

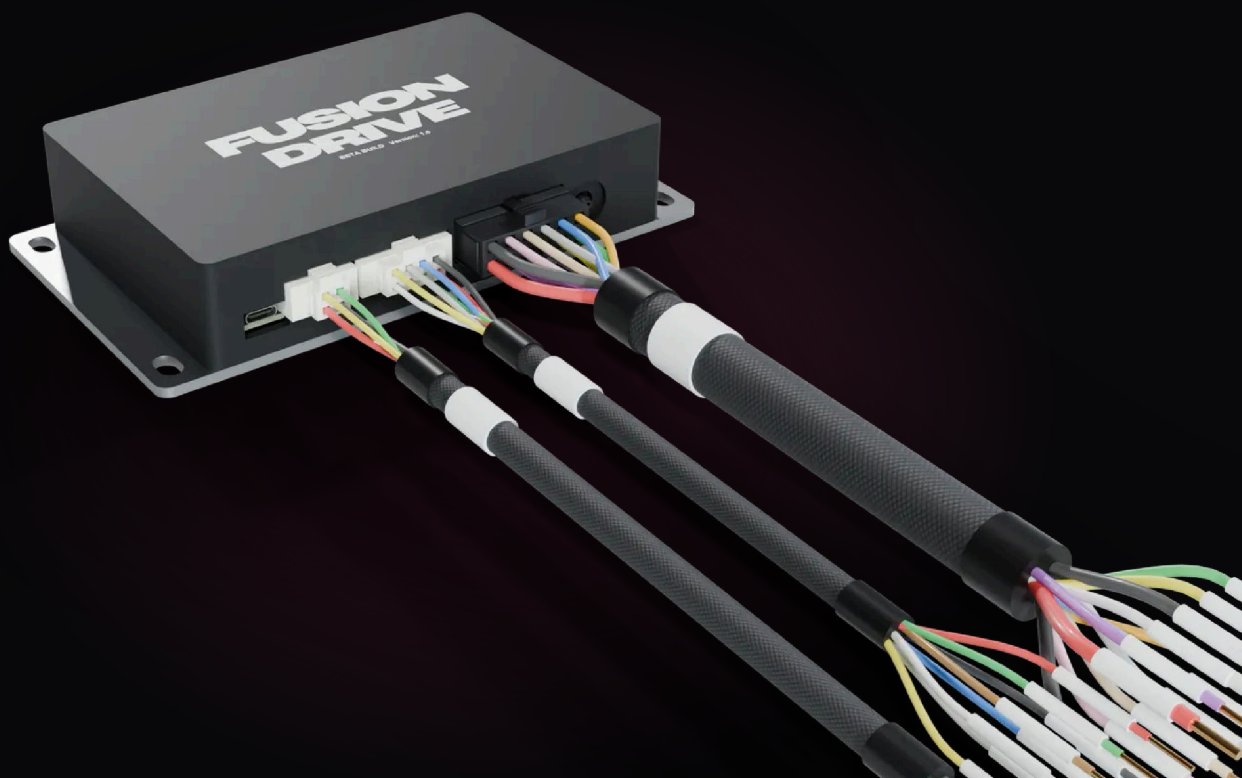


— SENSORS. CONTROLLERS. ACCESSORIES.

Connect your build.

Choose by interface.

Wire it. Configure it. Make it yours.



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1

— UNIVERSAL CONNECTIONS

Your build. Your connections.

FusionDrive brings compatible sensors, controllers and accessories into one place – whatever brand is on the box. Add measurements, request functions from equipment you already own, control suitable loads and run local automations around your whole setup.

A generic pressure sender, an existing gauge with a logging output, a reservoir switch, a pump or a custom CAN accessory can all be useful parts of an FD installation. A brand preset is optional. Start with the accessory's electrical interface and the job you want it to do.

1.1 Choose what you want to do

Your goal	Connection route	What remains in the car
See or log a measurement	Compatible linear voltage, a conditioned level or a supported CAN signal	Any electronics still needed to turn the physical quantity into that signal
Keep the original controls and add FD requests	Documented ground trigger, positive enable or isolated contact interface	Original controller, display, load driver and protective functions
Bring control into FD	FD OUT supplies power directly to a compatible load; add the required sensors and control/protection settings	The load, its wiring and required independent protection; extra electronics only where the interface needs them

Examples include oil, fuel, boost and exhaust pressure; gearbox or differential temperature; ethanol content; wideband lambda; fluid level/flow; position; accessory status; cooling, intercooler spray, auxiliary pumps, valves, warning lights and controller permissions. The installation must match the actual sensor, load and application.

1.2 Three things to establish first

- 1 The interface:** voltage or current range, supply, reference, polarity, impedance, waveform/protocol and response time.
- 2 The meaning:** its calibration or message definition, readiness/fault states, units and whether it reports a command or a physical measurement.
- 3 The operating envelope:** pressure, temperature, fluid compatibility, load current/inrush, driver type and the safe state when something is missing.

An output that measures between 0 and 5 V is not automatically a usable linear sensor signal. Likewise, an accessory marked PWM may expect a low-current command rather than chopped power. Use the matching recipe before connecting anything.

In these guides, **qualified means checked for the particular job** – matching voltage, current, waveform and wiring. It does not mean FD needs an extra module. Add an interface only where the electrical connection requires one.

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— UNIVERSAL CONNECTIONS

Find your wiring recipe

Choose from the accessory's specification. Use the numbered recipe for its circuit and setup; the inputs and outputs you assign remain shared across your whole installation.

2.1 Receive a measurement or state

Published interface	Recipe
Dedicated linear voltage wholly inside 0-5 V	U1 - sensor supply, signal and reference
Existing gauge/controller's compatible logging output	U2 - preserve the original measurement chain
Existing sender signal that needs a qualified shared tap	U3 - buffer the observation branch
Unpowered dry contact or float switch	U4 - slow state input with defined bias
Resistance, thermocouple, frequency, pulse, PWM duty or 4-20 mA	U5 - matched conditioner required
0-10 V, bipolar or differential analog	U5 - qualified conversion/reference interface; no direct IN connection
Powered 12 V status signal	U6 - protected receiver with bounded FD output
Documented compatible classic-CAN broadcasts	U7 - separate accessory CAN2 network

Compatible 0-4 V or 0.5-4.5 V outputs can use their own documented calibration within the input window. A sensor does not have to reach both 0 V and 5 V. Supply, loading, reference, validity and response still need to match.

2.2 Request a function or control a load

Published interface	Recipe
Compatible 12 V pump, solenoid, fan or lamp	U11 - direct PWM power from FD OUT
Ground-to-trigger / enable input	U8 - compatible low-side AUX request
Positive enable or isolated switch input	U11 if it accepts FD 12 V; U9 for another voltage or isolated contact
Additional permission in an existing switch chain	U10 - preserve native interlocks in series
Load exceeds FD capacity or needs another electrical interface	U12 - external driver only when needed

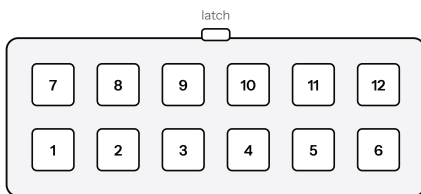
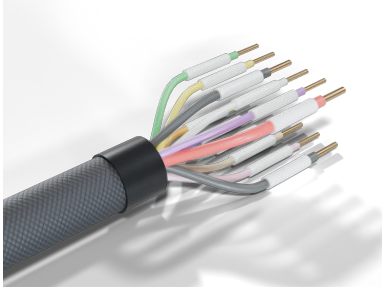
A servo, stepper, smart motor or analog-command device may require different power electronics or a protocol interface. Use its specified controller/interface; do not assume a generic PWM frequency is sufficient.

3

— UNIVERSAL CONNECTIONS

Know your FD connections

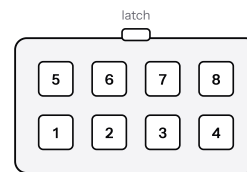
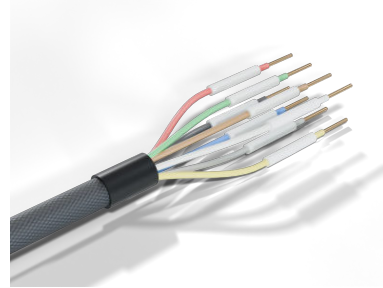
This guide is for the current **FD Design LS** board. It has six conditioned analog inputs, two low-side AUX outputs, four high-side OUT outputs and a separate CAN2 accessory bus. The drawings below show the actual FD harnesses and mating-face cavity views.

Harness B • J6 • 12-way

Bottom row, left to right: 1 BATT+ · 2 AUX1 · 3 IGN · 4 GND · 5 CAN2 H · 6 CAN2 L
Top row, left to right: 7 GND · 8 AUX2 · 9 OUT4 · 10 OUT3 · 11 OUT2 · 12 OUT1

Looking into the plug's mating face with the latch at the top

Original FusionDrive harness reference. Look into the plug mating face with the latch at the top. Wire drawings show logical terminal positions.

Harness C • J8 • 8-way

Bottom row, left to right: 1 IN1 · 2 IN2 · 3 IN3 · 4 +5V OUT
Top row, left to right: 5 IN4 · 6 IN5 · 7 IN6 · 8 GND

Looking into the plug's mating face with the latch at the top

Original FusionDrive harness reference. Look into the plug mating face with the latch at the top. Wire drawings show logical terminal positions.

3.1 Inputs and measurement supply - harness C / J8

Lead	Cavity / FD wire colour	Use
IN1 / IN2 / IN3	1 white / 2 brown / 3 green	Conditioned 0-5 V measurements or slow level inputs
IN4 / IN5 / IN6	5 yellow / 6 grey / 7 blue	Same input functions; six channels shared across the installation
+5 V OUT	4 red	Shared sensor supply, only for compatible sensors
SENSOR GND	8 black	Measurement reference; keep pump, relay and solenoid current out

Each input presents approximately **25 kOhm** to the sender in the current hardware design. The shared 5 V rail's design guidance is under approximately **500 mA total**, including its other consumers. That is not 500 mA per sensor or a verified assembled-board allowance. Add the actual consumption and margins; use an appropriate separate supply when needed.

