

SECTION 5: Electrical

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Control Modules — Red Area

Do not install any components into the control modules or module harness. Connecting into this system may affect control module operation. For example, connecting aftermarket electrical equipment into the brake light circuit or any other circuit which is connected to the PCM, anti-lock brake computer, air bag system or any other vehicle system will cause vehicle malfunction.

Controller Area Network (CAN) Bus

NOTICE:

Wiring faults in the CAN bus may shut down the vehicle and prevent further operation.

Do not splice or connect any equipment to the CAN bus wiring.

General Guidelines

- Do not modify the cooling system. High voltage vehicle components may be damaged if any cooling system modifications are attempted.
- Do not backprobe, splice or repair the high voltage system (orange) wiring/cables.
- Do not mount to or modify the high voltage system (orange) wiring/cables in any way.
- Do not cut, weld or screw into the HVTB case or penetrate the batteries in any way.
- Air bag restraint systems must remain intact as received from Ford Motor Company. Before modifications are done to the vehicle, the system must be depowered by following the instructions provided in the current Workshop Manual.
- Provide circuit protection (fuses) for all wiring. The fuse rating should not exceed either the rated wiring current capacity or the total current requirements for all the add-on components on the circuit. Install fuses as close to the point of tapped power as possible.
- Provide protective covering in all areas that could be damaged during normal equipment installations.
- Do not allow control panels attached to the instrument panel to protrude into the driver and passenger air bag deployment zones. For additional information, refer to Section 4: Reference in this guide.
- Do not install switches and gauges in the driver or passenger knee impact areas.
- Provide adequate retention for wiring harnesses so they are clear of bolts, corners or edges which could abrade the wires during normal vehicle operation.
- Properly secure all wiring relocated or removed while working behind the instrument panel to prevent chafing, squeaks and rattles.
- Anticipate misrouted wiring situations and protect all wiring from penetration by screws and raw edges.
- Weather-seal all electrical connectors exposed to the elements.
- Do not use quick splice connectors or wire nuts.
- Install the fuse panel so fuses are readily accessible.
- Make sure that connections are easily accessible for assembly and service.
- Inspect all Ford gauges, lights and switches for correct operation after instrument panel work is performed.
- Make sure submersible connectors do not lose their seals under extreme assembly conditions such as bending wires 90 degrees immediately after the connector.
- Whenever using connectors, use a socket (female) connector on the electrical source side and a plug (male) connector on the electrical load side to reduce the possibility of a short circuit when disconnected.
- Adherence to the above guidelines is not to be construed as approval by Ford Motor Company of any specific revisions or additions to the vehicles original electrical system.
- Document all revisions to the electrical system and place with the vehicle Owner's Literature. Color code and/or label all revisions or additions to wiring.
- Disconnect the negative battery cable of vehicles stored on-site to reduce the possibility of draining the battery by lights or other equipment.

Equipment Grounding Guidelines

- Do not ground the body to the transmission or transmission crossmember. Ground accessories to the chassis or the vehicle battery.
- Splicing into circuitry relating to the electronic engine and/or transmission control systems is not acceptable because of the adverse effect on the electronic system operation.
- Adequately protect electrical connections exposed to the elements.

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Wire Insulation

- Polyvinyl chloride (PVC) rated at 90°C (194°F) is the standard wire insulation acceptable for inside body use but is not acceptable for underhood/underbody wiring.
- Hypalon insulation should be used on links only (Ford specification ESB-M1L54-A).
- Cross-linked polyethylene (XLPE or SXL) rated at 125°C (257°F) is the required insulation for underhood/underbody applications (Ford specification ESB-M1L123-A).
- GXL can be used as an alternate wire (Ford specification ESB-M7L85B) as long as the concentricity specifications are met. To provide a water-resistant seal in conjunction with crimp connectors, a Duraseal® crimp connector is recommended since it is designed to account for outside wire diameter that is smaller than the present SXL wire.

Terminals and Connectors

Connector Types:

- Submersible (sealed) — A connector that is capable of being immersed in water.
- Weather-resistant — A connector that will retain its sealing and connection qualities while being exposed to adverse weather conditions.
- Duraseal® crimp — A supplier trade name for a sealed wiring repair or splice.

When a connection is not defined (typical situation — harness-to-harness connectors), the following suggestions should be implemented:

- Determine the connector type. If the vehicle will be located in an area exposed to water, salt accumulation and/or high temperatures (such as underhood, exterior panels and footwells), use a sealed connector. Use in-line connectors with secondary locks to prevent the terminal from being pushed out.
 - Do not use single wires smaller than 14 gauge in a 2-way or larger weather-resistant connector (the very large style), since the wire may break during disengagement.
 - Use Hypalon, XLPE or Elexar insulation in submersible connectors to maintain sealing integrity. PVC is not acceptable because its properties allow it to set in a deformed pattern, therefore compromising the integrity of the seal.
- Determine the terminal type. Base your decision on wire gauge, current carrying capacity, connector type and insulation type.
 - Use non-detent low insertion force terminals whenever possible.
 - Do not use low insertion force female terminals in weather-resistant connectors.
 - Analyze circuit requirements (signal levels, current, voltage) to determine the proper plating material (such as gold). Use of non-plated terminals is not recommended.
 - Do not use plugs to seal holes in micropin connector grommets. It is very easy to forget to insert them during manufacturing and ruin the seal. Use a grommet with only the necessary number of holes or use dummy wires at least 600 mm (24 in) long.
 - Fully align connectors prior to terminal connection — terminal cavities should have minimum tolerance to prevent terminals from floating, bending or pin push-out during mating/engagement.
 - Make sure connectors of similar type and color are identifiable to the operator to eliminate crossed connections and minimize assembly time. Avoid using similar types and colors of connectors close together.
 - Be sure that connectors have positive locking devices that allow easy installation with a low insertion force and easy removal. The connector snap should be easily felt and heard.
 - Eliminate the use of edgeboard, tang-type and molded-over connectors. The use of blade-type weather-resistant connectors is restricted to high-current applications which cannot be handled by submersible connectors.

Circuit Protection and Electrical Load

- Modification to the vehicle's existing low voltage (12 volts) wiring should be done only with caution and careful consideration of effects on the completed vehicle's electrical system. Anticipated circuitry should be studied to determine the required circuit protection and to avoid feedback loops.
- Added circuitry must be protected either by a base vehicle fuse or circuit breaker, or by a similar device supplied by the modifier.
- When adding loads to a base vehicle-protected circuit, make sure the total electrical load through the base vehicle fuse or circuit breaker is less than the devices load rating.
- Use 80% of the fuse rating to determine maximum steady state load to reduce nuisance fuse failures.
- Use 135% of the fuse rating when sizing wiring to protect the circuit in the event of an overload. Fuses will last for one hour at 135% of their rating.
 - Total current draw is the sum of the base vehicles circuit current requirement (measured with an ammeter) and the anticipated add-on component current requirements.
 - Never increase the rating of a factory installed fuse or circuit breaker.
 - If the total electrical load including additional electrical components, on any circuit, is less than the fuse protection rating or the capacity of some limiting component (switch, relay), the items to be added can be connected directly to that circuit. The headlamp switch circuits should never have additional lighting or electrical components directly connected.

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— Added devices that exceed the current capabilities of the factory-installed system are best controlled through the use of a relay or separate switch. The coil of the relay can be fed from the circuit in the factory harness (now acting as a signal circuit) with added wiring providing feeds to the added electrical device. The relay selection is important and depends on current requirements, number of cycles expected in the relay lifetime, whether the relay is to be operated intermittently or for long periods of time and whether the relay is exposed to weather conditions or is installed in a protected area. When the current requirements of a circuit exceed the capacity of an available relay, the load should be reduced or divided through the use of additional relays.

Wire Protection Requirements

General Notes

- Anticipate problems and design accordingly. Try to anticipate what could go wrong and modify your designs to address any adverse impact.
- Review all connector applications and electrical systems to determine the need for solder, grease, weather-resistant or sealed connectors. Make sure components and wire insulation are compatible with greased connectors (important for long-term durability).
- Make sure that drip loops or other means are provided to prevent water leakage into the vehicle through wiring assemblies that pass through the dash panel.
- Use greased or sealed connectors in floor pan troughs which are subject to moisture coming through the carpeting.
- Use XLPE insulation for uncovered runs that exceed 305 mm (12 in).

Electrical Protection

- Properly route wires away from noise-generating wires or components. However, if routing near noisy wires or plugging into noisy components is unavoidable, design additional protection into the harness.
- Electromagnetic interference (EMI) shielding — Consider shielding if you must route close to high-current or noisy circuits. Use shielded wire and ground one side. Seal all splices in wire assemblies that use bare coaxial shielding (braid or tape) for EMI suppression, and insulate or tape over all shielding ends that terminate near any open connectors. This prevents splice and terminal shorts to the shielding. Minimize the length of conductors which extend beyond the shield. Failure to do this reduces the effectiveness of the shield.
- Spike suppression, in general, is accomplished by connecting a diode or resistor-diode combination across the terminals of the noisy component. The diode should be sufficiently close to the component (both electrically and physically) so that inductive spikes are clamped off. Make sure the diode is connected with the proper polarity.

Proper routing and retention reduces the likelihood of chafing or pinching. When this ideal routing is unattainable, the following additional protection is needed:

Mechanical/Environmental Protection

NOTE:

This is not meant to be an all-inclusive list of methods for physically protecting the wires. There are other means of protection available that are not listed.

- Tape — Tape is the most basic means of protection. It contains the wires in a loose bundle and provides limited environmental protection. It does not protect against chafing and pinching.
- Kendall polyken fiberglass base tape (Ford specification ESB-M3G38-A) is used for engine compartment applications. This durable tape provides protection against cut-through and abrasion commonly found in underhood applications.
- Polyken 267 is a substitute tape that may be used in lower temperature areas of the engine compartment (apron area).
- Convolute — Use convolute for all underhood/underbody applications or when increased temperature, abrasion or pinch resistance is required. Convolute tubing comes in different diameters and materials to accommodate different temperature ranges and harness sizes.
- Use polyethylene convolute when abrasion is the only consideration; this convolute is adequate up to 96°C (205°F) maximum. Use nylon convolute when underhood/underbody or abrasion and temperature are considerations; nylon convolute is adequate up to 177°C (350°F) maximum.
- On all engine-mounted wiring or bend points, use vinyl tape on the outside of the convolute to prevent wiring from looping out. This tape must be able to withstand temperatures 135°C (275°F) or higher.
- Tape convolute junctions with abrasion-resistant tape (Polyken 267, fiberglass).
- Scroll — Similar to convolute, but without the ridges. Scroll is used where harness rigidity is required, especially for maintaining critical locator dimensions. Use scroll for short lengths only, as it is inflexible.

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Grommets and Sealing Requirements

Any additional wiring routed through sheet metal must pass through a grommet that both seals the opening and locates the wire(s). Two-piece grommets (rubber with plastic inserts) are recommended to facilitate installation and retention.

- Locate grommets so they are accessible for proper seating (achieved by pulling) in sheet metal holes.
- Ramp grommets at the insertion end to facilitate installation and sealing.
- Be sure the direction of the hole punch is in the direction of grommet seating and the hole is burr-free.
- Make sure the grommet molding compound adheres to the harness to prevent slippage.
- Make sure the grommet will withstand the environment (temperature, wet conditions).
- Be sure the holes are large enough to allow the installation of the harness without causing circuit damage.
- Use adhesive tape on main trunks or branches with at least a 50% overlap to prevent wicking through grommets. Be certain to diaper-wrap the takeouts.

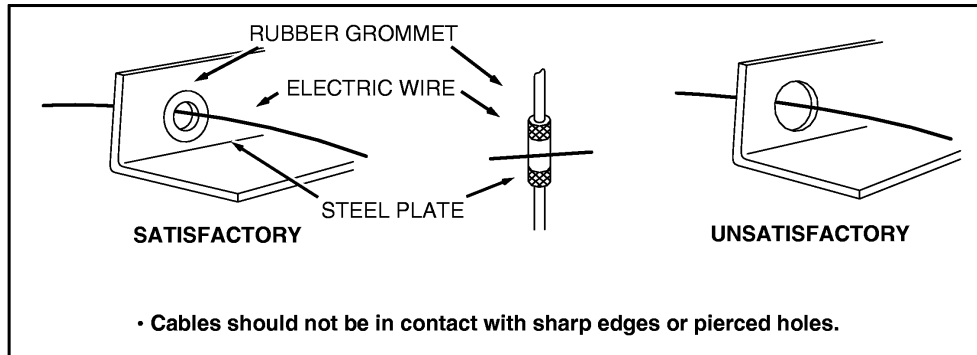
Wire Routing

⚠ WARNING:

Do not place electrical component attachments or ground screws adjacent to vehicle fuel tanks, fuel filler pipes, fuel lines, fuel vapor lines or carbon canisters. Failure to follow these instructions may result in severe personal injury in the event of a collision.

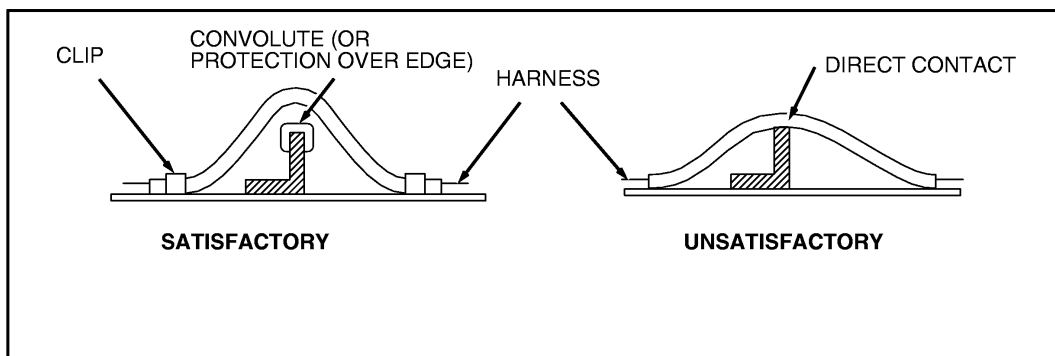
Wire harness routing should conform to the following:

- Protect wires routed through holes in sheet metal or castings with a grommet whether or not conduit is used (see figure below).



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- Route wires to avoid metal edges, screws, trim fasteners and abrasive surfaces. When such routing is not possible, use protective devices (shields, caps) to protect the wires. Cover metal edges with a protective shield and fasten the wiring within 76 mm (3 in) on each side of the edge (see figure below).



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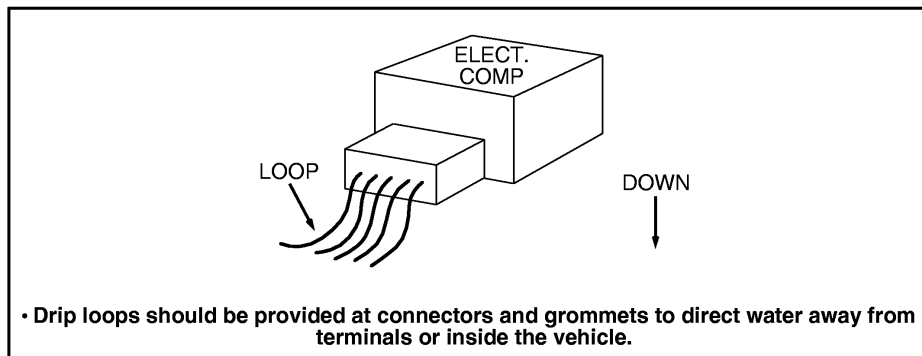
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- Route wires to provide at least 76 mm (3 in) of clearance to moving parts in their extreme movement location, unless positively fastened and protected by conduit.
- Avoid wire routing without conduit in areas where temperatures exceed 82°C (180°F). Heat insulation and heat shields must be used on the wires routed in high-temperature areas.
- Make certain that all underhood or underbody wiring is cross-linked polyethylene high-temperature insulation wire 135°C (275°F) (minimum rating) consistent with SAE specification J1128 Type SXL wire. Normal PVC wire must not be used in underhood or underbody applications.
- Make sure all ground locations are readily accessible for installation, service and verification.
- Do not place ground attachments in high splash areas.
- Underhood/underbody wiring must be routed in conduit for protection. Minimum conduit rating is 177°C (350°F).

Wire Retention and Routing

Use the following criteria to determine the location of retainers:

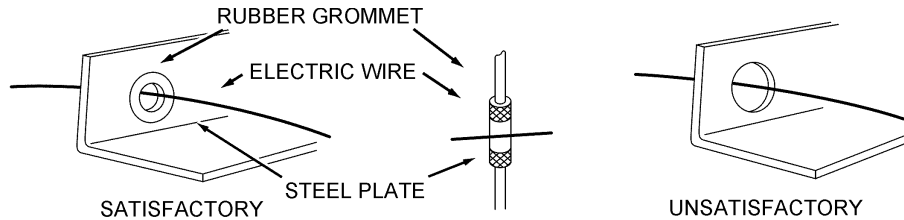
- Size and weight of wire bundle.
- Holes with poor accessibility that prevent installation of locators.
- Movement of wires that can result in abrasion, squeaks and rattles.
- When wiring is routed between 2 members where relative motion can occur, the wiring should be secured to each member with enough wire slack to allow flexing without damaging the wire.
- Wiring exposed to weather must provide a drip loop to prevent moisture from being conducted into the device through the wire connection (see figure below).



