Electrical Topology Diagram (Implementation v4)

As-of date: `2026-02-13`

Purpose: provide a complete, install-level electrical topology for the current build scope, including all major electrical components, fuse IDs, fuse housings, and planned wire gauges.

Related docs:

- Canonical electrical/system baseline: `docs/SYSTEMS.md`
- Detailed fuse matrix: `docs/ELECTRICAL_fuse_schedule.md`
- Decisions and unresolved items: `docs/TRACKING.md`
- Procurement source of truth: `bom/bom_estimated_items.csv`

Sweep Outcomes Included In This Revision

- Corrected Sterling `BB1248120` modeling basis to `~1500W` max output (`~26A` at `57.6V`), replacing prior `120A @ 48V` planning assumption.
- Added explicit fuse-holder/housing definitions for every fuse family (`Class T` , Lynx `MEGA` , inline `MIDI/ANL/AMI` , PV `gPV` , and `ATO/ATC`).
- Added conductor schedule across `48V` , `12V` , PV, and AC segments with explicit assumptions.

Complete Power Topology (48V Core + Charge Sources)

```
flowchart LR
    subgraph VEHICLE_12V["Vehicle 12V Charging Path"]
        ALT["Factory alternator\n(240A assumed)"]
        START["Starter battery 12V"]
        F08["F-08 150A\nsealed engine-bay holder"]
        B2B["Sterling BB1248120\n12V->48V (~1.5kW max)"]
        BBR["Sterling BBR remote\ncurrent-limit control"]
        ALT --> START
        START -- "2/0 AWG" --> F08 --> B2B
        BBR -. "control harness" .- B2B
    end

    subgraph PV_PATH["Solar Path (900W, 3S3P)"]
        PVA["PV String A\n3x100W"]
        PVB["PV String B\n3x100W"]
        PVC["PV String C\n3x100W"]
        F09A["F-09A 15A gPV"]
        F09B["F-09B 15A gPV"]
        F09C["F-09C 15A gPV"]
        COMB["PV combiner enclosure\n3x 10x38 fuse holders"]
        MPPT["Victron SmartSolar\nMPPT 150/45"]
        PVA -- "10 AWG PV" --> F09A --> COMB
        PVB -- "10 AWG PV" --> F09B --> COMB
        PVC -- "10 AWG PV" --> F09C --> COMB
        COMB -- "10 AWG PV +/-" --> MPPT
    end
```

```
    subgraph HOUSE_48V["House 48V Core"]
        BATA["Battery A\n48V 100Ah"]
        BATB["Battery B\n48V 100Ah"]
        F01A["F-01A 225A Class T\nBlue Sea block"]
        F01B["F-01B 225A Class T\nBlue Sea block"]
        DISC["48V disconnect\nVictron 275A"]
        SHUNT["SmartShunt 500A\nmain negative path"]
        LYNX["Victron Lynx Distributor M10\n+ bus / - bus / 4 MEGA slots"]
        MULTI["MultiPlus-II\n48/3000/35-50"]
        ORION["Orion-Tr 48/12-30\nIsolated"]
        F06["F-06 20A (or 23A)\ninline >=58V holder"]
    end

    BATA -- "2/0 AWG +" --> F01A --> DISC
    BATB -- "2/0 AWG +" --> F01B --> DISC
    DISC -- "2/0 AWG +" --> LYNX

    BATA -- "2/0 AWG -" --> SHUNT
    BATB -- "2/0 AWG -" --> SHUNT
    SHUNT -- "2/0 AWG -" --> LYNX
    LYNX -. "SmartShunt fused + sense/power lead\n(factory harness)" .- SHUNT

    LYNX -- "Slot 1: F-02 125A MEGA\n2/0 AWG +" --> MULTI
    MULTI -- "2/0 AWG -" --> LYNX

    MPPT -- "BAT+ via Slot 2: F-03 60A MEGA\n6 AWG" --> LYNX
    MPPT -- "BAT- 6 AWG" --> LYNX

    B2B -- "OUT+ via Slot 3: F-04 40A MEGA\n6 AWG" --> LYNX
    B2B -- "OUT- 6 AWG" --> LYNX

    LYNX -- "Slot 4: F-05 40A MEGA\n6 AWG" --> F06 --> ORION
    ORION -- "48V input - (6 AWG)" --> LYNX
```