Never join FD's 5 V output to an ECU or gauge's 5 V output. With an existing sender, keep its original excitation and assess the signal/reference loading; a buffer or independent sender may be necessary.

3.2 Control and power - harness B / J6

Lead	Cavity / FD wire colour	What ON does
AUX1 / AUX2	2 violet / 8 pink	Sinks a compatible input or return to ground; OFF releases it
OUT1 / OUT2	12 orange / 11 blue	Supplies positive load voltage from the dedicated feed
OUT3 / OUT4	10 grey / 9 tan	Same high-side function
Dedicated battery feed	1 red	Fused load supply for high-side outputs; ignition sense is not this feed
Power grounds	4 and 7 black	Connect both as specified for the installation
Ignition sense	3 white	Sense input used by an explicitly configured ignition policy
CAN2 H / CAN2 L	5 yellow / 6 green	Separate accessory CAN pair; never use as power/control wires

FD already contains four high-side PWM power drivers, designed for 10 A per OUT, sharing a 30 A fused supply. Compatible pumps, solenoids, fans and lamps connect directly: OUT to load positive, load negative to power ground (U11). No extra power-driver module is required for a load that fits FD. AUX1-2 are separate **1 A-class low-side** outputs for compatible ground requests or smaller loads.

Allow for running and start/stall current, PWM compatibility, wiring and temperature. Four simultaneous 10 A loads exceed the shared 30 A budget. The 10 A figure is documented design intent; final continuous performance still needs assembled-board testing.

Use the physically verified dedicated J6-1 feed for OUT loads. OBD power or a software feed indicator is not proof of a suitable pump/fan supply. The current board does not provide per-output current measurement or general short-circuit protection. Fit appropriate load wiring and fuses. Use U12 only if current/inrush or the electrical interface prevents direct OUT drive.

AUX is ground referenced and has clamp paths to FD's supply; it is not an isolated dry contact. Coordinate supply sequencing or use a suitable isolated interface so an independently powered accessory cannot backfeed an unpowered FD. Retain required transient, reverse-polarity and inductive-load protection.

3.3 Read the installation drawings

FD wire colours and cavity numbers identify its flying leads. Generic accessory wires are shown neutrally because their colours are unknown; connect by the accessory's documented terminal function. A sleeve marks a splice, a dot marks a junction, and a crossing without a dot is not connected. Logical terminal positions are not a connector-face pinout. Relays are shown with the coil de-energized.

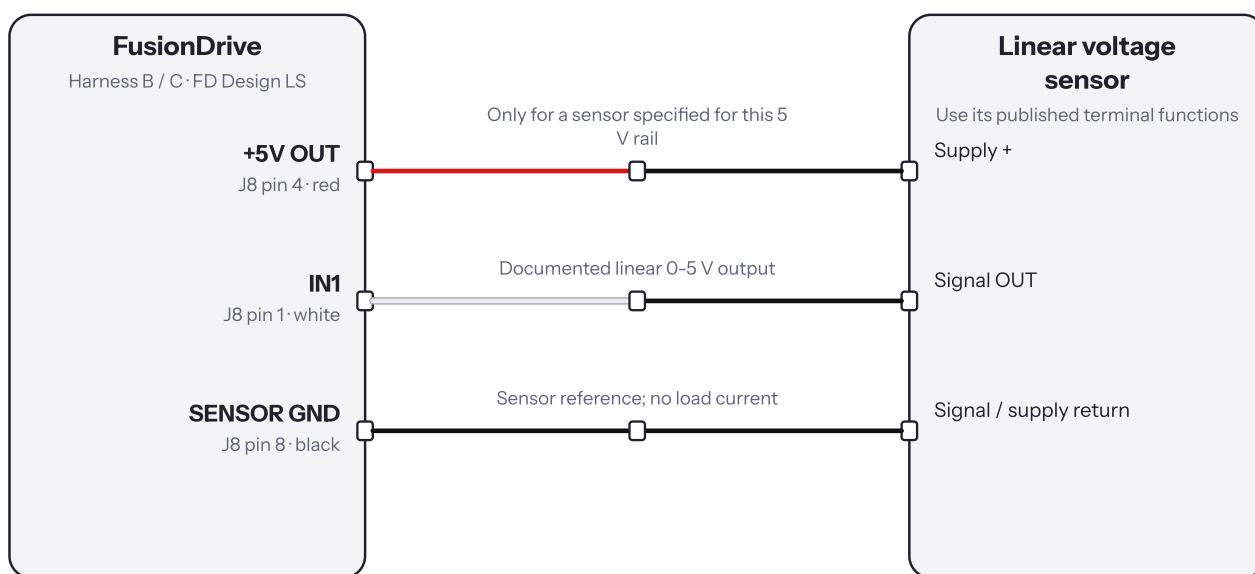
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— UNIVERSAL CONNECTIONS

Measurement wiring recipes

Choose a documented output whenever it is available. Keep an existing measurement chain intact, or use a dedicated sensor/conditioner where the original interface cannot be shared safely.

4.1 U1 • A dedicated linear voltage sensor



From	To	Interface
FD J8 pin 4 +5V OUT	Supply +	Only for a sensor specified for this 5 V rail
FD IN1 J8 pin 1	Signal OUT	Documented linear 0-5 V output
FD SENSOR GND J8 pin 8	Signal / supply return	Sensor reference; no load current

OFF / released: Sensor or FD unpowered: no reliable measurement. Check what the output does during supply loss.

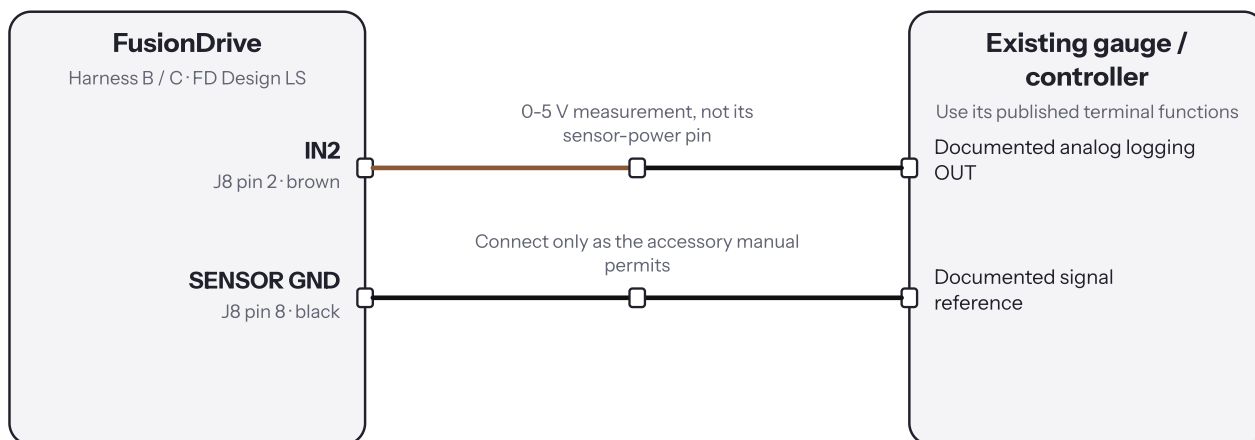
ON / active: FD reads the sensor voltage against J8-8 and converts it with the configured linear transfer.

App setup: Sensors > unused IN1 > Add Sensor > Type: Analog > Create. Use 0-5 V Generic, then edit the actual name, units and calibration. Leave extra voltage scale at 1 unless deliberately needed.

Prove it: For the hypothetical 0.5-4.5 V = 0-100 psi example, check 0.5 V = 0, 2.5 V = 50 and 4.5 V = 100. Also test supply loss and disconnected signal.

Installation detail: The sensor must accept 5 V excitation and the FD input load. If it needs another supply, follow that supply specification and connect only its compatible output/reference. Do not connect two 5 V rails together.

4.2 U2 • Keep a gauge or controller: use its logging output



FD lead colours are shown at left. Accessory wires are neutral: identify each terminal by function.

Connector positions here are logical; use the mating-face drawings to locate FD cavities.

From	To	Interface
FD IN2 J8 pin 2	Documented analog logging OUT	0-5 V measurement, not its sensor-power pin
FD SENSOR GND J8 pin 8	Documented signal reference	Connect only as the accessory manual permits

OFF / released: After loading and power-off checks pass, the original system retains its independent function when FD is absent. Keep its power, sensor, display and load wiring intact.

