ENGINEERING DATA PACKAGE / OCR TABLE BENCHMARK

EPM-240-8P
Traction motor datasheet

Synthetic 8-pole interior permanent-magnet synchronous machine

TEST DATA ONLY - NOT A REAL PRODUCT.
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CONTINUOUS OUTPUT **150 kW**	PEAK OUTPUT **220 kW**	DC LINK **800 V**
MAXIMUM SPEED **12 000 r/min**	MACHINE TOPOLOGY **IPMSM / 8P**	BENCHMARK STRUCTURE **20 tables**

Edition 1.0 • 19 November 2026 • Synthetic reference dataset • Units are SI unless stated otherwise

T01 / TABLE 1 OF 20

General ratings and identification

Nameplate data, rated operating point and declared tolerances

SYNTHETIC DATA

Property family	Characteristic	Nominal value		Permitted / operating range	
		Value	Unit	Lower	Upper
Identification	Machine designation	EPM-240-8P	—	—	—
	Frame / revision	245-L180 / Rev. C.4	—	—	—
	Serial number format	X8-26-000000	—	—	—
Rated output	Continuous mechanical power	150	kW	0	150
	Peak mechanical power	220	kW	0	220
	Rated shaft torque	238.7	N·m	0	238.7
	Rated speed	6 000	r/min	0	12 000
Supply	DC-link voltage, U_{DC}	800	V	650	900
	Number of phases	3	—	3	3
	Pole / slot count	8 / 48	—	8 / 48	8 / 48
Construction	Cooling / protection	Water-glycol / IP67	—	—	—
	Insulation / thermal class	Class 200 (R)	—	—	—
	Approximate mass	82.0 ± 2.0	kg	80.0	84.0

Note: All values are synthetic. “—” denotes not applicable or not specified; it is not a zero value.

Table ID T01 • Original merged cells are retained in this PDF and in the HTML source.

T02 / TABLE 2 OF 20

Torque-speed operating envelope

Motoring and regenerative quadrants; positive speed convention

SYNTHETIC DATA

Operating mode	Speed region	Speed n		Shaft torque T_m		Mechanical power P_m	
		From	To	Min.	Max.	Min.	Max.
Motoring	Constant torque	0	3 000	0	520	0	163.4
	Constant power	3 000	6 000	238.7	477.5	150.0	150.0
	Field weakening	6 000	12 000	119.4	238.7	150.0	220.0
	Overspeed (no load)	12 000	13 200	0	12	0	16.6
Regeneration	Continuous regen	0	6 000	-180	0	-113.1	0
	Peak regen	0	4 000	-420	0	-175.9	0
Coast / open circuit	All speeds	0	12 000	≈ 0	≈ 0	≈ 0	≈ 0

Note: Peak values are time-limited; simultaneous maximum speed, torque and power are not guaranteed.

Table ID T02 • Original merged cells are retained in this PDF and in the HTML source.

T03 / TABLE 3 OF 20

Rated and overload duty points

Discrete test points for dynamometer setup and thermal-soak checks

SYNTHETIC DATA

Test block	Point	n [r/min]	T_m [N·m]	P_m [kW]	Duration [s]	Duty description
Continuous	CP-01	6 000	238.7	150.0	∞	S1 reference
	CP-02	3 000	477.5	150.0	∞	Low-speed thermal limit
	CP-03	12 000	119.4	150.0	∞	High-speed field weakening
Overload	OL-10	2 000	520	108.9	60	10 min cycle; 10% duty
	OL-30	4 000	500	209.4	30	30 s pulse; 5 min rest
	OL-05	8 000	262.6	220.0	5	Peak-power validation
Regenerative	RG-01	3 000	-420	-131.9	20	DC-link absorption enabled
	RG-02	6 000	-180	-113.1	∞	Continuous regen reference

Note: $P_m = 2\pi n T_m / 60\,000$. Sign convention: motoring power and torque are positive; generating values are negative.

