The Complete Cybenetics Redundant Server PSU Test Protocol, Including Energy Efficiency, Output Noise, And Overall Performance Calculation of Redundant Server AC-DC Power Supplies

Revision 1.1

Authors: *Aristeidis Bitziopoulos*

Nicosia, Cyprus

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Derived from and aligned with the Cybenetics PSU Test Protocol, Revision 3.7. Where this document is silent, the Desktop protocol applies.

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Revision History

Version	Release Date	Notes
1.0	June 2026	First draft of the dedicated redundant server PSU methodology, adapted from the Cybenetics PSU Test Protocol Rev 3.7. Establishes single-module efficiency (ETA Redundant), the noise (LAMBDA) adaptation for server modules, and the standalone-module performance and protection test battery.
1.1	August 2026	Measurement uncertainties updated to the current controlled budgets (P19).

This protocol does not restate every definition, equation, and instrument requirement already published in the Desktop protocol. It documents only what is **added, modified, or removed** for redundant server power supplies. All carried-over procedures, uncertainty budgets, and calculations remain governed by Rev 3.7.

Prologue and Scope

Besides the non-redundant power supplies used in typical desktop PCs, Cybenetics also evaluates redundant power supplies installed in servers, storage systems, and networking equipment that operate around the clock (24/7). This protocol applies to all redundant server power supplies that deliver a single main rail (typically 12 V) plus a standby rail, or a main rail only — the Common Redundant Power Supply (CRPS) and its modern successor, the Modular Common Redundant Power Supply (M-CRPS), being the dominant standardized examples. Where a unit has no standby rail, the standby-specific items below simply do not apply.

Cybenetics evaluates a **single power module on its own.** The module is connected through its gold-finger (card-edge) output connector to a Cybenetics test fixture, or to a fixture supplied with the unit; the mainframe is not used. The certification measures the module's **energy efficiency** (ETA Redundant) and **output noise** (LAMBDA), and adds a battery of standalone performance and protection tests — transient / load-step response and declared peak-power excursions, hold-up time and timings, inrush, ripple and load regulation, standby, and protection features (OCP/OPP/OVP/OTP/SCP, fan-failure, surge/inrush parts).

Out of scope: the digital management interface (PMBus / SMBus / SPDM) is not exercised, and multi-module functions — current sharing, ORing, hot-swap, and redundancy behavior — are not tested, because each module is evaluated by itself rather than installed in a mainframe with other modules.

As with the Desktop protocol, this methodology is written so that any ISO/IEC 17025:2017 accredited laboratory with equivalent, calibrated equipment can reproduce the results. Cybenetics, as a certification body, will accept data from evaluated labs that follow this methodology. Redundant-PSU requirements are expected to be refined as the database grows; where a threshold is marked provisional it is a starting point subject to revision.

CRPS / M-CRPS Form Factor Overview

The table below summarizes the form-factor characteristics of these power modules as background. The newer M-CRPS base specification is maintained under the Open Compute Project (OCP); legacy CRPS derives from the Intel/SSI server power guidelines. Items marked as management or multi-module features describe the device class but are not part of the Cybenetics test scope (see Prologue and Scope).

CRPS / M-CRPS Form-Factor Attributes (background)

Attribute	CRPS / M-CRPS characteristic
Architecture	Mainframe + 2 or more hot-swap power modules; redundancy modes 1+1, 2+1, and N+1. Cybenetics tests one module on its own.
Main output	Single high-current 12 V rail. Minor system voltages are produced by DC-DC converters on the mainframe / power distribution board, not by the module.
Standby output	12 VSB on M-CRPS (older CRPS may use 12 V or 5 V standby), or none on main-rail-only units.
Output connector	2x25 (50-pin) gold-finger card-edge connector; this is where the test fixture attaches. Legacy CRPS variants use other gold-finger pinouts.