12V Distribution Topology (From Orion)

```
flowchart LR
    ORION["Orion-Tr 48/12-30\nIsolated converter"]
    F07["F-07 60A\ninline holder near Orion"]
    PANEL["12V fuse panel\nBlue Sea 5026/5032 style"]
    N12["12V negative busbar"]

    STAR["12V-01 Starlink PSU\n10A / 14 AWG"]
    FRIDGE["12V-02 Fridge\n15A / 14 AWG"]
    HEATER["12V-03 Diesel heater\n15A / 14 AWG"]
    PUMP["12V-04 Water pump\n10A / 14 AWG"]
    DET["12V-05 CO+Propane detector\n3A / 18/2"]
    LED["12V-06 LED strips\n5A / 18/2"]
    CERBO_PWR["12V-07 Cerbo GX feed\n3A / 18/2 (assumed)"]
    SP1["12V-08 Spare\n15A / 14 AWG"]
```

```
    SP2["12V-09 Spare\n15A / 14 AWG"]

    ORION -- "12V + (6 AWG)" --> F07 --> PANEL
    ORION -- "12V - (6 AWG)" --> N12

    PANEL --> STAR
    PANEL --> FRIDGE
    PANEL --> HEATER
    PANEL --> PUMP
    PANEL --> DET
    PANEL --> LED
    PANEL --> CERBO_PWR
    PANEL --> SP1
    PANEL --> SP2

    STAR --> N12
    FRIDGE --> N12
    HEATER --> N12
    PUMP --> N12
    DET --> N12
    LED --> N12
    CERBO_PWR --> N12
```

AC Path Topology (Shore + Inverter Output, Full Hierarchy)

```
flowchart LR
    subgraph SHORE_SRC["Shore Source Path"]
        INLET["Shore inlet (120VAC)"]
        CORD["Shore cord + adapters\n(service-limited by pedestal/source)"]
        EMS["Optional EMS/surge protection"]
        ACINBRK["AC input breaker/disconnect\n20A target (or sized to source)"]
        INLET --> CORD --> EMS --> ACINBRK
    end

    subgraph MULTI_AC["MultiPlus-II AC Conversion + Transfer"]
        ACIN["AC-in terminals (L/N/PE)"]
        XFER["Internal transfer relay + charger stage\n(shore present = pass-through +
charging)"]
        OUT1["AC-out-1 (inverter-backed output)"]
        OUT2["AC-out-2 (shore-only optional output)"]
        ACIN --> XFER --> OUT1
        XFER --> OUT2
    end

    subgraph AC_DIST["AC Distribution and Protection"]
        OUT1PROT["UL943-class RCD/GFCI + branch breaker(s)\nfor AC-out-1"]
        BR_A["Branch A: galley outlets"]
        BR_B["Branch B: office outlets"]
        OUT2PROT["AC-out-2 breaker + RCD/GFCI\n(shore-only future loads, optional)"]
        OUT1PROT --> BR_A
```

```
        OUT1PROT --> BR_B
    end

    subgraph AC_LOADS["Planned AC Loads"]
        IND["Induction cooktop"]
        MW["Microwave"]
        MON["External monitor + office chargers"]
        GENOUT["General 120V receptacles\n4 total locations (2 galley, 2 office)"]
        SHORE_ONLY["Future shore-only load (optional)\nA/C or electric water heat"]
    end

    subgraph USB_PD["USB/USB-C PD Strategy"]
        PD_DC["Locked: 12V branch -> DC USB-C PD modules\n4 total points (2 office, 2
galley)"]
        PD_AC["Alternative: USB receptacles on AC branch"]
    end

    ACINBRK --> ACIN
    OUT1 --> OUT1PROT
    OUT2 --> OUT2PROT

    BR_A --> IND
    BR_A --> MW
    BR_A --> MON
    BR_B --> GENOUT
    OUT2PROT --> SHORE_ONLY

    BR_A -. "if AC USB outlets selected" .-> PD_AC
```