Table ID T03 • Original merged cells are retained in this PDF and in the HTML source.

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Electrical ratings and terminal quantities

Three-phase quantities; RMS values unless explicitly marked peak

SYNTHETIC DATA

Quantity group	Parameter	Symbol	Rated		Short-time / limit		Unit
			Nominal	Tolerance	Maximum	Condition	
DC bus	Link voltage	U_{DC}	800	± 5	900	V	At inverter terminals
	Undervoltage threshold	U_{UV}	620	± 10	—	—	V
	Overvoltage trip	U_{OV}	—	—	930	V	Trip, 50 ms debounce
AC side	Phase current, continuous	$I_{ph,rms}$	250	± 3%	250	A	At 120 °C winding
	Phase current, peak	$I_{ph,pk}$	520	± 5%	520	A	≤ 10 s
	Fundamental phase voltage	$U_{ph,1}$	265	± 4	310	V	At base speed
Frequency	Electrical at 6 000 r/min	f_e	400	± 1	—	Hz	p = 4 pole pairs
	Electrical at 12 000 r/min	$f_{e,max}$	800	± 2	880	Hz	Overspeed excluded
Power quality	Power factor	cos φ	0.96	± 0.02	—	—	At rated point

Note: For balanced sinusoidal operation: $P_1 = \sqrt{3}\, U_{LL} I_L \cos\varphi$. “Peak” current is instantaneous phase-current magnitude.

Table ID T04 • Original merged cells are retained in this PDF and in the HTML source.

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Stator winding and slot / pole layout

Geometric winding specification and phase-belt assignment

SYNTHETIC DATA

Stator section	Feature	Overall		Phase A	Phase B	Phase C
		Value	Unit	Value	Value	Value
Topology	Slot / pole count	48 / 8	—	16 slots	16 slots	16 slots
	Slots per pole per phase, q	2	—	—	—	—
	Coil pitch	5 / 6	slot	—	—	—
	Winding factor, k_{w1}	0.948	—	—	—	—
Conductor	Parallel paths	2	—	—	—	—
	Turns per phase, N_{ph}	48	turn	—	—	—
	Copper area per slot	18.4	mm²	—	—	—
Insulation	Slot liner thickness	0.30	mm	Class 200	Class 200	Class 200
	Phase separation	Double	—	A-B	B-C	C-A
Connection	Winding connection	Star (Y)	—	Neutral floating	Neutral floating	Neutral floating
	Terminal resistance at 20 °C	$R_{LL,20}$ = 18.6	mΩ	6.20 mΩ/phase	6.20 mΩ/phase	6.20 mΩ/phase

Note: Slot / phase allocation shown as aggregate counts; detailed coil-side numbering is intentionally omitted in this synthetic example.

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Equivalent-circuit parameters versus temperature

Per-phase fundamental-frequency parameters; star-equivalent values

SYNTHETIC DATA

Parameter class	Parameter	Symbol	20 °C	100 °C	160 °C	Unit
Resistance	DC phase resistance	$R_{s,dc}$	6.20	8.15	9.62	mΩ
	AC phase resistance at 400 Hz	$R_{s,ac}$	7.10	9.34	11.02	mΩ
Inductance	Direct-axis inductance	L_d	0.285	0.279	0.274	mH
	Quadrature-axis inductance	L_q	0.612	0.598	0.584	mH
	Zero-sequence inductance	L_0	0.041	0.041	0.040	mH
Magnetic	PM flux linkage at 25 °C	Ψ_{PM}	0.118	0.114	0.109	Wb
	Reluctance saliency ratio	L_q/L_d	2.15	2.14	2.13	—
Derived	Copper temperature coefficient	α_{Cu}	0.00393	—	—	K^{-1}
	Time constant at 20 °C	$\tau = L_d/R_s$	46.0	—	—	ms

Note: Resistance correction: $R(T) = R(T_0)[1 + \alpha_{Cu}(T - T_0)]$. Values are illustrative and do not replace measured parameter identification.