Attribute	CRPS / M-CRPS characteristic
Form factor	1U class, nominal 73.5 mm width x 185 mm depth (length varies with power class). 2U and wider modules also exist.
Management (not tested)	PMBus / SMBus / I2C telemetry and FRU/EEPROM; M-CRPS may add SPDM. Cybenetics does not exercise these interfaces.
Multi-module features (not tested)	Current sharing (ISHARE), ORing, hot-swap, and redundancy require a mainframe and are outside this single-module certification.
Input variants	AC input (100-127 / 200-240 Vac); high-line-only high-power SKUs; and HVDC variants on some platforms. Certification is 230 V only (see Input Voltage).
Cooling	One or more high-RPM fans inside each module, PWM-controlled. The module's own fan power is included in the efficiency measurement.

Definitions (Additions and Changes)

The Desktop protocol definitions apply unchanged (AC/DC signal, ambient temperature, apparent power, AWG, efficiency, ripple, true power factor, crest factor, RMS, steady state, THD, UUT). The following terms are added or redefined for redundant server modules:

Mainframe (cage / backplane / PDB) — The chassis subassembly that hosts the power modules and distributes the 12 V bus. It is described here as background; Cybenetics tests the module without the mainframe.

Power module (PSM) — A single hot-swappable redundant power supply unit. Unless stated otherwise, the UUT in this protocol is one power module tested on its own via its gold-finger connector.

Redundancy (N+1 / N+N) — An operating configuration in which more modules are present than required to carry the load. Provided as background; redundant operation itself is not tested here.

12 VSB (standby rail) — The always-on standby output of a module, where present. Main-rail-only modules have no standby rail and skip standby-specific items.

PSON# / PWOK — Remote on/off control (PSON#) and power-good status (PWOK) signals on the module connector, used during the timing and hold-up tests.

Gold-finger (card-edge) connector — The module's 2x25 / 50-pin edge connector that mates to the backplane in service; in testing it mates to the Cybenetics or supplied fixture.

Relationship to the Desktop PSU Protocol

The matrix below maps every major element of the Desktop protocol (Rev 3.7) to its treatment in this redundant server PSU protocol. "Carried over" means applied verbatim; "Modified" means adapted as described in the referenced section; "Removed" means not applicable; "Out of scope" means a feature of the device that Cybenetics does not test.

Desktop-to-Server-Module Mapping

Desktop element	Status	Rationale
Calibrated equipment & Faganas ATE	Carried over	Same instrument classes and uncertainty discipline; module attaches via a gold-finger test fixture.
Hotbox / elevated ambient	Modified	Thermal profile tuned to server intake conditions.
>1450 load combinations, averaged efficiency	Modified	Load matrix simplified to a single 12 V main rail (+ 12 VSB if present); range 2-100%.
115 V / 100 V / 230 V test inputs	Modified	230 V-only certification scheme; no 115 V tables. Low-line/HVDC checked only for survival.
5 V / 3.3 V minor-rail tests	Removed	Minor rails are generated by mainframe DC-DC, not the module.
Vampire power (no-load standby)	Removed	Modules are designed for continuous operation; standby idle is not a meaningful mode.
Average 5VSB efficiency term	Removed	Standby load and its efficiency impact are minimal vs. total load.
LAMBDA noise grading	Modified	Same energetic-averaging method; provisional CRPS noise scale for high-RPM server fans.
EMI (CISPR 32 / EN 55032)	Carried over	Class A limits apply to data-center IT equipment.
ATX v3.x peak power excursions	Replaced	Server dynamic load-step plus declared peak-power tiers, not the ATX excursion ladder.
Hold-up time, PWR_OK, timings	Modified	Evaluated against server requirements.
Protections (OCP/OPP/OTP/SCP, fan-fail)	Modified	Single-12 V context; OVP added.
Overall performance algorithm	Modified	Re-weighted for 12 V (+ 12 VSB).
PMBus/SMBus/SPDM telemetry; current sharing, ORing, hot-swap, redundancy	Out of scope	Require a mainframe / multi-module setup or digital management; not part of this single-module certification.