AC Operating Behavior (Expected)

- Shore present: MultiPlus transfer relay closes, AC-in is passed to AC-out paths, and charger stage charges the `48V` bank.
- Shore absent: MultiPlus transfers to inverter mode and powers `AC-out-1` from battery; `AC-out-2` drops by design.
- Input current limit should be set to the actual shore source (`15A` , `20A` , or `30A` adapter-limited) to avoid pedestal/source breaker trips.

AC Safety/Protection Chain (What Must Exist)

- Upstream AC input protection/disconnect before MultiPlus AC-in.
- AC-out branch protection including UL943-class residual-current protection and overcurrent protection sized to branch wiring and expected load.
- Continuous equipment grounding path from shore inlet through MultiPlus and branch circuits, plus chassis bond in mobile install context.
- Neutral/ground handling must follow MultiPlus relay behavior; do not add an always-bonded downstream neutral-ground bond in branch receptacle wiring.

AC Reference Basis (Manufacturer Guidance)

- Victron MultiPlus-II `120V` installation guidance (`AC-in` breaker sizing, UL943-class residual-current protection on outputs, and AC-out-2 shore-only behavior):
  `https://www.victronenergy.com/media/pg/MultiPlus-II_120V/en/installation.html`

- Victron MultiPlus-II datasheet (`48/3000/35-50` baseline model reference): `https://www.victronenergy.com/upload/documents/Datasheet-MultiPlus-II-inverter-charger-120V-EN.pdf`

AC/USB Baseline Locked For BOM

- Shore interface: `30A` RV-style inlet baseline with adapter kit for `15A` / `20A` hookups.
- AC input protection: dedicated AC input breaker/disconnect upstream of MultiPlus AC-in.
- AC-out-1 distribution: two protected branches (`20A` galley, `15A` office) with GFCI-at-first-outlet strategy.
- Receptacle plan: `4` total `120V` receptacle locations (`2` galley, `2` office).
- USB charging plan: `4` DC-fed USB-C PD points on `12V` branches (`2` office, `2` galley) with `10A` per-zone branch fuse baseline.
- AC-out-2 remains optional and not in Phase 1 procurement baseline.

Monitoring and Control Topology

```
flowchart LR
    CERBO["Cerbo GX"]
    MULTI["MultiPlus-II"]
    MPPT["SmartSolar MPPT"]
    SHUNT["SmartShunt 500A"]
    ORION["Orion-Tr 48/12"]
    BTEMP["Battery temp sensor"]
    SHUNT_PWR["SmartShunt fused + lead\n(factory harness)"]

    CERBO -. "VE.Bus" .- MULTI
    CERBO -. "VE.Direct" .- MPPT
    CERBO -. "VE.Direct" .- SHUNT
    ORION -. "VictronConnect/BLE\n(no direct GX link in this baseline)" .- CERBO
    BTEMP -. "temp input" .- MULTI
    SHUNT_PWR -. "power/sense harness" .- SHUNT
```

Fuse Housing Map (Where Each Fuse Is Physically Housed)

Fuse ID	Fuse value	Housing method	Location
`F-01A`	`225A Class T`	Blue Sea Class T fuse block	Battery compartment near Battery A +
`F-01B`	`225A Class T`	Blue Sea Class T fuse block	Battery compartment near Battery B +
`F-02`	`125A MEGA`	Lynx integrated slot holder	Lynx Slot 1
`F-03`	`60A MEGA`	Lynx integrated slot holder	Lynx Slot 2
`F-04`	`40A MEGA`	Lynx integrated slot holder	Lynx Slot 3
`F-05`	`40A MEGA`	Lynx integrated slot holder	Lynx Slot 4
`F-06`	`20A` target / `23A` MIDI fallback	Inline sealed holder (`>=58VDC`)	Electrical cabinet near Orion branch source

