install than DC charging stations.

3] DC charging stations: This is the fastest charging station. Unlike the previous two types that simply deliver AC to the EVs and let the onboard charger handle the AC to DC conversion, the DC charging station converts AC to DC within the station and feeds the DC power directly to the EV battery. This way, the charging speed is not limited by the onboard charger and is significantly faster than the AC charging rate.
Designing power supplies to power different modules of an electric vehicle charger is a challenging proposition. Luckily Aimtec provides off the shelf solutions to help ease the challenge and reduce time to market.

Portable Electric Vehicle Chargers

These chargers use a PWM and ±12V volt pilot signal to communicate with the EVs. The power converters used to provide power to the many auxiliary circuits need to be able to generate positive 12V and negative 12V. The +12V is also used to drive the contactor and various electronics. Below is a typical block diagram of the portable electric vehicle charger.

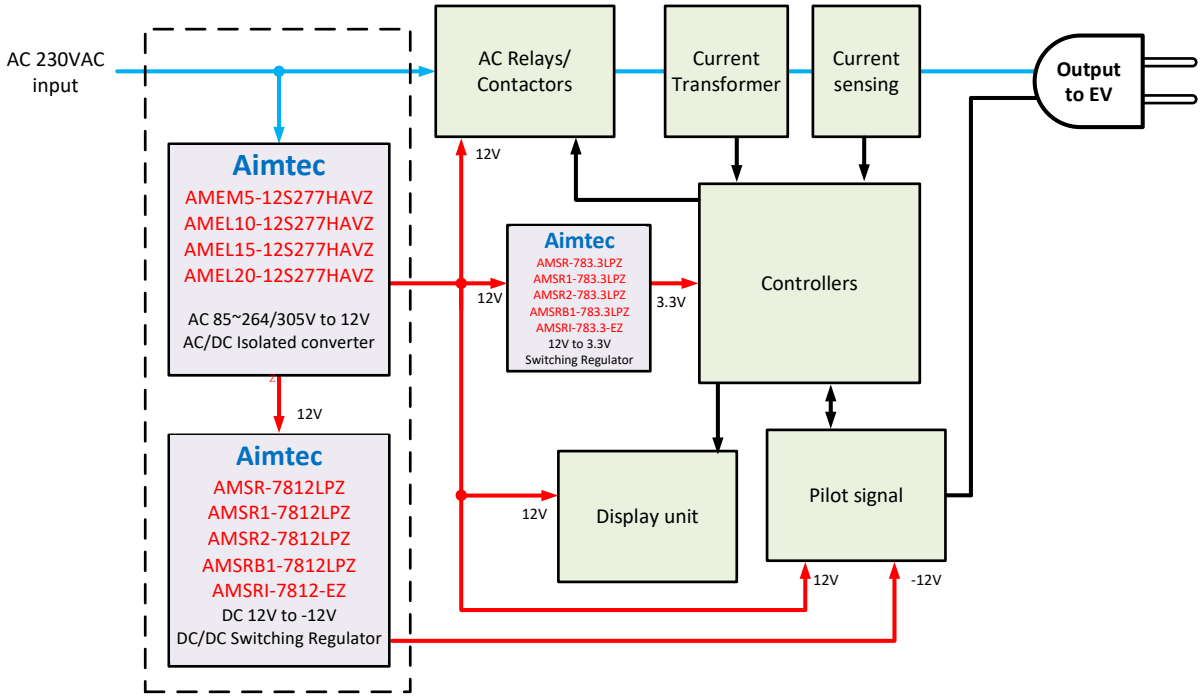


Figure 1. Portable AC charger

AC Charging station

Below is a simplified block diagram that shows the basic construction of an AC charging station. The design uses a higher wattage AC-DC converter that can accept an input of 90 to 305VAC. As the communication device consumes more power, we added a 12V to 5V converter to power the device electronics.

