

Understanding Inverters and Shore Power

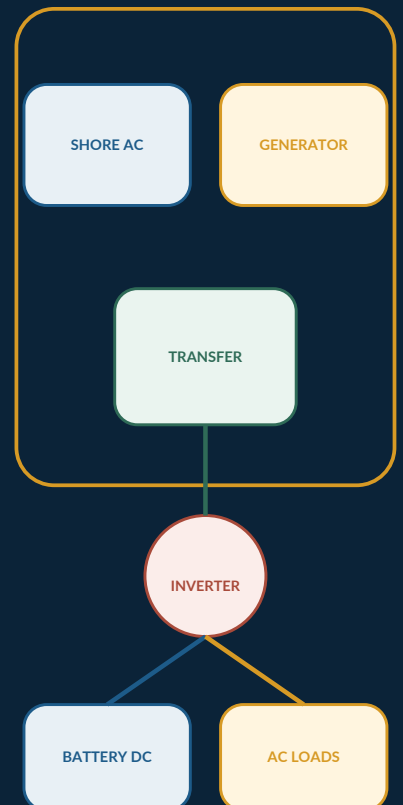
An owner's guide to shore connections,
AC conversion, protection and source transfer

Shore power and inverter power may
feed the same sockets in different ways.

Safety depends on source quality,
earthing, transfer and load control.

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CONNECT | CONVERT | TRANSFER

GUIDE OVERVIEW

What inverters and shore-power systems are designed to do

Shore power connects the yacht to an external AC source. Inverters create AC from battery DC away from the dock, while transfer equipment and protection decide which source may safely energise each circuit.

SCOPE	This guide covers common single-phase yacht systems using shore power, generators, inverters and inverter-chargers. Three-phase, high-voltage and large conversion systems require additional specialist design and operating procedures.
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By the end of this guide, you should be able to:

- Trace the power path from pedestal, generator or inverter to the yacht's AC distribution.
- Identify shore leads, inlets, protection, transformers, transfer switches, inverters and monitoring.
- Recognise unsuitable voltage, frequency, polarity, overload, leakage current and overheated connections.
- Understand how inverter rating, battery demand, pass-through and charging limits affect operation.
- Ask better questions during purchase, survey, refit, marina connection and offshore preparation.

CORE PRINCIPLE	A source is not safe merely because the lights come on. Voltage, frequency, conductor arrangement, protective earth, leakage protection and transfer logic must all be correct.
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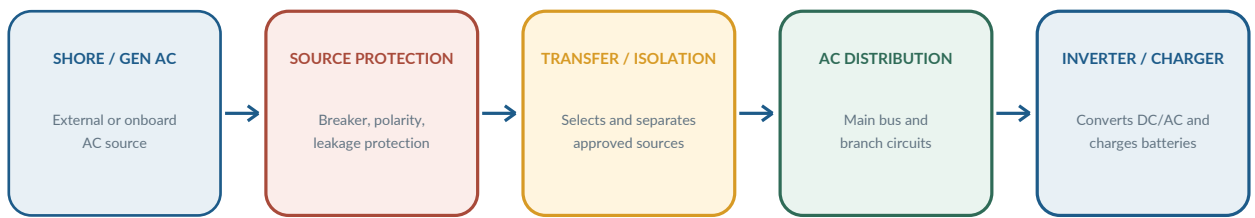
Safety

AC electricity can cause fatal shock and fire. Do not open live enclosures or defeat protective devices. Disconnect, verify isolation and use appropriately qualified assistance for testing, wiring changes, persistent trips, damaged shore equipment or uncertain earthing.

SYSTEM ARCHITECTURE

How shore, generator and inverter power fit together

Most cruising yachts have more than one AC source. The installation must prevent unapproved paralleling, establish the correct neutral and earth arrangement and transfer loads without exposing equipment or people.



Earthing, neutral switching, monitoring and source priority determine whether protection works correctly.