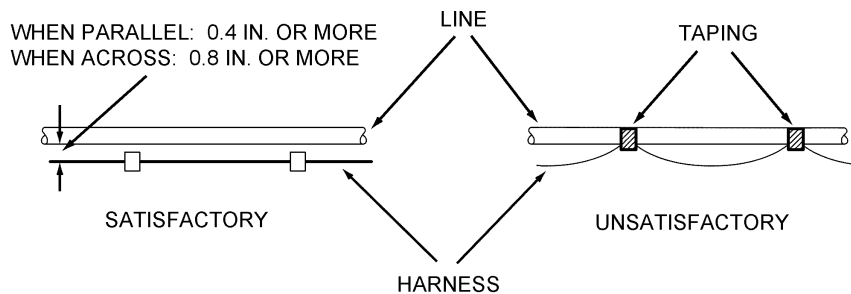
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- Avoid routing wires into areas exposed to wheel splash. When such routing cannot be avoided, adequate clipping and/or protective shields are required to protect the wires from stone and ice damage. Allow adequate slack in wiring between the engine and stationary components to compensate for engine roll.
- Avoid routing wires under the frame side members or at points lower than the bottom frame flange.
- Use plastic zip straps for bundling only (securing to other wires).
- The wire retainers and grommets installed by the assembly plant are usually designed to accommodate only the Ford-installed wires. Additional wiring or tubing should be retained by additional clips. When added wires or tubes are routed through sheet metal panels, use new holes with proper wire protection and sealing.

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- Cables should not be in contact with sharp edges or pierced holes.



- Harnesses should not be taped to fuel lines or other lines. A sufficient clearance should be maintained between harness and lines.

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For retainer screws, the following guidelines apply:

- Avoid using fasteners that are too long for the application or are in an area which might damage vehicle components, including wiring, brake lines, fuel tank and lines, powertrain components, exhaust system and suspension.
- Do not use pointed screws for attachments. Make sure that screws used in the vicinity of the wiring are blunt-ended.
- To minimize the potential for wiring shorts, do not use drill point screws. Trim components (including wiring shields) should use pin-type attachments instead of screws.
- Always check areas that screws protrude into for verification that an interference condition to other components does not exist.
- Make sure that retainers used are capable of withstanding the environment over the vehicle's life expectancy.

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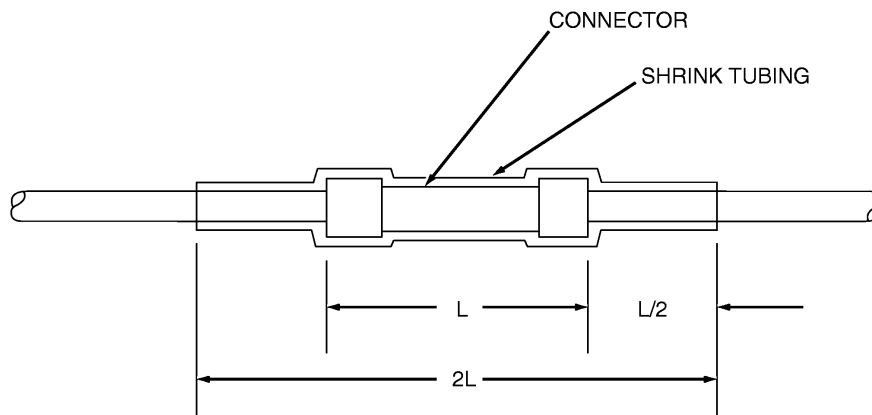
Splices and Repairs



WARNING:

Do NOT splice into or repair high voltage (orange) wiring/cables. The high voltage in this system is approximately 300 volts DC. Failure to follow these instructions may result in severe personal injury or death.

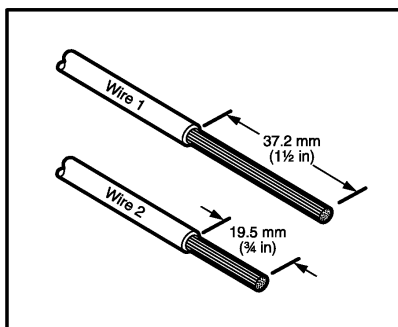
- Stagger the splices within a harness to reduce increased harness diameter. Splice only on straight areas as installed, not on bends.
- Strip wire ends, making sure that individual conductor strands are not damaged.
- When soldering, make sure an adequate mechanical joint exists before applying solder. Use only resin-core solder. Acid-core solder should not be used since it may result in corrosion.
- For crimp joints, use butt-type metal barrel fasteners and the proper tool at the appropriate setting for the wire size (such as Motorcraft® Crimp Tool S-9796) specifically designed for this type of work.
- Make sure splice joints are adequately sealed and insulated. In an outside environment, use Duraseal® butt connectors or equivalent. A durable substitute splice joint can be achieved by using a bare metal barrel, crimping, flow-soldering and covering with shrink tubing.
- Quality electrical tape can be used inside the vehicle but is not recommended for an outside environment.
- Make sure the new wire is not a lesser gauge than its original mating wire.



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Recommended Splicing Method — Solder (For 16 AWG and Smaller Diameter Wire Only)

1. Disconnect the battery ground cable.
2. Strip wires to appropriate length.



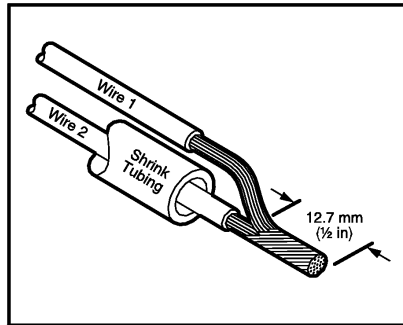
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3. Install heat shrink tubing.
4. Twist the wires together.

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5. **NOTE:**
Use resin-core mildly-activated (RMA) solder. Do not use acid-core solder.

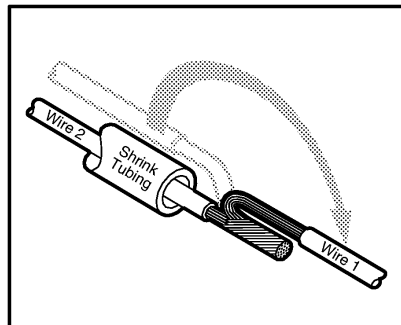
Solder wires together.



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6. **NOTE:**
Wait for solder to cool before moving wires.

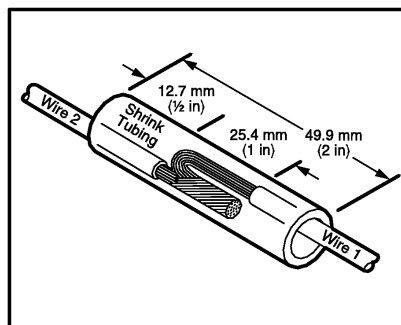
Bend wire No. 1 back in a straight line.



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7. **NOTE:**
Overlap tubing on both wires.

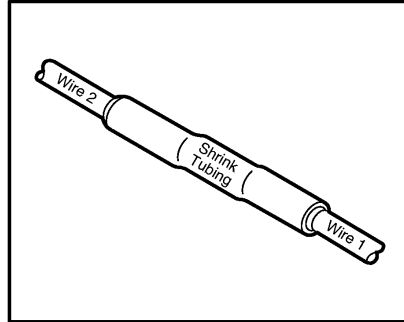
Evenly position heat shrink tubing over wire repair.



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- Use a shielded heat gun to heat the repaired area until adhesive flows out of both ends of heat shrink tubing.



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- Reconnect the battery ground cable.

Sealed Connectors

Ford Part Number	Part Name	Class
E6FZ-14488-A	Butt Connector Gauge: 18-22, Color: Red	C
E6FZ-14488-B	Butt Connector Gauge: 14-16, Color: Blue	C
E6FZ-14488-C	Butt Connector Gauge: 10-12, Color: Yellow	C

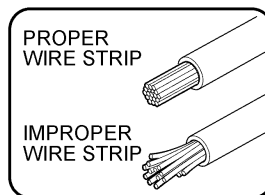
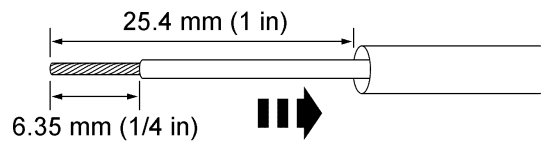
Heat Shrinkable Tubing (Heat Shrink) (Ford Specification ESB-M99D56-A2)

Heat shrinkable tubing is available in various diameters for different splice sizes and configurations. When shrunk, it forms a small, flexible hermetic seal.

Other methods (tape, PVC mold) do not provide a hermetic seal and are not recommended. Splice balancing is critical with heat shrink insulation. If the splice is extremely unbalanced (more circuits on one side than the other), heat shrink insulation will not provide a proper seal. Evaluate the use of double terminals instead of splices where practical in these situations.

Recommended Splicing Method — Crimp (For 10 - 22 AWG Diameter Wire to Like Wire Diameter)

- Disconnect the battery ground cable.
- Strip wires to appropriate length.
- Install heat shrink tubing.



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- Select the appropriate wire splice for the wires to be spliced from Rotunda Wire Splice Kit 164-R5903.

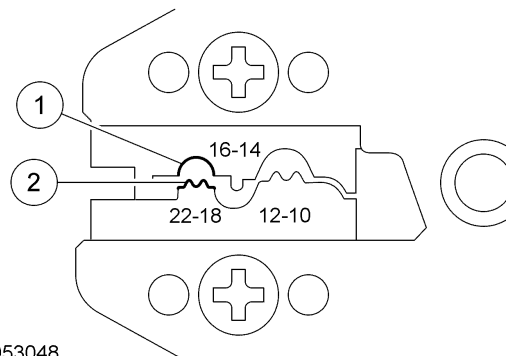
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5. **NOTE:**

Rotunda Pro-Crimper 164-R5901 supplied with the wire splice kit is the only tool that can be used with these splices.

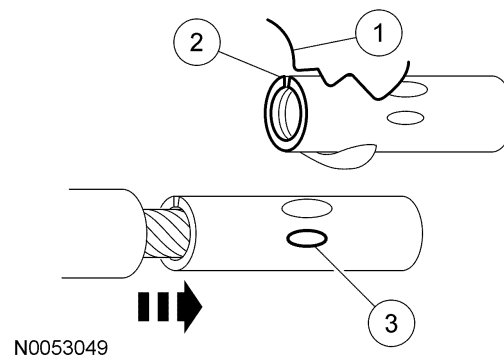
Identify the appropriate chamber on the Rotunda Pro-Crimper by matching the wire size on the dies with the wire size stamped on the butt splice.

- (1) Cavity
- (2) Indenter



6. Crimp the connector.

- (1) Center one end of the wire splice in the appropriate crimping chamber.
- (2) Insert stripped wire into the barrel.
- (3) Holding the wire in place, squeeze the tool handles until the ratchet releases.

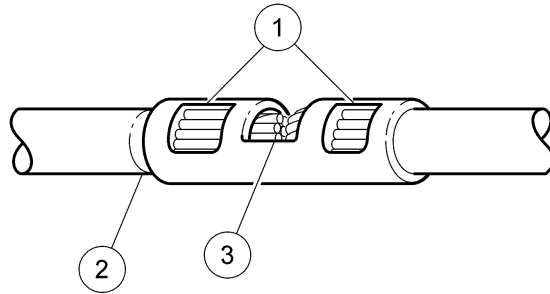


7. Repeating Step 6, crimp the other half of the splice.

8. Check for acceptable crimp.

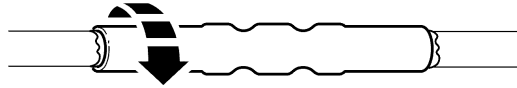
- (1) Crimp should be centered on each end of the butt splice.
- (2) Wire insulation does not enter butt splice.
- (3) Wire is visible through inspection hole of splices.

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9. Evenly position supplied heat shrink tubing over wire repair.
10. Use a shielded heat gun to heat the repaired area until adhesive flows out of both ends for the heat shrink tubing.



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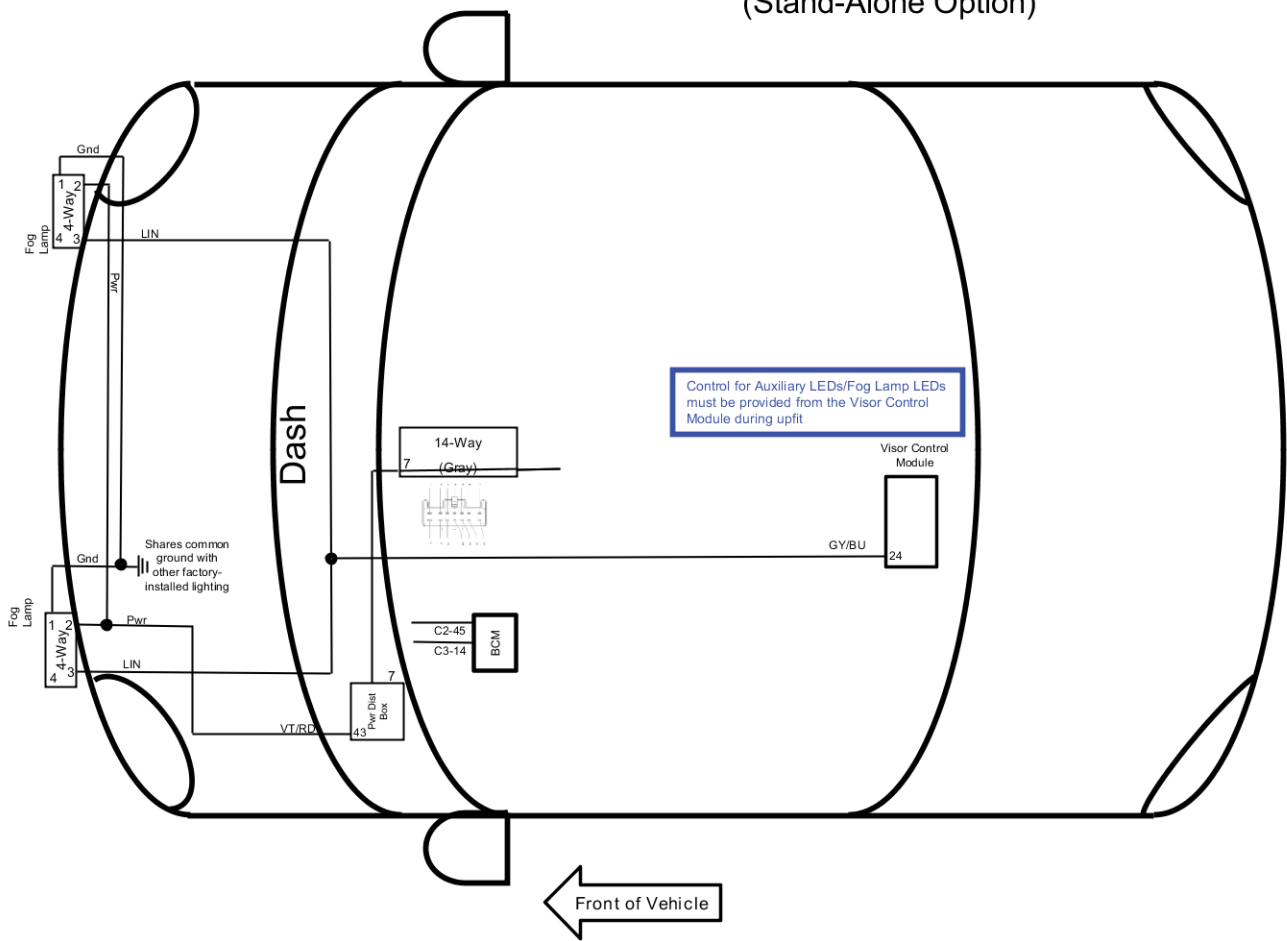
11. Reconnect the battery ground cable.