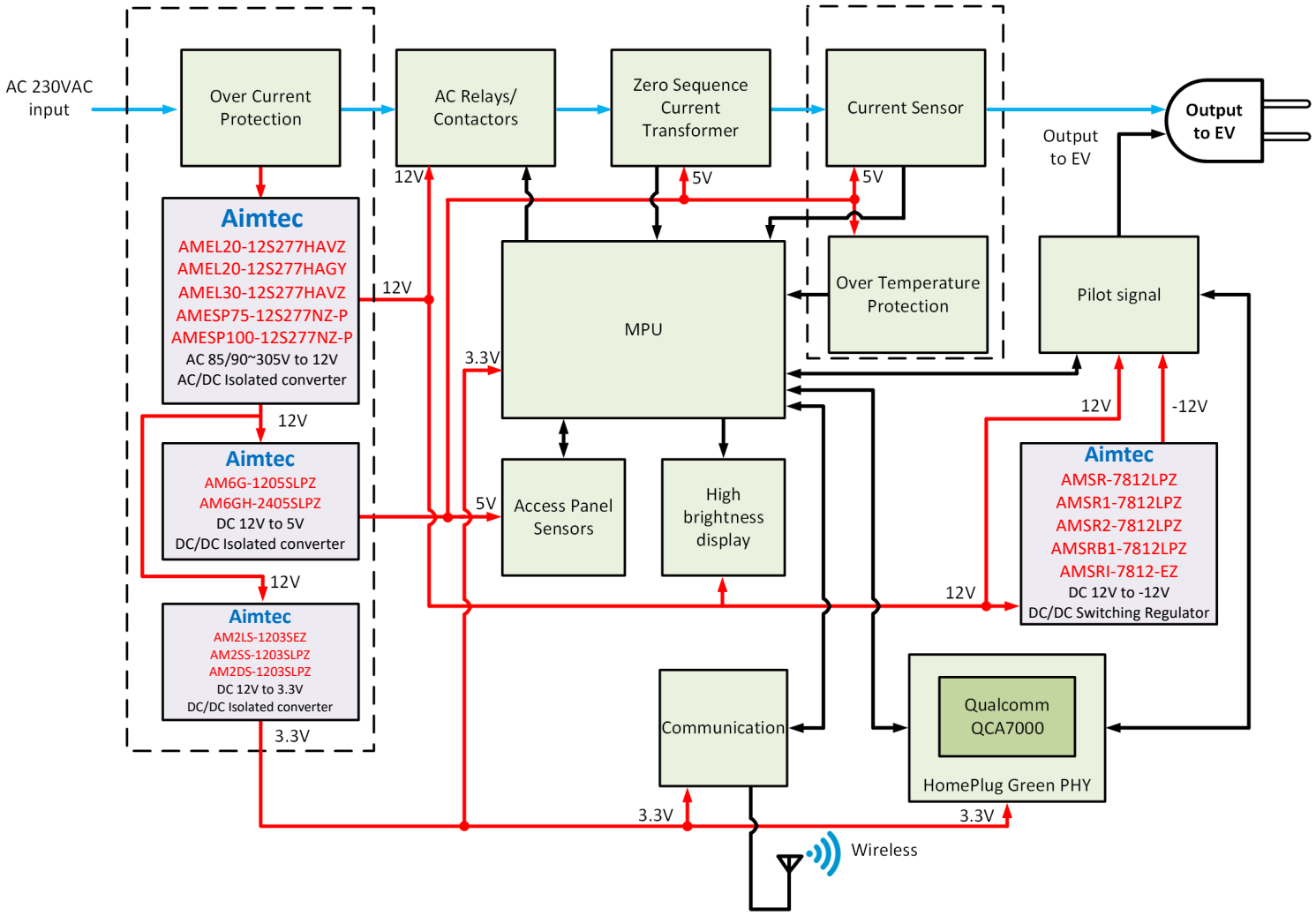


Figure 3. AC charging station

DC Charging station

The DC charging stations does not use pilot signals to communicate with the electric vehicles, thus eliminating the need for -12V converters. Instead, it relies on a more complicated CAN bus communication, therefore an additional isolated 5V DC-DC converter is used to ensure the quality of the CAN bus commutation.
The power rating for DC charging stations can be over 100kW, hence more protective devices are required and a higher power rated AC-DC converter is recommended. Typical DC charging station use a resonance circuit to bring the output voltage to the desired level and is usually done by IGBTs. Aimtec's isolated dual asymmetrical IGBT drivers can be utilized to generate the required positive and negative voltages to drive the IGBTs while providing an extra layer of protection. The below block diagram provides an overview of a DC charging station.