Test Setup and Measurement Conditions

The instrument classes and accuracy requirements of the Desktop protocol (programmable AC source ≥ 4 kVA, multi-channel DC electronic loads, ≤ ±0.1% power analyzer, ≥ 100 MHz / ≥ 1 GS/s oscilloscope, Class 1 acoustics chain, ≤ ±0.5 °C temperature, tachometer, bench DMM, online UPS and isolation transformer) apply in full. The following additions and changes are specific to redundant server modules:

- **Module test fixture (gold-finger).** The module is connected through its 2x25 / 50-pin card-edge output connector to a Cybenetics test fixture, or to a fixture supplied with the unit. The mainframe is not used; each module is evaluated on its own. The fixture brings out the 12 V main rail, 12 VSB (if present), and the PSON#/PWOK signals needed for the timing and protection tests.
- **High-current DC load capability.** Sized for the full 12 V output of high-power server modules (commonly 800 W-3000 W per module).

- **HVDC / 48 V source (when applicable).** A DC source for modules rated for 240/336 Vdc or 48 Vdc input, in addition to the AC source.
- **Fan power.** The module's own fan power consumption is included in the efficiency measurement (the fans are part of the module). There is no mainframe fan in the test, since the module is tested without the mainframe.
- **Not used.** No PMBus/SMBus/SPDM host adapter and no mainframe/multi-module fixture are required, because telemetry and multi-module behavior are out of scope.

Input Voltage

The redundant server PSU program is a **230 V-only scheme**: all efficiency and noise certification measurements are performed at 230 V input, consistent with ETA (Redundant). There are no 115 V certification tables (unlike the desktop ETA program, which certifies at both 115 V and 230 V). Functional start-up and survival at the low end of a SKU's rated AC range, and any rated HVDC input, are still exercised as protection / ride-through checks but do not produce a certification grade. The label rating governs the maximum wattage; we additionally verify behavior at 110% load and apply elevated ambient stress as below.

Thermal Conditions

Tests start near 30 °C with the module in a hotbox that simulates a server intake environment; the chamber is driven toward the upper end of the module's rated operating range so that fan behavior, efficiency under heat, and protections are characterized under realistic data-center stress rather than at an unrealistically low ambient. Each load point is held for several minutes and all readings are averaged by Faganas (the C# data-acquisition layer) as the final result, exactly as in the Desktop protocol.

Efficiency Measurements Procedure (ETA Redundant)

We apply at least 1450 different load combinations on the module, covering 2% to 100% of its operational range. Because a server module exposes a single 12 V main rail plus (where present) the 12 VSB standby, the load matrix is far simpler than the three-rail desktop sweep: the 12 V rail is stepped across its full range while any standby load is held at a fixed, representative value. The overall efficiency and power-factor results are the arithmetic average of all measurement points, which (with interpolation) yields tens of thousands of effective points across the entire operating range. Averaging the whole range makes it impossible to tune a unit to a handful of fixed load levels.

Consistent with ETA (Redundant), Cybenetics does **not** measure vampire power and does **not** include an average standby-efficiency term for these modules: the standby load is negligible relative to the total. Any standby rail is still logged and reported, and gross anomalies are flagged.

Efficiency Grading (ETA Redundant)

Certification uses the 230 V efficiency and power-factor thresholds below. If a unit narrowly misses a limit (within 0.1%) we may request a second and, if needed, a third sample, per the standard re-evaluation rule; a difference with the upper limit of ≤ 0.05% is rounded to the higher class. If a unit fails the power-factor requirement it drops to the class whose PF requirement it meets, regardless of efficiency.