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Police Interceptor Utility — Wiring Diagram Package Options

Auxiliary/Fog Lamp LEDs (Stand-Alone Option)

2020 Utility Police Interceptor Auxiliary/Fog Lamp LEDs (Stand-Alone Option)

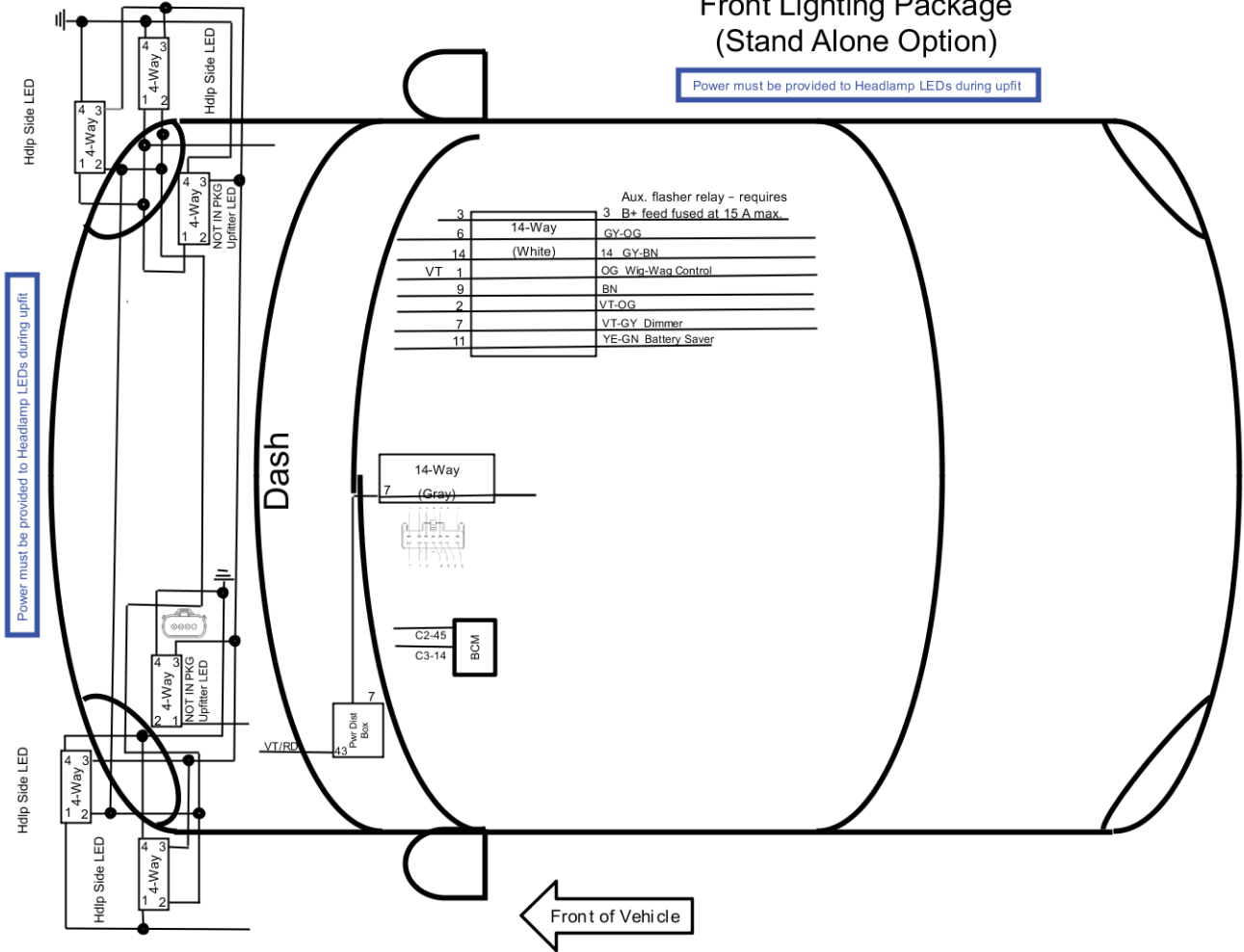


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Front Lighting Package (Stand Alone Option)

2020 Utility Police Interceptor Front Lighting Package (Stand Alone Option)

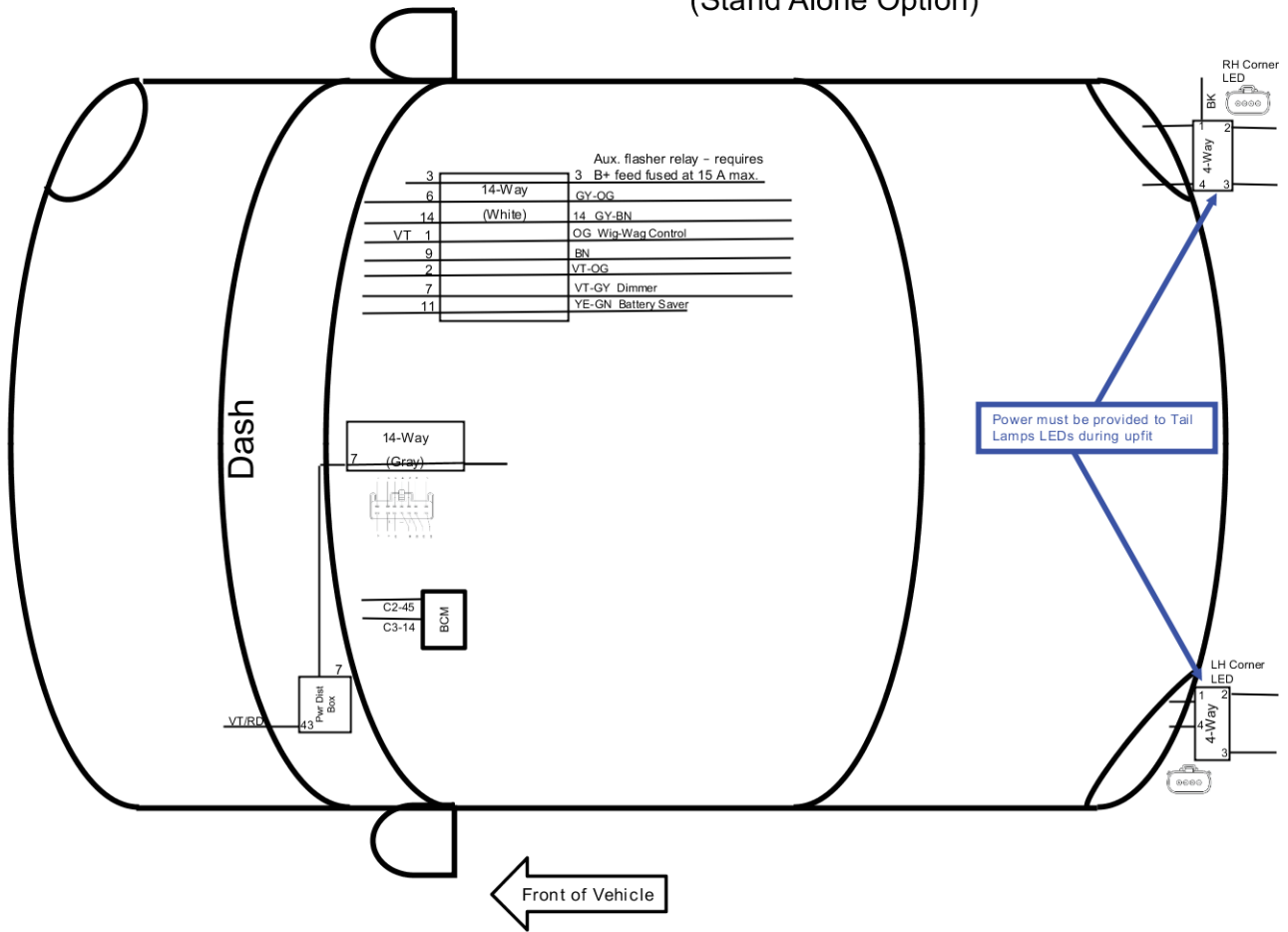


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Tail Lamp LEDs (Stand-Alone Option)

2020 Utility Police Interceptor Tail Lamp LEDs (Stand Alone Option)

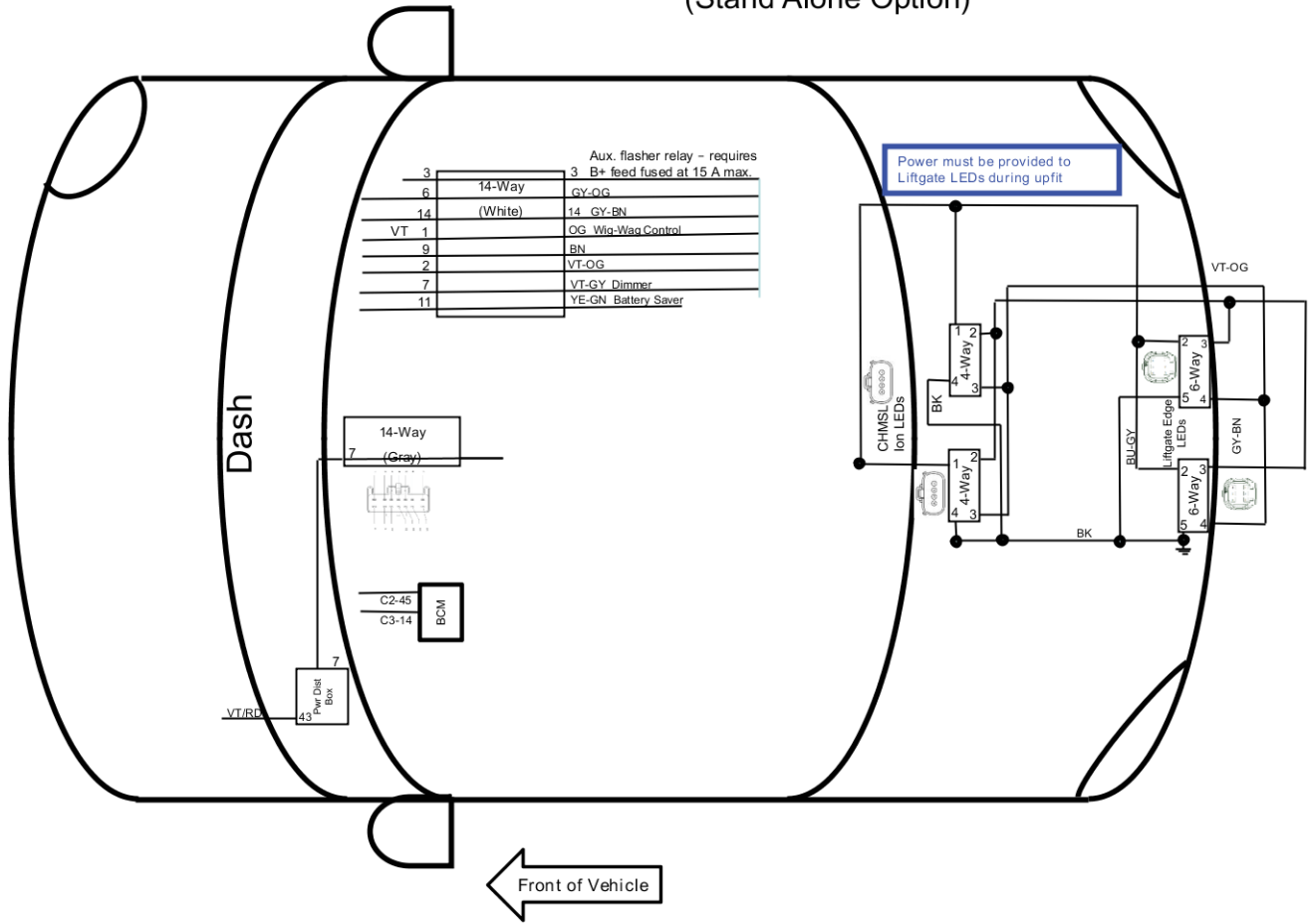


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Liftgate Lighting Package (Stand-Alone Option)

2020 Utility Police Interceptor Liftgate Lighting Package (Stand Alone Option)

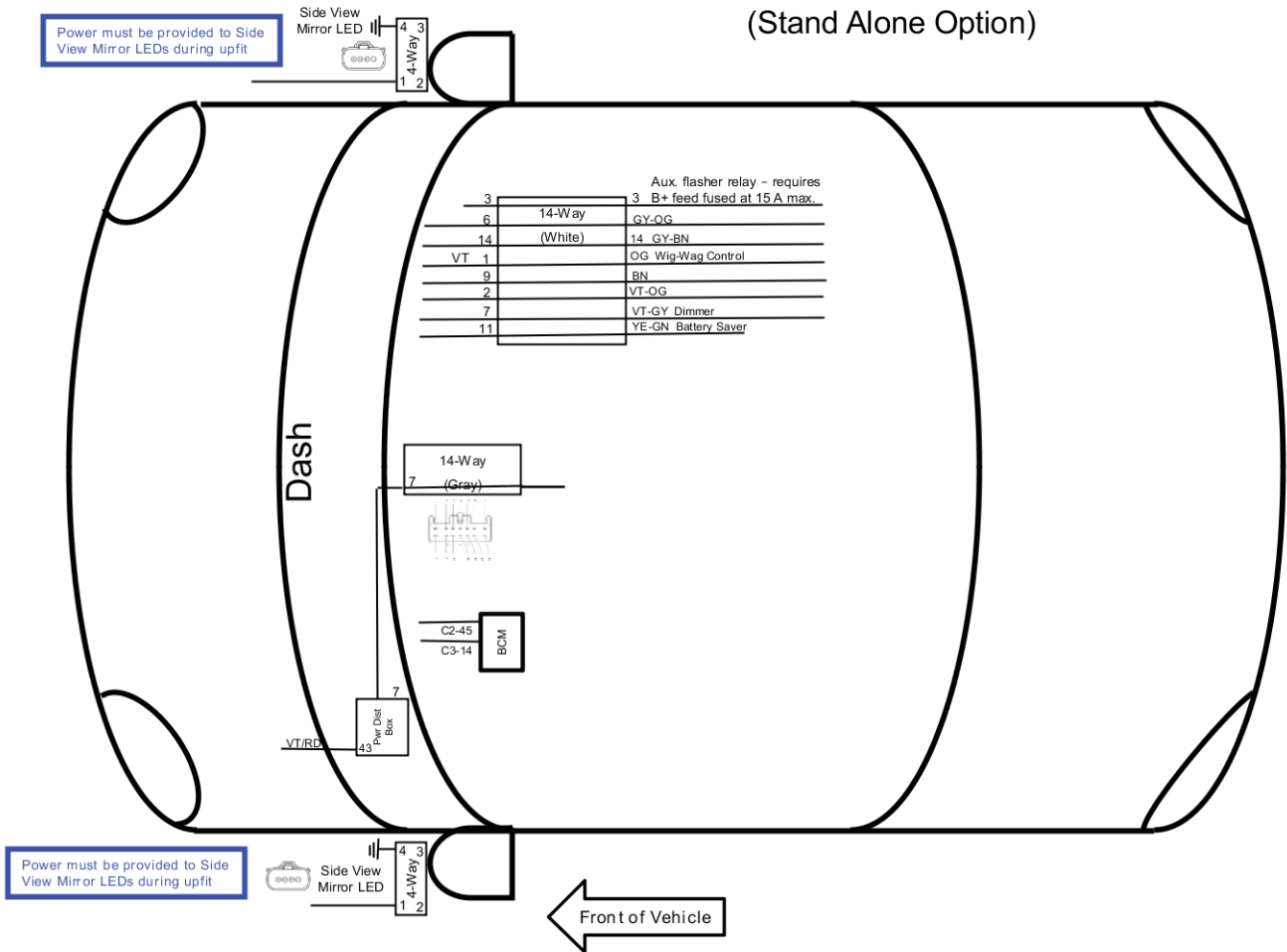


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Side View Mirror LEDs (Stand-Alone Option)