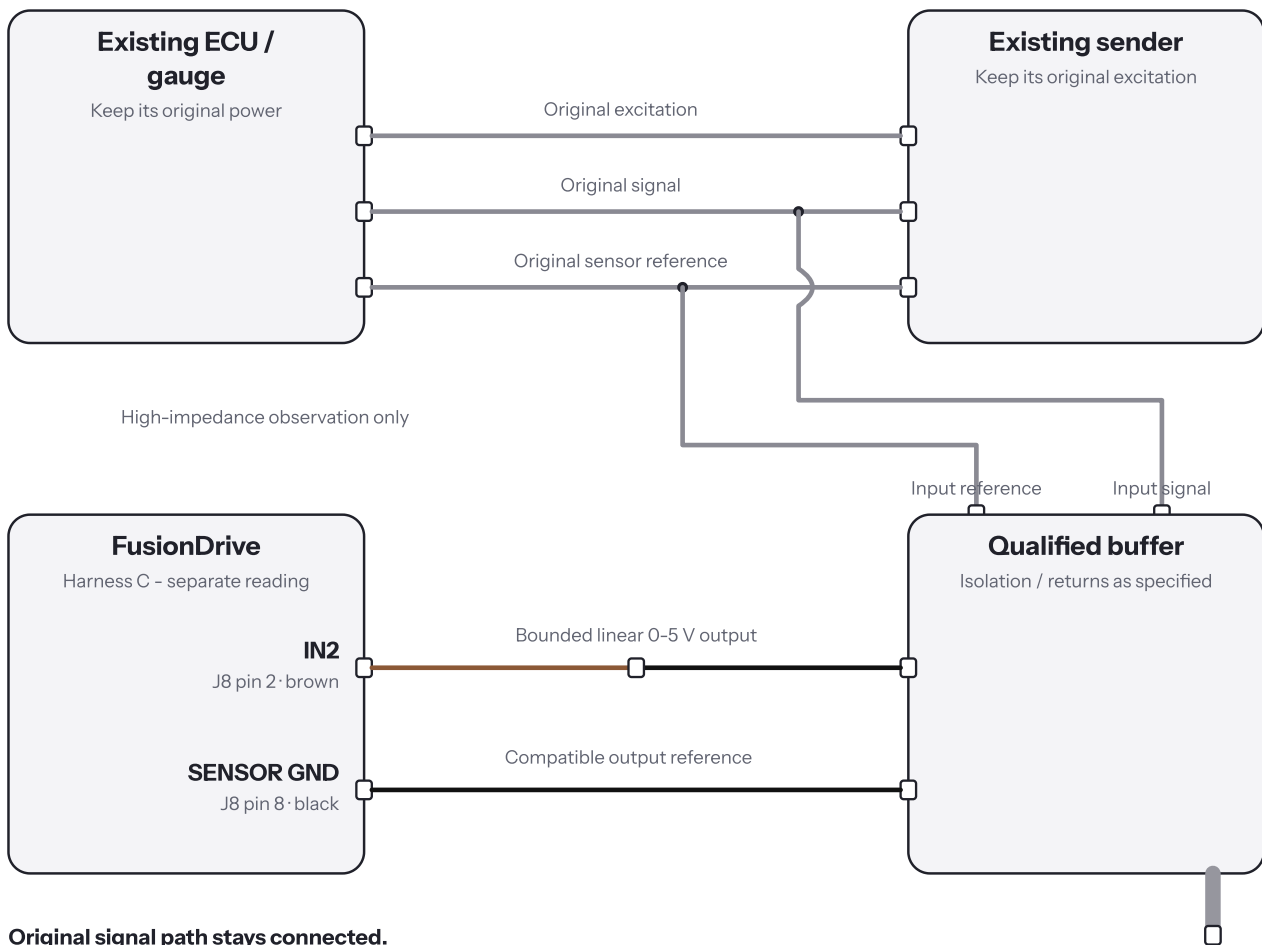
ON / active: FD displays and records the documented output. The gauge/controller still performs its native function.

App setup: Create IN2, name the actual quantity, and enter the logging-output transfer. If the output is lambda, use lambda; an AFR scale requires the stated fuel reference.

Prove it: Compare FD and the original instrument at three operating points. Check startup, warm-up, fault codes, sensor disconnection and power-off behavior.

Installation detail: Keep the existing supply and load loom intact. A spare logging output is different from tapping the original sensor. An in-range fault voltage may look like a real measurement; decode or measure readiness separately where required.

4.3

U3 · Observe an existing sender through a qualified buffer

Original signal path stays connected.

Bridge at the signal/reference crossing = no connection. Dots mark the two observation branches.

Input and output references may be isolated. Complete the selected buffer circuit; no 5 V rails are joined.

From	To	Interface
Retained sender signal to existing ECU/gauge	Buffer high-impedance input	A branch only; original signal path remains intact
Retained sender signal reference	Buffer specified input reference	Qualified observation return; isolate from output reference if required
Buffer conditioned OUT	FD IN2 J8 pin 2	Bounded linear 0-5 V signal
Buffer signal reference	FD SENSOR GND J8 pin 8	Compatible reference; use isolation if required
Specified protected supply and return	Buffer complete power interface	Independent qualified supply; no rail joining

OFF / released: A qualified buffer must leave the original sender/receiver unaffected when FD or the buffer is off.

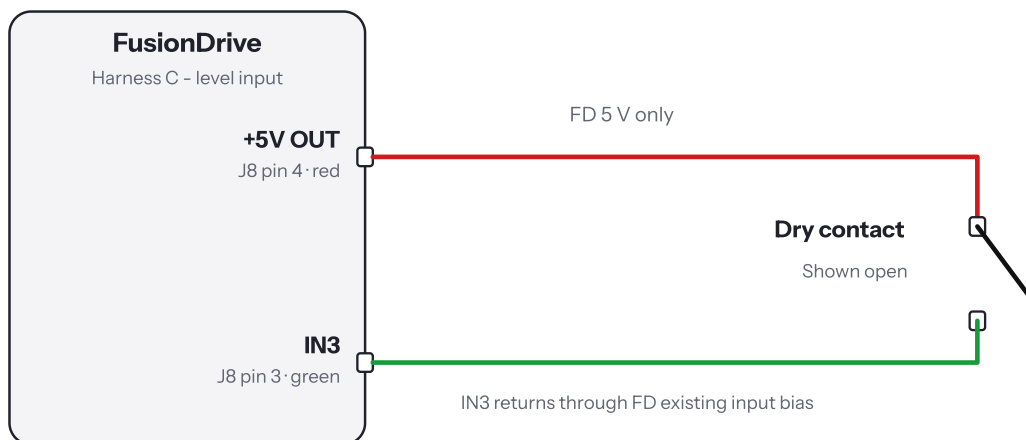
ON / active: The existing receiver sees its original signal; FD receives a separate buffered measurement.

App setup: Configure IN2 from the buffer output specification. If it changes scale or linearizes a sender, use the resulting transfer rather than the raw sender curve.

Prove it: Measure the original reading before/after the branch, with FD on/off, buffer on/off and signal/ground faults. Qualify loading, grounding, bandwidth and power sequencing.

Installation detail: FD analog inputs present about 25 kOhm at the connector. Direct tee wiring is not automatically invisible. A buffer also does not automatically convert a nonlinear sender; select the complete required measurement interface.

4.4 U4 • A dry contact, float or slow switch



Closed = near 5 V. Open = normally low. A broken wire can look like an open contact.

Use a contact rated for low signal current; verify actual voltages and contact reliability.

From	To	Interface
FD +5V OUT J8 pin 4	Dry contact terminal A	No external voltage on this contact
Dry contact terminal B	FD IN3 J8 pin 3	Closed applies 5 V; open uses FD input bias

OFF / released: With the contact open, the FD input bias normally pulls the reading low. A broken wire can produce the same result.

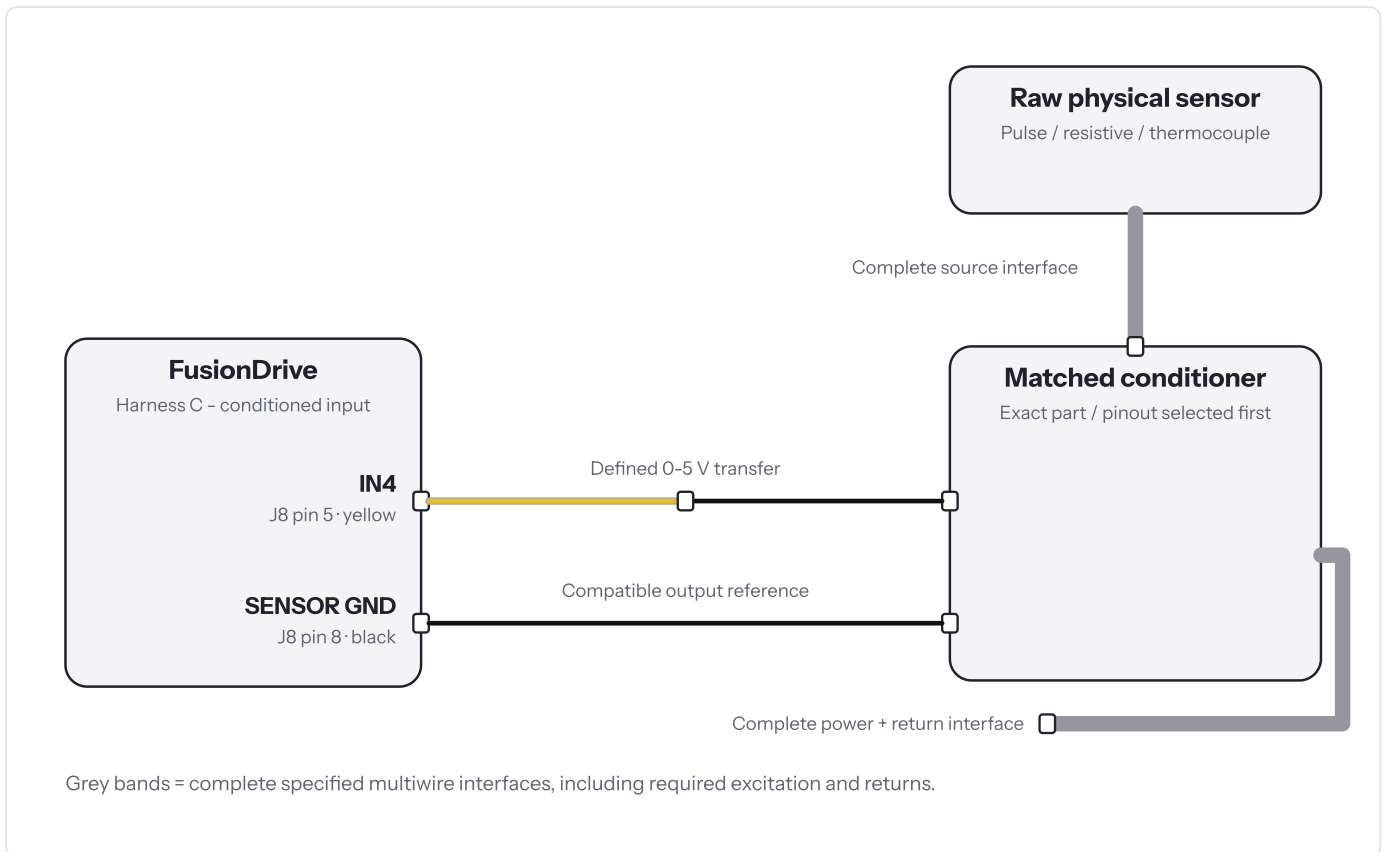
ON / active: With the contact closed, the input reads near the FD 5 V rail. Contact current is limited by the input circuit.