ETA (Redundant) Efficiency Levels — 230 V Input

Efficiency level (230 V)	Overall efficiency	Power factor
DIAMOND	≥ 95%	≥ 0.950
TITANIUM	≥ 93% & < 95%	≥ 0.940
PLATINUM	≥ 91% & < 93%	≥ 0.930
GOLD	≥ 88% & < 91%	≥ 0.920
SILVER	≥ 85% & < 88%	≥ 0.910
BRONZE	≥ 82% & < 85%	≥ 0.900

Output Noise Measurements (LAMBDA, CRPS Adaptation)

The LAMBDA measurement method is retained: we map the module's fan-speed range to noise. With the unit installed on the fixture, we record the fan-speed (RPM) range across the load matrix while monitoring it with a tachometer; we then, in the hemi-anechoic chamber, take dB(A) measurements at small RPM intervals (e.g., per 50 RPM) with the module switched off and its fan driven by an external supply, eliminating electronic-load noise. Faganas assigns a dB(A) value to each logged fan speed and energetically averages the result.

Energetic averaging is unchanged: because dB is logarithmic, each A-weighted level is converted to linear sound pressure, averaged, and converted back to dB(A), per ISO 7779 and ECMA-74. Background-noise (K1) correction is applied as in the Desktop protocol.

Differences for Server Modules

- **Microphone position.** A single fixed microphone is used, identical to the Desktop methodology: one bystander position at 1 m horizontal distance, 1.5 m height, ~30° incidence, per ISO 7779 / ECMA-74 and ISO 11201. The chamber geometry and background-noise correction are unchanged from the Desktop protocol.
- **Operating point.** Server fan speed is governed jointly by load and intake temperature. Noise is therefore reported with the load/thermal operating point stated, and the average reflects the realistic fan-speed range observed across the load matrix at the defined ambient.
- **Coil whine.** Electronic-noise screening (> 6-6.5 dB(A)) is performed as in the Desktop protocol using a passively-cooled load tester.

Noise Grading

The desktop LAMBDA scale (A++ < 15 dB(A) … Standard 40-45 dB(A)) is unrealistic for high-RPM 1U server fans, which routinely exceed it. Two reference scales are shown below: the established desktop scale (for context) and a **provisional** server scale shifted up by ~20 dB. The server scale is a starting point only and will be finalized as the database grows, consistent with the ETA (Redundant) philosophy of evolving requirements.

LAMBDA Noise Levels (server scale provisional)

Grade	Desktop LAMBDA (reference)	Proposed server scale (provisional)
A++	< 15 dB(A)	< 35 dB(A)

Grade	Desktop LAMBDA (reference)	Proposed server scale (provisional)
A+	15 - < 20 dB(A)	35 - < 40 dB(A)
A	20 - < 25 dB(A)	40 - < 45 dB(A)
A-	25 - < 30 dB(A)	45 - < 50 dB(A)
Standard++	30 - < 35 dB(A)	50 - < 55 dB(A)
Standard+	35 - < 40 dB(A)	55 - < 60 dB(A)
Standard	40 - < 45 dB(A)	≥ 60 dB(A)

EMI Emissions

Conducted and radiated EMI are evaluated against CISPR 32 / EN 55032 using the equipment and pass/fail method of the Desktop protocol (peak detector first; quasi-peak and average if needed; separate Phase and Neutral runs for conducted EMI). Server modules are data-center IT equipment and are assessed against the Class A limits; the ATX 4 dB margin allowance does not apply, so the unit is held to the CISPR 32 / EN 55032 limits directly. Conducted limits (Class A): 79/66 dBµV (QP/Avg) for 0.15-0.50 MHz and 73/60 dBµV for 0.50-30 MHz.

Module Performance and Protection Tests

Beyond efficiency and noise, the standalone module is characterized for the same performance and protection aspects as a desktop PSU, adapted to the single-12 V topology. All tests are performed on the module alone via the test fixture.