Common operating modes

- Shore mode: External AC passes through inlet protection, isolation or conversion equipment and the source selector.
- Generator mode: An onboard alternator supplies the AC bus through its own protection and bonding arrangement.
- Inverter mode: Battery DC is converted into AC for selected circuits, usually with limited continuous and surge capacity.
- Inverter-charger pass-through: External AC feeds loads while the same unit charges the battery bank.
- Power assist: Some systems combine limited shore or generator input with temporary inverter output.
- Bypass or degraded mode: A separate route may preserve selected loads when the inverter-charger is unavailable.

SOURCE IDENTITY MATTERS	The same socket may be energised from shore, generator or inverter. Protection and neutral bonding can be different in each mode, so diagrams and transfer logic must match the actual installation.
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SHORE-SOURCE QUALITY

Voltage, frequency, phase, polarity and available current

Before connection, the yacht needs a source that matches its electrical system. Adapters may change the shape of a plug, but they do not automatically correct voltage, frequency, earthing or capacity.

VOLTAGE
Must match equipment and remain within limits

FREQUENCY
50 or 60 Hz affects motors, clocks and some chargers

PHASE / POLARITY
Correct conductor relationship and source identification

CAPACITY
Available current must cover the selected onboard load

A pedestal that energises the cable is not necessarily a suitable or safe source for the yacht.

Area	What can be wrong	Owner focus
Nominal voltage	Pedestal supplies a different voltage or split-phase arrangement from the yacht.	Confirm measured source and equipment rating before closing the yacht breaker.
Frequency	50 Hz equipment is supplied at 60 Hz or vice versa.	Motors, pumps, clocks, transformers and chargers may behave differently or overheat.
Polarity / conductor identification	Line and neutral are reversed or an expected neutral is absent.	Use installed indication and competent testing; do not treat a warning as cosmetic.
Available current	Pedestal rating is lower than onboard load or shared marina supply sags under demand.	Set input limits and avoid repeatedly tripping or overheating the connection.
Voltage stability and waveform	Long marina cables, poor connections or local generators produce low, high or distorted voltage.	Monitor under load and investigate flicker, buzzing, charger faults or motor overheating.
Three-phase source	Wrong phase sequence, missing phase or unsuitable phase-to-neutral voltage.	Use vessel-specific procedures and qualified testing for multi-phase systems.

ADAPTERS DO NOT CONVERT ELECTRICITY

A travel adapter or improvised lead may connect incompatible systems physically. Voltage transformers, frequency converters and shore-power converters have specific roles and ratings.

SHORE LEADS AND INLETS

Connectors, cable rating, strain relief and overheating

The shore lead is exposed to weather, movement and repeated handling. A loose or corroded contact creates resistance, and resistance creates heat at exactly the point carrying the yacht's full shore load.



Area	Common weakness	Owner focus
Pedestal socket and breaker	Damage, moisture, weak contact, wrong rating or shared overload.	Inspect before use, keep dry and stop if heat, smell, arcing or repeated trips develop.
Plug and connector pins	Corrosion, pitting, discolouration, looseness or incomplete engagement.	Clean/dry condition, secure locking and no burnt or softened material.
Cable size and length	Undersized or excessively long lead creates voltage drop and heat.	Correct current/voltage rating, marine suitability and no damaged insulation or repairs.
Coiled cable	Heat cannot escape when high current flows through a tightly coiled lead.	Deploy as instructed and avoid leaving excess cable in water or across traffic routes.
Boat inlet	Water entry, rear-terminal looseness, heat damage or poor strain relief.	Inspect front and accessible rear connections; investigate any warm or discoloured inlet.
Dual shore inlets	Unclear selection, common neutral/earth or accidental energisation of unused inlet.	Understand interlocks, caps, labels and whether both sources may ever be connected.

HEAT IS A WARNING,
NOT A NORMAL
FEATURE

A shore plug or inlet that becomes noticeably hot under ordinary load needs the load reduced and the connection investigated before continued use.

PROTECTION AND EARTHING

Breakers, leakage devices and protective conductors

Overcurrent protection limits cable and equipment damage. Leakage protection detects current flowing outside the intended conductors, while the protective earth provides a fault-current path that supports rapid disconnection.

