The Complete Cybenetics Test Protocol for Power Adapters Energy Efficiency, Multi-Output Operation and Overall Performance Calculation

Revision 1.6

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Revision History

Version	Release Date	Notes
1.0	June 2026	Initial PA ETA proposal covering power classes, 115 V/230 V levels, no-load and power-factor criteria, PD/PPS profiles, reference cabling and thermal evaluation.
1.1	June 2026	Reformatted to the Cybenetics master-protocol template and filed in the Power Adapters protocol share.
1.2	July 2026	Expanded to physical multi-output and shared-capacity adapters; introduced hierarchical efficiency aggregation, mandatory conducted EMI, conditional fan-noise testing, regulatory rule versioning, standardized multi-port scenarios and complete reporting/data-quality gates.
1.3	July 2026	Internal working revision — not released; superseded before Revision 1.4.
1.4	July 2026	Defines the commissioned laboratory capability: one Chroma 63600 mainframe with five independent 400 W load channels and two PicoScope 4444 differential oscilloscopes. Up to five PA outputs can now be loaded and measured simultaneously; the report records the per-output route and the cross-scope timing limitation.
1.5	July 2026	Adds a complete bench-to-report operator walkthrough and integrates the On-Bright OBPD011 manual fast-charge fixture. Defines de-energized wiring, profile commissioning, true no-load versus negotiated-zero-load states, five-output routing, safety/abort gates, evidence capture, external EMI handoff and controlled shutdown.
1.6	July 2026	Editorial consistency pass following review of Rev. 1.5: documented the skipped Revision 1.3, clarified that rule-set versions are independent of the document revision, made the multiple-output ranking-value versus awarded-medal distinction explicit, and corrected the author line. ETA efficiency, no-load and power-factor limits unchanged.

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Definitions

Power Adapter / External Power Supply (PA/EPS)

A self-contained external AC-DC converter that supplies one or more regulated DC outputs to one or more powered products.

Physical Output / Port

A distinct connector or hard-wired output capable of delivering power independently or as part of a shared-capacity group.

Output Profile

A fixed-voltage, USB Power Delivery (PD), Programmable Power Supply (PPS), or proprietary operating point defined by voltage, current and maximum continuous power.

Multiple-Output PA

An adapter with more than one physical power output, whether independent or sharing a common total-power limit.

Multiple-Voltage PA

A PA capable of supplying more than one output voltage simultaneously through more than one power output.

Shared-Capacity Ports

Outputs whose sum of individual nameplate powers exceeds the maximum combined power available when they operate simultaneously.

Dynamic PA and Guaranteed Power

A PA that can supply a higher peak power for a limited time and a lower continuous power indefinitely. Classification and continuous-load testing use guaranteed power.

Nameplate Output Power (Pout)

The maximum continuous combined output power. For multiple outputs, it is the sum delivered at the declared simultaneous load condition without exceeding the guaranteed combined limit.

No-Load Power

Input power with the PA energised and no output connected to a primary load.

Connected-Idle Power

Input power with one or more negotiated outputs connected but drawing no useful load. It is reported separately from regulatory no-load power.

ETA

The Cybenetics efficiency-rating program. Independent ETA levels are calculated for 115 V and 230 V input.

EMI

Electromagnetic interference. This protocol requires conducted-emissions testing as a certification gate; radiated EMI may be included by work order.

Scope and Governing Principles

This protocol applies to external AC-DC power adapters with one or more physical outputs, including fixed-output adapters, barrel-jack and proprietary adapters, USB-C/USB-PD/PPS chargers, multi-port chargers, high-power EPR/notebook adapters, and adapters with integrated wireless-charging functionality where applicable.

The protocol deliberately separates three result layers:

1. Regulatory compliance: market-specific pass/fail calculations using the rule set applicable to the selected work-order regions.
2. Cybenetics ETA rating: comparative efficiency levels at 115 V and 230 V using versioned Cybenetics thresholds.
3. Engineering performance: regulation, ripple, transient, thermal, protection, PD/PPS, multi-port and optional acoustic characterization.

Scope boundary: Safety-document collection or documentary safety review is not required by this protocol. This exclusion does not remove measured thermal, protection, surge or EMI tests, and it does not alter a manufacturer's legal product-compliance obligations.

- All applicable measurements are stored at the raw operating-point level; headline values are calculated, not manually re-entered.
- A non-applicable test is stored explicitly as N/A with a reason; it is never represented by a blank field.
- Thresholds, formulas and regional rules are revisioned so historical reports always retain the rule set used when they were issued.

Power Classes

Power class is based on maximum continuous combined output power. For a dynamic PA, guaranteed power is used. Temporary boost or peak power is recorded separately and does not increase the class.

Class	Continuous combined output power	Typical products
A – Ultra-Low	Pout ≤ 6 W	Small wall adapters and accessory chargers
B – Low	6 W < Pout ≤ 49 W	Phone/tablet chargers and light notebook adapters
C – Medium	49 W < Pout ≤ 150 W	Mainstream notebook and multi-port GaN adapters
D – High	Pout > 150 W	USB-PD EPR, gaming-notebook and workstation adapters

Table 1 — Power-class definitions.

Work Order and Product Capability Inventory

Before testing, the operator records the complete electrical capability map. The resulting inventory drives the editor, automated importer, required-test matrix and publication completeness rules. The installed automated bench supports up to five simultaneously active physical outputs; a DUT requiring more than five simultaneous outputs is held for the planned second mainframe and associated scope routing before a complete multi-output certification run is started.

- Manufacturer, model, sample number, serial number, Lab ID, Report ID and Certification ID.
- Input voltage/frequency range, rated input current, power class and target regions.