2020 Utility Police Interceptor Side View Mirror LEDs (Stand Alone Option)

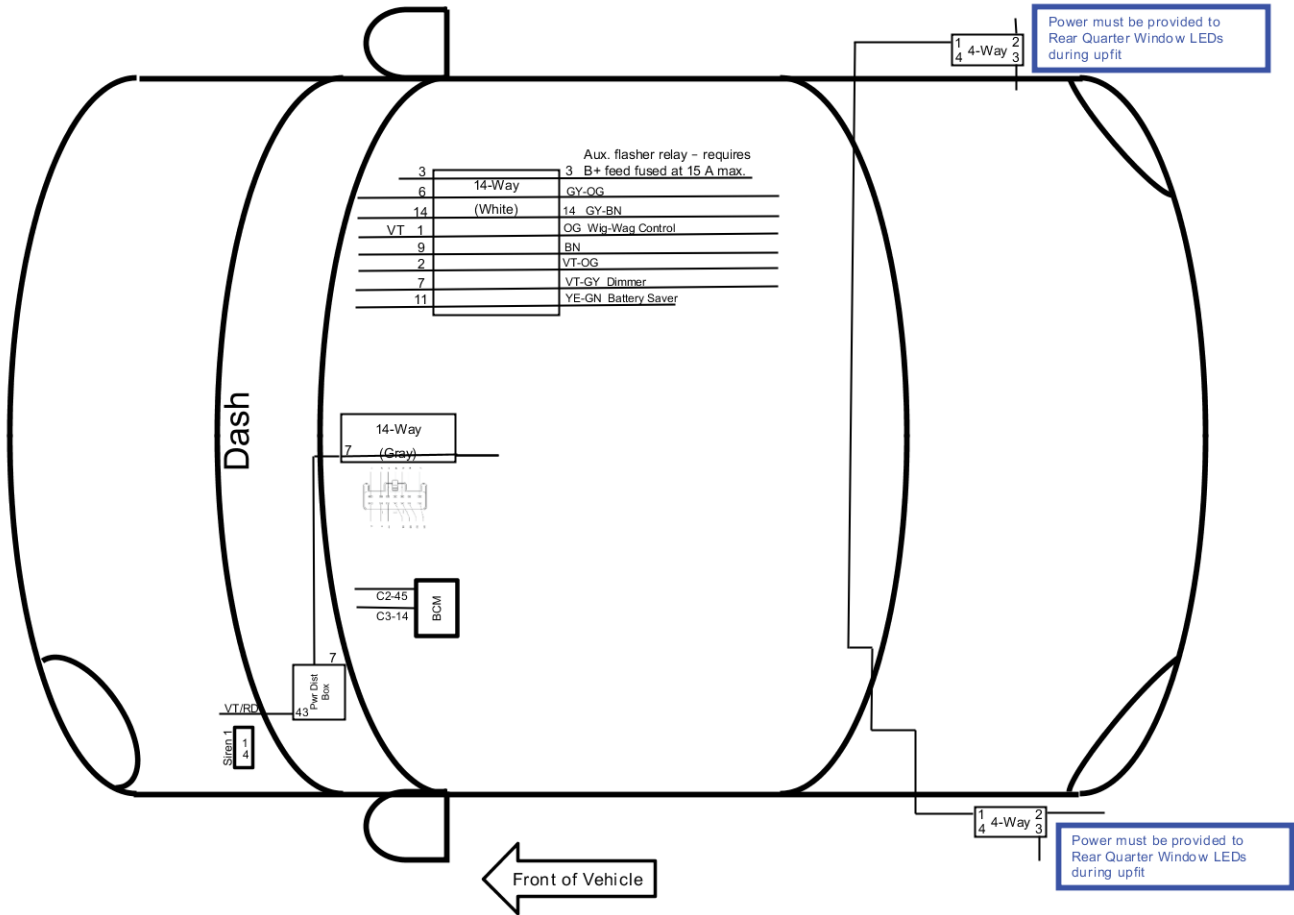


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Rear Quarter Window LEDs

2020 Utility Police Interceptor Rear Quarter Window LEDs

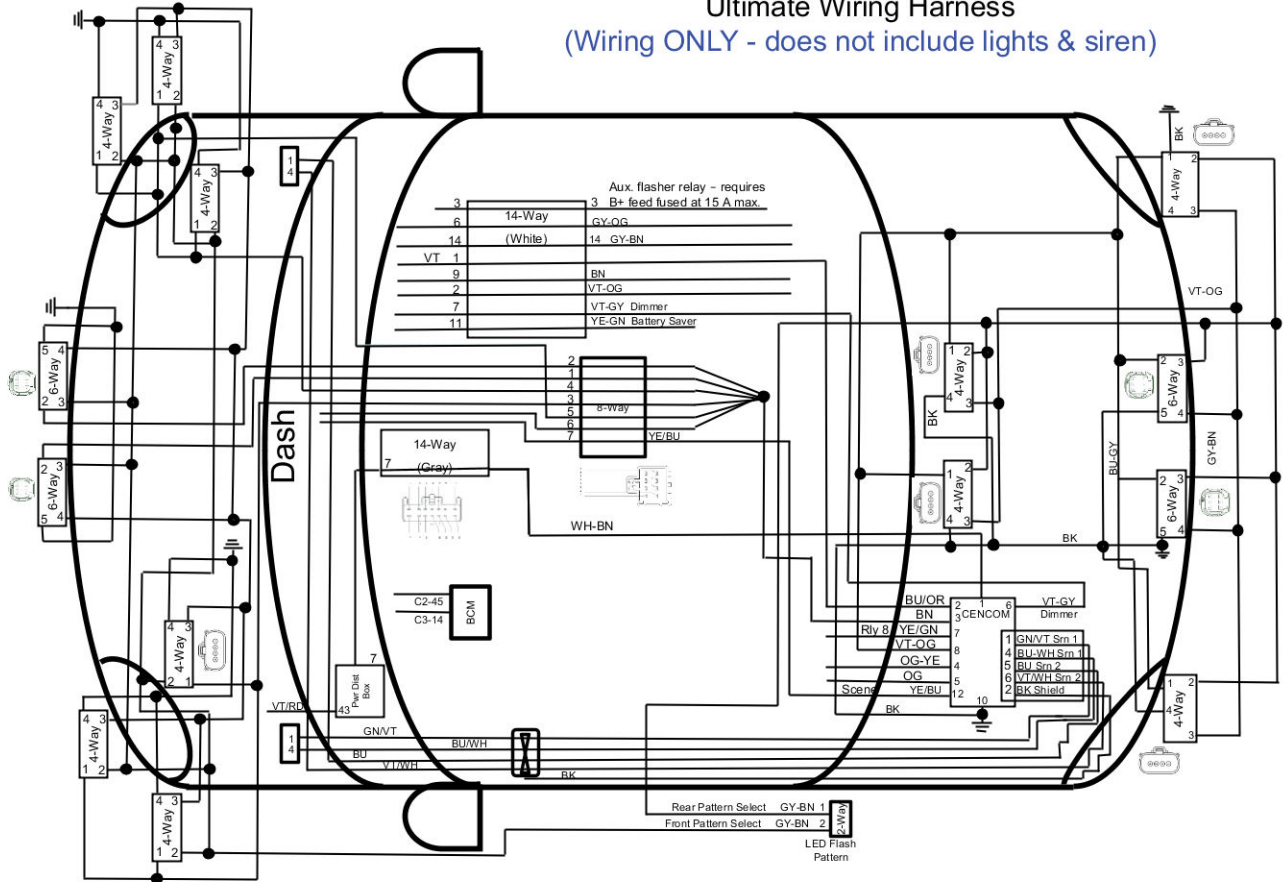


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Ultimate Wire Harness (Wiring ONLY-does not include lights and siren)

2020 Utility Police Interceptor Ultimate Wiring Harness (Wiring ONLY - does not include lights & siren)

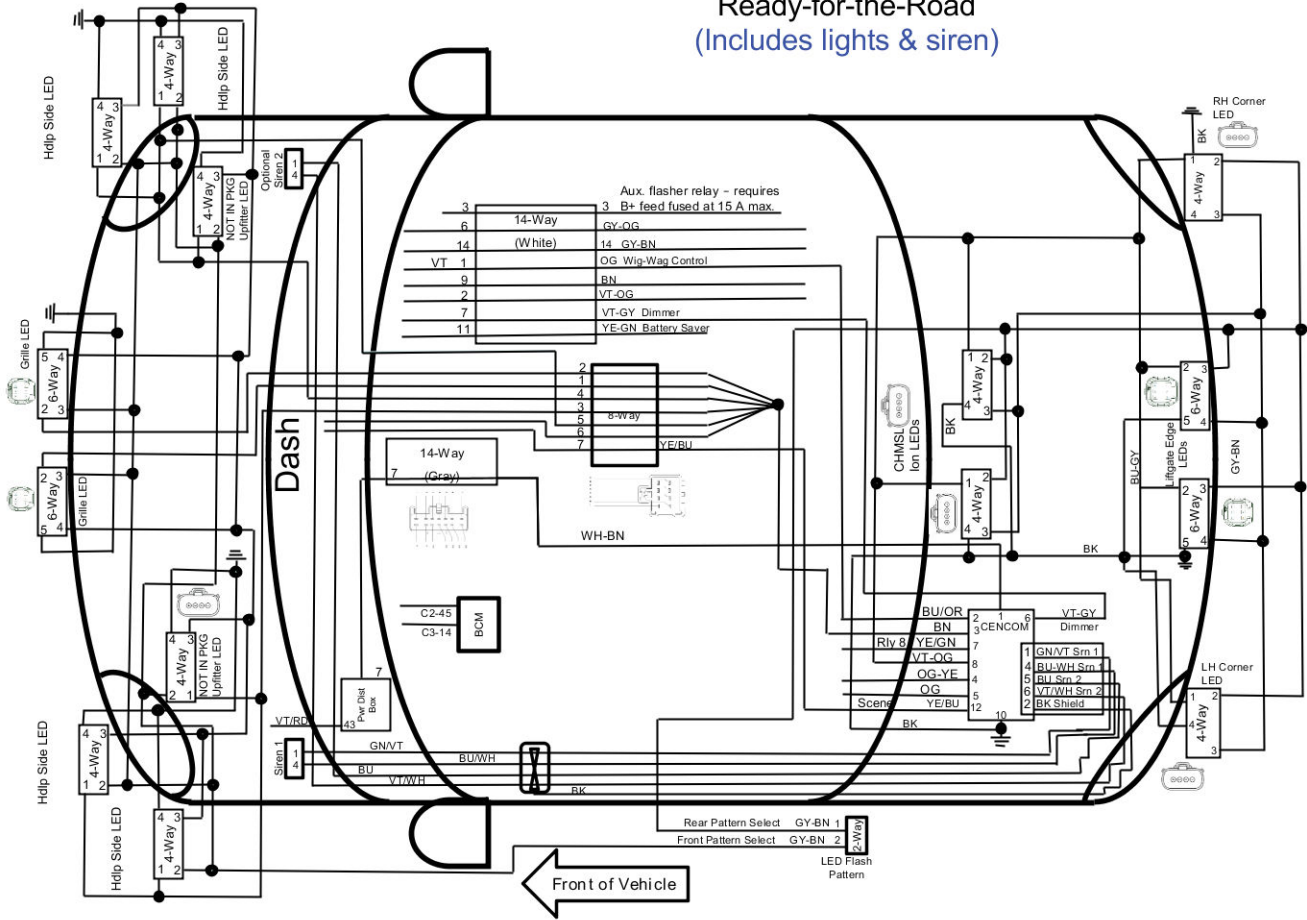


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Ready-for-the-Road (Includes lights and sirens)

2020 Utility Police Interceptor
Ready-for-the-Road
(Includes lights & siren)

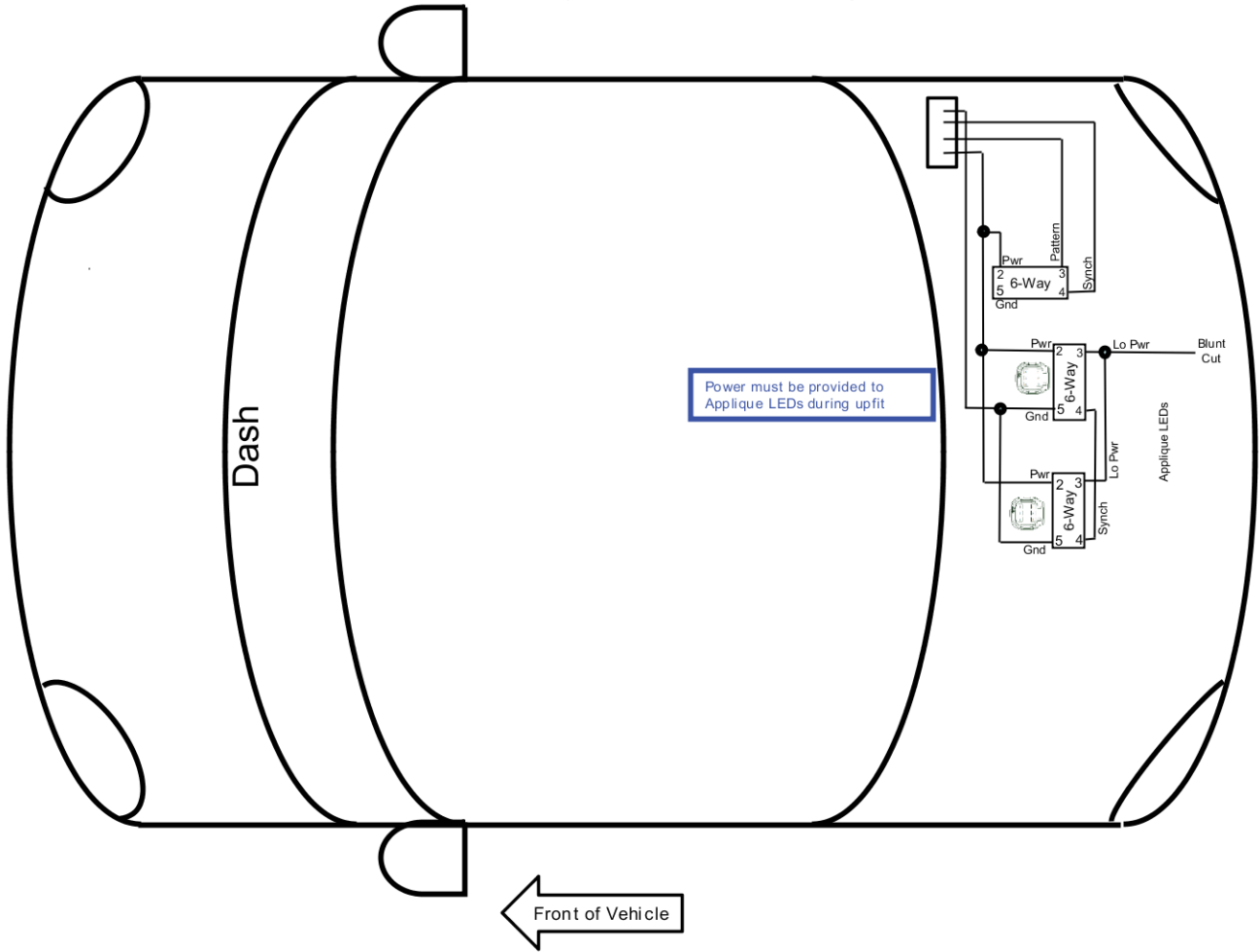


N0180356

Section 5: Electrical

Lift Gate/License Plate Applique LEDs (Stand-Alone Option)

2020 Utility Police Interceptor Lift Gate/License Plate Applique LEDs (Stand-Alone Option)

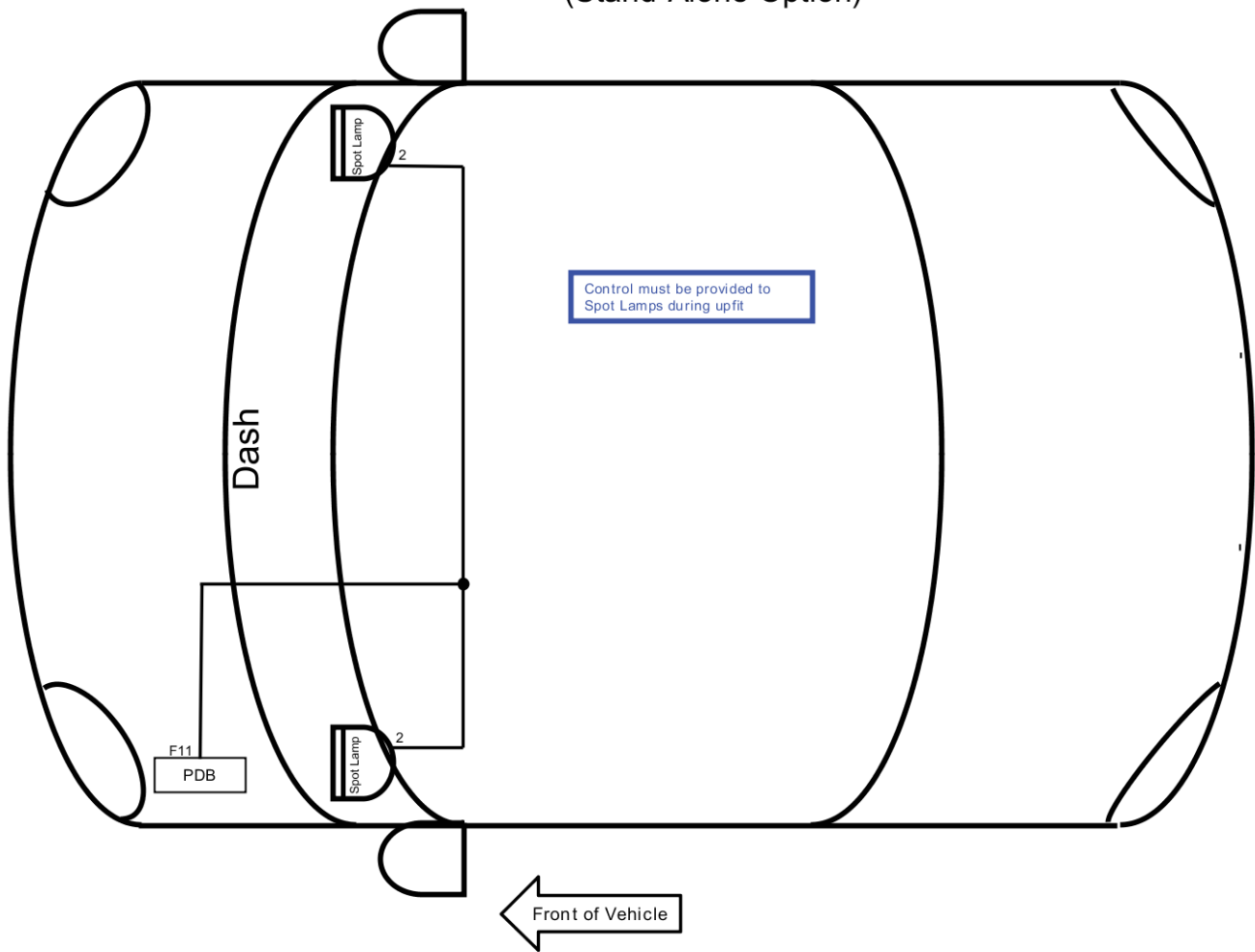


N0180357

Section 5: Electrical

Spot Lamps (Stand-Alone Option)

Spot Lamps (Stand-Alone Option)