App setup: Create IN3 with Type Digital (On/Off). Set Switch threshold (V), Hysteresis half-band (V) and Reverse level logic for the chosen normally-open or normally-closed contact. Name the meaning, for example Reservoir healthy.

Prove it: Measure actual open/closed voltages. As an illustrative starting point only, Switch threshold 2.5 V and Hysteresis half-band 0.5 V initialize high above 2.5 V, then transition high above 3 V and low at/below 2 V. Test contact bounce and broken wires.

Installation detail: This is a slowly sampled state input, not a pulse counter. The shown circuit switches 5 V to IN; a contact to ground alone is not equivalent. Do not put an externally powered 12 V switch output on IN.

4.5 U5 • Special sensors through a matched conditioner



From	To	Interface
Raw sensor / pulse source	Complete conditioner sensor interface	All specified excitation, signal and return wires
Conditioner linear OUT	FD IN4 J8 pin 5	Bounded 0-5 V output with defined transfer
Conditioner output reference	FD SENSOR GND J8 pin 8	Signal reference only
Specified protected supply and return	Complete conditioner power interface	Match voltage and power-loss behavior

OFF / released: A missing sensor or failed conditioner must have a known reported fault behavior; it may not simply become zero.

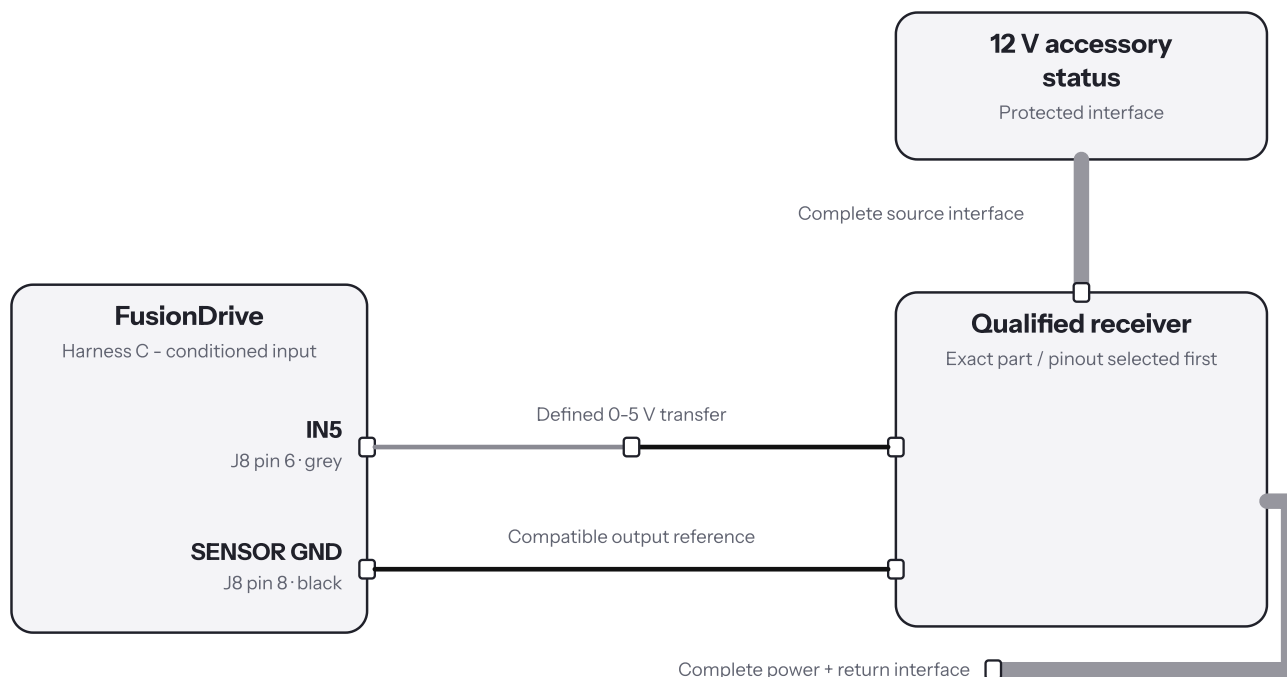
ON / active: The conditioner converts the raw sensor into a measurement the current FD input path can interpret.

App setup: Use the conditioner output calibration on IN4. Match units and the conditioner filtering/response time to the measurement. Keep a separate ready/fault channel if needed.

Prove it: Stimulate the original physical source at several points. Test open/short sensor faults, conditioner supply loss, saturation and response delay.

Installation detail: Examples: thermocouple amplifier with cold-junction compensation; thermistor/RTD linearizer; pulse/frequency-to-voltage converter; 4-20 mA receiver; PWM-duty receiver. A bare LSU oxygen sensor still needs its matched wideband controller. Select actual parts before wiring.

4.6 U6 • Read a 12 V accessory status safely



Grey bands = complete specified multiwire interfaces, including required excitation and returns.

From	To	Interface
Accessory 12 V status and reference	Complete protected receiver input interface	All specified source signal/reference wires
Receiver logic OUT	FD IN5 J8 pin 6	Bounded 0-5 V in normal and fault states
Receiver output reference	FD SENSOR GND J8 pin 8	Use isolated output if references require it
Specified protected supply and return	Complete receiver power interface	Match source and FD power sequencing

OFF / released: Status OFF must map to a defined inactive value. A missing supply or broken wire must be considered separately.

ON / active: A qualified receiver translates the accessory status into a bounded FD level.

App setup: Create IN5 with Type Digital (On/Off). Set polarity from the receiver, not from the original 12 V wire alone. Use it as commanded/active status unless its meaning proves actual delivery.

Prove it: Test status low/high, both systems powering in either order, open signal, short-to-ground and permitted overrange faults at the receiver input.

Installation detail: FD IN is not a general 12 V digital pin. A resistor divider alone is not a universal automotive receiver. Use a specified interface with suitable transient protection, impedance, isolation where required and power-off behavior.

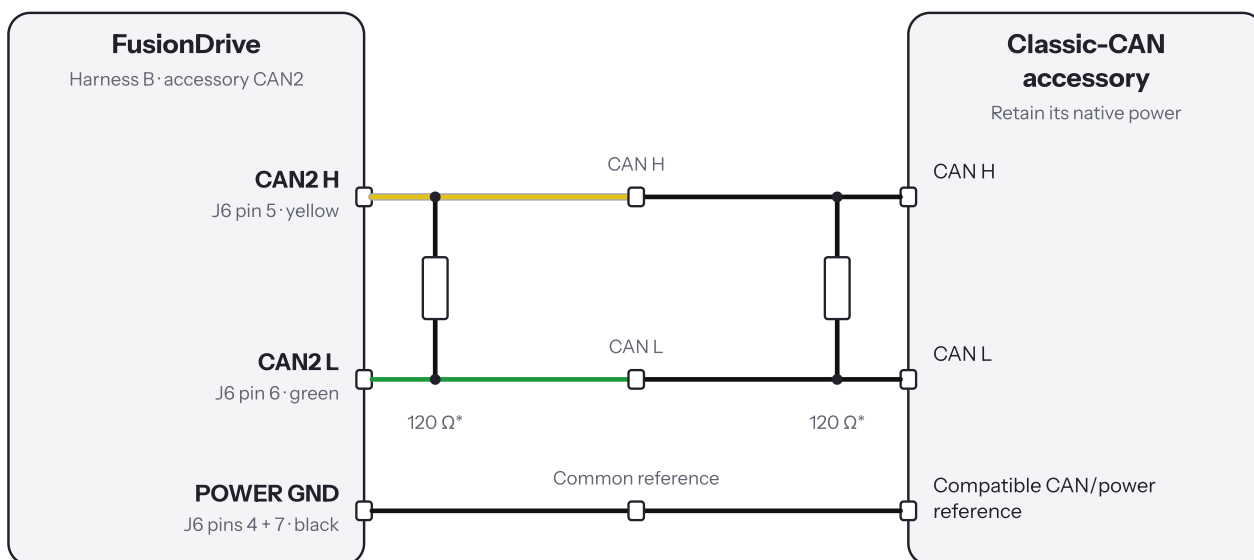
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— UNIVERSAL CONNECTIONS

Connect an accessory on CAN2

CAN2 can carry several measurements on a pair of wires when the accessory publishes a supported message format. The current software receives **classic CAN frames up to eight bytes**. It does not automatically identify the meaning of arbitrary traffic.

5.1 U7 • A separate CAN2 accessory network



*Exactly two end terminations in the complete bus. Use existing resistors; add only missing ones.

Keep H/L twisted. The reference conductor is separate from the CAN pair. Match bitrate and frame format.

From	To	Interface
FD CAN2 H J6 pin 5	CAN H	Accessory bus H
FD CAN2 L J6 pin 6	CAN L	Accessory bus L
FD POWER GND J6 pins 4 + 7	Compatible CAN/power reference	Reference separate from H/L; retain correct power returns

OFF / released: No fresh matching messages means no fresh accessory measurement. Bus initialized is not proof of accessory health.

ON / active: FD receives documented classic-CAN broadcasts and decodes selected integer fields.

App setup: More > OBD Settings > Accessories · CAN2. Match 250/500/1000 kbit/s; start with transmit disabled. Open Accessory signals & decoders, then add a decode or Import DBC.

Prove it: Confirm ID, standard/extended format, payload length, bit layout, units and readiness/fault fields. Verify raw bytes against an independent known value and stop traffic to prove stale handling.

Installation detail: Keep this network separate from vehicle CAN1. Use exactly two end terminations; FD J12 controls its 120 Ohm resistor and is open by default. A lone transmitting accessory may need an ACK-capable receiver: deliberate normal mode may be needed after compatibility is established; listen-only FD does not ACK. Do not enable unsolicited transmit mappings.