OVERCURRENT

Breaker or fuse limits cable and equipment damage

LEAKAGE PROTECTION

RCD, RCBO or ELCI detects current leaving intended path

PROTECTIVE EARTH

Provides low-impedance path for fault current

SOURCE DISCONNECTION

Transfer/interlock prevents unapproved source paralleling

Device or path	Purpose	Owner focus
Pedestal breaker	Protects the shore circuit and limits available current.	Rating, condition and whether it trips before the yacht's own protection.
Inlet main breaker	Provides local overcurrent protection and isolation close to the entry point.	Correct poles, rating, accessibility and signs of heat or nuisance operation.
RCD / RCBO / ELCI	Trips when leakage exceeds the device threshold; terminology and location vary.	Test only as instructed and investigate recurring trips rather than resetting repeatedly.
Protective-earth conductor	Connects exposed conductive parts to the source grounding system or isolation arrangement.	Continuity, connections and no unauthorised removal to solve galvanic problems.
Branch-circuit breakers	Protect individual cables and appliances.	Labels, rating, load grouping and whether inverter-fed circuits are clearly identified.
Insulation / leakage monitoring	Provides warning of degraded insulation or current to earth.	Normal baseline, alarm history and professional diagnosis of persistent change.

A TRIP IS EVIDENCE

Resetting once after removing an obvious overload may be reasonable. Repeated leakage, polarity or breaker trips require diagnosis before the protective margin disappears.

GALVANIC ISOLATION AND TRANSFORMERS

What each device does - and does not do

Protecting the yacht from galvanic current is not the same as providing electrical isolation from shore. The installed neutral and earth arrangement must be understood before judging any isolator or transformer.

DIRECT SHORE CONNECTION

Shore conductors feed yacht through protection

GALVANIC ISOLATOR

Blocks low-voltage galvanic current in earth conductor

ISOLATION TRANSFORMER

Magnetically separates yacht AC system from shore supply

AUTOTRANSFORMER / CONVERTER

May adapt voltage or frequency but is not automatically isolation

Each arrangement changes the neutral, earth and leakage-protection design; labels alone are not enough.

Arrangement	Main function	Owner focus
Galvanic isolator	Blocks low-voltage DC galvanic current in the shore-earth path while allowing higher fault current to pass.	Correct rating, fail-safe/monitoring arrangement, no bypass and testing to manufacturer procedure.
Isolation transformer	Transfers AC power magnetically without a direct conductive shore connection on the secondary.	Rating, cooling, secondary neutral-earth bond, overcurrent protection and enclosure condition.
Boost / autotransformer	Adjusts voltage but generally does not provide galvanic isolation by itself.	Input range, output current, protection and clear distinction from an isolation transformer.
Frequency / shore converter	Converts incoming power to controlled voltage/frequency and may provide isolation depending on design.	Continuous rating, cooling, harmonic load, bypass mode and what happens after internal failure.
Direct connection	Yacht protective earth remains connected to shore according to the system design.	Galvanic protection, leakage, bonding and sacrificial-anode condition need coherent assessment.
Temporary workaround	Removing earth, using unsafe adapters or bypassing protection may hide symptoms.	Do not trade shock/fire protection for reduced corrosion; diagnose the actual bonding or leakage issue.

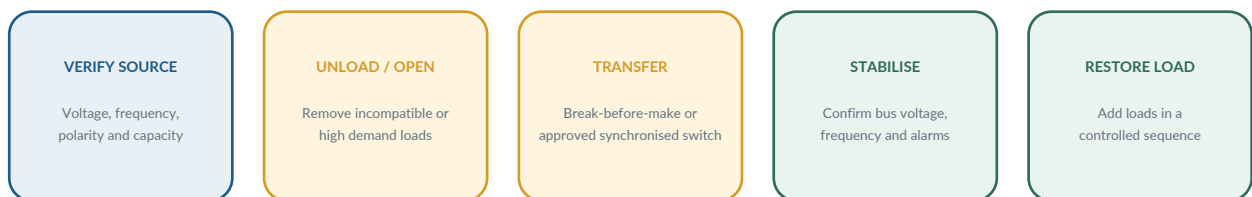
NAMES ARE NOT PROOF

Some equipment is loosely described as an isolator or transformer. Verify the electrical function, connection diagram and protection, not only the marketing label.