F-07	60A	Inline sealed holder (>=32VDC)	Electrical cabinet at Orion 12V + source end
F-08	150A	Sealed engine-bay MEGA/ANL holder	Engine bay near starter battery +
F-09A/B/C	15A gPV each	10x38 touch-safe fuse holders in PV combiner	Roof-entry combiner enclosure
F-10	Per branch (ATO/ATC)	Integrated blade sockets in 12V panel	Electrical cabinet
OEM-SHUNT	Factory low-current inline fuse (SmartShunt harness)	Integrated inline holder in Victron harness lead	Electrical cabinet near Lynx positive tap

Conductor Schedule (Start-to-Finish)

Segment ID	Circuit segment	Nominal voltage	Current basis	Overcurrent protection	Planned wire gauge
C-01	Battery A + -> F-01A	48V	Battery branch, fuse-limited	F-01A 225A	2/0 AWG
C-02	Battery B + -> F-01B	48V	Battery branch, fuse-limited	F-01B 225A	2/0 AWG
C-03	Class T outputs -> disconnect input	48V	Combined trunk current	F-01A/B	2/0 AWG each branch
C-04	Disconnect output -> Lynx + bus	48V	Aggregate branch current (<=265A theoretical from Lynx slots)	Upstream Class T fuses	2/0 AWG
C-05	Battery negatives -> SmartShunt battery side	48V	Aggregate return current	N/A (main negative path)	2/0 AWG each branch
C-06	SmartShunt load side -> Lynx - bus	48V	Aggregate return current	N/A	2/0 AWG
C-06A	Lynx positive tap -> SmartShunt positive sense/power lead	48V	Shunt electronics supply (very low current)	Factory inline fuse in OEM harness	OEM harness lead

C-07	Lynx Slot 1 (F-02) -> MultiPlus DC+	48V	Inverter branch, fuse-limited	F-02 125A	2/0 AWG (manual minimum AWG 1 on short runs)
C-08	MultiPlus DC- -> Lynx - bus	48V	Inverter return current	F-02 protects paired positive	2/0 AWG
C-09	MPPT BAT+ -> Lynx Slot 2 (F-03)	48V	Controller output (45A max)	F-03 60A	6 AWG
C-10	MPPT BAT- -> Lynx - bus	48V	Controller return current	F-03 protects paired positive	6 AWG
C-11	Sterling output + -> Lynx Slot 3 (F-04)	48V	Charger output (~26A nominal max)	F-04 40A	6 AWG planned (10 AWG minimum per Sterling table)
C-12	Sterling output - -> Lynx - bus	48V	Charger return current	F-04 protects paired positive	6 AWG
C-13	Lynx Slot 4 (F-05) -> F-06 holder	48V	Orion branch feeder, fuse-limited	F-05 40A	6 AWG
C-14	F-06 -> Orion 48V + input	48V	Orion input, fuse-limited	F-06 20A/23A	6 AWG planned (8 AWG minimum per Orion table)
C-15	Orion 48V - input -> Lynx - bus	48V	Orion input return current	F-06 protects paired positive	6 AWG
C-16	Starter battery + -> F-08 -> Sterling input +	12V	Charger input path, fuse-limited	F-08 150A	2/0 AWG planned (2 AWG minimum per Sterling table)
C-17	Vehicle return/chassis -> Sterling input -	12V	Charger input return	F-08 protects paired positive	2/0 AWG planned