5.2 Configure from the accessory's actual message definition

- 1 Read the exact firmware/protocol document or supported DBC for the accessory. Record its power, bitrate, IDs, standard/extended flag, payload length, signal position, signedness, byte order, multiplier, offset and units.
- 2 Enable CAN2 at the matching supported bitrate. Observe the raw traffic with transmission disabled first. Correct termination and the need for an ACK-capable receiver depend on the complete network; listen-only FD does not acknowledge frames.
- 3 Add the required integer signals manually or import the supported DBC entries. Name every measurement clearly. Several signals may come from the same frame; give them distinct labels.
- 4 Select readiness, fault and validity fields as separate decodes where the accessory defines them. Add the necessary conditions to any automation; importing a value does not automatically associate its fault bits.
- 5 Save to the device, wait for acknowledgement, reload the configuration and check the decoded reading against an independent known value. Stop the accessory's traffic and verify the actual loss-of-data response.

5.3 A decoding example, not a universal CAN address

Suppose a hypothetical accessory specifies standard ID **0x600**, an unsigned 16-bit little-endian pressure at payload bits 0-15, multiplier **0.1**, offset **0**, unit **kPa**. Bytes **E8 03** represent 1000, so the decoded value is **100.0 kPa**. This only demonstrates the arithmetic. Use the IDs and layout supplied for the actual accessory; do not transmit this example onto a vehicle network.

Current decode rules support 1-64-bit integer layouts, signed/unsigned Intel/Motorola decoding and scale/offset. Results become floating-point values, so a 64-bit field does not preserve arbitrary 64-bit integer precision. DBC multiplexed and floating-point signals are not supported by the current import path. A DBC range or enumeration does not become an automatic validity rule.

CAN2 has no general accessory request/response polling engine in the current implementation. Use supported broadcast messages, a configured accessory broadcast mode or a compatible gateway. Sensor-to-CAN transmit mappings are a separate broadcasting feature, not an arbitrary polling tool. Keep transmit disabled unless the exact receiving system and message plan require it.

5.4 Freshness and health

For generic decoded-CAN automation sources, the current firmware treats a measurement as unavailable after **1,000 ms** without a valid matching update. A malformed/truncated frame does not refresh the cache; a previous reading can remain until it expires. That timeout may be too slow for some protective uses.

CAN2 Connected indicates bus initialization, not that a particular accessory or measurement is healthy.

Guard the actual measurement and its documented ready/fault signals. Missing required sources reset the rule; this does not make every accessory physically safe or return an external stepped boost controller to a low group.

CAN1 remains the vehicle/OBD path. Use supported available vehicle measurements where appropriate and account for their actual rate, units and freshness. Do not bridge the vehicle and accessory buses just because both use CAN.

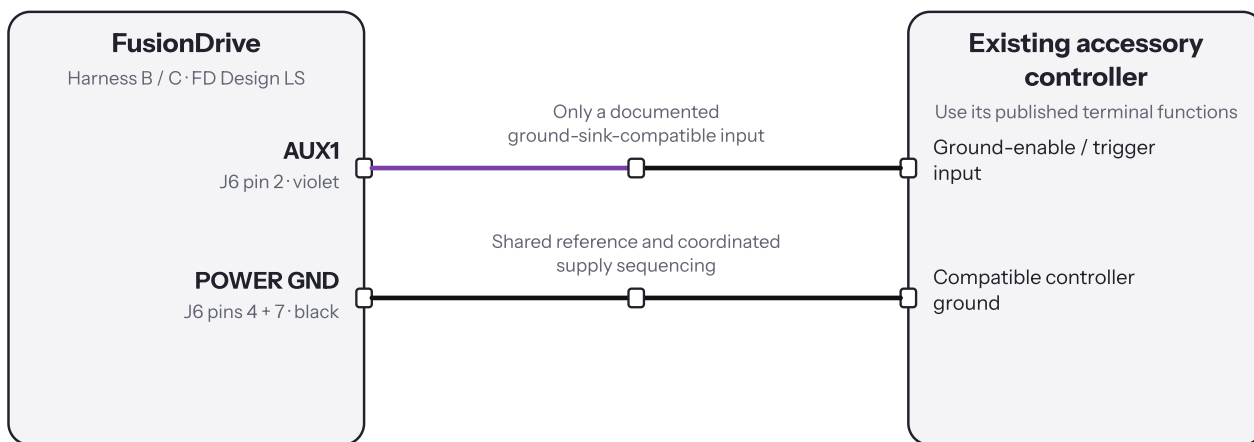
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— UNIVERSAL CONNECTIONS

Control wiring recipes

Start with U11 for direct load control. FD OUT1-4 provide PWM power to compatible pumps, solenoids, fans and lamps. U8-U10 add requests to a retained controller or provide an isolated contact where needed. U12 is the exception for loads outside FD capacity or requiring another electrical interface. Replacing a controller also requires its necessary control, measurement and protection functions.

6.1 U8 • Request a documented ground-trigger input



FD lead colours are shown at left. Accessory wires are neutral: identify each terminal by function.

Connector positions here are logical; use the mating-face drawings to locate FD cavities.

From	To	Interface
FD AUX1 J6 pin 2	Ground-enable / trigger input	Only a documented ground-sink-compatible input
FD POWER GND J6 pins 4 + 7	Compatible controller ground	Shared reference and coordinated supply sequencing

OFF / released: AUX released: the accessory follows its own inactive-input behavior. With validated supply sequencing, FD power loss also releases the request; rule out clamp-path backfeed.

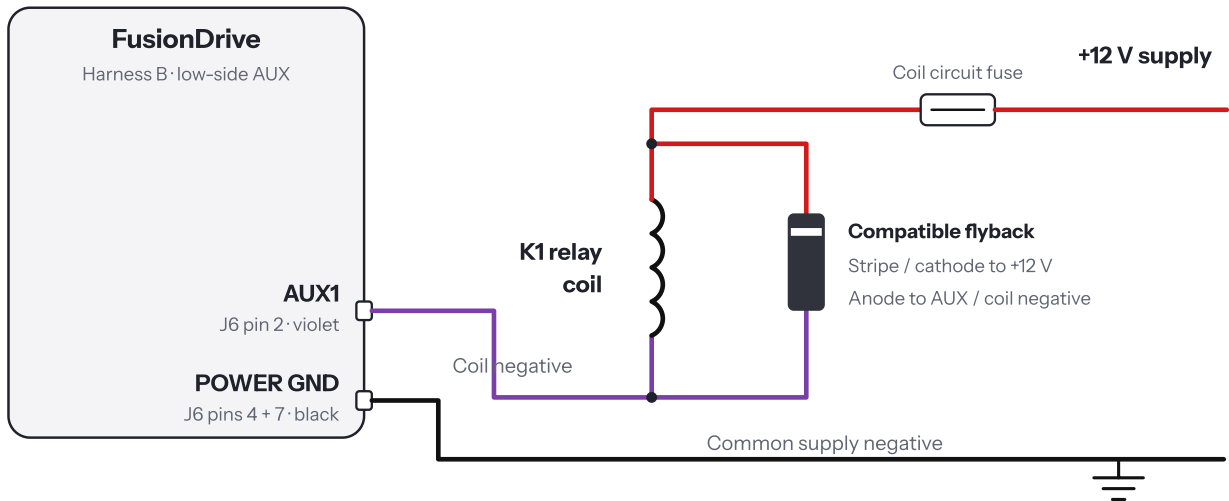
ON / active: AUX sinks the input toward ground. The accessory decides whether this means enable, inhibit, scramble or a step pulse.

App setup: Use a free AUX1 in More > Outputs, or assign a dedicated controller role. For a level request use verified binary 0/100%; for a momentary request use compatible Custom EBC pulse control or a timed automation pulse. Manual duty stays commanded until cleared.

Prove it: Measure pull-up voltage, sink current and unpowered backfeed; test both power-up orders. Confirm the actual function when held, pulsed, released and disconnected.

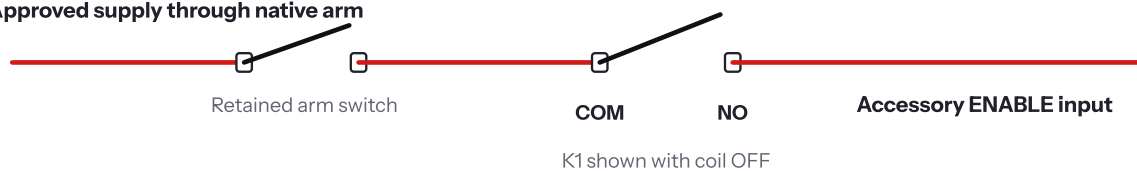
Installation detail: Retain native controller power, displays, load wiring and interlocks. Ground-to-inhibit is not fail-safe permission: loss of FD releases the inhibit. AUX is neither a dry contact nor a 0-5 V analog output. Use an isolated interface when the references/supplies require it.

6.2 U9 • Provide an isolated positive enable



K1 CONTACTS • electrically isolated from the coil

Approved supply through native arm



Coil and contact circuits remain separate. A mechanical relay is binary only: 0% or 100%.

NO closes only when energized; OFF interrupts the permitted path.

Match coil current, suppression polarity and contact ratings to the selected relay before installation.

From	To	Interface
Fused coordinated 12 V supply	Relay coil positive	Select coil and suppression for this supply
FD AUX1 J6 pin 2	Relay coil negative	Compatible coil current; binary only
Accessory permitted supply via native arm/safety interlocks	Relay COM	Accessory-defined positive voltage after original interlocks
Relay NO	Accessory ENABLE input	NO closes only when coil is energized
FD POWER GND J6 pins 4 + 7	Coil supply negative	Coil reference; contacts remain isolated

OFF / released: Coil released: NO contact open, additional enable removed. Retain any separate native safety function.