SOURCE SELECTION AND TRANSFER

Moving between shore, generator and inverter power

A transfer device should connect only an approved source, prevent unsafe source paralleling and establish the correct conductor and neutral arrangement before loads are restored.



Area	Possible weakness	Owner focus
Manual selector switch	Worn contacts, unclear position, incorrect pole switching or operation under excessive load.	Positive positions, labels, rating and correct unloading procedure.
Automatic transfer switch	Accepts poor source, chatters, fails to transfer or transfers without required delay.	Voltage/frequency limits, time delays, preferred source and manual bypass.
Interlocks	Shore and generator can be connected together unintentionally.	Mechanical/electrical interlock test and no undocumented bypass.
Neutral switching	Neutral remains connected or is disconnected in the wrong source mode.	Design drawing, source-bond arrangement and leakage-device operation in every mode.
Transition and sensitive loads	Brief interruption resets navigation, refrigeration, controls or IT equipment.	UPS/inverter support, restart sequence and awareness of loads that do not recover automatically.
Bypass arrangement	Bypass defeats protection or cannot be used when the main unit fails.	Clear approved procedure, labels and loaded test without exposing live parts.

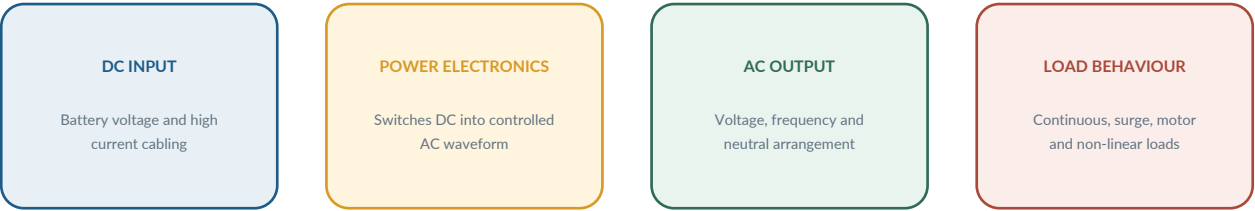
**SOURCE TRANSFER IS
NOT SIMPLY
SWITCHING A BREAKER**

Loads, neutral bonding, phase relationships and charger/inverter behaviour may all change. Follow the vessel's operating sequence.

INVERTER FUNDAMENTALS

Continuous power, surge load, efficiency and DC demand

An inverter creates AC from battery DC. Its useful capability depends on continuous rating, short-term surge, waveform, cooling, battery voltage, cable capacity and the ability of the bank to hold voltage under load.



At 24 V DC, a 3 kW AC load can demand well over 125 A before losses and surge are considered.

Area	What it means	Owner focus
Continuous rating	Power the inverter can deliver continuously under stated temperature and ventilation.	Derating in hot compartments and no assumption that nameplate power is available indefinitely.
Surge rating	Short-duration capacity for motor, compressor or transformer starting.	Duration, battery voltage sag and whether multiple loads start together.
Waveform	Pure sine, modified sine or other output quality affects connected equipment.	Sensitive electronics, induction motors, chargers and audio/communications interference.
DC input current	High AC power requires very high battery current at low DC voltage.	Cables, fuses, isolators, voltage drop, battery BMS and terminal temperature.
Efficiency and standby load	Some energy becomes heat and the inverter consumes power even with little AC load.	Include conversion and idle losses in the energy budget.
Low/high-voltage shutdown	Inverter trips to protect itself or the battery.	Trip level under load, battery reserve and whether essential circuits disappear unexpectedly.