C-18	Orion 12V + -> F-07 -> 12V panel + bus	12V	Converter output path (30A continuous, 60A fuse)	F-07 60A	6 AWG planned (8 AWG minimum per Orion table)
C-19	Orion 12V - -> 12V negative busbar	12V	Converter output return	F-07 protects paired positive	6 AWG
C-20	12V panel -> Starlink PSU	12V	Branch load	F-10 10A	14 AWG duplex
C-21	12V panel -> Fridge	12V	Branch load	F-10 15A	14 AWG duplex
C-22	12V panel -> Diesel heater	12V	Branch load	F-10 15A	14 AWG duplex
C-23	12V panel -> Water pump	12V	Branch load	F-10 10A	14 AWG duplex
C-24	12V panel -> CO + propane detector	12V	Branch load	F-10 3A	18/2
C-25	12V panel -> LED strips	12V	Branch load	F-10 5A	18/2
C-26	12V panel -> Cerbo GX power feed	12V	Branch load (~3W)	F-10 3A (assumed)	18/2
C-27	PV strings -> F-09 combiner -> MPPT PV input	PV string voltage (3S)	String current + combiner output current	F-09A/B/C 15A each	10 AWG PV wire
C-28	Shore inlet -> shore cord/adapter -> AC input breaker/disconnect	120VAC	Source-limited shore current	Source-size-matched AC breaker/disconnect (20A target baseline)	10/3 shore feed to inlet/breaker area
C-29	AC input breaker/disconnect -> MultiPlus AC-in	120VAC	MultiPlus AC input current	Upstream AC breaker/disconnect (C-28)	12 AWG stranded AC conductors
C-30	MultiPlus AC-out-1 -> branch RCD/GFCI + breaker assembly	120VAC	Inverter-backed branch distribution current	UL943-class RCD/GFCI + branch breakers (20A galley, 15A office)	12 AWG stranded AC conductors
C-31	Branch A -> galley receptacle locations (2)	120VAC	Branch load (induction, microwave, galley outlets)	C-30 branch protection stack	12 AWG stranded AC conductors

C-32	Branch B -> office receptacle locations (2)	120VAC	Branch load (monitor and office outlet use)	C-30 branch protection stack	12 AWG stranded AC conductors
C-33	MultiPlus AC-out-2 (optional) -> shore-only future load branch	120VAC	Shore-only branch current	Dedicated breaker + UL943-class RCD/GFCI for AC-out-2	12 AWG stranded AC conductors
C-34	12V panel -> USB-C PD branch (office zone, 2 outlets)	12V	Device charging branch current (zone budget target ~100-120W)	F-10 branch fuse (10A baseline)	14 AWG duplex baseline
C-35	12V panel -> USB-C PD branch (galley zone, 2 outlets)	12V	Device charging branch current (zone budget target ~100-120W)	F-10 branch fuse (10A baseline)	14 AWG duplex baseline

Additional Components Included In Topology Scope

- `48V` disconnect (`275A`)
- Pre-charge resistor (commissioning/soft-charge aid before connecting large DC loads)
- 12V negative busbar
- Shore AC inlet + cord/adapter interface hardware
- AC input breaker/disconnect hardware (compact load-center baseline; DIN-only if swapped at SKU lock)
- AC branch RCD/GFCI + breaker hardware
- Receptacle boxes + `120V` outlets (`4` planned locations: `2` galley, `2` office)
- Optional AC-out-2 branch protection path for future shore-only loads
- USB-C PD branch hardware (`4` DC-fed points, `2` office + `2` galley)
- Battery temperature sensor wiring to inverter/monitoring path
- SmartShunt fused positive sense/power lead (factory harness)

Assumptions (Explicit)

1. Cable sizing assumes stranded copper conductors, enclosed vehicle routing, and typical one-way run lengths of `<=10 ft` unless otherwise stated.
2. Voltage-drop design intent used here: `<=2%` on major `48V` power runs and `<=3%` on `12V` branch circuits.
3. `F-09` PV string fuse value (`15A`) remains provisional until final module datasheet max-series-fuse rating is confirmed.
4. Cerbo GX feed is assumed from the `12V` panel (`12V-07`) for branch-level serviceability.
5. Orion branch remains split-protection (`F-05` upstream feeder + `F-06` device-level input fuse).

6. Big 3 alternator-upgrade path is purchase-later; this diagram captures the current stock-alternator-first architecture.

Completion Status

- DC/PV topology is complete for current BOM scope and load model scope.
- AC hierarchy is now complete at architecture level, including transfer behavior, branch strategy, and protection chain.
- Remaining work is SKU-level part lock and run-length field validation for the now-locked AC/USB architecture.