SWTCH Installation Technical Specifications

Communication Hardware

Table of Contents

Background Information

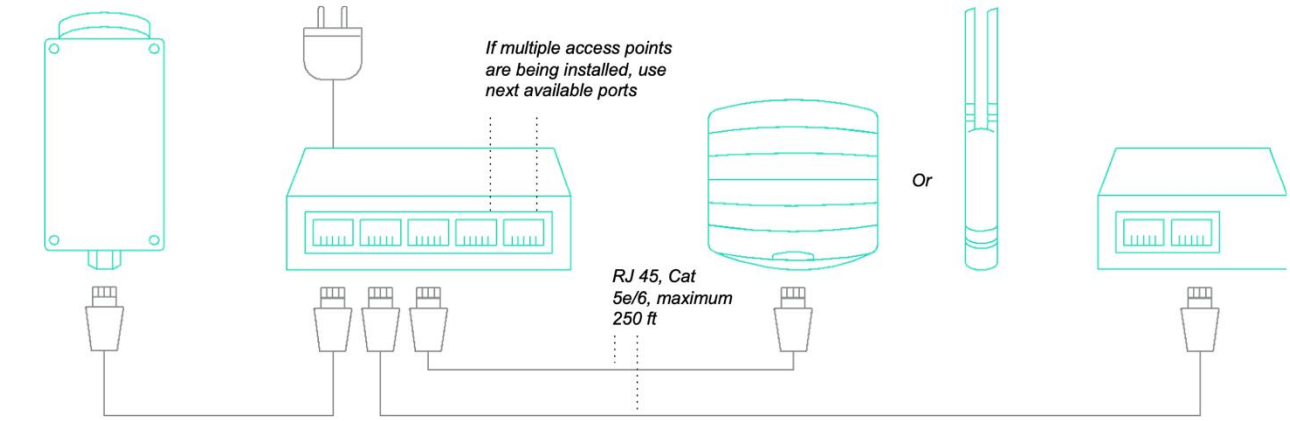
Importance of Connectivity

SWTCH's EV Charging Network has an internet-tied backbone. All connected chargers communicate on this platform and allow for simple operation, management, and troubleshooting from anywhere in the world. With that in mind, all connected chargers must possess a strong network connection, whether that be via cellular, direct-connect ethernet, or wireless connection. A strong connection is vital to network performance and the exceptional uptime our platform currently provides when compared to other industry providers.

Power Outages or Loss of Connection

Although the Communication installations are robust, SWTCH cannot control external factors that result in power loss situations. In the event of a power failure, the charger will terminate the existing charging session. In the event of a loss of connection (Communication failure), the chargers are programmed locally to reduce to a "Fallback Limit." This fallback limit ensures that all load management functionality and safety is maintained even when the chargers are unable to communicate with the network platform.

SWTCH Communication Components



Cellular Gateway
located in an area with greater than or equal to -85 dBm LTE signal

POE Switch
located at 120V source

Wireless Access Point
located within 80 ft line-of-sight of chargers

Cloud Controller
(ONLY for installations with more than 10 Wireless Access Points)

Cellular Gateway

Indoor Installations

The purpose of the Cellular Gateway is to connect the system to the local cellular provider (AT&T, Verizon, T-Mobile, Bell, Rogers, etc). The Cellular Gateway is to be installed in a secure location with stable cellular connection, on the building exterior. The distance of the run from the Cellular Gateway to the POE switch is up to 250 feet.

Outdoor Installations

The only difference in an outdoor installation is that the Cellular Gateway will additionally broadcast a local Wireless network. This allows for removal of the Wireless Access Point component. It is important to note that in order to maintain a 80 foot line of sight, additional Cellular Gateways or wireless access points may be required.

PoE Switch (Power over Ethernet)

Indoor Installations

The POE switch serves to connect all Wireless Access Points with the incoming internet connection. The POE switch also provides power to the downstream devices (Cellular Gateway, Cloud Controller, WAPs). The PoE switch is to be installed within a locked location (minimum 12x12" junction box/enclosure). The POE switch also needs access to a 120V power source. This power source also needs to be ***Locked and Secure.*** Multiple PoE Switches can be used if the distance to cover all WAPs is large. The PoE Switches would then be daisy chained with a CAT6 cable, each with their own 120V power supply.