Table ID T06 • Original merged cells are retained in this PDF and in the HTML source.

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dq-axis operating map samples

Selected current vectors for MTPA and field-weakening regions

SYNTHETIC DATA

Region	Point	n [r/min]	i_d [A]	i_q [A]	β [electrical °]	T_e [N·m]	V_s [V rms]
MTPA	M-01	500	-34	180	-79.3	168	74
	M-02	1 500	-71	320	-77.5	292	183
	M-03	3 000	-112	440	-75.7	510	262
	M-04	3 000	-126	500	-75.9	520	286
Field weakening	FW-01	6 000	-210	330	-122.5	239	298
	FW-02	9 000	-285	210	-143.6	171	301
	FW-03	12 000	-315	145	-157.2	119	307
Regeneration	RG-03	4 000	-64	-390	-99.3	-402	276
	RG-04	8 000	-180	-210	-130.6	-178	305

Note: Park convention: i_d is negative in field weakening. β = atan2(i_q, i_d) according to the stated sign convention.

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T08 / TABLE 8 OF 20

Back-EMF and air-gap flux harmonics

Open-circuit line-to-line voltage at 1 000 r/min, 25 °C rotor temperature

SYNTHETIC DATA

Signal	Component	Order h	Frequency [Hz]	Amplitude [V rms]	Relative level [%]
E_{LL}	Fundamental	1	66.67	38.4	100.00
	3rd harmonic	3	200.00	0.18	0.47
	5th harmonic	5	333.33	1.12	2.92
	7th harmonic	7	466.67	0.76	1.98
	11th harmonic	11	733.33	0.31	0.81
Air-gap B_r	Fundamental peak	1	—	0.82	100.00
	5th spatial harmonic	5	—	0.024	2.93
	7th spatial harmonic	7	—	0.015	1.83
THD, line-line	$\mathrm{THD} = \sqrt{\Sigma E_h^2}/E_1$	—	—	3.72	%

Note: Voltage amplitudes scale approximately with speed under open-circuit conditions; harmonic phase angles are not included.

Table ID T08 • Original merged cells are retained in this PDF and in the HTML source.

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Efficiency map - motoring

η = Pshaft / Pdc; stabilized coolant at 65 °C and UDC = 800 V

SYNTHETIC DATA

Load torque T/T_{rated}	Speed band					
	1 000 rpm	2 000 rpm	4 000 rpm	6 000 rpm	8 000 rpm	12 000 rpm
10 %	84.1 %	88.7 %	90.8 %	90.1 %	88.2 %	82.5 %
20 %	89.4 %	92.6 %	94.8 %	94.2 %	92.1 %	87.0 %
40 %	92.1 %	95.0 %	96.4 %	96.8 %	95.6 %	91.3 %
60 %	92.8 %	95.7 %	96.9 %	97.1 %	96.4 %	92.8 %
80 %	92.5 %	95.4 %	96.8 %	97.2 %	96.6 %	93.0 %
100 %	91.9 %	95.0 %	96.5 %	97.0 %	96.1 %	92.4 %
120 %	90.2 %	94.1 %	95.9 %	96.2 %	94.8 %	90.1 %
Measurement status: interpolated grid; cells within ±0.4 percentage points (pp)						

> **Note:** Cells are efficiency percentages, not absolute power. Values below 10% torque are excluded from the map.

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Loss breakdown versus speed and load

Estimated steady-state loss partition at 65 °C inlet coolant

SYNTHETIC DATA

Load case	n [r/min]	Pout [kW]	Copper losses		Iron losses		Other losses
			P_{Cu} [kW]	Share [%]	P_{Fe} [kW]	Share [%]	P_{misc} [kW]
Low speed	1 500	25.0	0.82	37.6	0.31	14.2	1.05
	2 500	65.0	1.46	42.0	0.58	16.7	1.44
Base speed	6 000	150.0	2.05	38.0	1.24	23.0	2.11
	7 500	180.0	2.41	40.1	1.72	28.6	1.88
High speed	10 000	180.0	1.88	32.8	2.36	41.2	1.49
	12 000	150.0	1.54	28.1	2.84	51.8	1.10
Total at rated point / 6 000 r/min		150.0	2.05	38.0	1.24	23.0	2.11

Note: Other losses include magnet eddy-current, mechanical, stray-load and windage components. Share denominator: total motor loss, not Pout.