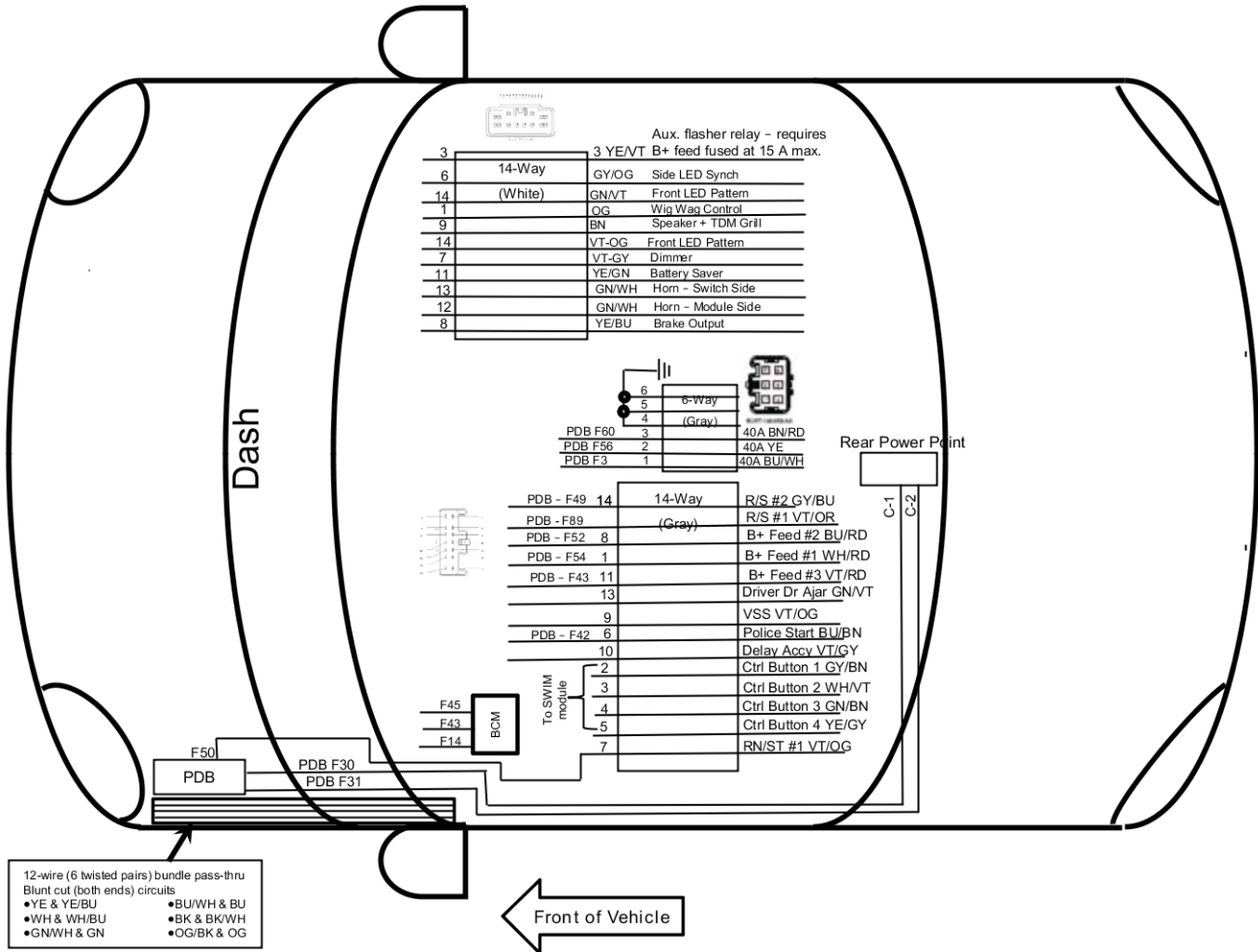


N0180358

Section 5: Electrical

Base Vehicle — No Wiring Options

2020 Utility Police Interceptor Base Vehicle - No Wiring Options



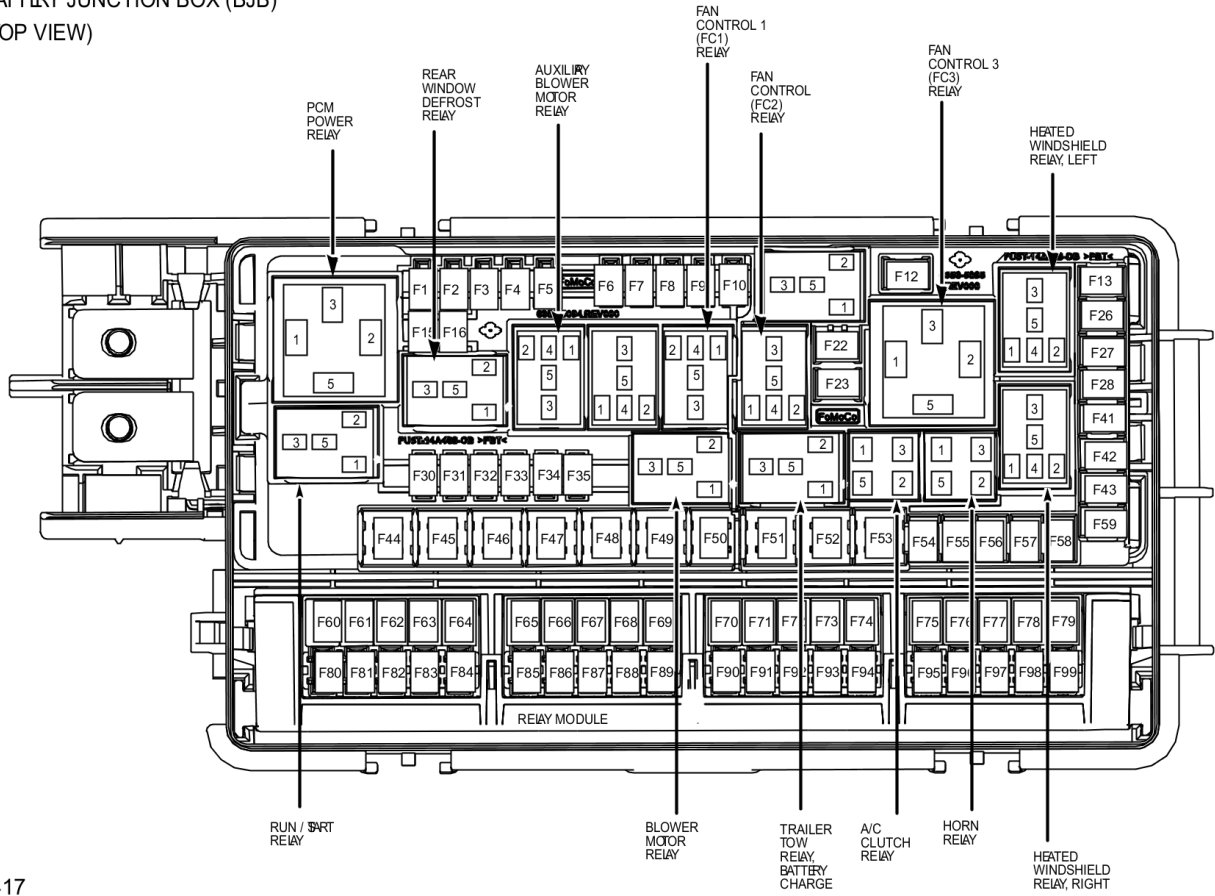
N0180359

Section 5: Electrical

Wire Diagram

Battery Junction Box (BJB)

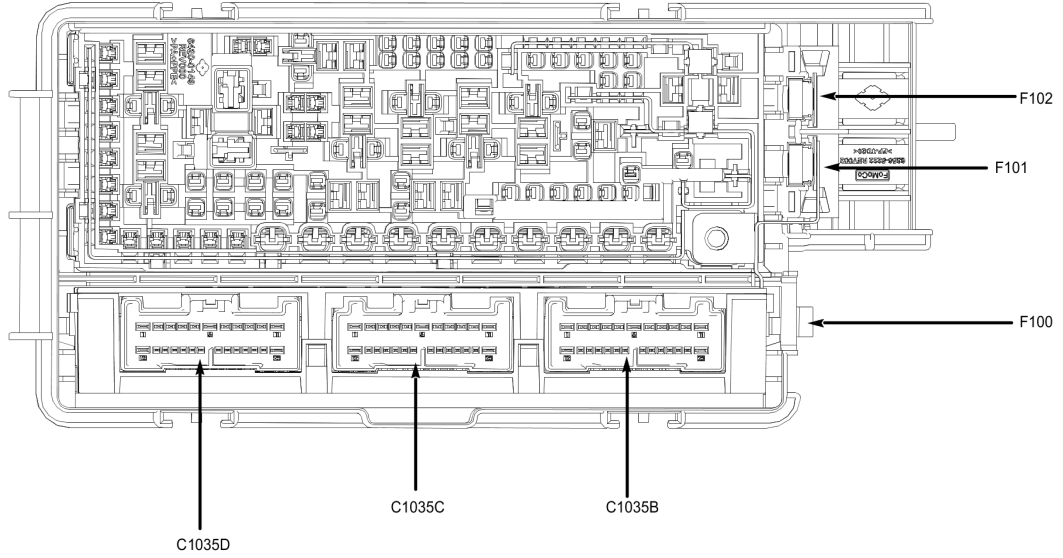
BATTERY JUNCTION BOX (BJB)
(TOP VIEW)



N0180417

Section 5: Electrical

BATTERY JUNCTION BOX (BJB)
(BOTTOM VIEW)

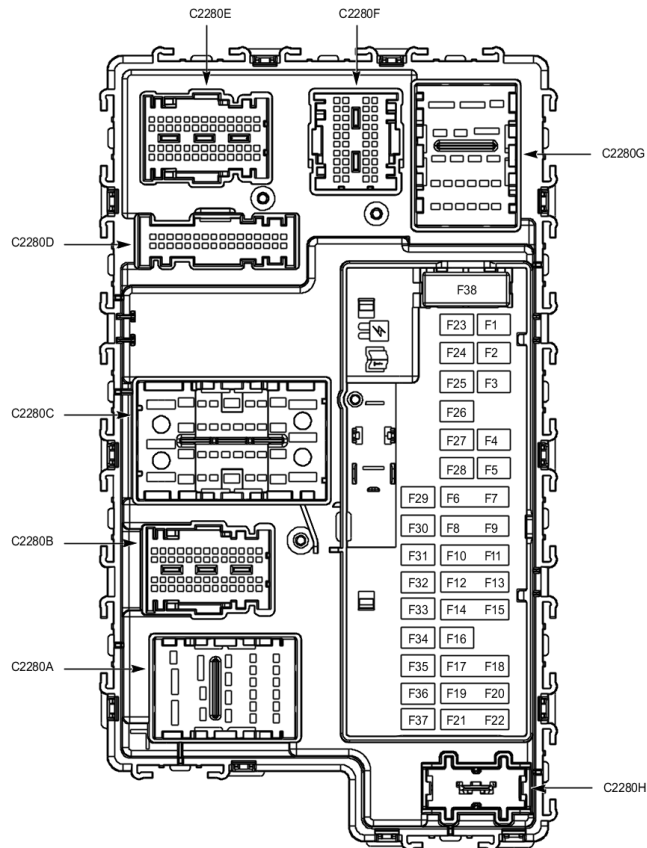


N0180418

Section 5: Electrical

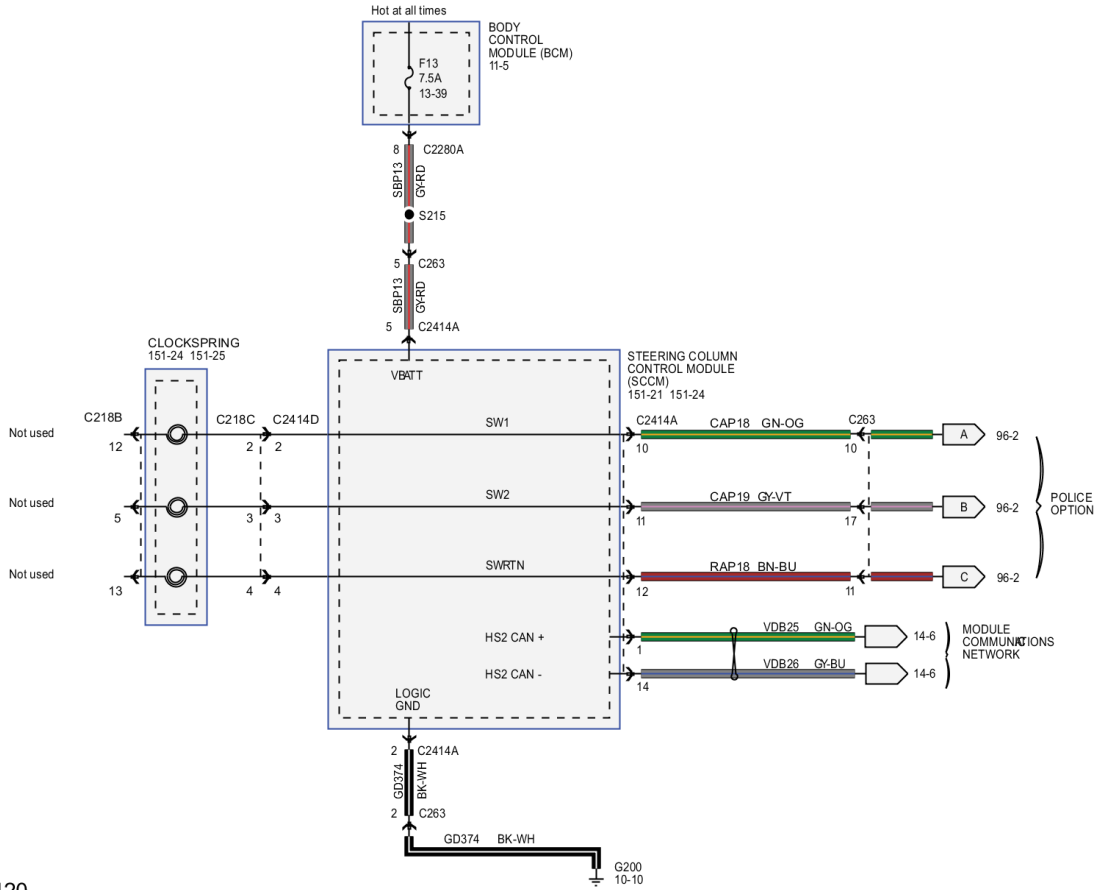
Body Control Module (BCM)

BODY CONTROL MODULE (BCM)