Outdoor Installations

In an outdoor installation, the PoE Switch is no longer required. The Cellular Gateway in outdoor applications can be powered via 208V. Therefore, the POE Switch and additional components such as a wireless access point are no longer needed.

Wireless Access Points (WAPs)

Indoor Installations

For indoor installations, the wireless access points are typically installed on the ceiling. Their purpose is to distribute a Wireless signal for the chargers to connect. Generally, these WAPs need to be located within 80 feet of the nearby charging stations. Additionally, it must have a clear line-of-sight. The WAP for indoor installations has a cone shaped signal coverage. It is best to install above the chargers and a safe distance away from walls and other obstructions. For further install guidelines please refer to the contained installation recommendations.

Outdoor Installations

No longer required. See 208V Cellular Gateway for Outdoor Applications in Figure 2 on Page 9

Cloud Controller

The Cloud Controller allows the network to interface with SWTCH's backend. The Cloud Controller is to be installed within a locked location (minimum 12x12" junction box/enclosure, ideally the same location as the PoE switch) and is powered by an ethernet connection to the POE switch. The Cloud Controller is required and included in the Communication Hardware Package when the number of wireless access points exceeds 10 units per installation.

SIM Cards

Within the Cellular Gateway, a SIM card will need to be installed. This SIM card allows the Cellular Gateway to begin communicating with the cellular network provider. (ex: AT&T, Verizon, Bell, Rogers, etc.). SIM cards are typically installed prior to the installation of hardware.

Data Cables (Cat6A F/UTP)

The data cables used for installation shall be a minimum rating of Cat5e; Cat6A F/UTP is preferred. Use of Cat6A F/UTP is a design effort to mitigate internal and external noise – this is a shielded cabled.

Communication Fundamentals

Signal Strength

The signal strength is the wireless signal power level received by the wireless client. In these installations, this is the signal that is received by the charger. As part of the SWTCH final commissioning checklist, this signal strength value will be recorded. A stronger signal strength results in a more reliable connection and faster speeds. *Generally*, signal strength is represented in dBm format (0 to -100). *For signal strength, the closer the value is to 0, the stronger the signal. Example: A signal strength of -41 dBm is stronger than that of a -65 dBm.*

Noise Level

The noise level indicates the amount of background noise within the install environment. Noise can be generated by many different sources. Noise level is also measured in dBm format (0 to -100). *For Noise level, the closer the value is to 0, the greater the noise level. Negative values indicate less background noise. For example, -75 dBm is lower noise level than -20 dBm. A large negative value is desired for Noise Level.*

RF Interference

The RF interference can be caused by wireless and non-wireless devices. This RF interference can greatly impact that performance of a wireless network and drastically reduce device connection and performance. One of the ways to determine if there is large RF interference present is to conduct a RF spectrum analysis during a site walkthrough. *To optimize the performance of your wireless network, it is best to locate and avoid sources of interference prior to installations.*
Example: electrical wiring, transformers, electrical panels, lighting, garage doors, etc.

Why do these considerations matter?

If any of the above obstructions and interference sources are not considered when installing a network, the network will have been installed with the potential for the below negative impacts:

Negative Impacts:

- Reduced Data Rate Transfer
- Signal Attenuation
- Loss of data packets

All the above can ultimately lead to a complete loss of connection. Troubleshooting would then need to occur to rule out many of the above considerations. It is best practice to limit these obstructions and interferences by planning out the installation prior to installing any network hardware.

Design and Install Considerations

Physical Obstructions

Examples:

- Concrete and Masonry Walls, Pillars, and beams
- Thick Timber Walls
- Metal Walls and Beams
- Electrical equipment (Tx, panel)
- Garage doors
- Parked vehicles

Wireless Interference Sources

Examples:

- Existing Wireless Infrastructure (Nearby Access Points and Clients external to network)
- Electrical wiring
- Transformers
- Personal Hotspots
- Poorly designed wireless networks

Non-wireless Interference Sources

Examples:

- Microwave Ovens
- Security Cameras
- Zigbee Devices
- Bluetooth Devices
- Fluorescent Lighting
- Poor electrical connections

Noise Interference

Examples:

- Electromagnetic Interference
    - Proximity to copper or fiber optic wires
    - Power Lines
    - Generators
    - Large Motors
- Radiofrequency Interference
    - Unshielded copper wires
    - Cross Talk – nearby cables or conductors can trigger signals in wires within a network

Install Best Practices

Best Practices and Recommendations

Cabling

- Avoid leaving loose cables on the floor; Instead use vertical, horizontal, overhead cable managers, or conduit for protection
- Utilize proper length for networks that require patch cables
- Bundle related cables entering the enclosure utilizing Velcro-ties where reasonably needed for support and organization (every 3 feet / 1 meter)
- Include Drip Loops on all connections where moisture can collect
- For damp locations, utilize best practices including but not limited to the use of cable glands, myers hubs, drip loops, and conduit
- Include RJ45 Dust Covers for all ethernet ports not in use

Cable Testing

- Test all installed networking cable to ensure RJ45 crimping is correct and secure and all 4 pairs are terminated properly

Grounding

- Ensure the enclosure with all installed devices is properly grounded

Airflow

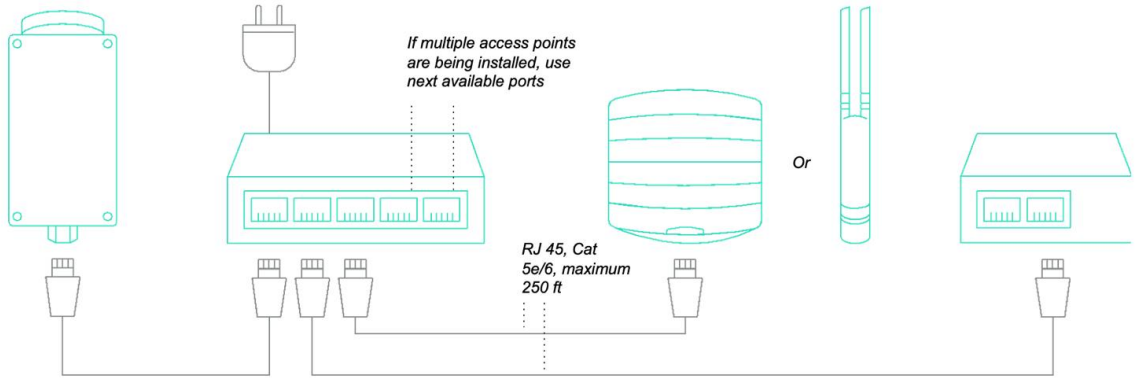
- Proper airflow through an enclosure is needed to ensure the installed equipment does not overheat
- Avoid direct covering of any openings in the enclosure via the included holes for ventilation
- Evenly space out installed equipment where applicable to ensure airflow between installed devices

Surge Protection

- Use only a surge protector/power distribution unit to connect all the internal equipment to an electrical outlet
- This will ensure the continued operation of the hardware from any potential damaging surge or outage

Install Topology

Figure 1: Indoor Communication Hardware Components



Cellular Gateway
located in an area with greater than or equal to -85 dBm LTE signal

POE Switch
located at 120V source

Wireless Access Point
located within 80 ft line-of-sight of chargers

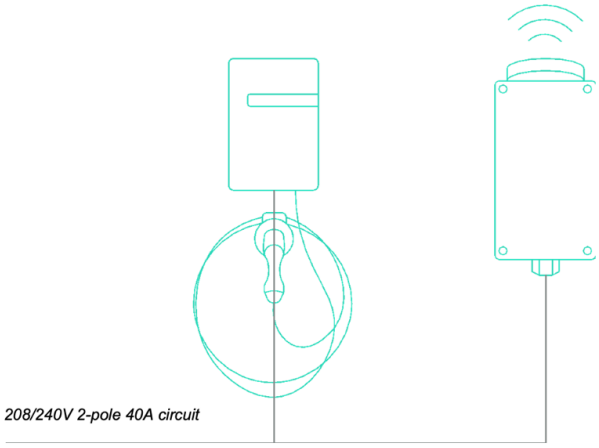
Cloud Controller
(ONLY for installations with more than 10 Wireless Access Points)

Figure 2: Outdoor Communication Hardware Components – 120V/208V/240V Cellular Gateway

Power to 120V/208V/240V Cellular Gateway to be shared with a centrally located EV charger, allowing clear signal to all charging stations.