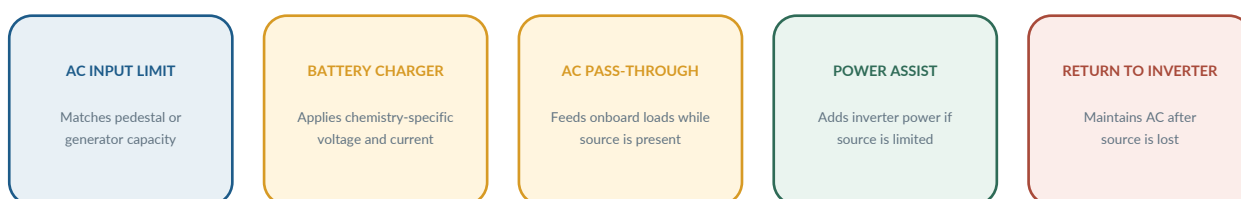
WATTS ON AC BECOME AMPS ON DC

Large kettles, heaters, cooking appliances and air-conditioning can draw hundreds of amps from a 12 V or 24 V bank. The battery and cabling, not only the inverter, set the practical limit.

INVERTER-CHARGERS AND POWER ASSIST

Pass-through, charging, input limits and seamless supply

An inverter-charger can charge batteries from shore or generator power, pass AC through to loads and provide inverter power when the source is lost. Some units can supplement a limited source temporarily.



Function	Possible weakness	Owner focus
AC input current limit	Set above pedestal capacity or left too low to support charging and loads.	Adjust for each source and remember that charger demand is part of total AC load.
Battery charging profile	Wrong chemistry, voltage, temperature sensing or current limit.	Match the exact battery bank and coordinate with other chargers.
Pass-through rating	Internal relay or terminals carry more current than allowed.	Total downstream load, connection temperature and protective-device rating.
Power assist / load support	Battery quietly discharges while the yacht appears to be on shore or generator power.	Monitor net battery current and understand duration, limits and recharge consequence.
UPS-like transfer	Transfer is not fast enough for all loads or causes repeated cycling on unstable shore power.	Sensitive-load behaviour and whether source-acceptance limits are too broad or narrow.
Bypass after failure	Loss of one combined unit removes charging and all pass-through AC.	Manual bypass, alternate charger and which circuits remain available.

POWER ASSIST CAN HIDE AN UNDERSIZED SOURCE

The system may prevent a pedestal trip by drawing from the batteries. That preserves comfort briefly but can leave the bank depleted if the crew do not recognise it.

NEUTRAL, EARTH AND LEAKAGE PROTECTION

Why source mode changes the protection arrangement

AC protection depends on a controlled relationship between line, neutral and protective earth. Shore, generator and inverter sources may establish that relationship differently, and the transfer system must support each mode.

SHORE SOURCE

Neutral-earth bond exists at shore source as designed

GENERATOR SOURCE

Onboard source requires its own approved bond arrangement

INVERTER SOURCE

May create or switch neutral bond in inverter mode

TRANSFER DEVICE

Must switch conductors and bonding as the design requires

Issue	What can go wrong	Owner focus
Multiple neutral-earth bonds	Parallel return paths carry current through protective earth or bonding conductors.	Source-specific design, switched neutral where required and professional leakage testing.
No effective source bond	Fault current may be too low to operate protection correctly.	Verify inverter/generator source mode and protective-device operation.
RCD/ELCI nuisance trip	Appliance leakage, moisture, wiring fault, combined normal leakage or incorrect bonding.	Segment circuits and diagnose; do not simply increase trip rating or bypass the device.
Neutral not switched	An inactive source remains connected through neutral, defeating separation.	Transfer-pole arrangement and isolation in every source combination.
Inverter output floating or bonded	Unit configuration does not match the yacht's distribution and protection design.	Manufacturer settings, internal relay behaviour and current drawings.
Portable equipment and adapters	Unexpected neutral/earth connections alter leakage and shock protection.	Use approved equipment and avoid household workarounds on marine systems.
THIS IS SPECIALIST TERRITORY	Neutral and earth faults can leave a system apparently operational while shock protection is compromised. Persistent leakage or bonding uncertainty needs competent investigation.	

FAILURE AWARENESS

Warning signs and immediate response

Most problems begin with heat, smell, discolouration, flicker, repeated trips, inverter alarms, unstable transfer or a battery bank discharging when the crew believe it is charging.