- Every physical port, connector type and whether it is independent or belongs to a shared-capacity group.
- Every fixed output profile, PD PDO, PPS range, maximum current and maximum continuous power.
- Maximum combined output power, guaranteed power, peak power duration and every advertised simultaneous power split.
- Cooling type and fan presence (Yes/No).
- Wireless-charging capability and any other integrated function that affects the applicable tests.

Test Equipment and Calibration

Equipment	Minimum purpose
Programmable AC source	100–240 V, 50/60 Hz; voltage regulation and low source THD
Precision power analyzer	Simultaneous input voltage/current/true power/PF/harmonics; milliwatt no-load resolution
Programmable electronic loads	Independent channel per simultaneously active output; stable at low current. The installed bench is one Chroma 63600 mainframe populated with five independent 400 W channels, allowing up to five PA outputs to be tested simultaneously.
USB-C PD/PPS analyzer	Manual PD/PPS fixture selects the requested profile and records the selected PDO/PPS state. Automatic negotiation is not part of the installed bench; dynamic negotiated transitions are recorded only when the fixture/work order provides an auditable procedure.
Oscilloscope and probes	Ripple, overshoot, load transients, PPS transitions and power redistribution. The installed bench uses two PicoScope 4444 differential oscilloscopes: outputs 1-4 use Scope 1 inputs A-D and output 5 uses Scope 2 input A.
EMI receiver and LISN	Conducted EMI scans with line/neutral results and exportable traces
Thermal chamber / hot box	Controlled 40 °C class test condition and repeatable airflow
Temperature instrumentation	Thermocouples and/or calibrated thermal camera
Milliohm meter and DMM	Reference-cable characterization and voltage-drop measurements
Acoustic facility	Required only when the PA contains one or more fans

Table 2 — Core equipment for the complete PA protocol.

All instruments shall have current calibration status recorded in the test run. Measurement uncertainty, range and resolution shall be sufficient for the smallest expected value, especially no-load power and low-current efficiency.

Reference Cabling and Measurement Plane

- USB-C/USB-PD ports use characterized EPR-capable reference fixtures and cables suitable for the tested current.
- Barrel and proprietary outputs use matched characterized leads per connector family.
- Cybenetics comparative results are measured at the fixture/device end of the reference cable so the result reflects delivered power.
- Regulatory calculations use the cable correction or measurement plane required by the applicable rule set. Both raw and corrected values are retained.

Environmental and Input Test Conditions

Normal efficiency, regulation and electrical-performance measurements are made at 25 °C ±2 °C after output stabilization. The separate hot evaluation is made at 40 °C ±2 °C unless a work-order or applicable standard specifies another condition. No forced cooling is applied unless it is an integral part of the product.

Input condition	Purpose	Extent
115 V / 60 Hz	ETA 115 V and USA	Full Cybenetics run
230 V / 50 Hz	ETA-230V and EU	Full Cybenetics run
220 V / 50 Hz	China	Regional compliance run when selected
100 V / 50 and 60 Hz	Japan	Regional compliance run when selected
220 V / 60 Hz	South Korea	Regional compliance run when selected
230 V / 60 Hz	Middle East	Regional compliance run when selected

Table 3 — Input-condition matrix. The work order selects any regional additions beyond the two ETA runs.

- The AC-source voltage waveform and THD are recorded; for EU 2025/2052 measurements, supply-voltage THD shall not exceed 2% through the 13th harmonic.
- Measurements are taken only after voltage, current, power and temperature have stabilized at the operating point.
- Normal and hot test runs carry separate condition identifiers; their data are never mixed in one efficiency average.

End-to-End Laboratory Walkthrough

This section is the controlling operator sequence for a complete Faganas Power Adapters run. It converts the requirements in the rest of this protocol into a bench procedure that may be followed from sample receipt through report release. The detailed test sections remain controlling for calculations, operating points and pass/fail rules.

STOP RULE Do not continue when the DUT capability, cable rating, fixture limit, instrument route, polarity, calibration state or expected voltage is unknown. Keep every Chroma input OFF and programmed to 0 A until the specific output/profile has passed the unloaded-voltage gate.

Stage 1 - Open the work order and identify the sample

- Confirm the work order, target markets, required input conditions, hot-test condition, optional tests and report language.
- Record manufacturer, model, sample and serial numbers, Lab ID, Report ID, Certification ID, label ratings and cooling declaration.
- Photograph the DUT, rating label, supplied cables and every output connector before testing.
- Quarantine the sample if there is visible damage, contamination, loose hardware, a damaged cable or an unreadable rating label.

Release gate: the sample identity and requested scope agree with the physical DUT and the work order.

Stage 2 - Build the capability and simultaneous-output map

- List every physical output O1-O5, connector type, fixed voltage, advertised current and continuous power.
- For USB-C or proprietary fast-charge ports, record every fixed PDO/profile, PPS/AVS range, current capability and cable requirement from auditable capability evidence.
- Record the maximum combined power, guaranteed power, temporary peak power and every advertised simultaneous power split.
- Mark ports that share capacity. Do not plan a combination that the adapter does not advertise or sustain.
- If more than five outputs must be active simultaneously, stop the complete run until the second Chroma mainframe and validated scope routing are commissioned.

Release gate: the Faganas output/profile inventory is complete and has no impossible allocation.