- In 120V applications, a wall outlet is required to power the POE Switch and Gateway

- In 208/240V applications, the Gateway can be powered directly via the EVSE feeder using a Polaris connector or other industry approved equivalent



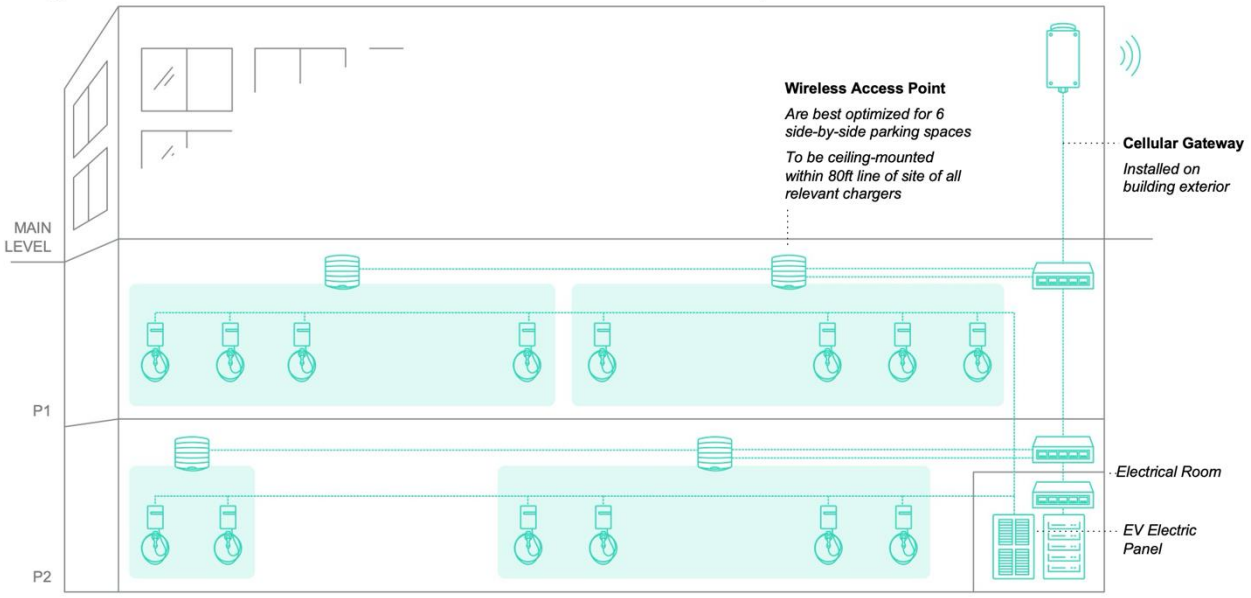
Install Guidelines

INDOOR SETUPS

1. **Identify the optimal location for the Cellular Gateway**
    a. Utilizing a cellular device, determine the signal strength expressed in decibels (dBm). This reading should be taken near the proposed/optimal location of the Cellular Gateway.
        i. iPhone Users
            1. Turn off your device Wireless
            2. Dial *3001#12345#* and press call
            3. Select the menu button (3 horizontal lines)
            4. Underneath RAT, select "Serving Cell Info"
            5. Record the reported value for "RSRP"
        ii. Android Users
            1. The methods for android users can differ from device to device. Please try the below sequences:
                a. Enter Settings > About Phone > Status or Network > Signal Strength or Network Type and Strength
                b. Enter Settings > More Options or More Settings > About Phone > Mobile Networks > Signal Strength
            2. If you are unable to determine your device's signal strength using the instructions above, download the mobile app called Network Cell Info Lite
    b. Using one of the above methods, ensure the recorded value results in a signal strength greater than -90 dBm on the network for a continuous 5-minute period
        i. **Note:** *For Rogers and Telus network devices – they will not measure the signal strength correctly, and therefore cannot be used.*
    c. For more advanced and accurate readings, an Octopus LTE Meter can be used
2. **Install the PoE Switch in the Electrical/Communications Room**
    a. Ensure the PoE switch and other hardware are installed within a locked junction box or enclosure; the power source should also be inside the junction box or enclosure **locked and secure**
    b. Plug the PoE switch into a 120V power source
        i. Ensure the power light on the PoE switch lights up
3. **Install the Cellular Gateway**
    a. Install the Cellular Gateway in the previously determined optimal location after having verified the signal strength meets SWTCH requirement
    b. Run a ***CAT-6A F/UTP*** cable from the PoE switch to the Cellular Gateway within conduit. This will provide power to the Cellular Gateway. For the RJ45 connections, SWTCH utilizes the RJ45 Pinout T-568B standard. A diagram of this standard can be found under the SWTCH Communication Components section of this guide
        i. Note: The Cellular Gateway can be placed up to 250 feet ethernet length away from the junction box/enclosure. If this occurs, the Cellular Gateway will not transmit data.
    c. Consult the **SWTCH Deployment Team (844) 798-2438 ext. 3** once the connectors have been landed to the PoE switch and Cellular Gateway. The deployment team will complete a final verification of the LTE signal strength and confirm the installation
4. **Install the Wireless Access Points**
    a. Ensure the optimal location of the Wireless access points (WAPs) considering all design and install factors. The WAPs must be located within 80 feet of the EV charging stations AND have a direct unobstructed line-of-sight.