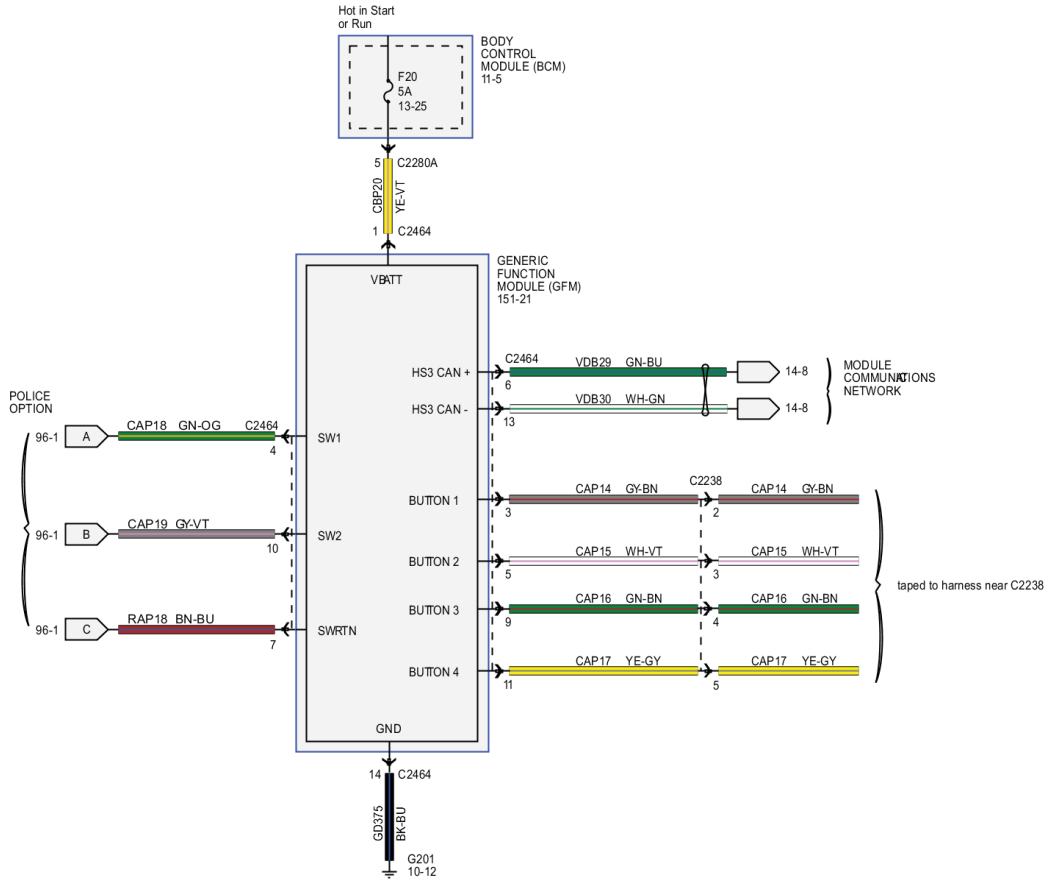
N0180419

Section 5: Electrical



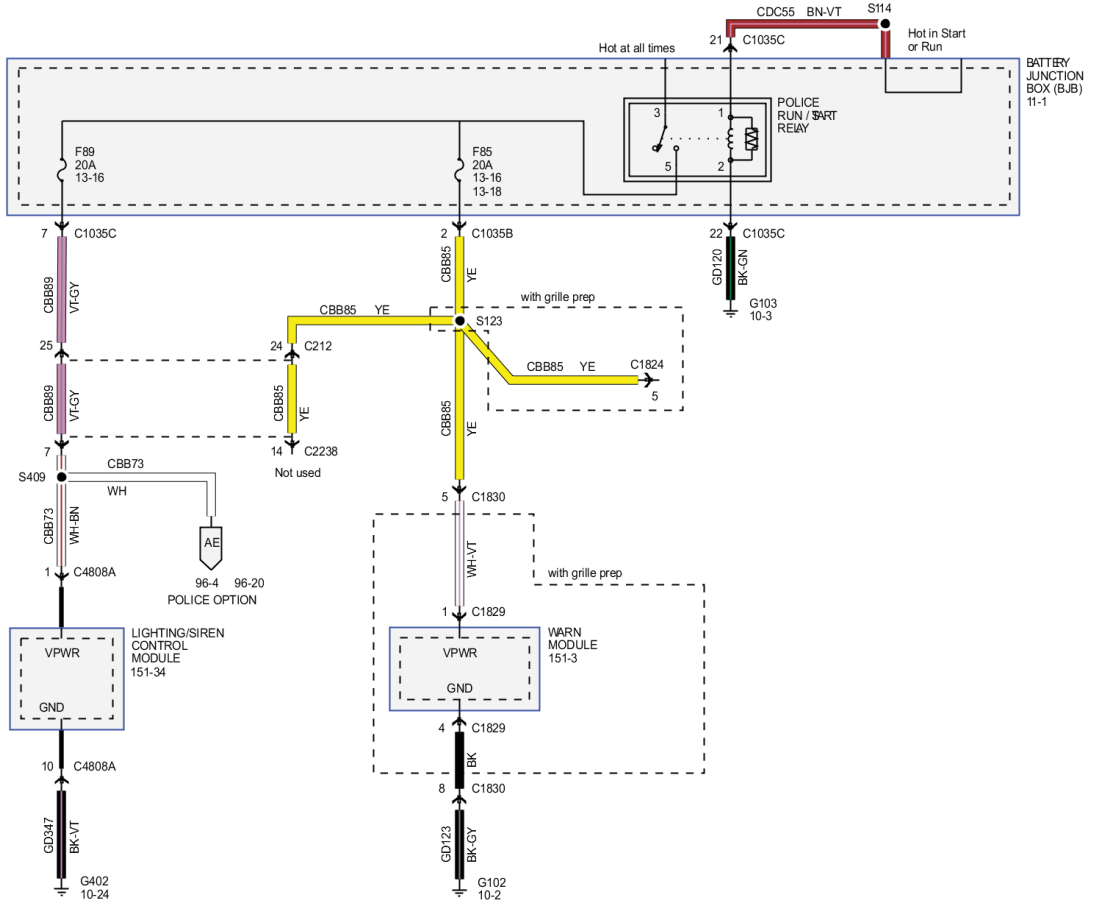
N0180420

Section 5: Electrical



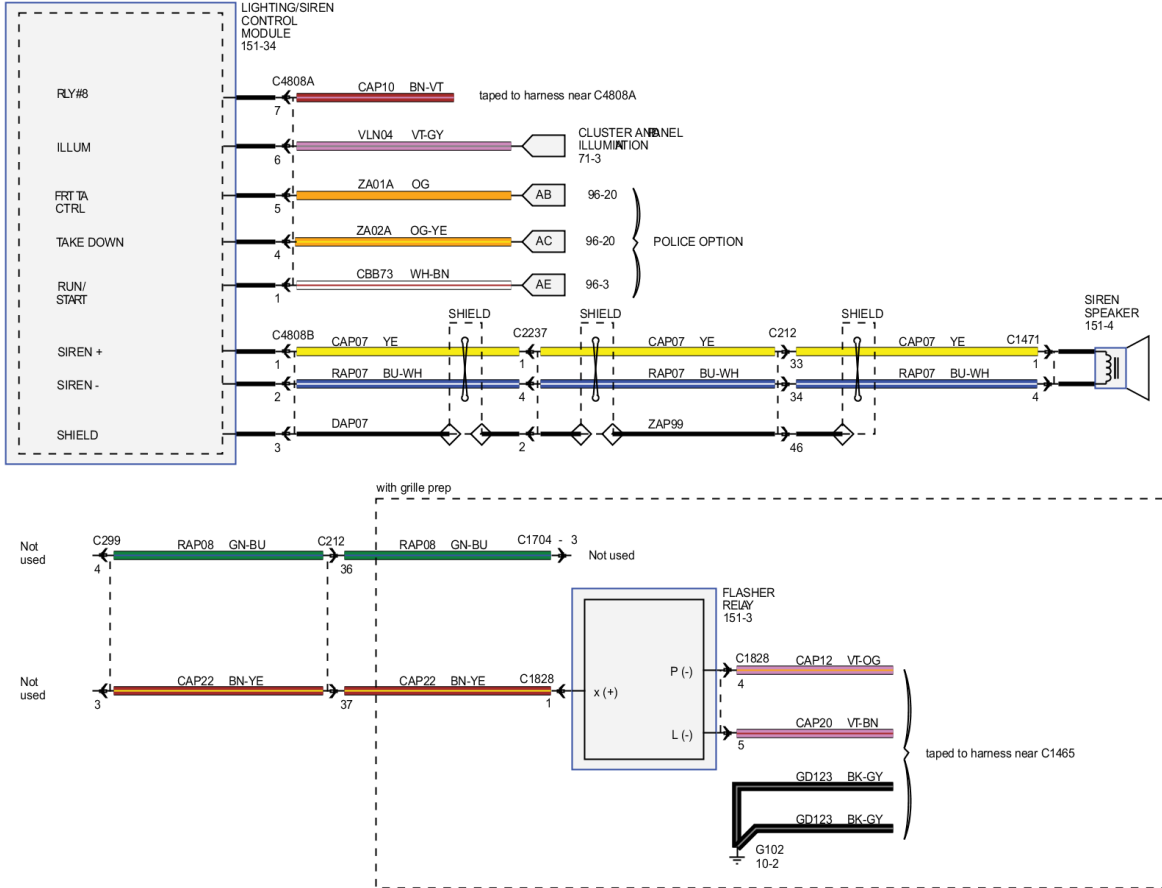
N0180421

Section 5: Electrical



N0180422

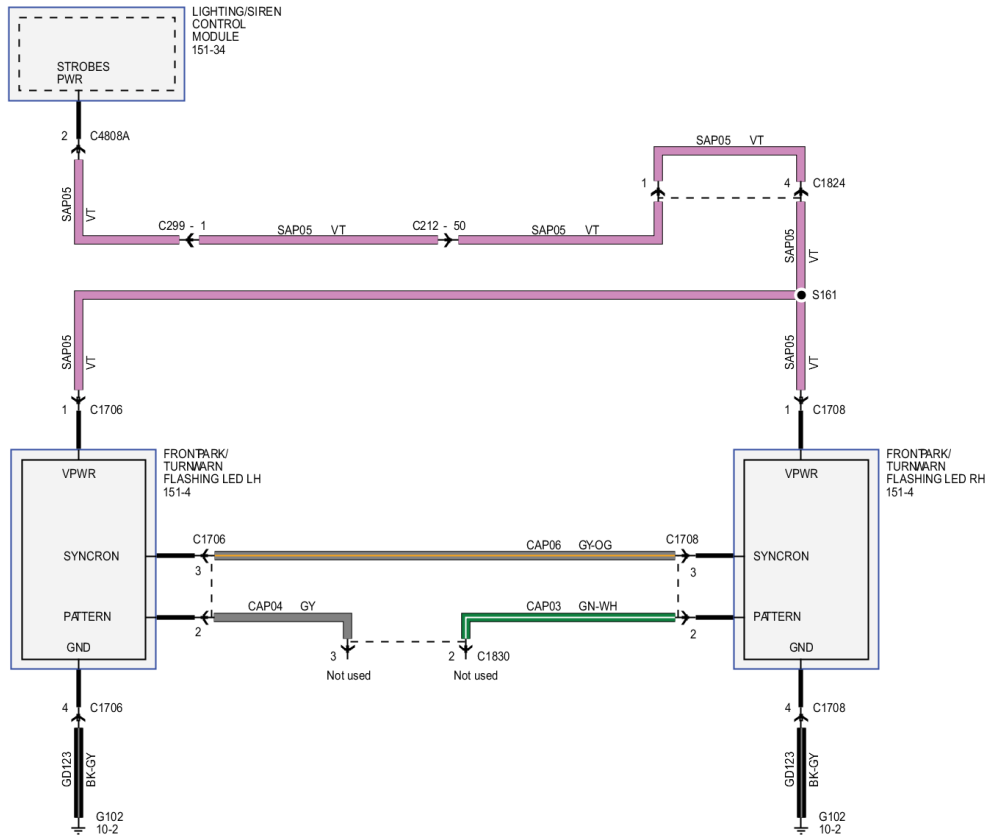
Section 5: Electrical



N0180423

Section 5: Electrical

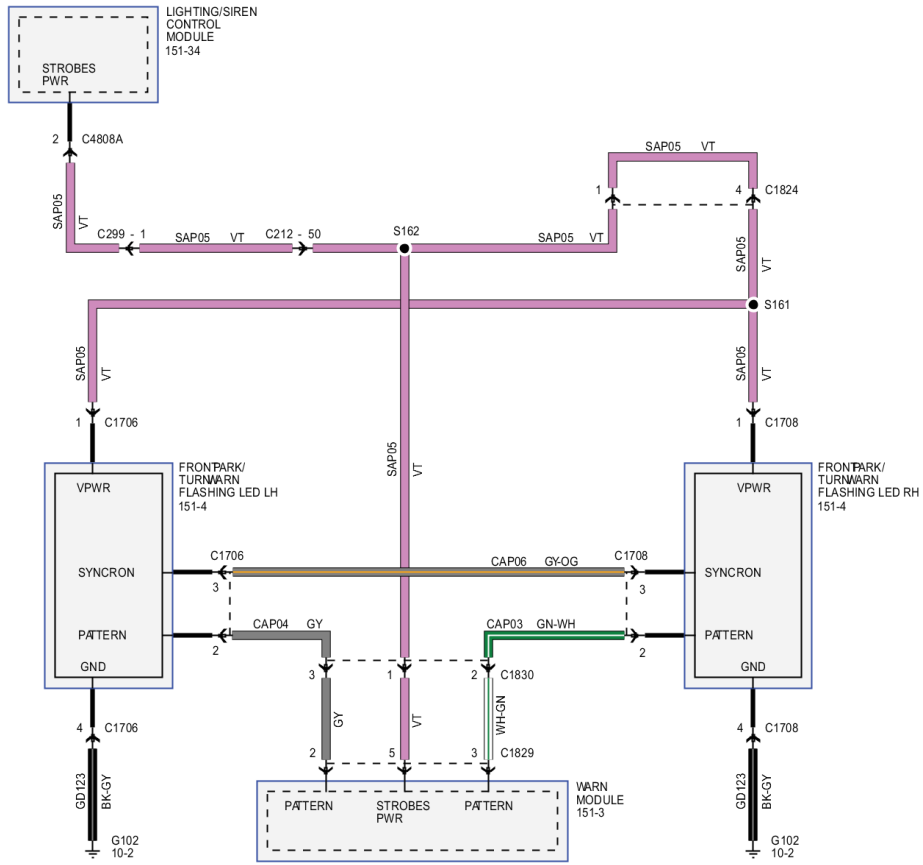
WITHOUT GRILLE PREP



N0180424

Section 5: Electrical

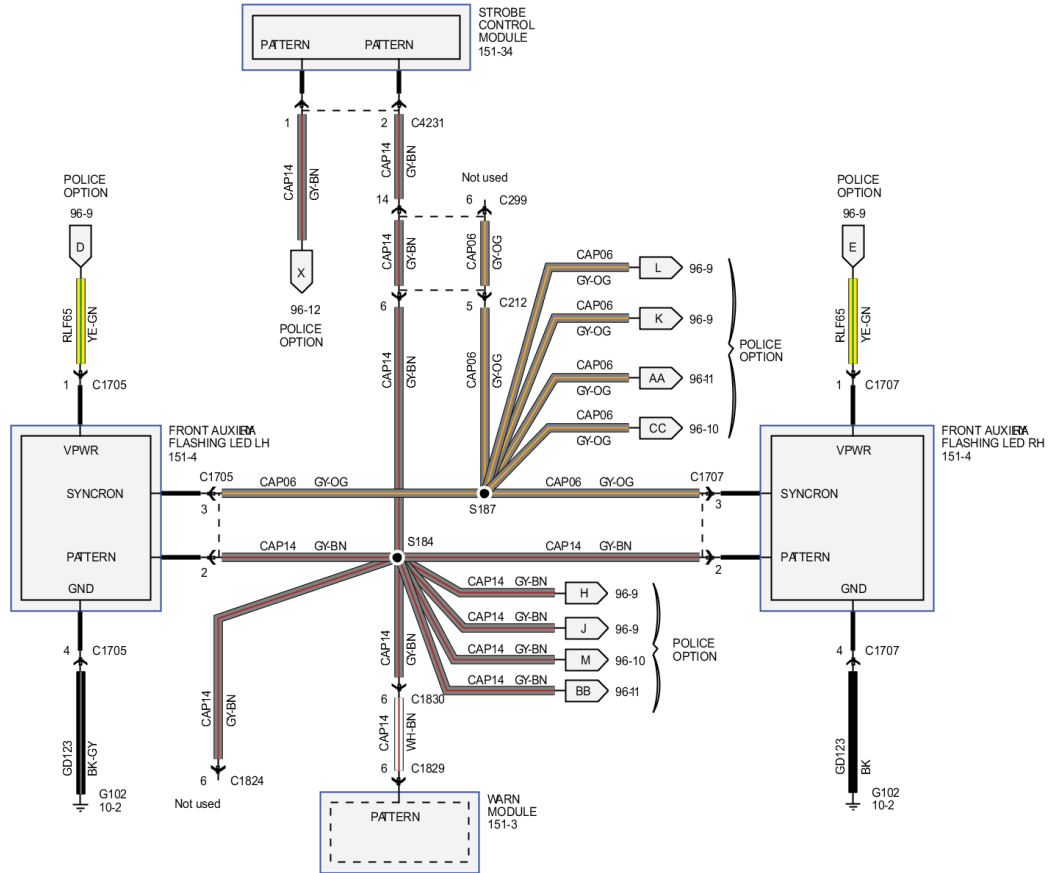
GRILLE PREP



N0180436

Section 5: Electrical

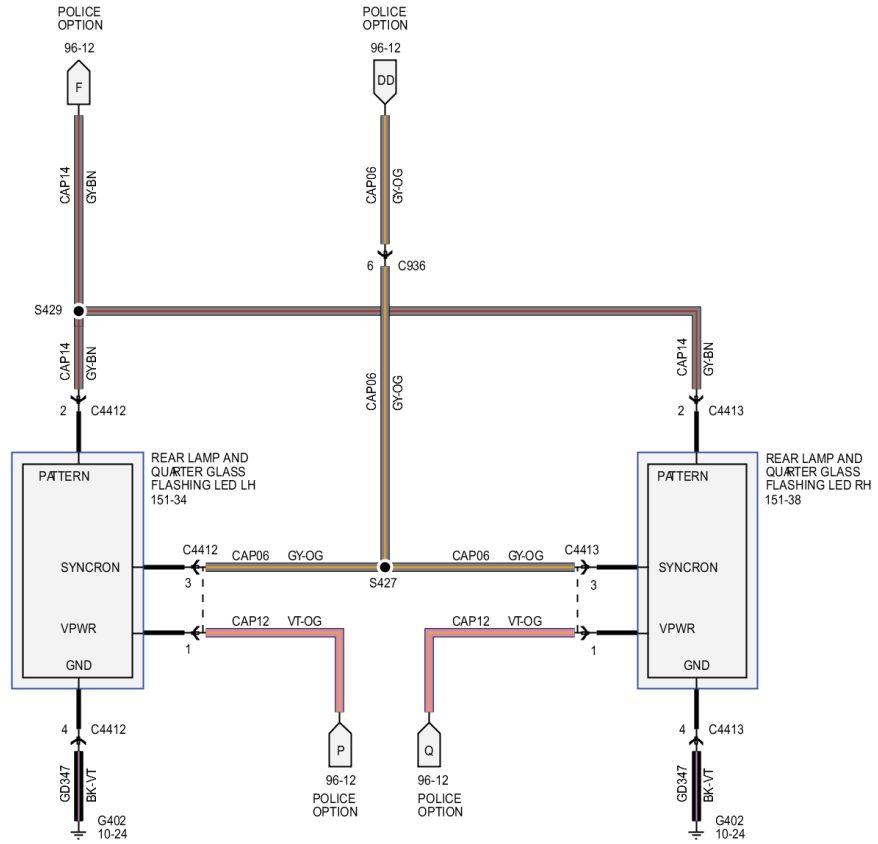
WITH GRILLE PREP



N0180437

Section 5: Electrical