Stage 3 - Verify bench readiness

System	Required preflight	Record
AC source - ASR2100	Correct USB/LAN resource; output OFF; 115/60 and 230/50 programs available; voltage/current limits appropriate.	Asset/serial, route, programmed condition
Input analyzer - HMC8015	Correct range, wiring and integration mode; low-power range suitable for no-load work.	Asset/serial, range, calibration ID

System	Required preflight	Record
Load bank - Chroma 63600	Channels 1-5 identified; every input OFF; 0 A programmed; limits do not exceed DUT/cable/fixture ratings.	Mainframe/module IDs and channel map
Scopes - two PicoScope 4444	Differential inputs and approved accessories; correct ranges/coupling/bandwidth; no overload warning.	Serial, input, range, coupling, bandwidth
Temperature - TC-08	Required thermocouples identified, attached and plausible at ambient.	Asset/serial and probe map
OBPD011 fixture	Verified 5 V supply/polarity; board revision/asset ID; labelled bench acceptance limit; LOAD polarity known.	Fixture ID/revision, supply and acceptance limit

- Confirm calibration status and the test-date validity of every measurement instrument.
- Record ambient temperature and verify that the test area, hot box and airflow match the selected condition.

Release gate: Faganas communications are open, all required devices are healthy and no channel contains stale data.

Stage 4 - Make the de-energized connections

- Set ASR2100 output OFF. Confirm all Chroma inputs OFF and 0 A. Disconnect the DUT output cables before changing fixture or load wiring.
- Connect AC source -> HMC8015 -> DUT input in the approved order. Apply protective earth only where the DUT design requires it; never create an unintended output return connection.
- Assign O1-O5 to the fixed routes below. Use short load leads and the approved differential measurement accessories at the defined output measurement plane.

DUT output	Chroma load	Ripple/transient input	Negotiation interface
O1	Channel 1	PicoScope #1 A	OBPD011/direct breakout as applicable
O2	Channel 2	PicoScope #1 B	Independent fixture if negotiation is required
O3	Channel 3	PicoScope #1 C	Independent fixture if negotiation is required
O4	Channel 4	PicoScope #1 D	Independent fixture if negotiation is required
O5	Channel 5	PicoScope #2 A	Independent fixture if negotiation is required

CROSS-SCOPE LIMIT O1-O4 are simultaneous on PicoScope #1. O5 is captured on PicoScope #2. The two scopes are not phase-synchronised; report per-output response to the common event and do not claim precise timing between the two instruments.

Release gate: polarity, cable rating, load route, scope route and measurement plane are independently checked and recorded.

Stage 5 - Energize the DUT and capture baseline states

- With all output paths physically disconnected, program the selected input condition and turn the ASR2100 output ON.

- Allow input power and DUT temperature to stabilize. Confirm the input voltage/frequency and absence of abnormal sound, smell, arcing or heating.
- Measure true no-load input power with no primary output load, fixture or powered product connected. A Chroma channel at 0 A is not, by itself, proof of true no-load.
- After true no-load is accepted, connect one required negotiation fixture or breakout at a time with its Chroma input still OFF and at 0 A. These are connected-idle/negotiation states, not true no-load.

Release gate: true no-load and each required connected-idle state have distinct records and identifiers.

Stage 6 - Commission every output profile

- For a non-negotiated fixed output, verify the expected open-circuit voltage at the assigned route before enabling its load.
- For a negotiated port, use the OBPD011 procedure in the next section. Keep the assigned load OFF/0 A while selecting or changing a mode, voltage or current request.
- Create the Faganas queue entry as Name=Voltage,Current. For a fixed PDO use the current advertised for that PDO; for PPS/AVS use the operating contract-current request selected on the fixture.
- The profile current is a contract/rated limit used for planning and safety. It is not a command to draw that current immediately; the Chroma channel controls actual load current.
- Confirm the physical F/V selection when Faganas asks, then allow the application to verify unloaded output voltage. If it does not match, keep the load OFF and correct the setup.

Release gate: every profile has a verified voltage, contract/rated current, cable, fixture state and immutable O1-O5 route.

Stage 7 - Execute the normal electrical runs

- Run the complete 115 V/60 Hz and 230 V/50 Hz ETA sequences separately. Add regional input conditions only when selected by the work order.
- At each operating point wait for stabilization, then retain input voltage/current/power/PF; output voltage/current/power; efficiency; ripple; temperatures; profile; route and capture ID.
- For every fixed profile, perform the defined 10-100% sweep and explicitly retain 10%, 25%, 50%, 75% and 100%. For PPS, test minimum, midpoint and maximum voltage at the required loads.
- Increase load through the application plan; do not jump directly to full contract current during first commissioning. Watch all active outputs for collapse, renegotiation or current limiting.
- Complete line/load regulation, light-load points, full-load PF and the applicable guaranteed/peak-power records without mixing input or thermal conditions.

Release gate: every required single-port/profile/input point is complete, stable and linked to raw evidence.

Stage 8 - Execute simultaneous-output scenarios

- Use one Chroma channel per output and one suitable trigger/interface per independently negotiated USB-C port. One OBPD011 can negotiate only one port.
- Connect and negotiate outputs one at a time with all loads OFF/0 A. After the final port is connected, recheck every output because multi-port power sharing may change the available profiles.
- Confirm the final O1-O5 profile combination in Faganas, then run balanced, priority-port, advertised-split, all-ports low-load, full-combined-load, worst-thermal and redistribution scenarios as applicable.
- Use simultaneous Chroma readbacks to calculate total delivered power. Never replace a required simultaneous result with sequential single-port measurements.

Release gate: every active output remained within its supported allocation and every per-output measurement is retained beneath the aggregate.

Stage 9 - Capture ripple, transient and redistribution evidence

- Capture ripple at 10%, 25%, 50%, 75% and 100% per profile and at the worst simultaneous condition using the documented coupling, range and bandwidth.
- Perform applicable load steps, negotiated-voltage transitions, port connect/disconnect events and power-redistribution events. Record overshoot, undershoot, interruption and recovery per output.
- Save the machine-readable measurements and corresponding screenshots/capture files with DUT, run, input, output/profile, scenario and capture identifiers.
- For a five-output event, label O5 evidence cross-scope unsynchronised and avoid any phase-accurate inter-scope conclusion.