HOT CONNECTOR

Resistance creates heat, voltage drop and fire risk

NUISANCE TRIP

Overload, leakage or poor source quality needs diagnosis

INVERTER SHUTDOWN

Low DC voltage, overload, heat or internal fault

TRANSFER FAILURE

Source is lost, paralleled or not accepted as expected

RECOGNISE

Trip, smell, heat, alarm or source change

REDUCE LOAD

Stop high-demand and non-essential equipment

STABILISE

Preserve essential AC/DC and battery reserve

ISOLATE / CHECK

Source, cable, inlet, protection and inverter

RECOVER / ESCALATE

Use alternate source or seek specialist assistance

Evidence or failure	Possible cause	Immediate thinking
Hot plug, inlet or cable	Loose contact, corrosion, overload, undersized lead or water damage.	Reduce load, disconnect safely and do not continue using a heat-damaged connection.
Shore breaker or RCD trips	Overload, leakage, poor source, water ingress or wiring/appliance fault.	Remove load and isolate circuits; repeated resets without diagnosis remove protection margin.
Inverter trips on load	Overload, surge, low battery voltage, high temperature or DC voltage drop.	Shed load and check battery, cabling, ventilation and the exact fault code.
AC lost during transfer	Source rejected, transfer switch, control power, contactor or interlock fault.	Preserve essential services and use an approved alternate source or bypass.
Battery discharging on shore	Power assist, charger disabled, low input limit, failed pass-through or source too weak.	Reduce AC load and confirm net battery current, charger state and source capacity.
Burning smell or visible arcing	Severe connection or equipment failure with fire exposure.	Isolate power if safe, follow the fire plan and seek emergency/specialist assistance.

DO NOT NORMALISE IT

A plug that is always warm, an inverter that needs frequent resets or an RCD that trips only in rain has an unresolved defect.

OPERATIONAL PRACTICE

Connecting, disconnecting and managing loads

A disciplined shore-power routine reduces arcing, overheating and accidental overload. The exact sequence should follow the yacht and marina instructions, but source verification and controlled loading are universal principles.

Stage	Good operating thinking	Avoid
Before connection	Inspect pedestal, plug, cable and inlet; confirm ratings, source quality and yacht breakers open.	Connecting a damaged, wet or unknown source because the socket fits.
Connection	Make secure dry connections, energise the pedestal and verify indications before accepting the source.	Making or breaking high-current connections under full load.
Load restoration	Add major loads progressively and watch voltage, current, connector temperature and alarms.	Starting charger, heaters, cooking and air-conditioning together on a small pedestal.
While connected	Keep cable protected, check for heat and know whether power assist is discharging the bank.	Leaving connectors in water, traffic routes or tightly coiled at high load.
Disconnection	Unload the yacht, open onboard and pedestal breakers as instructed, then disconnect and cap dry fittings.	Pulling a live connector or using the plug as the normal switch.
Different marina or country	Confirm voltage, frequency, socket, earthing and conversion requirements before arrival.	Assuming an adapter resolves all compatibility issues.

Load priorities away from shore

- Separate essential AC loads from comfort loads where practical.
- Know which circuits are inverter-fed and which require generator or shore power.
- Avoid using battery energy for resistance heating unless the bank and energy plan support it.
- Consider automatic restart behaviour of refrigeration, pumps and chargers after transfer.
- Preserve DC energy for navigation, communications, bilge pumps, controls and starting.

THE QUIETEST SOURCE IS NOT ALWAYS THE BEST SOURCE	Running large inverter loads may be less efficient and less resilient than starting the generator. Decide from energy, load and reserve - not noise alone.
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MAINTENANCE STRATEGY

Inspection, testing, records and realistic spares

Maintenance should preserve source quality, connection integrity, protective-device operation, transfer logic, inverter cooling and accurate monitoring. A successful no-load test is not enough.