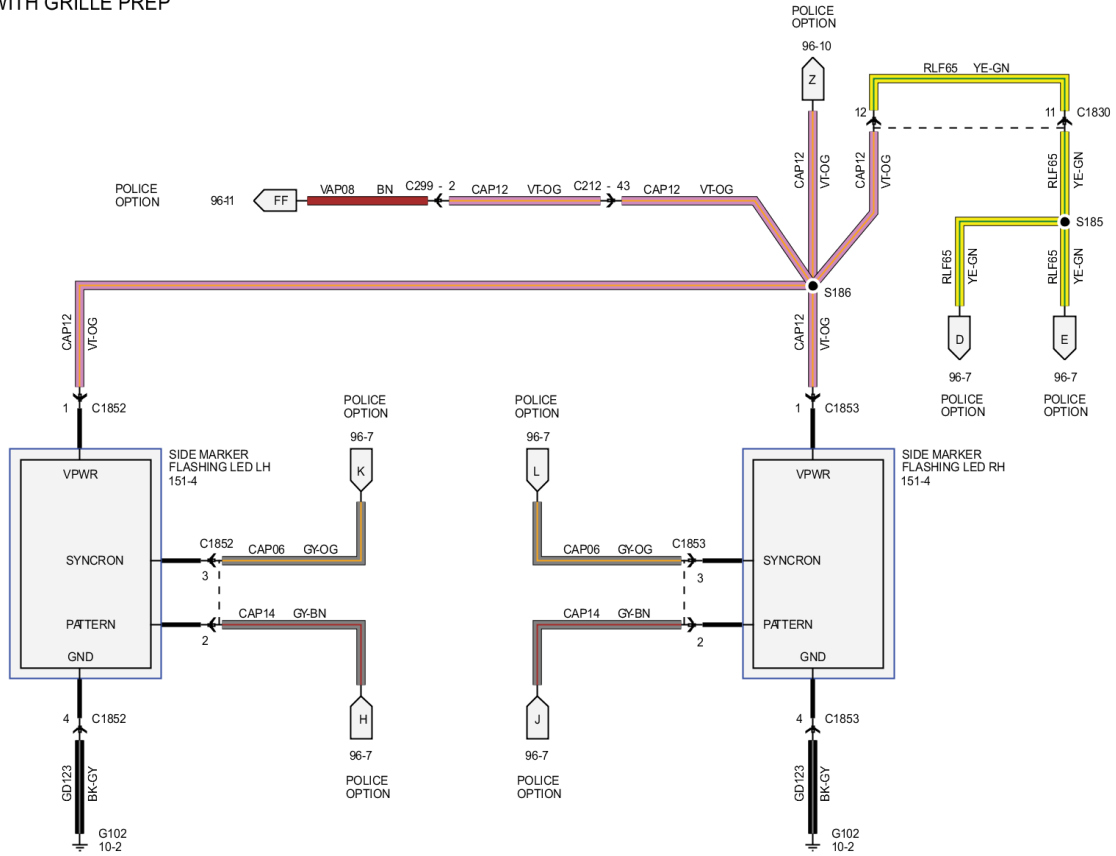
WITH GRILLE PREP



N0180438

Section 5: Electrical

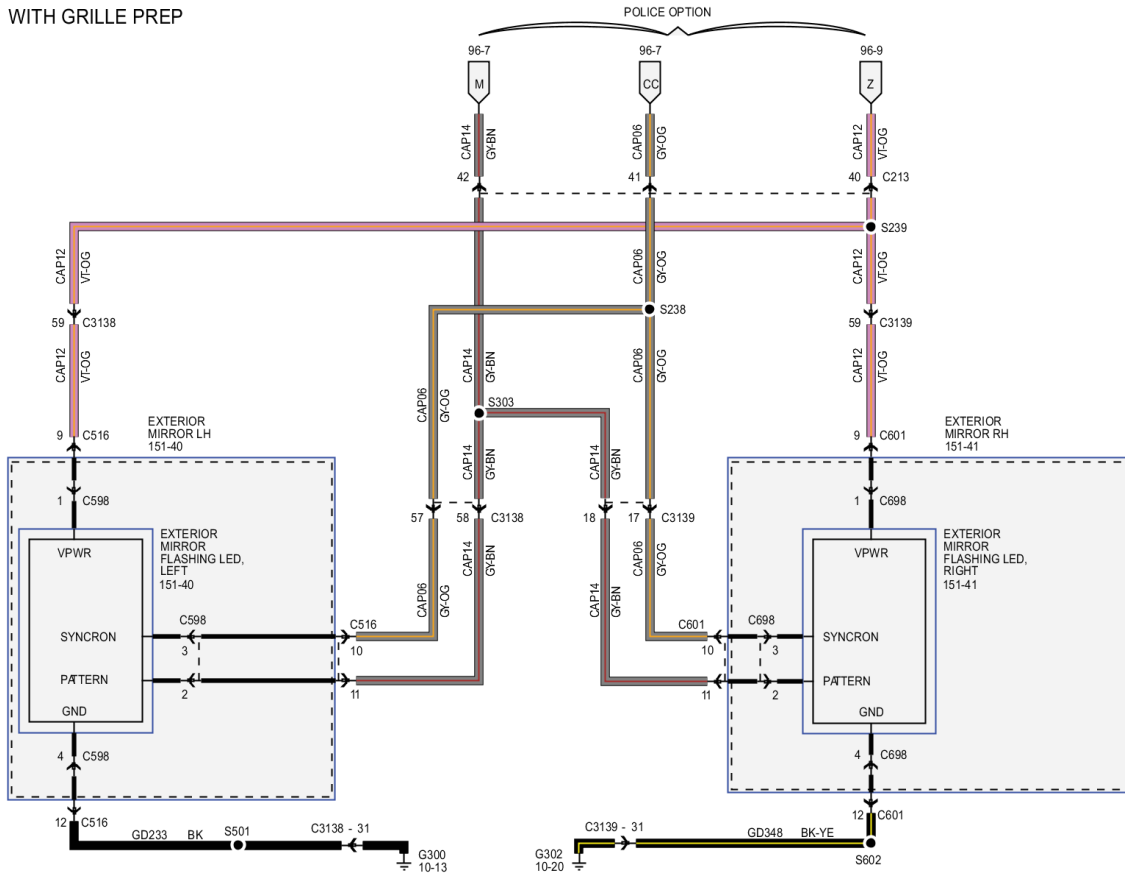
WITH GRILLE PREP



N0180439

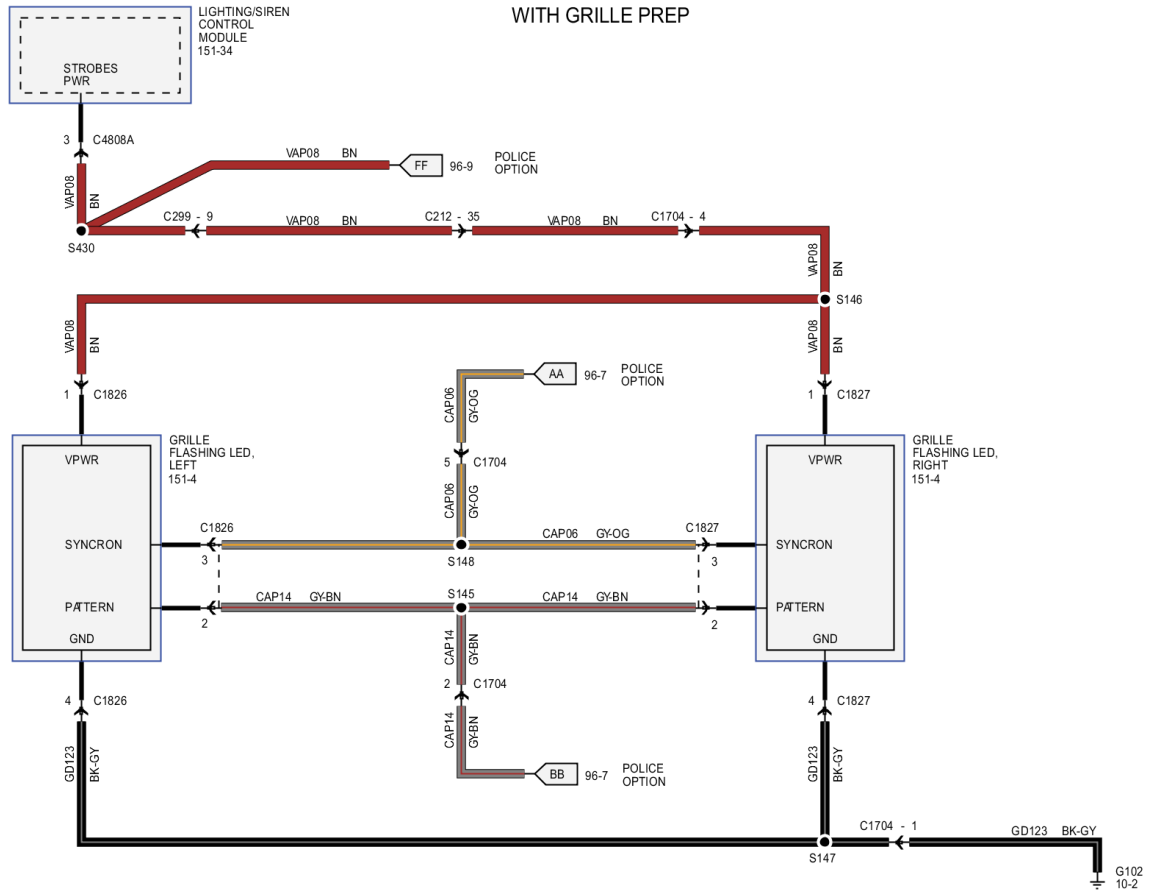
Section 5: Electrical

WITH GRILLE PREP



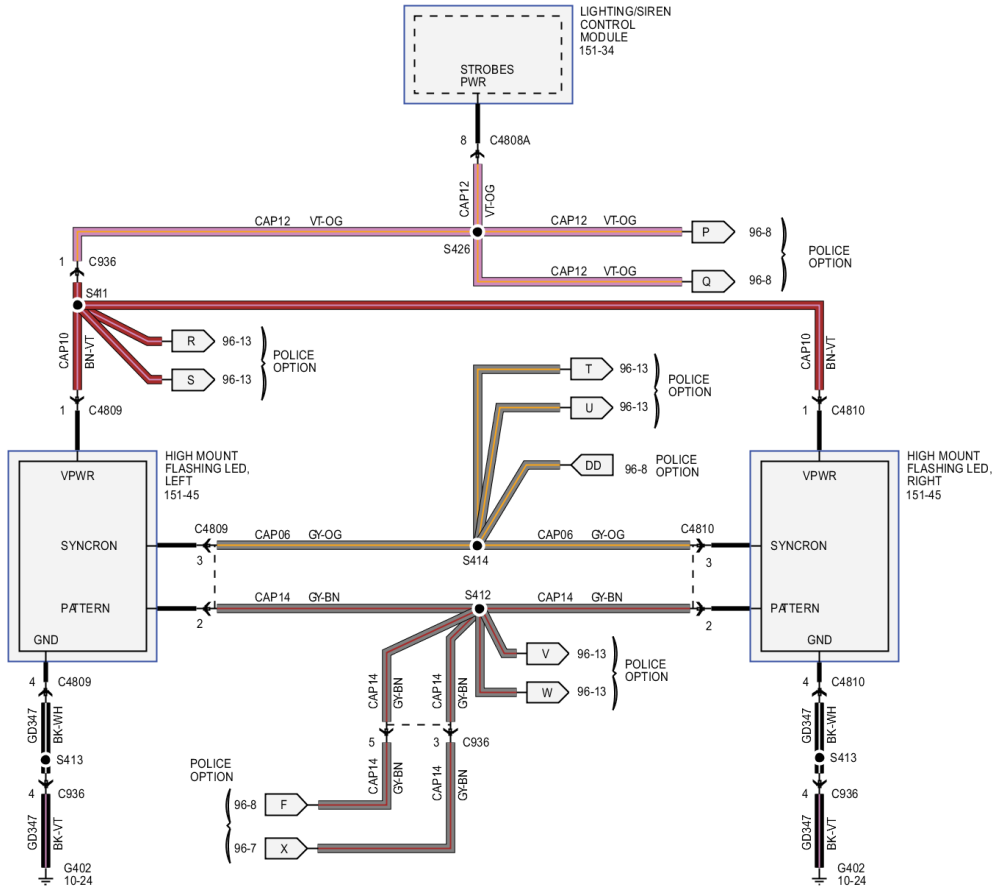
N0180440

Section 5: Electrical



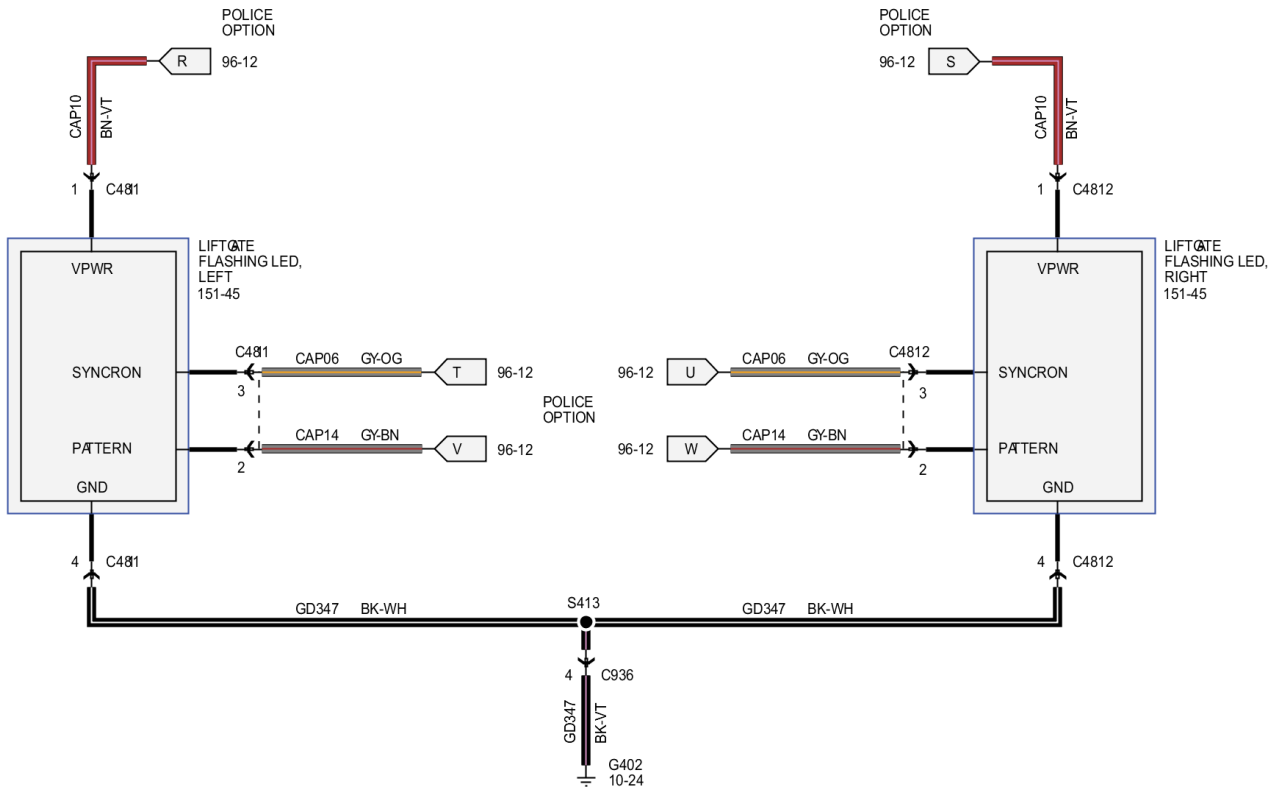
N0180441

Section 5: Electrical



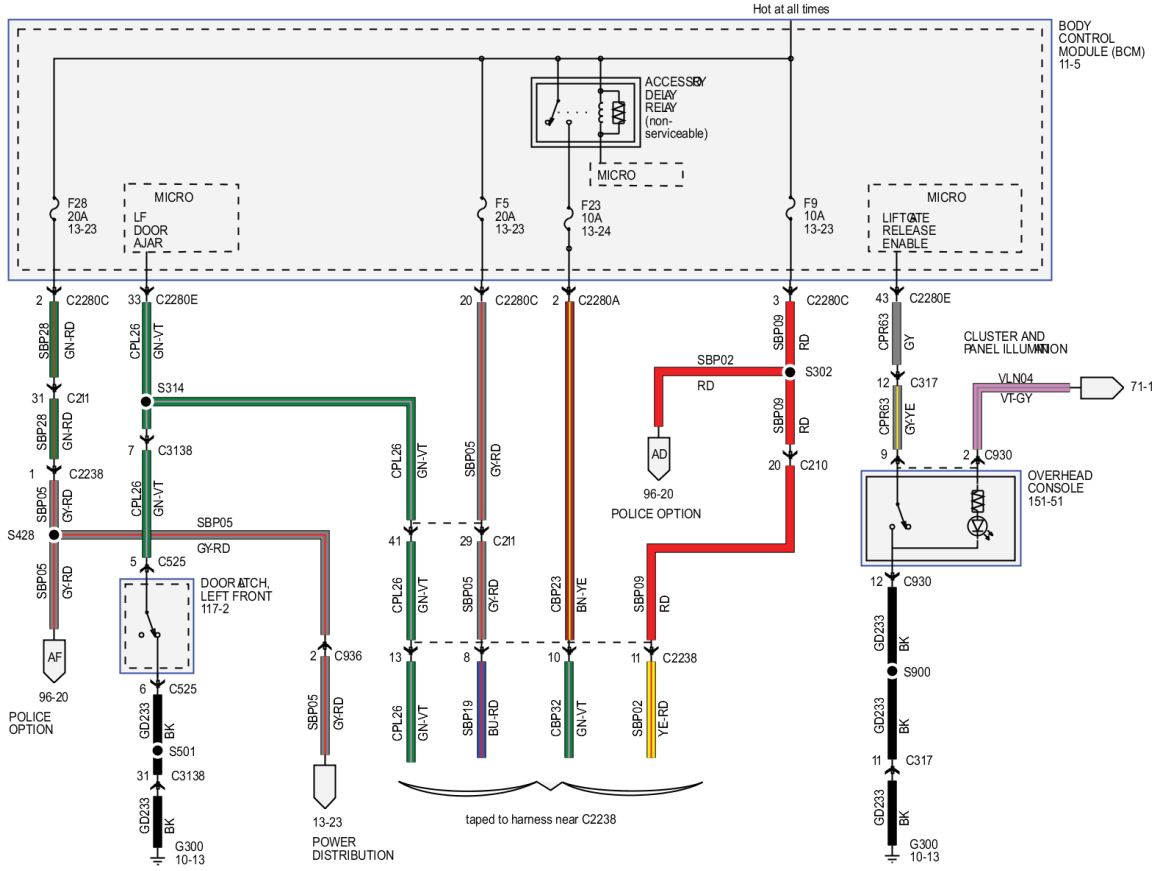
N0180442

Section 5: Electrical



N0180443

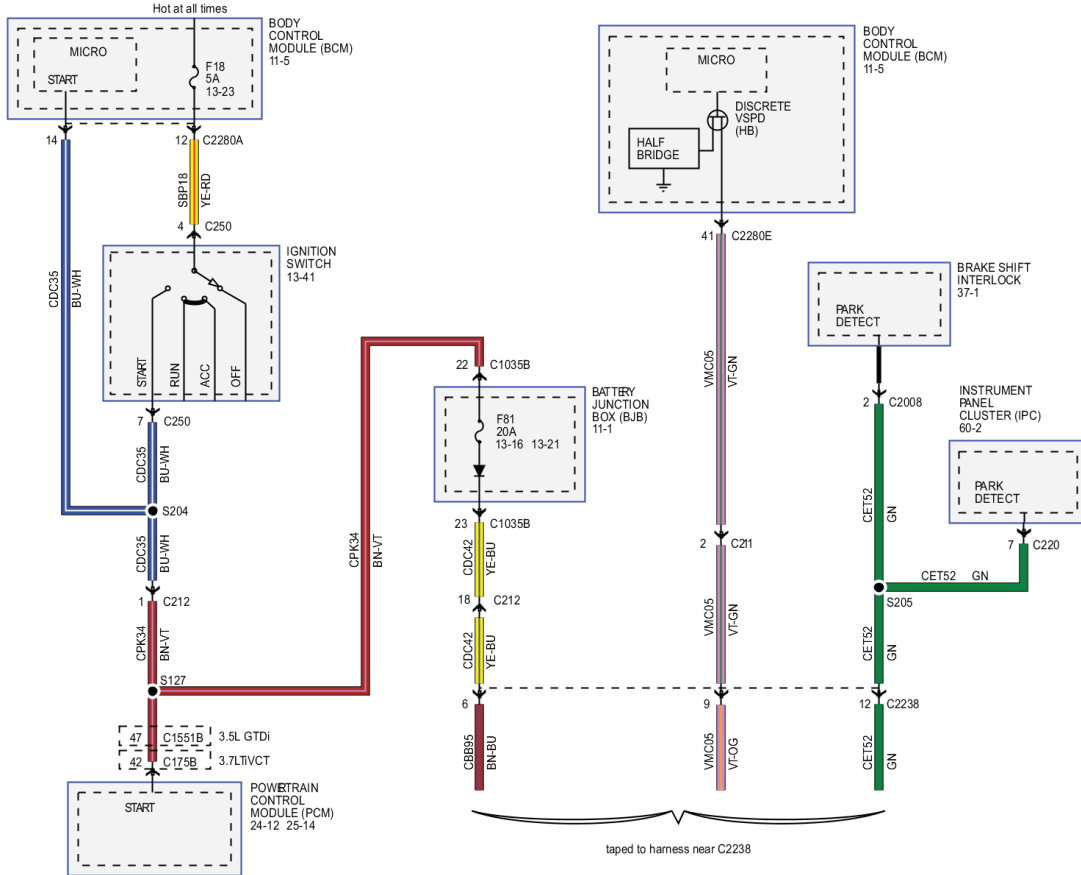
Section 5: Electrical



DOOR AJAR SWITCHES ARE CLOSED WHEN DOOR IS CLOSED.