Release gate: the settings and capture identity required to reproduce each waveform are stored with the result.

Stage 10 - Protection, hot and optional tests

- Run OCP/OPP only through the implemented, validated Chroma procedures and record trigger, shutdown/current-limit behavior, damage outcome and recovery method.
- Controlled OVP is unsupported on the installed bench. Automatic OTP is unsupported. SCP is run only after the specific fixture/path has been validated; otherwise record N/A with the reason.
- Maintain the full-load and worst multi-output thermal conditions until the protocol stabilization/equilibrium rule is met. Record ambient, enclosure, connector/cable and internal temperatures where instrumented.
- Run fan/RPM/acoustic work only when a fan is actually present. Store fanless as explicit N/A - fanless.
- EMI is executed and retained in the separate EMI application/workflow. Faganas does not control or acquire that test; link the external result to the same sample/report identifiers when certification requires it.

Release gate: every applicable test is complete; every omitted test is explicit N/A with a technically valid reason.

Stage 11 - Validate, package and release the run

- Run the application completeness and consistency checks. Resolve missing profiles, impossible allocations, stale values, route mismatches, headline/table differences and missing media.
- Review abnormal events and warnings. A functional, thermal, protection or external EMI failure is not averaged away.
- Verify sample, operator, date/time, environment, rule-set version, calibration IDs, instrument serials/routes, fixture ID/revision, cable IDs and raw-file hashes.
- Generate the transactional run package and confirm its manifest/hashes before accepting or publishing the result.
- Apply the rating/calculation rules only to accepted source data. Any correction creates an audited revision rather than overwriting raw evidence.

Release gate: a second-person or authorized review confirms technical completeness and the final report matches the accepted package.

Stage 12 - Controlled shutdown and bench reset

- Ramp every active Chroma channel to 0 A, set each input OFF and confirm current has fallen before touching a fixture key, connector or load lead.
- Return negotiated profiles toward 5 V or disconnect Type-C. Use the documented reset path only with the load OFF.
- Turn the ASR2100 output OFF to depower the DUT. Confirm the output and input states are safe before disconnecting cables.
- Remove thermocouples and cables without damaging the sample. Record final sample condition and any abnormality.
- Reset instrument limits/ranges as required, clear temporary bench data only after package verification, and leave all load inputs OFF.

ABORT AND MAKE SAFE Immediately disable the affected load channel(s) for unexpected voltage, collapse/oscillation, cable or connector overheating, smoke, odor, arcing, instrument overload, communication loss, reversed polarity, an unsupported profile or a route mismatch. Turn the AC source output OFF when load removal alone does not make the setup safe. Record the state before retrying; do not bypass a failed release gate.

Manual Fast-Charge Fixture - On-Bright OBPD011

The OBPD011 is a manual sink/trigger interface, not an electronic load, power meter or USB-IF compliance analyzer. It requests a DUT-supported fast-charge profile and exposes the negotiated output at LOAD+ and LOAD-. The assigned Chroma channel supplies the actual load.

Figure 1 - On-Bright OBPD011 manual fast-charge fixture. Manufacturer product image.

FIXTURE ACCEPTANCE LIMIT The manufacturer page does not publish the load-path voltage, current, power, connector, trace or terminal rating, and it does not publish DC-005 polarity. Before use, verify the dedicated 5 V supply and polarity, record the actual board revision, and establish a labelled conservative bench acceptance limit. EPR/AVS button availability is not proof that the complete fixture path is safe at every source rating.

Connection and preflight

Connection/control	Purpose	Operator requirement
DC-005	5 V fixture supply	Use only the verified, labelled supply and polarity; confirm LED9.
Type-C	DUT source connection	Connect only when the selected mode procedure instructs and while load is OFF/0 A.
LOAD+ / LOAD-	Negotiated output to Chroma	Verify polarity and lead rating; never connect/remove under load.
F1-F8	Protocol/mode	Confirm the corresponding LED1-LED8; do not infer voltage from the LED.
V1-V8	Mode-specific profile/action	Use the active-mode map below; verify output voltage independently.

- Set the assigned Chroma input OFF and program 0 A. Turn other affected outputs OFF before changing a shared adapter state.
- Connect the PicoScope 4444 differential input across the same output pair with the approved accessory, range, coupling and bandwidth.
- Power the fixture from the verified 5 V supply, confirm LED9, then follow the exact mode sequence. Treat LOAD terminals as energized whenever Type-C is connected.
- After negotiation settles, measure LOAD+ to LOAD-. Enable load only after the voltage agrees with the intended Faganas profile.

Mode and button map

Key	Mode	Fixed selections	Adjustment / special action
F1	PD PDO	V1-V5: PDO1-PDO5; V7: PDO8/EPR entry	V8: Hard Reset; V6 undocumented
F2	PPS APDO	V1: PPS1; V2: PPS2	V3/V4: +/-20 mV; V5/V6: +/-500 mV; V7/V8: Icc +/-50 mA
F3	QC 2.0/3.0	V1/V2/V3: 5/9/12 V; V4: enter QC 3.0	V5/V6: +/-200 mV; V7/V8 unused
F4	FCP	V1-V5: 5/9/12/15/20 V	V6-V8 undocumented
F5	SCP_B	V1-V5: 5.5/9/12/15/20 V	V1 also enters; V6/V7: +/-100 mV; V8 unused
F6	UFCS	V2-V6: 5/9/12/15/20 V	V1: enter/exit; V7/V8: +/-100 mV
F7	AVS	V1: AVS1; V2: AVS2	V3/V4: +/-100 mV; V5/V6: +/-1000 mV; V7/V8: Icc +/- (step unpublished)
F8	EPR PDO	V1/V2/V3/V4: PDO1/PDO8/PDO9/PDO10	V5-V8 undocumented in this mode

DOCUMENTATION CONFLICT One manufacturer overview calls F8 reserved, while the later full table and dedicated section define F8 as EPR PDO. Validate the actual board revision at 5 V with the load OFF before relying on F8. PDO8 is identified as 28 V; determine PDO9/PDO10 from the DUT capability set and measured output, not from the button number.