Standby (12 VSB)

Where the module has a standby rail, 12 VSB is characterized for regulation and ripple across its load range and during main-rail on/off transitions, and reported for information and regulation compliance. Main-rail-only modules skip this test.

Hold-up Time and Timings

Hold-up time is the interval the module maintains the 12 V rail in regulation after AC loss at full load. The M-CRPS requirement is ≥ 11 ms hold-up at full load (legacy CRPS units commonly specify ≥ 10 ms), measured at nominal input. PWOK must de-assert before the 12 V rail leaves regulation (a “fake” power-good is penalized, as in the Desktop algorithm). PSON# on/off timing and PWOK assertion delays are measured at light and full load, and the output rise time must fall within the 10-70 ms window. These pass criteria follow the OCP M-CRPS base specification and the SKU’s design spec; reporting follows the Desktop convention.

Key CRPS / M-CRPS Timing and Electrical Requirements (typical)

Timing / parameter	CRPS / M-CRPS requirement (typical)
Hold-up time (12 V, full load)	≥ 11 ms (M-CRPS); ≥ 10 ms common on legacy CRPS
PWOK de-assert vs. regulation	PWOK must drop ≥ 1 ms before 12 V leaves regulation
Output rise time (12 V & 12 VSB)	10 - 70 ms

Timing / parameter	CRPS / M-CRPS requirement (typical)
AC-on delay / PWOK rising	≤ 3 s AC-on / ≤ 50 ms rising (SKU-dependent)
12 V / 12 VSB regulation (static & dynamic)	±5% total output regulation window
Output ripple & noise	≤ 1% of nominal (≈ ≤ 120 mV on 12 V)
Inrush current	< 35 A peak cold start (< 55 A warm start on some SKUs)
OCP (12 V)	Staged latch-off, e.g., 125% / 135% of rated current
OVP (12 V & 12 VSB)	< 15 V (latch-off on 12 V; hiccup on 12 VSB)

Values per the OCP M-CRPS base specification and representative compliant datasheets; the exact figure for a given unit follows its design spec.

Transient / Load-Step Response

Transient behavior is evaluated in two complementary ways - a dynamic load-step (slew) test and the unit's declared peak-power excursions. There is a server guideline for both: the OCP M-CRPS base specification covers them under Dynamic Loading and Peak Load Protection. It is structured differently from the ATX v3.1 power-excursion ladder, but it exists.

Dynamic load-step. A step load of 50% of maximum output is applied to the 12 V rail at a 0.5 A/µs slew rate with the specified output capacitance; the rail must stay within ±5% with overshoot/undershoot ≤ 5% and recover cleanly. Any standby rail is exercised with its own smaller step. Unlike ATX, CRPS does not grant a relaxed transient window (ATX allows -8% on PCIe / -7% elsewhere); the same ±5% applies both statically and dynamically.

Peak-power excursions. Server modules declare peak-output tiers in their load table, and we test against them. Typically there are two tiers above the continuous rating: a short peak of roughly 10 ms and a sustained peak of about 20 seconds, the latter bounded by the thermal sensor. We verify that the 12 V rail holds regulation through each declared excursion, that no false protection trip occurs, and that recovery is clean. This is the server analog to the ATX v3.x power excursions - but where ATX v3.1 mandates a fixed percentage/duty ladder (110/120/160/180/200% at 100 µs to 100 ms, aimed at GPU spikes through the 12V-2x6 connector), CRPS peak magnitudes and durations are declared per SKU and limited by thermal protection, because the module feeds a backplane where downstream DC-DC and bulk capacitance buffer the CPU/GPU spikes.

CRPS Output Load Tiers (magnitudes per SKU; example values from a 2.6 kW / ~210 A unit)

Tier	Magnitude (12 V main)	Duration	Notes
Continuous (Pmax)	Rated current (e.g., ~211 A)	Indefinite	Rated continuous output at the certified ambient.
Sustained peak (CLST)	Rated + ~6 A (example)	≥ 20 s	Thermally limited; must hold ≥ 20 s at max operating temperature.
Short peak (Pmax app)	Rated + ~30 A (example)	≈ 10 ms	Instantaneous excursion; rail stays in regulation, no protection trip.