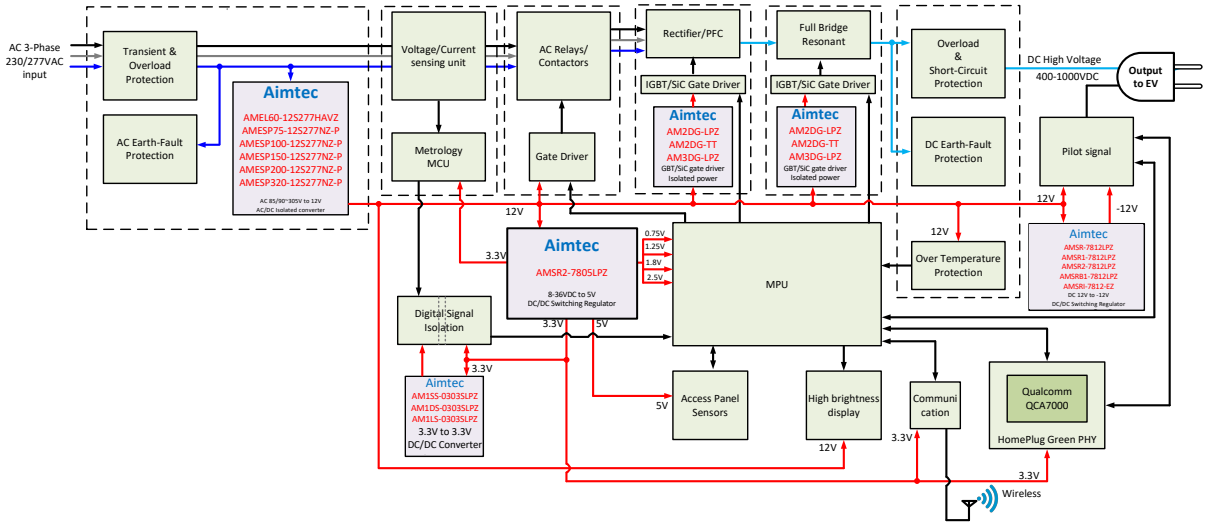


Figure 4. DC charging station - CCS

SAE J2931 requires that all DC chargers with CCS plug uses HomePlug Green PHY for high level communication. It uses the same pin as the control pilot signal, so it is backward compatible. The HPGP features higher data rate than CAN bus and is capable of transmitting more information like payment and billing information. As it is designed for smart grid and smart appliance, the HPGP is compatible with HomePlug AV, HomePlug AV2 and IEEE 1901 specification. This allows higher degree of integration with other smart devices like smart meter and realize smart building. The below block diagram provides a DC charging station with integrated HomePlug Green PHY solution.