Fixed USB PD PDO - F1

- Press F1 and confirm LED1, then connect the DUT Type-C cable.
- Press V1-V5 to request PDO1-PDO5. Use only PDOs advertised by the DUT. V7 is the documented EPR/PDO8 28 V entry and requires an EPR-capable DUT and cable.
- Wait for negotiation, verify unloaded voltage, and record Name=Voltage,Current using the advertised current for that PDO.
- V8 is Hard Reset. Keep load OFF/0 A, press it to return toward SPR, and disconnect Type-C if the expected reset is not observed. Verify voltage before reconnecting load.

PPS / APDO - F2

- Press F1 and V1 to establish the 5 V PD state, connect the DUT Type-C cable, then press F2 and confirm LED2.
- Press V1 for PPS1 or V2 for PPS2. Adjust voltage with V3/V4 (+/-20 mV) or V5/V6 (+/-500 mV). Adjust the requested contract current with V7/V8 (+/-50 mA).
- Verify unloaded voltage and enter the verified Voltage plus selected contract-current request in Faganas. Increase actual Chroma load gradually through the planned operating points.

QC, FCP, SCP_B and UFCS

Mode	Safe operating sequence
QC - F3	With Type-C disconnected press F3; reconnect; V1/V2/V3 select 5/9/12 V, or V4 enters QC 3.0 and V5/V6 trim +/-200 mV; verify before load.
FCP - F4	With Type-C disconnected press F4; reconnect; V1-V5 select 5/9/12/15/20 V; verify before load.
SCP_B - F5	With Type-C disconnected press F5; reconnect; V1-V5 select 5.5/9/12/15/20 V and V6/V7 trim +/-100 mV; verify before load.

Mode	Safe operating sequence
UFCS - F6	With Type-C disconnected press F6; reconnect; V1 enters/exits, V2-V6 select 5/9/12/15/20 V and V7/V8 trim +/-100 mV; verify before load.

AVS and EPR

- AVS - F7: use only with a suitable DUT and cable. V1/V2 select AVS1/AVS2; V3/V4 adjust +/-100 mV; V5/V6 adjust +/-1000 mV. V7/V8 change Icc, but the manufacturer does not publish the step. Do not assume the PPS step; validate the actual board/request before loading.
- EPR - F8: keep load OFF, connect an EPR-capable DUT/cable, validate F8 behavior at 5 V, then use V1/V2/V3/V4 for PDO1/PDO8/PDO9/PDO10. Verify every unloaded voltage against the DUT capability evidence before load.
- To exit EPR, disconnect Type-C. The F1/V8 Hard Reset path is also documented for return to SPR; verify the resulting voltage before any load is enabled.

Mode change, multi-port use and recovery

- Any mode change is treated as a return to the 5 V level. Keep load OFF/0 A, press the target F key, disconnect/reconnect Type-C, confirm 5 V, then select the higher profile and verify it.
- One OBPD011 has one Type-C input and one LOAD pair. Use one independently suitable trigger/interface for every negotiated USB-C output that must remain active in a simultaneous test.
- After the final port is connected, re-verify all outputs because the adapter may redistribute power or renegotiate. Update the plan if the sustained combination differs from the original advertisement.
- If voltage is wrong/unstable, immediately disable the affected Chroma channel, disconnect Type-C, return toward 5 V or power-cycle the fixture, and turn the AC source OFF if needed. Record requested profile, measured voltage, cable, route and behavior before retrying.

NOT USB-IF COMPLIANCE The OBPD011 procedure supports controlled engineering and production-style loading. It does not decode or certify protocol compliance, and its LEDs are not proof of negotiated voltage or current. Retain external capability evidence and measured voltage for every commissioned profile.

Operator checklist - before enabling any load

- Verified 5 V fixture supply and polarity; LED9 ON; fixture ID/revision recorded.
- Correct DUT port, cable/EPR rating, Chroma channel and PicoScope input mapped.
- LOAD+ / LOAD- polarity correct; load input OFF; 0 A programmed.
- Correct F-mode LED and intended V action selected.
- Measured unloaded voltage agrees with the Faganas profile.
- Contract/rated current is recorded correctly and is not confused with immediate load current.

- All outputs were rechecked after the final multi-port connection.
- Fixture-path acceptance limit and every cable/instrument limit are respected.

No-Load and Connected-Idle Measurements

No-load power is measured separately at every required input condition with the PA energised and no primary load connected. Connected-idle states are additional Cybenetics measurements and are not substituted for regulatory no-load power.

1. True no-load: no powered product or electronic load connected to any output.
2. Single-port connected idle: each negotiable output is connected individually with zero useful load.
3. All-ports connected idle: all ports are negotiated/connected with zero useful load, where technically possible.

The database stores input power, PF, negotiated state, active ports and input condition for each state. ETA no-load limits are applied only to the defined no-load measurement.

Single-Port and Per-Profile Efficiency Procedure

Every physical port is characterized independently. Every advertised fixed profile is tested, because ports and profiles can have different conversion stages and losses.

Profile type	Required operating points
Fixed voltage / proprietary	10% to 100% of profile current in 5% steps; explicitly include 10%, 25%, 50%, 75% and 100%
USB-PD fixed PDO	Full 10–100% sweep for every advertised fixed PDO on every port
PPS	Minimum, midpoint and maximum PPS voltage; 10%, 25%, 50%, 75% and 100% of the applicable current plus dynamic transition tests
Dynamic/boost profile	Continuous tests use guaranteed power; peak capability and duration are recorded separately

Table 4 — Per-profile efficiency test points.