Tier	Magnitude (12 V main)	Duration	Notes
Dynamic step	50% of max @ 0.5 A/µs	Transient	Slew test; output within ±5%, overshoot/undershoot ≤ 5%.

CRPS expresses peak capability as the rated current plus a fixed adder, not as a percentage: on the representative 2.6 kW / ~210 A unit above, +6 A for ~20 s and +30 A for ~10 ms work out to only a few percent sustained and roughly 10-15% for the short pulse - far below the ATX v3.1 ladder. Exact adders and durations come from each unit's load table; the ATX 12VHPWR / 12V-2x6 excursion table is not applied.

Inrush Current

Peak inrush at cold start is captured at high-line (and low-line where supported), at the worst-case AC phase angle, and must remain within the module's rating — typically < 35 A peak cold start, with warm-start inrush also recorded (compliant units specify < 55 A). Behavior with the bypass relay / NTC scheme is noted.

Protection Features

Protections are evaluated in the single-12 V context. The following are checked, and bonus points awarded in the performance calculation:

- **OCP / OPP on the 12 V rail** — server units commonly stage OCP as latch-off at about 125% (OCP1) and 135% (OCP2) of rated current; the trigger must be high enough to ride real spikes but low enough to protect the module at elevated temperature.
- **OVP / UVP on 12 V (and 12 VSB)** — OVP typically < 15 V (latch-off on 12 V; hiccup on 12 VSB); must protect the load within the spec window.
- **OTP** — shuts the module down before the secondary side exceeds a safe temperature (provisional: < 190 °C secondary), critical for 24/7 operation.
- **SCP** — a short on the 12 V output shuts the module down and it recovers cleanly after repeated/prolonged short tests; any standby rail recovers on short removal.
- **Fan-failure protection** — if the module fan stops, the module must protect itself (throttle / derate / shutdown) before its internals are damaged.
- **Surge / inrush parts (MOV/TVS, NTC + bypass relay)** — present and effective.

AC input: the module must start and run at the low end of its rated input range under full load, and must survive (recover normally) a brief excursion below that range, following the Desktop method adapted to the SKU's rated range. These low-line/HVDC checks are functional/survival only and are not graded, because the certification scheme is 230 V-only.

Overall Performance Calculation (Server-Module Adapted)

The Desktop performance algorithm is re-weighted for the single-main-rail topology. Terms tied to absent rails or non-applicable modes are removed. As with the Desktop algorithm, we start from a perfect score of 100, subtract weighted penalties, then add the capacity normalization and the timing/protection bonuses. Weightings shown are provisional and will be tuned against the database.

Penalty terms (subtracted):

$$\mathbf{Eq1 = 1.2 \times V.Reg(+12V) + 0.4 \times V.Reg(+12VSB)}$$

Load regulation — minor-rail terms removed; the 12 V rail dominates.

Eq2 = 0.10 x Ripple(+12V) + 0.04 x Ripple(+12VSB)

Ripple suppression — from the 100% load test.

Eq3 = 2 x Max.Dev(+12V, load-step) + 0.3 x Max.Dev(+12VSB)

Transient response — server load-step.

Eq4 = 1.25 x (overshoot(+12V) + overshoot(+12VSB))

Turn-on transient voltage overshoots.

Eq5 = 0.8 x (100 - Average_Efficiency)

Average efficiency — ETA Redundant average.

Eq6 = 0.03 x (100 - Efficiency_at_2%_load)

Efficiency at 2% load.

Eq7 = 6 x (1 - Average_PF)

Average power factor.