Area	Good maintenance evidence	Why it matters
Shore lead and inlet	Full-length inspection, connector pin condition, strain relief, rear terminals and loaded temperature.	Prevents resistive heating, arcing and loss of shore supply.
Protection devices	Breaker, RCD/RCBO/ELCI test records and professional leakage/insulation investigation where needed.	Confirms shock and fire protection remains effective.
Isolation / conversion equipment	Cooling, terminals, alarms, fan condition, insulation and output readings.	Supports safe connection across different marinas and load conditions.
Transfer switching	Source acceptance, interlocks, neutral switching, time delays and bypass tested.	Prevents source paralleling and unexpected loss of AC.
Inverter / charger	DC voltage drop, AC load, surge, charger profile, fans, temperature and fault history.	Confirms continuous and degraded operation rather than only display status.
Loaded system test	Voltage, frequency, current, temperature and transfer behaviour recorded under representative demand.	Reveals weak connections, source sag and thermal derating.

Useful spares and tools

- A correctly rated spare shore lead or repairable connector only where approved and safely replaceable.
- Specified fuses, control relays, cooling-fan or sensor parts for critical conversion equipment where realistic.
- Portable voltage/polarity indication and temperature instruments used within competence and equipment rating.
- Dry caps, strain reliefs and cable-management equipment for protecting connectors and leads.
- Current diagrams, source limits, inverter fault codes, bypass procedure and specialist contacts.

WORK TO REFER	Live AC work, neutral/earth diagnosis, leakage testing, shore-converter repair, transformer work, transfer logic and persistent overheating require appropriately qualified specialists.
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OFFSHORE READINESS

Buyer questions and readiness checklist

An offshore-ready installation has safe shore connection, understood source transfer, protected AC distribution, realistic inverter endurance and a plan for losing one source without losing essential services.

Area	Questions for purchase or survey
Architecture	Can shore, generator, inverter, transfer, isolation, neutral/earth and bypass arrangements be traced on current drawings?
Shore connection	Are lead, plugs, inlet, main breaker and source-monitoring equipment correctly rated and free of heat damage?
Protection	Do overcurrent, leakage and protective-earth arrangements operate correctly in every source mode?
Inverter capability	Are continuous, surge, waveform, cooling and DC-current requirements suitable for actual connected loads?
Charging and pass-through	Do input limits, charging profile, pass-through rating and power-assist behaviour match the batteries and sources?
History and support	Are recurring trips, overheated connectors, transfer faults, modifications and obsolete components fully explained?
Degraded operation	Can the crew preserve essential AC/DC power after loss of shore, generator, inverter-charger or one transfer path?

Quick readiness check

	Readiness statement
☐	I can trace shore, generator and inverter power to the circuits each source supplies.
☐	Accepted voltage, frequency, polarity, phase arrangement and current limits are known.
☐	Shore cable, plugs, inlet, breakers and protective-earth path are in credible condition.
☐	RCD/RCBO/ELCI and source-transfer functions have been tested as instructed.
☐	Isolation transformer, galvanic isolator or converter function is correctly understood.
☐	Inverter continuous/surge limits, DC demand and battery endurance are realistic.
☐	An approved bypass or alternate-source plan exists after inverter-charger or transfer failure.
☐	More than one person knows the response to heat, leakage trip, source loss and inverter shutdown.

KEY TAKEAWAY

A dependable shore-power and inverter system combines compatible sources, sound connections, correct earthing and leakage protection, controlled source transfer, realistic inverter loading and a clear degraded-power strategy.

Guidance to consult

Use current shore-power, inverter, charger, transformer, isolator, generator and protection-device instructions, together with vessel electrical drawings and applicable flag-state, coding, class, insurance, marina and yard requirements.

Understanding Yacht Systems

Practical guides for owners, buyers
and offshore cruising crews.

AMTG-022

Understanding Inverters and Shore Power

RELATED GUIDES

AMTG-003 Understanding Marine Electrical Systems

AMTG-004 Understanding Electrical Redundancy

AMTG-005 Understanding Generators and Load Management

AMTG-021 Understanding Battery Banks and Charging Systems

AMTG-023 Understanding AC and DC Distribution

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