At each point, record input voltage/current/power/PF, output voltage/current/power, efficiency, ripple, temperature and the negotiated profile. No-load is measured separately.

$$\eta i = (Pout,i \,/\, Pin,i) \times 100\%$$

$$Eprofile = (1 \,/\, N) \times \Sigma\, \eta i \quad for\ the\ defined\ profile\ load\ sweep$$

Multiple-Output and Shared-Capacity Procedure

A multiple-output PA is tested both as a collection of individual ports and as a combined system. Total delivered output power is the sum of the simultaneously measured power at every active output.

$$\eta scenario,i = (\Sigma j\ Pout,i,j\ /\ Pin,i) \times 100\%$$

Scenario family	Required method
Balanced	All active ports receive equal proportional loading.
Priority-port	The highest-power port is loaded first; remaining guaranteed power is allocated to the other active ports.
Advertised splits	Every simultaneous power distribution explicitly advertised by the manufacturer is tested.
All-ports low load	All ports are active at a low combined load to expose poor light-load behavior.
Full combined load	All applicable ports operate at the maximum continuous combined output power.
Worst thermal split	The allocation producing the highest internal or connector temperature is retained as a standardized result.
Redistribution	Ports are connected/disconnected and load is transferred while voltage, interruption, overshoot and renegotiation are captured.

Table 5 — Standardized multi-output scenario families.

For shared-capacity ports, the proportional-allocation derating factor is the ratio between maximum combined output power and the sum of the individual port nameplate powers. Each port reference current is multiplied by this factor for the applicable simultaneous load condition. For DUTs with up to five active outputs, every standardized simultaneous scenario is executed with one dedicated Chroma channel per output; total delivered power is calculated from the simultaneous per-channel readbacks. A DUT needing more than five simultaneous outputs is not represented by a substitute or sequential result: it requires the planned second mainframe and validated routing before the all-port scenarios are complete.

- Scenario families are weighted, not raw scenario counts, so products with more advertised profiles do not gain or lose rating weight solely because of profile count.
- For EU compliance, adaptive supplies are tested at the lowest and highest applicable output voltage, and multiple-output/nameplate calculations follow the selected regulatory rule set.
- Every per-port measurement and allocation is stored and published; the aggregate never replaces the underlying evidence.

Hierarchical Efficiency Aggregation

Flat averaging of every raw profile and scenario is prohibited because it gives disproportionate weight to products with many ports or profiles. Rev. 1.2 uses hierarchical aggregation.

$$Eport = arithmetic\ mean\ of\ all\ required\ Eprofile\ values\ for\ that\ physical\ port$$

$$Esingle = arithmetic\ mean\ of\ Eport\ across\ physical\ ports$$

$$Emulti = arithmetic\ mean\ of\ the\ standardized\ multi\text{-}output\ scenario\text{-}family\ results$$

$$Ecomparative = Esingle \quad (single\text{-}output\ PA)$$

$$Ecomparative = 0.5 \times Esingle + 0.5 \times Emulti \quad (multiple\text{-}output\ PA)$$

Ecomparative is the published ranking value. To prevent a weak operating mode from being hidden, the efficiency eligibility level for a multiple-output PA is the lower level achieved independently by Esingle and Emulti. For a single-output PA, it is the level achieved by Esingle.

Note: for a multiple-output PA the published ranking value (Ecomparative) and the awarded ETA level are derived from different quantities by design — the ranking value is the 0.5×Esingle + 0.5×Emulti blend, while the awarded medal uses the lower of the Esingle and Emulti eligibility levels. A unit's ranking figure and its medal may therefore reflect different operating modes.

ETA Efficiency Levels and Awarding Logic

A PA receives independent ETA certifications for 115 V and 230 V. Power class is based on continuous combined output power. The tables below are the initial Rev. 1.2 rule set and are versioned for later recalibration after a representative beta population is available. Rule-set versions are independent of this document's revision number: the "Rev. 1.2 rule set" is the efficiency rule set first defined in document revision 1.2 and remains current in this document.

ETA level	Class A ≤6 W	Class B 6–49 W	Class C 49–150 W	Class D >150 W
DIAMOND	≥87	≥92	≥94	≥95
TITANIUM	≥85	≥90	≥92	≥93
PLATINUM	≥83	≥88	≥90	≥91
GOLD	≥81	≥86	≥88	≥89
SILVER	≥78	≥84	≥86	≥87
BRONZE	≥75	≥81	≥83	≥84

Table 6 — Minimum overall efficiency (%), 230 V input.

ETA level	Class A ≤6 W	Class B 6–49 W	Class C 49–150 W	Class D >150 W
DIAMOND	≥85	≥90	≥92	≥93
TITANIUM	≥83	≥88	≥90	≥91
PLATINUM	≥81	≥86	≥88	≥89
GOLD	≥79	≥84	≥86	≥87
SILVER	≥76	≥82	≥84	≥85
BRONZE	≥73	≥79	≥81	≥82

Table 7 — Minimum overall efficiency (%), 115 V input.

No-Load Limits

ETA level	Class A ≤6 W	Class B 6–49 W	Class C 49–150 W	Class D >150 W
DIAMOND	0.020	0.030	0.050	0.075
TITANIUM	0.030	0.040	0.070	0.100
PLATINUM	0.040	0.055	0.090	0.130
GOLD	0.050	0.070	0.110	0.150
SILVER	0.060	0.085	0.130	0.180
BRONZE	0.075	0.100	0.150	0.210

Table 8 — Maximum no-load power (W), applied separately at each ETA input voltage.

Power-Factor Limits

Power factor is measured and reported at every load point. It affects the ETA level only when rated continuous output exceeds 70 W.