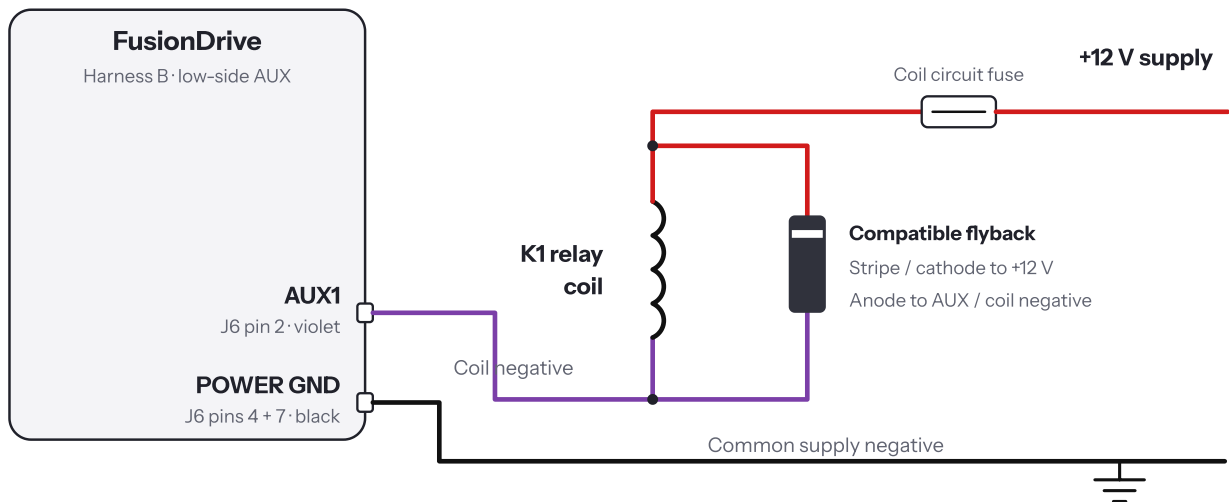
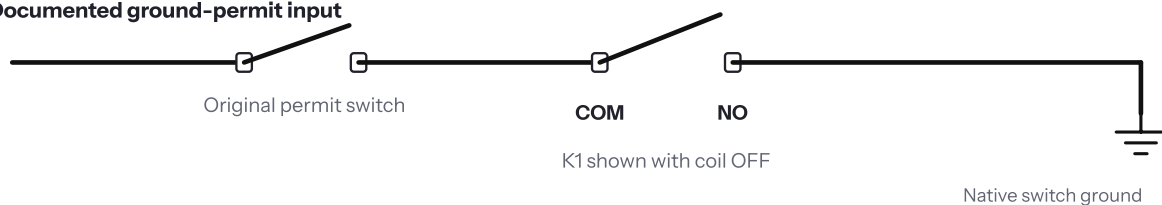
ON / active: Coil energized: NO joins the accessory permitted supply after its original arm/interlocks to ENABLE.

App setup: Free AUX1, binary 0/100%, no ramps or output calibration. Save/reload. Use the accessory specified voltage on the isolated contact circuit.

Prove it: With the load prevented from operating, prove contact open/closed, native arm behavior, rule false, missing input, FD power loss and welded-contact risk handling.

Installation detail: Coil and contact voltage can differ. Never substitute FD 12 V for an undocumented 5 V enable. Choose exact coil/contact ratings and terminal labels from the selected relay. Suppression polarity must match; a mechanical relay cannot produce progressive PWM.

6.3

U10 • Add permission without bypassing the original switch**K1 CONTACTS • electrically isolated from the coil****Documented ground-permit input**

Coil and contact circuits remain separate. A mechanical relay is binary only: 0% or 100%.

NO closes only when energized; OFF interrupts the permitted path.

Match coil current, suppression polarity and contact ratings to the selected relay before installation.

From	To	Interface
Fused coordinated 12 V supply	Relay coil positive	Compatible coil supply
FD AUX1 J6 pin 2	Relay coil negative	Binary 0/100%; compatible suppression
Accessory documented ground-permit input	Existing native switch then relay COM	Original switch stays in series
Relay NO	Native switch reference ground	Requires both original and FD permission
FD POWER GND J6 pins 4 + 7	Coil supply negative	Contacts isolated from coil circuit

OFF / released: Either native switch open or added NO contact open breaks this ground-permit path.

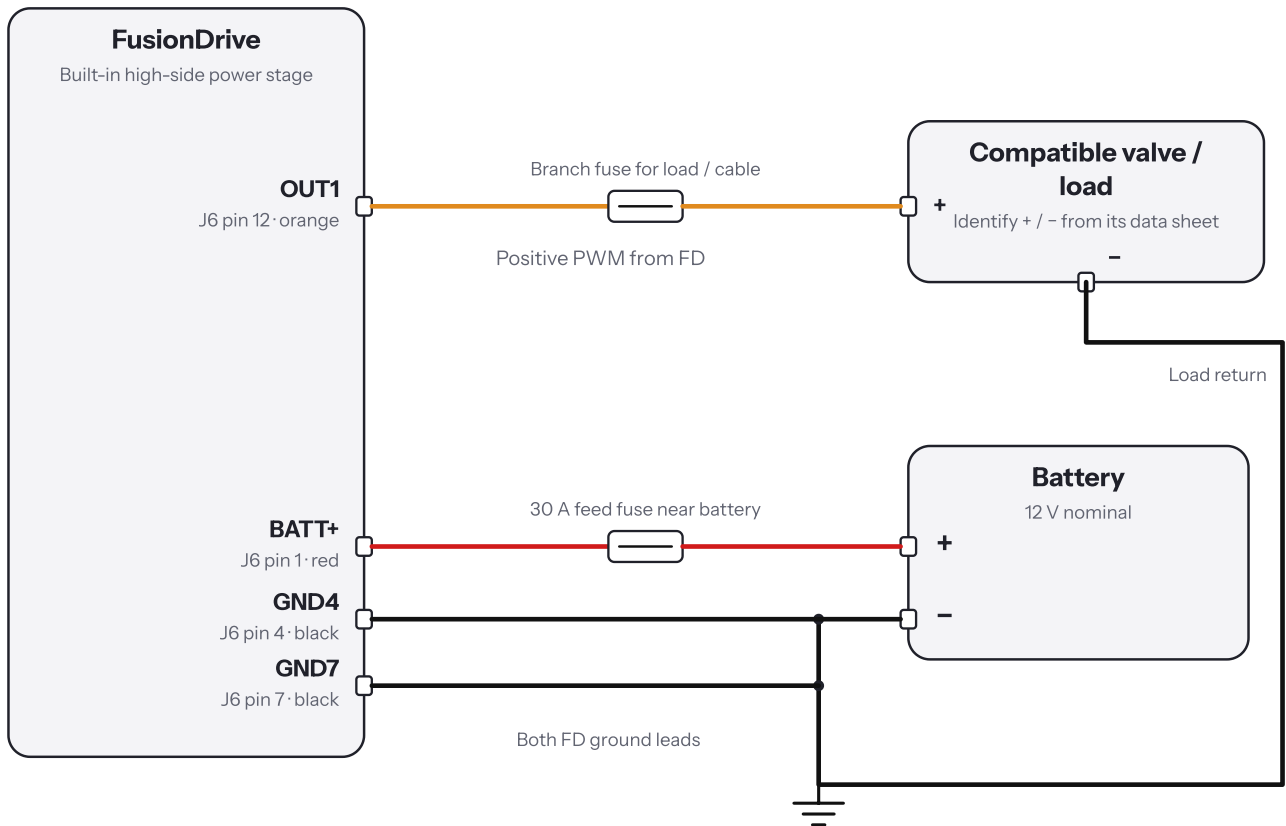
ON / active: Only both native permission and energized FD relay complete the documented permit path.

App setup: Assign a free AUX, configure reversible permission from explicit valid conditions, and establish a known OFF baseline. Save/reload and test the release behavior.

Prove it: Test all four combinations of native switch open/closed and FD contact open/closed. Also test missing input, disabled rule, restart, maximum active time and FD supply loss.

Installation detail: This is a documented ground-permit example. Do not insert it into an unknown ECU/injector/ignition signal. A parallel bypass wire would defeat the original switch. Restoration of a previous ON state is not an OFF guarantee.

6.4 U11 • Drive a load directly from FD



OUT1-4: designed 10 A each, shared 30 A fused feed. Verify actual running / start current and heat.

Disconnect both old controller/load wires. Use the load maker's required suppression and PWM frequency.

From	To	Interface
Battery through correctly sized external fuse/cable	FD BATT+ J6 pin 1	Dedicated feed, not OBD load power
FD OUT1 J6 pin 12	Load positive	PWM load power from FD - no extra driver
Load negative	Rated power return	Keep load current out of J8 sensor ground
FD POWER GND J6 pins 4 + 7	Common power ground	Both ground leads connected

OFF / released: OUT off removes the FD sourced command. Other supplies or wiring can still create alternate current paths.