b. Connect one end of the Cat6A F/UTP RJ45 cable to an open PoE port in the PoE switch, and the other end into the WAP. This connection also serves to power the WAP.
c. Confirm the access point has powered on and is showing a steady green light
d. Using your cellular device, open your Wireless settings and verify the Wireless network is being broadcast (**Network SSID: SWTCH**)
e. Verify that the EV charging station is connected to the Wireless network broadcasted by the WAP. If it is connected, there will be a triangle displayed on the EV charger display screen.
f. See below sample indoor installation

Figure 3: Indoor Installation Example



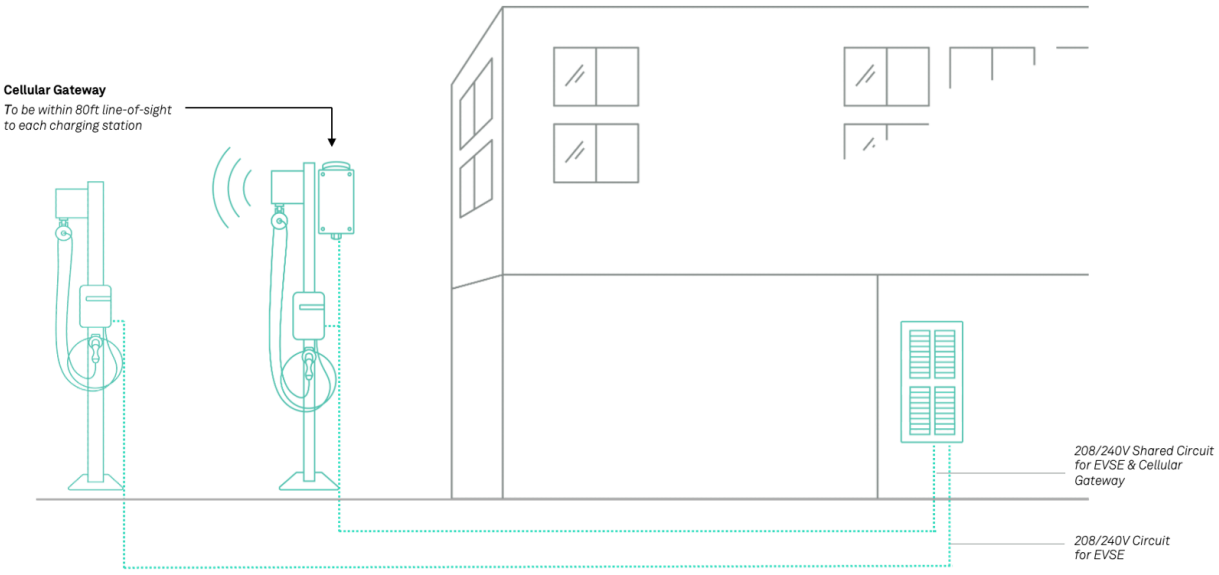
5. **Install the Cloud Controller (only for installations with 10+ Access Points)**
   a. Install the Cloud Controller within the locked junction box or enclosure
   b. Connect one end of the Cat6A F/UTP RJ45 cable to an open PoE port in the PoE switch, and the other end into the Cloud Controller. This connection also serves to power the Cloud Controller.