ETA level	PF — 230 V	PF — 115 V
DIAMOND	≥0.950	≥0.985
TITANIUM	≥0.940	≥0.980
PLATINUM	≥0.935	≥0.975
GOLD	≥0.930	≥0.970
SILVER	≥0.920	≥0.960
BRONZE	≥0.900	≥0.950

Table 9 — Minimum full-load power factor for PAs above 70 W.

Final ETA Award

1. Calculate the efficiency eligibility level. For a multiple-output PA, use the lower level reached by Esingle and Emulti.
2. Calculate the highest level whose no-load limit is satisfied.
3. For PAs above 70 W, calculate the highest level whose full-load PF limit is satisfied.
4. The provisional ETA level is the lowest of the applicable efficiency, no-load and PF levels.
5. Apply all mandatory certification gates. A failed gate prevents certification; it is not converted into a lower medal.

$$ETAfinal = min(LevelEfficiency, LevelNo\text{-}load, LevelPF) \text{ subject to all mandatory gates}$$

Regulatory Compliance Layer

Regulatory compliance is calculated independently from the Cybenetics ETA level. Each market uses a versioned rule set with its own scope, formulas, measurement plane, input conditions and effective dates.

Region	Rule family	Core calculation
United States	DoE Level VI / 10 CFR 430	No-load plus average efficiency at 25%, 50%, 75% and 100% using the applicable DOE formula
European Union – current	Regulation (EU) 2019/1782	No-load and average active efficiency at the required fixed load points
European Union – from 14 Dec 2028	Regulation (EU) 2025/2052	No-load, 10% low-load where applicable, 25/50/75/100% average efficiency, multi-output/adaptive rules and interoperability
Other selected regions	GB, Top Runner, MEPS, BEE, SASO/ESMA	Calculated using the version selected in the work order

Table 10 — Regulatory rule families. Exact formulas are maintained as versioned rule records.

Compliance separation: A product may earn a strong Cybenetics efficiency result yet remain uncertified for a target market if it fails that market's mandatory regulation. Both outcomes are shown explicitly.

Mandatory Conducted EMI

Conducted EMI is mandatory for every PA certification under this protocol. The minimum method follows EN 55032/CISPR 32 Class B using a calibrated EMI receiver and LISN. Radiated EMI is outside the mandatory base scope unless included in the work order.

Operational boundary: EMI acquisition is performed in the separate Cybenetics EMI application and laboratory workflow, not in Faganas Power Adapters. The resulting trace package is linked to the same DUT, sample and report identifiers.

- Run at 115 V / 60 Hz and 230 V / 50 Hz.
- Capture and retain line and neutral traces, limits, detector settings, frequency range, equipment and calibration references.
- Test the highest-power single-port profile.
- For a multiple-output PA, also test the worst conducted-emissions simultaneous scenario identified during pre-scan.
- Record Pass/Fail and the minimum margin to the applicable limit.
- A conducted-EMI failure blocks certification at both ETA levels until corrected and retested.

Regulation, Ripple and Transient Performance

Load and Line Regulation

Output voltage is recorded at every efficiency point. Regulation is calculated per output/profile across the load sweep and across applicable input voltages. For simultaneous scenarios, each active output is evaluated independently.

Ripple and Noise

Ripple is measured at the output measurement plane using the documented bandwidth, probe connection and test fixture. Results are recorded per port/profile at 10%, 25%, 50%, 75% and 100% load and for the worst simultaneous scenario. On the installed five-output bench, outputs 1-4 are captured simultaneously on PicoScope 4444 #1 inputs A-D and output 5 is captured on PicoScope 4444 #2 input A; the report retains scope serial number, input, coupling, range, bandwidth and capture ID for every output. Intermediate-load ripple materially higher than full-load ripple is flagged for review.

Transient and Redistribution Tests

- Profile load steps representative of low-to-medium and medium-to-full load operation.
- Port connection and disconnection during shared-capacity operation.
- USB-PD/PPS voltage transitions, renegotiation, overshoot, undershoot and interruption time.
- Power redistribution when a priority port becomes active or inactive.
- Pass/fail outcome plus scope screenshots and machine-readable measurements. Channels on the same PicoScope are captured simultaneously. A five-output event spans two instruments and is labelled cross-scope, unsynchronised: it supports per-output transient/redistribution evidence but is not used to claim phase-accurate timing between the two PicoScopes.

Protection Tests

Protection behavior is measured at normal temperature and repeated at the hot condition where technically applicable. Each result stores trigger value, shutdown outcome, damage outcome, recovery method and operator notes.

Protection	Required coverage
OVP	Per output rail/profile where the design permits a controlled test
OCP	Per physical output and shared-capacity group
OPP	Combined adapter output at normal and hot conditions
SCP	Each physical output; confirm shutdown/current limiting and safe recovery
OTP	Thermal shutdown behavior where implemented
Fan failure	Informational Yes/No/N/A field; test required only when a fan is installed

Table 11 — Protection-test coverage.

Thermal and Hot Performance

Thermal behavior is measured, not inferred from safety documents. The full-load and worst multi-output conditions are maintained until thermal equilibrium at the specified ambient.

- Record enclosure hot spots, accessible-surface temperatures, connector and cable temperatures, internal temperatures where instrumented, and ambient temperature.
- Measure efficiency degradation between the normal and hot conditions.
- Retain thermal images and temperature/time curves.
- A measured accessible-surface failure against the applicable protocol limit blocks certification.

Conditional Fan and Acoustic Testing

Noise testing is conditional and does not affect ETA efficiency levels in Rev. 1.2.

Cooling declaration	Editor behavior	Completion rule
Fan = No	Acoustic section is hidden and stored as N/A — fanless	No acoustic blocker
Fan = Yes	Acoustic section, RPM fields and upload slots are displayed	Noise data are required before completion

Table 12 — Conditional acoustic workflow.