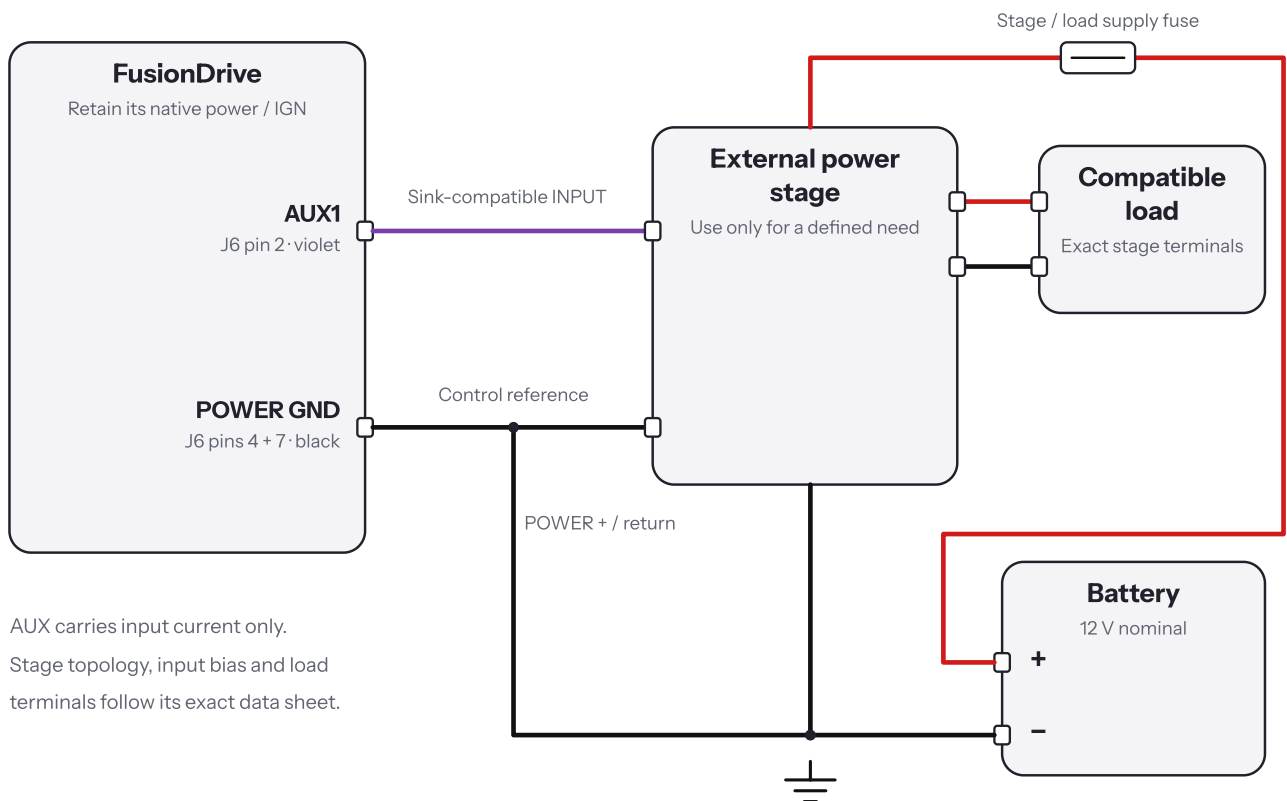
ON / active: FD supplies PWM power directly to the load positive lead from its dedicated feed. No separate power driver is needed when the load fits the FD output.

App setup: More > Outputs > select the physical OUT/AUX. Start Mode Off. Select frequency, duty limits, ramps and calibration from the load specification. For a lamp or relay use suitable binary operation.

Prove it: Use a current-limited test load first. Then qualify actual steady/inrush/stall current, flyback/turn-off behavior, simultaneous-load temperature, dedicated feed and ignition policy.

Installation detail: OUT1-4 are designed for 10 A per channel and share a 30 A fused feed. Account for running/start/stall current, PWM and temperature; do not allocate four simultaneous 10 A loads. Retain required suppression/protection and disconnect both old driver-to-load connections. Use U12 only when direct drive does not fit.

6.5 U12 • External driver: only when needed



AUX carries input current only.

Stage topology, input bias and load terminals follow its exact data sheet.

Exception: use a separate stage only for a specified current, inrush, thermal, polarity or interface need.

From	To	Interface
FD AUX1 J6 pin 2	Driver ground-sink PWM input	Verify voltage/current, polarity and frequency
FD POWER GND J6 pins 4 + 7	Driver compatible command reference	Separate from load-current routing
Battery via rated fuse	Driver POWER	Driver owns the load power path
Driver load terminals	Load terminals	Exact topology follows the selected driver

OFF / released: A lost or unpowered FD command must produce the chosen safe driver state; verify its input bias and missing-command policy.

ON / active: The external driver switches load power from the FD command and retains its native enable/interlock wiring. FD duty does not prove actual current, speed or fluid delivery.

App setup: Assign the free output to the correct generic or dedicated control function. Match the driver input waveform; test 0%, an intermediate command and 100% only where allowed.

Prove it: Test driver enable/interlocks, missing command, reversed power-up order, frequency limits, duty bounds, current/thermal behavior and independent measurement of the load.

Installation detail: Use U11 direct drive first. U12 is for loads beyond FD current/inrush capability or those needing a separate power stage. Retain required motor electronics. This drawing requires a ground-sink PWM input with matching pull-up, frequency and power sequencing. Stepper, servo, analog or serial inputs need their own specified interface; this drawing does not convert those protocols.

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— UNIVERSAL CONNECTIONS

Configure, save and prove it

Current app workflow: Configure this installation from its function in Settings. Controls provides live actions and the Dashboard provides glance controls; use a card's edit menu to return to setup. A configured output remains visible even when disabled. Enabled rules operate their assigned enabled outputs automatically; there is no extra output mode to select. Live Off, On or duty takes over a generic output until you choose Resume automation. Setup keeps the electrical limits, calibration and response settings. Assigned boost, WMI and nitrous outputs use their controller-specific actions, preserving sensor protections and any paired fuel/stage logic. Nitrous Arm allows its configured activation conditions to operate; it is not an unconditional spray command.

Setup and vehicle data: Starting presets remain editable; Add Sensor includes calibration and fine tuning before Create. Use dedicated IGN, fresh running-engine OBD evidence, or both for vehicle activity; a dedicated IGN wire is optional when valid OBD evidence is available. If the pressure hose is unused, explicitly select OBD pressure in setup. A valid atmospheric sensor reading cannot identify a disconnected hose. These app choices do not change the product-specific electrical compatibility or limitations described below.

The phone is a configurator, display and recorder. Saved sensors, output settings, controllers, CAN definitions and automations live on the ESP and run there. Editing a draft field is not the same as receiving acknowledgement that the device saved it.

7.1

Calibrate a generic voltage input

- 1 Connect to the intended FD in normal mode. Open **Sensors**, select an unused input, then **Add Sensor > Type: Analog**. Use **0-5 V Generic** as a neutral starting point and complete calibration and fine tuning before Create.
- 2 Set a useful name and correct unit. Enter the documented low/high connector voltages and their matching engineering values. The low voltage must be lower than the high voltage; descending engineering values are allowed.
- 3 Keep the extra voltage scale at 1 unless you deliberately need it. Set display limits separately; a gauge display range is not the sensor transfer curve.
- 4 Save and wait for acknowledgement. Use the circular-arrow refresh to fetch the sensors from the device, reopen the entry and verify the saved values.
- 5 Check at least three points using a known stimulus/reference. Watch live connector voltage, acquisition age and signal status. Test both physical response and electrical faults.

The linear conversion is **value = low value + (voltage - low voltage) x (high value - low value) / (high voltage - low voltage)**. For the hypothetical 0.5-4.5 V = 0-100 psi sender, 2.5 V gives 50 psi. These numbers are an example, not a generic pressure-sensor preset.

A thermistor, nonlinear position sender or frequency sensor cannot be made accurate merely by entering two endpoints. Retain the necessary electronics or use a conditioner that outputs a supported signal.

7.2 Decide what a fault looks like

Analog samples older than **500 ms** become unavailable in the current input path. Engineering conversion rejects voltages outside the configured window plus a 2.5% span margin; values within that margin can clamp to an endpoint. Neither behavior proves that a sensor is healthy.

An open circuit may read zero, zero can be a valid 0-5 V measurement, and a sender's in-range error output can resemble a plausible value. Use raw voltage, availability and separate readiness/fault information where needed. Establish suitable plausibility and cross-checks for the actual application.

For a level input, threshold and hysteresis define switching; Reverse Logic changes the meaning. Identify whether broken wiring should mean unhealthy. It is a sampled level input, not guaranteed capture of a brief pulse or accurate frequency/duty measurement.

7.3 Set up a generic output

- 1 Keep the physical load disconnected. Open **More > Outputs > select the physical OUT/AUX**. Confirm the channel label, pin and current owner; start with Mode Off.
- 2 Name the function. Choose Generic or a relevant starting preset, then enter the accessory's verified frequency, duty limits, ramps and output calibration. For a mechanical relay, use binary 0/100%, no ramp and no duty calibration.
- 3 Choose the ignition policy deliberately. **Turn off on Ignition Off** needs J6-3 correctly connected and tested; it is not a phone-disconnect policy and is not enabled by default.
- 4 Tap Save, wait for **Saved to device**, then **Reload saved values**. Compare the saved configuration before operating a dummy load.
- 5 For an isolated manual test, configure and enable the channel, save and verify its setup, then use Controls to prove physical Off → intended On → Off. Clear manual demand afterward. Choose **Resume automation** for generic automation control before testing the rule. Keep Off while wiring; test all required release and power-sequencing states before using the real load.

The accepted software setting range is **1-40,000 Hz and 0-100% duty**. This is not a tested electrical range for every channel or load. The driver uses 8-bit PWM hardware resolution; presets are starting values, not component approvals. PWM switching is not a native 0-5 V analog output.

7.4 Allocate shared outputs once

Six inputs and six outputs are a shared installation budget. An output owned by boost, WMI, nitrous or EBC cannot simultaneously be a separate generic duty channel. Controller assignments can reserve a channel even while that controller is disabled. Use the supported controller action when changing an owned function.

Dedicated functions are under **More > Boost Control / WMI Control / Nitrous**. For a compatible external stepped boost controller, use **More > Boost Control > Third-party EBC > Controller setup > EBC Model > Custom EBC**. Its one/two ground-trigger wires, group count and pulse timing must match the accessory. FD does not automatically receive confirmation of the actual external group.

External EBC uses AUX1 for one wire and both AUX1/AUX2 for two. A wet nitrous stage needs separate nitrous and fuel control outputs. An extra safety request consumes another channel. Write the complete allocation down before buying interfaces or terminating wires.

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— UNIVERSAL CONNECTIONS

Local automations and useful logs

The current local rule engine supports ten rules, up to eight conditions and eight actions per rule, expression logic, hysteresis, trigger/release delay, cooldown, maximum active time, timed actions and bounded acyclic rule links. Nominal computation is every 20 ms; that is not a measured end-to-end response time through a sensor, CAN transport, interface and load.