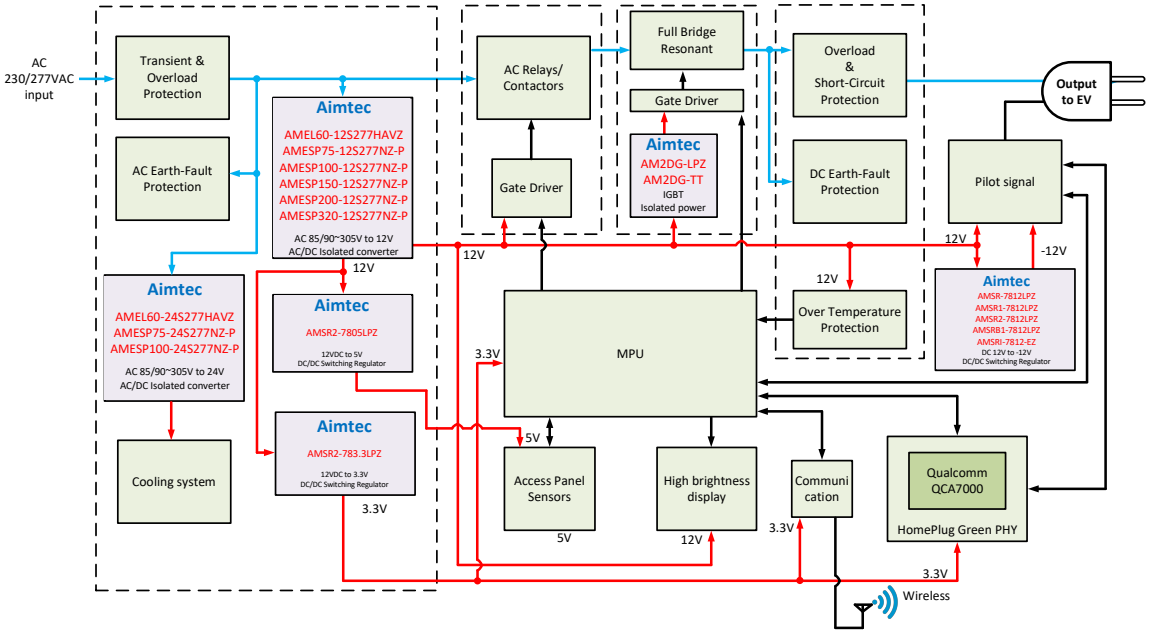


Figure 5. DC charging station with HPGP

Aimtec AC/DC Converters

Aimtec Series	Power (W)	Input (VDC)	Single Output (VDC)	Triple Output (VDC)	Operating Temperature (°C)	Isolation I/O (VDC)
AMEM3-277HAVZ	3W	85-305	3.3, 5, 9, 12, 15, 24	-	-40 to +85	4KVAC
AMEM5-277HAVZ	5W	85-305	3.3, 5, 9, 12, 15, 24	-	-40 to +85	4KVAC
AMEL10-277HAVZ	10W	85-305	3.3, 5, 9, 12, 15, 24	-	-40 to +85	4KVAC
AMEL15-277HAVZ	15W	85-305	3.3, 5, 9, 12, 15, 24	-	-40 to +85	4KVAC
AMEL20-277HAVZ	20W	85-305	3.3, 5, 9, 12, 15, 24	-	-40 to +85	4KVAC
AMEL20-277HAGY	20W	85-305	3.3, 5, 9, 12, 15, 24	-	-30 to +70	4KVAC
AMEL30-277HAVZ	30W	85-305	3.3, 5, 9, 12, 15, 24, 48	-	-40 to +85	4KVAC
AMEL60-277HAVZ	60W	85-305	5, 12, 15, 24, 48	-	-40 to +85	4.2KVAC
AMESP75-277NZ	75W	90-305	5, 12, 15, 24, 48	-	-25 to +70	4KVAC
AMESP100-277NZ	100W	90-305	5, 12, 15, 24, 48	-	-30 to +70	4KVAC
AMESP150-277NZ	150W	90-305	5, 7, 12, 15, 24, 27, 48	-	-30 to +70	4KVAC
AMESP200-277NZ	200W	90-305	5, 12, 15, 24, 48	-	-30 to +70	3KVAC
AMESP320-277NZ	350W	90-305	5, 12, 15, 24, 36, 48	-	-30 to +70	3KVAC