Eq8 = 0.15 x (Required_holdup - Holdup_ms)

Hold-up time — Required_holdup = 11 ms (M-CRPS); 10 ms common on legacy CRPS.

Eq9 = 0.15 x (PWOK_holdup - (Holdup - 1))

Power-OK signal — penalizes a power-good that outlasts regulation.

Removed versus desktop: the average 5VSB-efficiency term and the standby/vampire-power term are dropped, and the +5 V / +3.3 V contributions vanish because those rails are not on the module.

Capacity normalization (added):

Eq10 = 0.4 x (Rated_Module_Watts / 100)

Capacity — normalizes the regulation/ripple advantage of small units, per the Desktop method.

Bonuses (added): Protection bonuses follow the Desktop scheme adapted to the single-12 V context.

- 0.25 — 12 V OCP / total OPP staged within the server margin (provisional: latch-off by ≤ 135% of rated).
- 0.25 — OTP shutting the module down at < 190 °C secondary.
- 0.25 — SCP on 12 V (and any standby rail) with clean recovery after repeated short tests.
- 0.25 — MOV/TVS surge protection present and effective.
- 0.25 — NTC thermistor + bypass relay inrush protection.
- 0.25 — Fan-failure protection (module protects itself if the fan stops).

Final rating:

Eq11 = 100 - (Eq1 + ... + Eq9) + Eq10 + Timing_Bonus + Protection_Bonus

The result is the unit's overall performance rating. As with the Desktop algorithm, because all underlying data is retained, every change to the weightings can be re-applied across the whole database to keep historical comparisons consistent.

Uncertainty Estimations

The expanded uncertainties established in the Desktop protocol (k = 2, ≈ 95% confidence, per JCGM 100:2008 / GUM) carry over, since the same calibrated instrument chain is used:

Carried-Over Measurement Uncertainties

Measurement	Expanded uncertainty (k = 2)
Efficiency	±0.18%
Output noise	±1.23 dB
Conducted EMI	±2.35 dB

References

[1] Cybenetics PSU Test Protocol, Revision 3.9, August 2026 (parent document).

[2] Cybenetics ETA (Redundant) efficiency requirements — cybenetics.com.

[3] Cybenetics LAMBDA (PSUs) noise requirements — cybenetics.com.

[4] Open Compute Project, Modular Common Redundant Power Supply (M-CRPS) Base Specification.

[5] Intel / SSI Server System Infrastructure, Power Supply Design Guidelines (CRPS).

[6] ISO 7779:2018 — Acoustics: Measurement of airborne noise emitted by IT and telecommunications equipment.

[7] ISO 11201:2010 — Acoustics: Determination of emission sound pressure levels in an essentially free field.

[8] ECMA-74 — Measurement of Airborne Noise Emitted by IT and Telecommunications Equipment.

[9] CISPR 32 / EN 55032 — Electromagnetic compatibility of multimedia equipment: emission requirements.

[10] ISO/IEC 17025:2017 — General requirements for the competence of testing and calibration laboratories.

[11] JCGM 100:2008 (GUM) — Evaluation of measurement data: Guide to the expression of uncertainty in measurement.

[12] IEC 62301 / EN 50564 — Measurement of standby power (referenced for standby methodology).

Epilogue

This protocol extends the Cybenetics methodology to redundant server PSU modules by reusing everything that still applies from the Desktop protocol and adapting or replacing what does not. Each module is tested on its own through its gold-finger connector, without the mainframe: the single-12 V topology, the 230 V-only scheme, and the removal of vampire-power and minor-rail terms drive the efficiency and performance changes, while a server-appropriate noise treatment and a standalone protection / transient battery complete the methodology. Digital management (PMBus/SMBus/SPDM) and multi-module functions (current sharing, ORing, hot-swap, redundancy) are deliberately out of scope. Provisional thresholds — notably the server noise scale and the bonus weightings — are marked as such and will be finalized as the database grows, exactly as the ETA (Redundant) program intends.