8.1 Build a rule around a real state

- 1 Choose an available calibrated measurement, level, OBD value or decoded CAN source. Include explicit accessory readiness and health conditions where those fields exist.
- 2 Set the thresholds, hysteresis and timing from the actual process. Longer debounce can suppress noise but delays response. Match the measurement's rate to the job.
- 3 Add a permitted output or controller action. Avoid two unrelated rules fighting over the same hardware. Establish the intended normal, active and released states.
- 4 Configure **Restore Previous Value When False** only with a known baseline. Restoring a previous ON state is not an OFF guarantee. Some setting actions are not reversible permits.
- 5 Save, read back, and test false/true, missing source, disabled rule, timeout, cooldown, restart and power loss. Record the physical result, not just the button state.

Missing required sources reset a rule immediately, even when a release delay, OR or NOT would otherwise suggest a hold. Generic output requests are cut on that reset, and affected dedicated controllers are disabled by supported safety paths. This does not universally reset an external EBC group, reverse every setting action or establish a complete mechanical safe state.

8.2 Phone-free operation is intentional

Disconnecting the phone **does not turn outputs off**. Local control continues, and a manual command may remain selected during the same powered run until cleared or replaced. Reboot clears manual requests; saved controllers and automations can then act on their conditions. Treat those as different events and test both.

OTA, reboot preparation and sleep contain output-off paths. They are not a substitute for a physical isolation/arming arrangement or a verified load-specific emergency response. For cooling, retain an independent thermal fallback; removing FD power must not remove the only protection against overheating.

8.3 Record what happened and why

Choose the physical measurements, their raw voltages/validity where available, vehicle context, output commands, controller state and automation events that explain the job. Give everything meaningful names and units. A useful pump log combines command with measured pressure/flow or current; a command alone only proves that software requested it.

Overlay temperatures, pressure, lambda, RPM/load, external-controller status and automation events as available. Include the signals needed to explain both a trigger and a failure to trigger. Check the actual logged timestamps and sample rate; a requested rate or visible channel does not prove complete coverage of every CAN frame.

Logs can be recorded on the phone and backed up to Cloud. ESP-resident control does not mean an absent phone is still recording. Confirm recording, storage and synchronization separately from local control.

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— UNIVERSAL CONNECTIONS

Worked installations beyond brand presets

These examples show how the recipes combine. Their allocations are independent examples, not instructions to put all of them on the same pins. Thresholds and actual parts must be selected for the vehicle and load.

9.1 Extra cooling assistance

Use U1 or U5 for a compatible temperature measurement on IN1, or an appropriately fresh vehicle/CAN temperature. Use U9 or U10 for an AUX1-driven qualified isolated contact at the fan controller's documented extra-request/permission input. Keep its original thermostat, driver and thermal fallback active.

The local rule requests extra cooling above the chosen threshold with suitable hysteresis. It releases the FD request below the lower threshold. A failed FD or stale sensor removes only the additional request; the independent thermal system must still provide cooling. Record temperature, request, controller status and measured fan feedback if available. Command ON alone is not proof the fan moved air.

9.2 Reservoir monitoring and an auxiliary pump

Use U4 on IN3 for a dry-contact reservoir-healthy signal. A compatible linear flow/pressure sensor uses U1; use U5 only if its signal needs conditioning. Connect a compatible two-wire pump directly to a free OUT using U11. Use U12 only if the pump exceeds FD capacity or requires another drive interface. Reserve any valve/interlock channels and retain required level, pressure and load protection.

Require the intended enable and a valid healthy reservoir before the pumping action. Add a maximum active time and appropriate recovery policy. Evaluate measured delivery after a commissioned startup interval; an ON command or full tank does not prove an unblocked line. This pattern can serve a transfer pump or spray system, but its thresholds, pump drive and protection must match the fluid and consequence of failure.

9.3 Keep a modification controller and gain visibility

Leave the native controller, display, sensors, power stage and interlocks in place. Use U2 for a documented spare logging output on IN2 or U7 for broadcast data on CAN2. Add U8 for a ground request or U10 for isolated series permission only where its specification supports it.

Configure the local rule for the actual requested function. If the input advances a group, treat it as a step with a known pulse duration and confirm synchronization; do not call it a proportional target input. Log actual pressure/flow/status alongside the request and vehicle context so a tuner can distinguish intention from result.

9.4 Temperature warning without replacing the ECU

Use U1 or U5 for a dedicated linear temperature transmitter or matched conditioner monitoring a gearbox/differential on IN1. Use U11 for a compatible warning lamp/buzzer directly on a free OUT, or U9 only if an isolated contact is required, with a local temperature rule and hysteresis. Verify missing-sensor behavior and retain existing vehicle warnings.

A warning output gives the user useful information; it does not itself protect the component. Logs can show the trend and operating conditions that preceded it, including RPM/load and other available temperatures.



— UNIVERSAL CONNECTIONS

Commission the complete installation

Start with loads disconnected and a current-limited signal/test load. Complete the exact accessory's installation procedure and any required professional electrical/mechanical checks. Prevent unintended boost, injection, nitrous, pump or actuator operation during setup.

Check	Evidence to record
Model-independent interface facts	Supply, references, transfer/protocol, polarity, input loading, driver/load rating and exact terminals
Continuity and supplies	Correct cavities, fuses, both power grounds, separate sensor return and no joined 5 V rails
Calibration	Low/middle/high reference points, units, signed/absolute/gauge conventions and saturation
Signals and faults	Open/short input, power loss, sensor-not-ready, invalid/status codes, stale CAN and slow updates
Actuation	True OFF/ON, permitted intermediate PWM, original interlocks and independent measured response
Releases	Rule false, disabled, max time, cooldown, wrong source, missing source and restored baseline
Lifecycle	Phone disconnected, ignition off/on, ESP restart, each supply starting/stopping first and saved readback
Full load	Current/inrush/stall, flyback and turn-off timing, combined-load heat, pressure/leaks and environmental rating
Logging	Actual received channels, units, timestamps, sample rate, events, export and optional cloud backup

Do not enter PASS because the diagram exists or a command returned success. Enter the measured result for the actual assembly. Record unresolved behavior and correct/retest it before enabling the affected function.

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— UNIVERSAL CONNECTIONS

Your installation worksheet

Print or copy this page for each accessory. Keep it with the saved configuration and commissioning record.

Item	Your record
Vehicle / FD device / firmware	_____
Accessory and job	_____
Datasheet / connector revision	_____
Keep native control or transfer its function	_____
Interface and selected recipe	_____
Supply / ground / load protection	_____
Sensor transfer or CAN ID / layout	_____
Ready, fault and missing-source behavior	_____
Extra interface, only if needed	_____
Safe released state / physical fallback	_____
App name, units, owner and saved version	_____
Commissioning date / reviewer / evidence	_____

11.1 Shared channel allocation

Resource	Assigned purpose and owner
IN1 / IN2 / IN3	_____
IN4 / IN5 / IN6	_____
OUT1 / OUT2 / OUT3 / OUT4	_____
AUX1 / AUX2	_____
CAN2 IDs / labels / update periods	_____

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— UNIVERSAL CONNECTIONS

Scope and reference record

This is a universal connection–design review for the current FD Design LS hardware and local ESP/iOS implementation reviewed on 12 September 2026. It supplements the nine general integration guides and the 48 exact-product guides. A product does not have to appear in the branded catalogue to use a compatible documented interface.

The PDF uses the same print design, product imagery and harness references as the existing FusionDrive documentation. The generic schematics were drawn for this guide. These installations have not received physical electrical, hydraulic, thermal, dyno or vehicle validation through this document task. No universal load rating or universal controller replacement is established.

12.1 Local primary sources

- PCB/FD Design LS/docs/pcb-layout-and-routing.md, lines 156 and 241: 10 A–per-OUT routing and dissipation design; docs/firmware-and-programming.md, line 147: shared 30 A feed and approximately 10 A–per-channel design.
- FD Design LS hardware–design.md: harness J6/J8 pinout; sensor input divider/loading; shared 5 V guidance; high/low-side outputs, power, protection and J12 termination.
- FD Design LS manufacturing update: update-LS/00-UPDATE-NOTICE-LS.md; current AUX topology and component substitutions.
- docs/V1_LS_HARDWARE_LIMITATIONS.md and tests/hardware-ls/evidence.json: independently checked board allocation and retained limitations.
- ESP/FusionDrive/modules/io/SensorManager.h: input conversion, level thresholds, validity, freshness and persistence.
- ESP/FusionDrive/modules/can/CANManager.h and CANSignalDecoder.h: CAN bus configuration, decoding, freshness, rule storage and actual transmit behavior.
- ESP/FusionDrive/modules/control/PWMOutputControl.h, ControlJSON.h and Config.h: output ownership, requests, ranges and settings.
- ESP/FusionDrive/modules/control/AutomationEngine.h, storage/ConfigValidation.h and core/ControlTick.h: rule limits, missing–source handling and local control scheduling.
- iOS SensorsView, PWMOutputsView, CANBusConfigurationView, CANDecodeEditorView, DBCImportView, AutomationEditorView and HardwareMap: actual app fields, paths, validation and channel naming.

The adjacent research/input-audit.md and output-audit.md contain file/line citations. The source snapshot, PDF hash, navigation checks and rendered review pages are retained in this guide's local qa folder. Review against changed firmware or hardware before reissuing the guide.



Questions?

Documentation · fusiondrive.io/docs

Support · in the app: [More](#) → [Settings](#) → [Device & firmware](#) → [Report an Issue](#)

Local review library · [FD V3](#) / [docs](#) / [accessory-integration](#) / [universal-guide](#)

FusionDrive switches real current to real loads and can control boost, water/methanol injection and nitrous. Fuse every feed and every load, respect the ratings in the specifications, and set failsafes before you drive. Configure and tune with the vehicle stationary. The installer is responsible for compliance with local vehicle regulations. Universal connection-design review for current FD Design LS hardware and firmware. Confirm each accessory interface, calibration, load and safe state. A compatible signal can be used regardless of brand; this is not a universal direct-connect or controller-replacement approval. No physical electrical, hydraulic, thermal or vehicle validation was performed for these installations. Qualified interface blocks require selected parts and complete datasheet wiring. Complete and record commissioning before enabling the affected function.