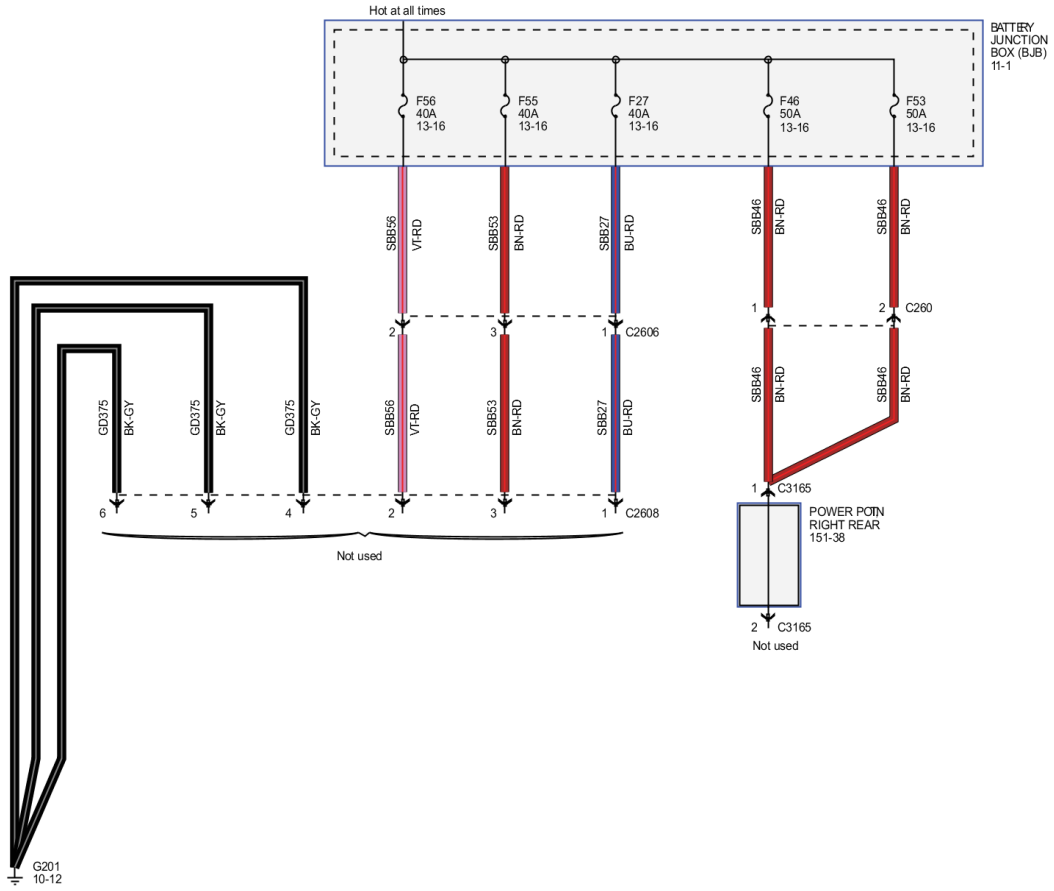
N0180444

Section 5: Electrical



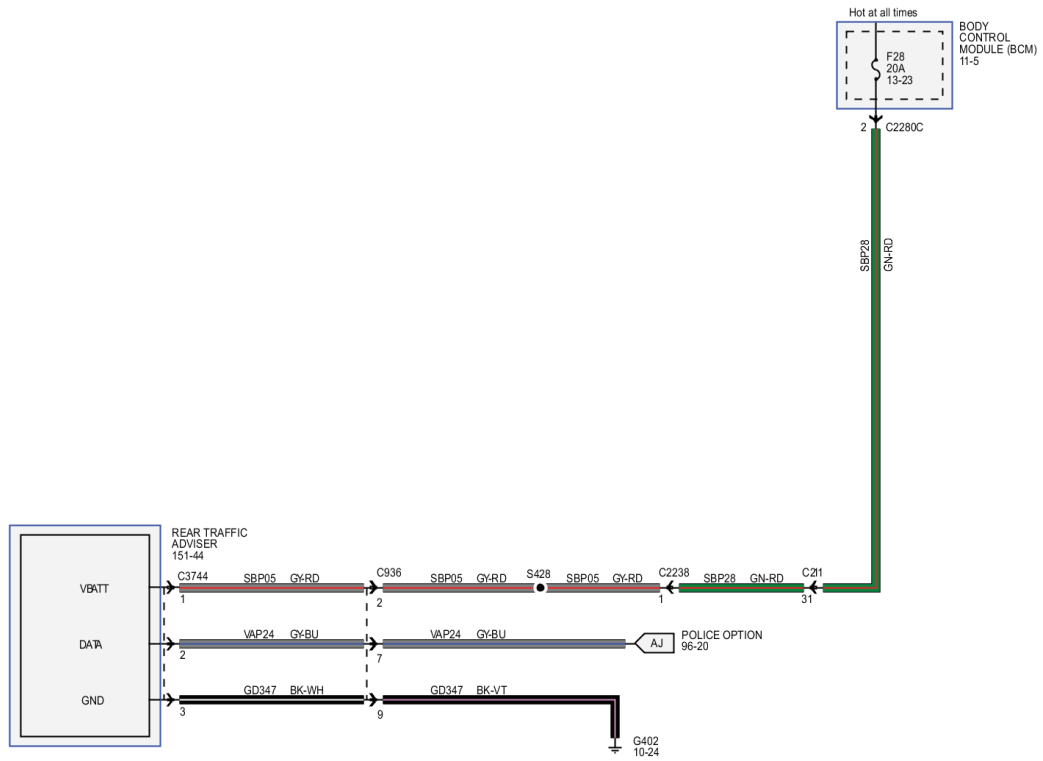
N0180445

Section 5: Electrical



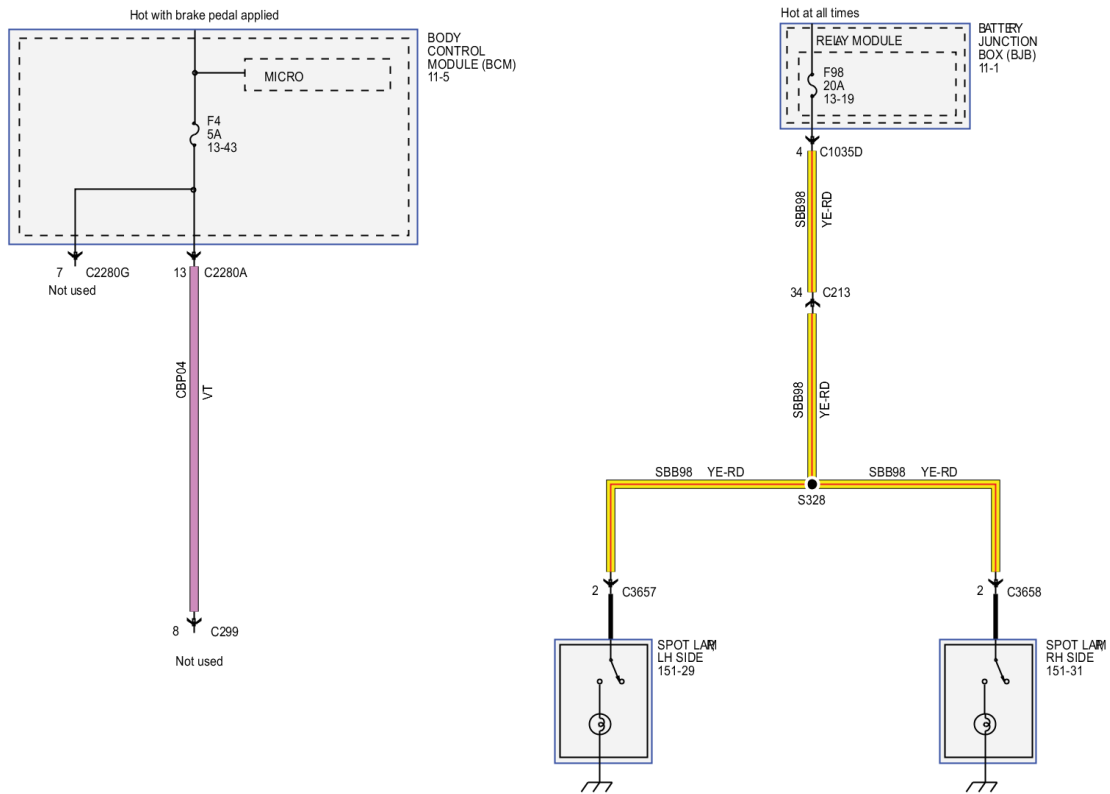
N0180446

Section 5: Electrical



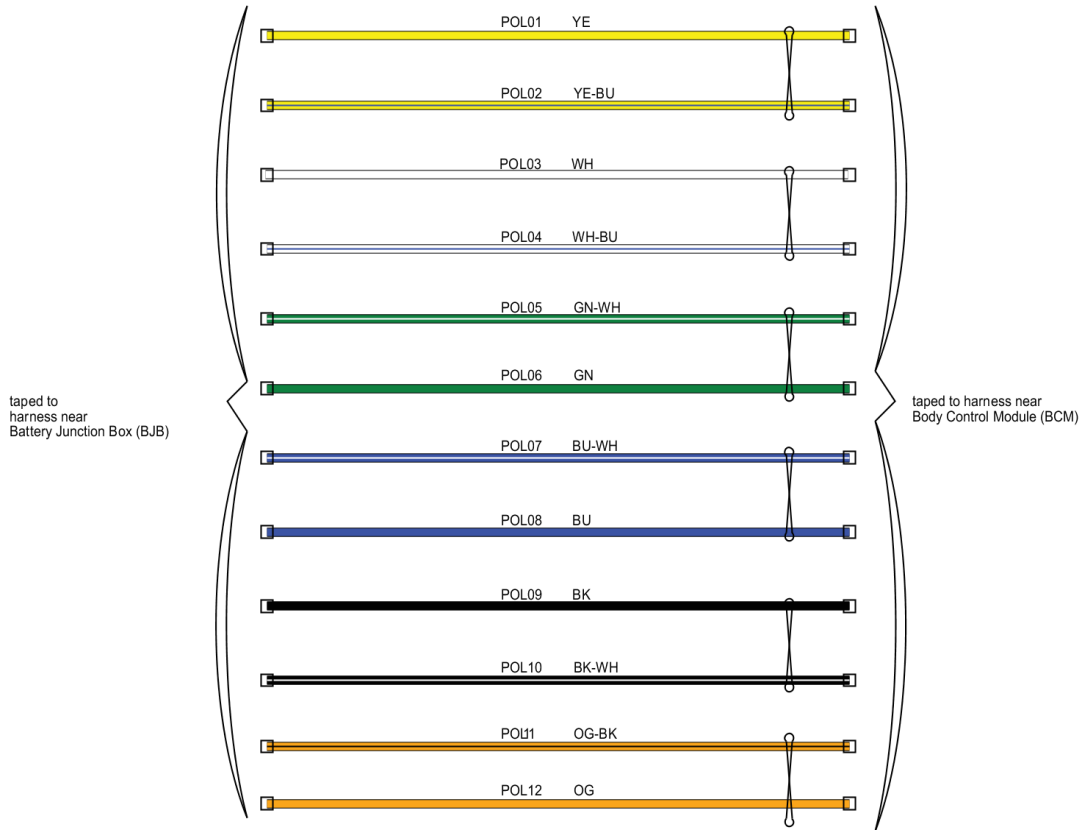
N0180447

Section 5: Electrical



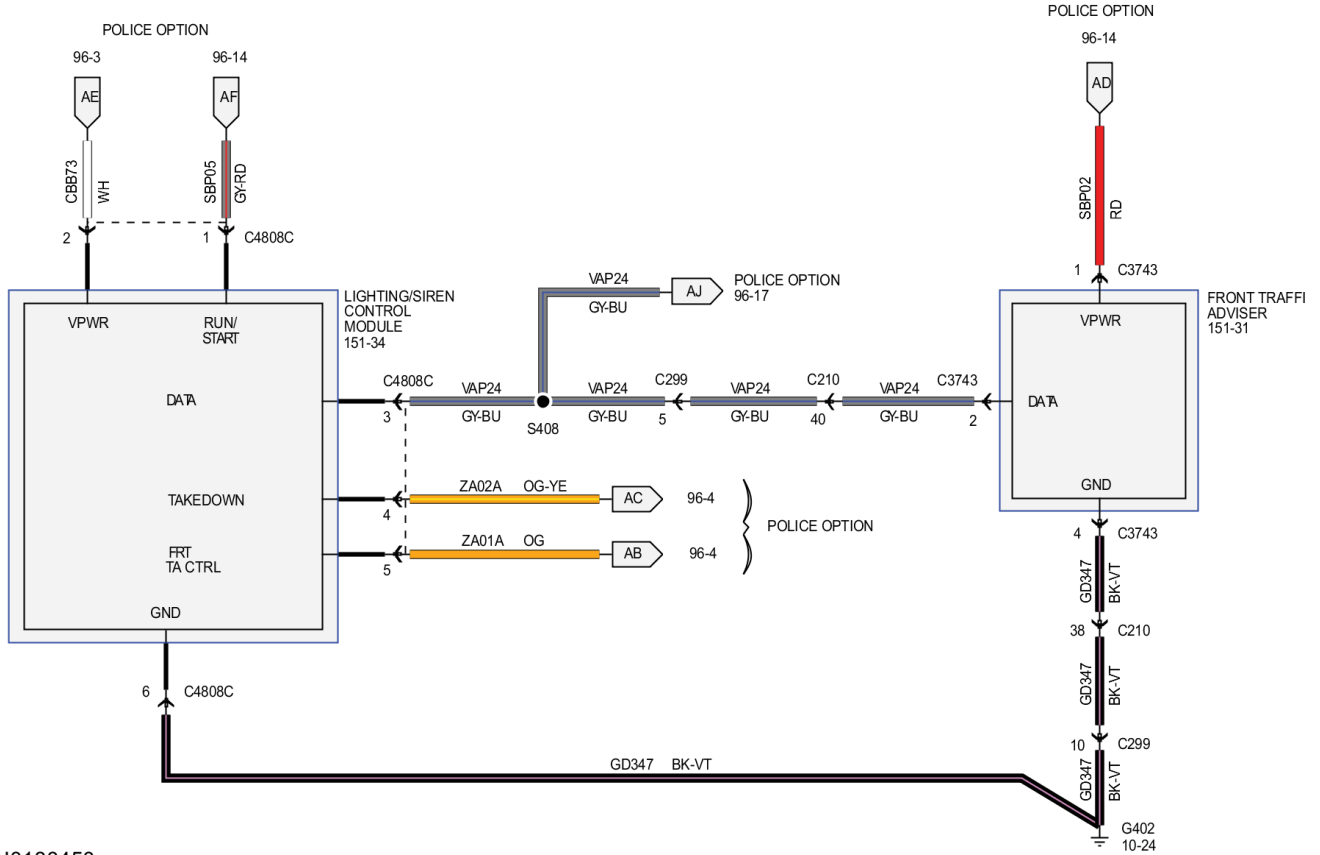
N0180448

Section 5: Electrical



N0180449

Section 5: Electrical



N0180450