Aimtec DC/DC Converters

Aimtec Series	Power (W)	Input (VDC)	Single Output (VDC)	Dual Output (VDC)	Operating Temperature (°C)	Isolation I/O (VDC)
AM1/2S-Z	0.5W	3.3, 5, 12, 15, 24, 48	3.3, 5, 7.2, 9, 12, 15, 18, 24	-	-40 to +85	1KVDC/3KVDC
AM1DR-LPZ	1W	5, 12, 24	3.3, 5, 9, 12, 15, 24	-	-40 to +85	1.5KVDC/3KVDC
AM1DS-LPZ	1W	3.3, 5, 12, 15, 24	3.3, 5, 9, 12, 15, 24	±3.3, ±5, ±9, ±12, ±15, ±24	-40 to +105	1.5KVDC/3KVDC
AM1LR-LPZ	1W	5, 12, 15, 24	3.3, 5, 9, 12, 15, 24	-	-40 to +85	1.5KVDC/3KVDC
AM1SS-LPZ	1W	3.3, 5, 12, 15, 24	3.3, 5, 9, 12, 15, 24	-	-40 to +105	1.5KVDC
AM1DR-LPZ	1W	5, 12, 24	3.3, 5, 9, 12, 15, 24	-	-40 to +85	1.5KVDC/3KVDC
AM1PS-LPZ	1W	5, 12	3.3, 5, 9, 12, 15, 24	-	-40 to +105	1.5KVDC
AM1LS-LPZ	1W	3.3, 5, 12, 15, 24	3.3, 5, 9, 12, 15, 24	±3.3, ±5, ±9, ±12, ±15, ±24	-40 to +105	1.5KVDC/3KVDC
AM2LS-LPZ	2W	5, 12, 15, 24	5, 7, 9, 12, 15, 24	-	-40 to +105	1.5KVDC/3KVDC
AM2SS-LPZ	2W	5, 12, 24	3.3, 5, 9, 12, 15, 24	-	-40 to +105	1.5KVDC
AM2DS-LPZ	2W	3.3, 5, 12, 15, 24	3.3, 5, 9, 12, 15, 24	±3.3, ±5, ±9, ±12, ±15, ±24	-40 to +105	1.5KVDC/3KVDC
AM2DG-LPZ	2W	5, 12, 15, 24	-	+20/-4, +15/-8, +15/-8.7, ±9, +17/-8.7	-40 to +105	4KVAC
AM2DG-TT	2W	12, 15, 24	-	+12/-12, +15/-3, +15/-4, +15/-5, +15/-9, +15/-15, +16.5/-4, +17/-9, +18/-4, +18/-5, +18/-9, +20/-3.5, +20/-5	-40 to +100	5KVAC/6KVDC
AM3DG-LPZ	3W	12, 15, 24	-	+15/-2.5, +15/-3.5, +15/-4, +15/-8, +15/-8.7, +18/-3, +20/-4, +20/-5	-40 to +105	4KVAC
AM6G-LPZ	6W	5, 12, 24	3.3, 5, 9, 12, 15, 24	±5, ±12, ±15, ±24	-40 to +85	1.5KVDC
AM6GH-LPZ	6W	24, 48	3.3, 5, 6, 9, 12, 15, 24	±5, ±9, ±12, ±15, ±24	-40 to +85	1.5KVDC

Aimtec Switching Regulators

Aimtec Series	Output Current (A)	Input (VDC)	Single Output (VDC)	Operating Temperature (°C)	Isolation I/O (VDC)
AMSR-78Z	0.5A	4.75-34	1.5, 1.8, 2.5, 3.3, 5, 6.5, 7.2, 9, 12, 15	-40 to +85	-
AMSR-78LPZ	0.5A	4.75-36	3.3, 5, -5, 9, 12, -12, 15, -15	-40 to +85	-
AMSROL-78EZ	0.5A	4.75-36	3.3, 5, 6.5, 9, 12, 15	-40 to +85	-
AMSRI-78-EZ	0.5A	4.75-36	3.3, -3.3, 5, -5, 9, -9, 12, -12, 15, -15	-40 to +85	-
AMSRL1-Z	1A	3-36	1.2, 1.5, 1.8, 2.5, 3.3, 5, 6.5, 9, 12, 15	-40 to +105	-
AMSRB1-78LPZ	1A	6-36	3.3, 5, -5, 6.5, 9, 12, -12, 15, -15	-40 to +85	-
AMSR1-78LPZ	1A	6-36	3.3, 5, -5, 6.5, 9, 12, -12, 15, -15	-40 to +85	-
AMSR2-78LPZ	2A	4.5-36	1.8, 2.5, 3.3, 5, 6.5, 9, 12, 15	-40 to +85	-