OUTDOOR SETUPS

Pedestal Mount

1. **Mount the 208/240V Cellular Gateway to the centermost pedestal in the system.**
    a. This will allow for the best system coverage
2. **Connect the Cellular Gateway to the EVSE feeder circuit using a Polaris Connector or other industry approved equivalent.**
    a. This connection is typically installed inside the pedestal near the access plate.
    b. Consult the **SWTCH Deployment Team (844) 798-2438 ext. 3** once the cellular gateway has been connected and powered on. The deployment team will complete a final verification of the LTE signal strength and confirm the installation.
3. **See below sample (Note: The 208V cellular gateway does NOT require its own circuit)**

Figure 4: Outdoor Communication Install Specification



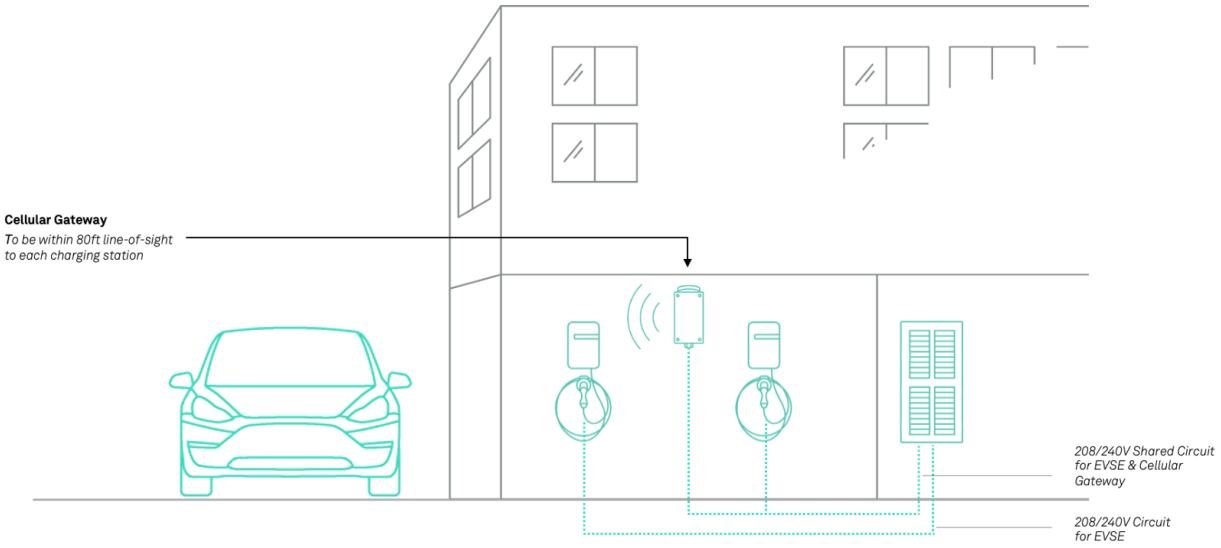
Notes:

- Cellular gateway mounted to pedestal (centermost is desired)
- Cellular gateway mounted at the top of pedestal
- Cellular gateway within 80ft line-of-sight to each charging station

Wall Mount

1. **Mount the 208/240V Cellular Gateway on the wall closest to the EV charging stations**
    a. This will allow for the best system coverage.
2. **Connect the Cellular Gateway to the EVSE feeder circuit using a Polaris Connector or other industry approved equivalent.**
    a. This connection is typically installed inside a small junction box mounted on the wall near the EVSE.
    b. Consult the **SWTCH Deployment Team (844) 798-2438 ext. 3** once the cellular gateway has been connected and powered on. The deployment team will complete a final verification of the LTE signal strength and confirm the installation.
3. **See below sample layout.**

Figure 5: Outdoor Communication Install Specification



Notes:

- Cellular gateway mounted to wall (closest to stations is desired)
- Cellular gateway within 80ft line-of-sight to each charging station

Thank you for working with the SWTCH team to ensure reliable connectivity of SWTCH's EV Charging Management System!

Should you need any additional support during this process, please contact SWTCH Deployment Team at deployment@swtchenergy.com or 1-844-798-2438 ext 3.