- For fan-equipped PAs, measure steady-state sound pressure and fan speed at representative load points through full combined load after thermal stabilization.
- Publish a load/noise curve, maximum noise, relevant tonal observations and fan-speed behavior.
- PA acoustic levels may be introduced only after enough fan-equipped samples exist to establish defensible thresholds.

Additional Cybenetics Performance Tests

The following tests are reported separately from the ETA medal unless a future rule-set revision explicitly incorporates them:

- Hot-box efficiency degradation curve.
- Multi-port derating and redistribution map.
- Real-world smartphone charging curve, including taper and trickle behavior.
- USB-PD/PPS dynamic behavior and voltage tracking.
- Reference-cable resistance and voltage drop.
- Wireless efficiency, alignment sensitivity and coil temperature when wireless charging is integrated.
- Peak-power duration and recovery for dynamic adapters.

Sampling, Repeatability and Borderline Results

1. If a rating result is within 0.1 percentage points of a level boundary, request a second sample.
2. If the second sample differs from the first by more than 0.5 percentage points, request a third sample.
3. Every sample retains its own measurements, identifiers and calculated outcome; results are never overwritten by another sample.
4. The certification record identifies the sample set and the rule used to determine the published result.
5. An abnormal protection, EMI, thermal or functional failure is never averaged away.

Data Quality, Traceability and Automated Validation

- Raw imported measurements and media hashes are immutable after acceptance; corrections create an audited revision. For every multi-output point, the run stores the logical output ID, Chroma mainframe/channel, PicoScope serial/input, commanded load, load readback and capture ID; these route records are immutable with the raw measurement.
- Headline values, scores and ETA levels are calculated from source measurements and rule-set versions.
- The editor checks missing ports/profiles, impossible power allocations, headline/table mismatches and incomplete mandatory media.
- Cross-voltage checks flag abnormally large 115 V versus 230 V differences in efficiency, regulation, ripple and other comparable metrics.
- Intermediate-load ripple materially exceeding nearby full-load results is flagged.
- Calibration IDs, instrument ranges, uncertainty, operator, dates and environmental conditions are retained with each run.
- Manual overrides require a reason, user identity and timestamp and never alter the underlying raw data.

Mandatory Certification Gates

Gate	Required state	Effect
Applicable regional efficiency rule	Pass	Failure prevents certification for that market
Conducted EMI	Pass	Mandatory for every PA certification
Thermal/touch-temperature evaluation	Pass	Measured evaluation; no safety-document upload required
Required protection tests	Complete and coherent	Missing trigger/outcome or damage blocks certification
Required electrical data (up to five simultaneous outputs on the installed bench)	Complete	All selected ports, profiles, inputs and scenarios accounted for
Required media/raw evidence	Complete	EMI traces, scope captures, tables and thermal evidence present
Unresolved functional failure	None	A failed or broken sample remains a blocker

Table 13 — Mandatory gates applied after provisional ETA calculation.

Certification and Reporting

Each certified PA receives separate ETA-230V and ETA 115 V results tied to the product, sample set, methodology revision and rule-set version. The public report and databases must expose enough detail to understand the result without revealing private work-order information.

- Product identity, input ratings, power class, continuous/guaranteed/peak power and cooling type.
- Complete physical-port, fixed-profile, PD/PPS and shared-capacity map.
- ETA level and efficiency result at 115 V and 230 V.
- Single-port block, multi-port block and overall comparative efficiency.
- Per-port/per-profile efficiency curves and standardized multi-output scenarios.
- No-load, connected-idle and full-load PF results.
- Regional compliance results with rule-set version and effective date.
- Mandatory EMI traces, pass/fail result and margin.
- Regulation, ripple, transient, PD/PPS and protection results.
- Normal/hot thermal results, temperature rise and thermal imagery.
- Conditional fan/noise results or explicit N/A — fanless status.
- Equipment, calibration, uncertainty, test dates, analyst and authorization records.
- For negotiated outputs, fixture asset/revision, protocol mode, F/V action, requested profile/current, cable ID, verified unloaded voltage and fixture acceptance limit.

Rule-Set Versioning and Beta Calibration

ETA thresholds in Tables 6–9 remain an initial proposal. They must be implemented as versioned data rather than hardcoded application constants. Each rule set records revision, effective date, input voltage, power class, efficiency threshold, no-load limit, PF limit and applicable gates.

During the beta phase, Cybenetics shall review the population distribution by power class, port count and topology. Any recalibration creates a new rule set; previously issued reports retain their original calculated result unless explicitly reissued under a newer revision.

References

[1] U.S. Department of Energy, Energy Conservation Standards for External Power Supplies, DoE Level VI, 10 CFR Part 430 and Appendix Z.

[2] Commission Regulation (EU) 2019/1782, ecodesign requirements for external power supplies.

[3] Commission Regulation (EU) 2025/2052, ecodesign requirements for external power supplies, wireless chargers, wireless charging pads, battery chargers and USB Type-C cables.

[4] EN 50564:2011 / IEC 62301, measurement of standby and no-load power.

[5] EN 55032 / CISPR 32, electromagnetic compatibility of multimedia equipment — emission requirements.

[6] EN/IEC 61000-3-2, limits for harmonic current emissions.

[7] IEC 62368-1, audio/video, information and communication technology equipment — safety requirements and accessible-surface temperature limits.

[8] USB Type-C Cable and Connector Specification, Release 2.4.

[9] USB Power Delivery Specification, Revision 3.2, Version 1.1.

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[12] Cybenetics, On-Bright OBPD011 USB-C Fast-Charge Test Fixture - English Operator Guide and Faganas Power Adapters Bench Methodology, Revision 1.0, July 2026.