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Thermal network and temperature limits

Lumped thermal nodes used by the supervisory derating model

SYNTHETIC DATA

Thermal zone	Node / component	C_{th} [J/K]	R_{th} to coolant [K/W]	Continuous limit [°C]	Transient limit [°C]	Sensor tag
Stator	Copper hot spot	2 850	0.036	180	200 / 10 s	NTC-W1
	Slot liner	1 220	0.052	155	180 / 60 s	NTC-S2
	Stator yoke	4 600	0.028	150	165 / 60 s	NTC-S3
Rotor	Permanent magnet	1 480	0.091	150	165 / 5 s	EST-R1
	Rotor core	3 200	0.074	180	200 / 10 s	EST-R2
	Shaft	1 050	0.063	160	180 / 60 s	—
Coolant	Inlet manifold	—	—	65	75 / 30 s	NTC-CI
	Outlet manifold	—	—	85	95 / 10 s	NTC-CO

Note: R_{th} values are equivalent fitted values for the synthetic thermal model; they are not directly additive across parallel heat paths.

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T12 / TABLE 12 OF 20

Liquid-cooling circuit characteristics

Water / ethylene-glycol mixture 50:50 by volume; nominal inlet 65 °C

SYNTHETIC DATA

Circuit segment	Quantity	Nominal			Minimum	Maximum	Acceptance / note
		Symbol	Value	Unit	Value	Value	
Pump	Volumetric flow	$\dot{Q}$	12.0	L/min	8.0	16.0	No air entrainment
	Inlet pressure	p_{in}	180	kPa(g)	120	250	kPa(g)
	Coolant inlet temperature	T_{in}	65	°C	−20	80	°C
Motor jacket	Pressure drop at 12 L/min	Δp_m	24	kPa	18	35	kPa
	Wetted volume	V_m	0.82	L	0.75	0.90	L
Connections	Inlet port	G 3/8	—	—	—	—	ISO 228-1
	Outlet port	G 3/8	—	—	—	—	ISO 228-1
	Leak test	p_{test}	300	kPa	—	—	60 s; ≤ 1 cm³/min

Note: Coolant properties assumed at 65 °C: ρ = 1 045 kg/m³; c_p = 3.55 kJ/(kg·K); λ = 0.41 W/(m·K).

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T13 / TABLE 13 OF 20

Insulation system and dielectric verification

Production and type-test requirements; values are synthetic targets

SYNTHETIC DATA

Test family	Test item	Applied quantity		Duration	Pass criterion		Test reference
		Value	Unit		Value	Unit	
Insulation resistance	Phase-to-frame	U_{test} = 1 000	V DC	60	≥ 100	MΩ	IEC 60034-1*
	After humidity conditioning	500	V DC	60	≥ 20	MΩ	Internal WI-EL-07
	Polarization index, PI	$R_{10\ min}/R_{1\ min}$	—	—	≥ 2.0	—	IEEE 43*
Withstand voltage	Stator to frame	2.4	kV AC rms	60	No breakdown	—	IEC 60034-1*
	Repetitive impulse	V_{pk} = 1.8	kV	10^6 pulses	No partial discharge above 10 pC	—	Internal WI-EL-12
Partial discharge	Apparent charge	$q_{PD} \leq 10$	pC	—	≤ 10	pC	IEC 60270*
Insulation material	Thermal class	200 (R)	—	—	—	—	IEC 60085*

Note: Asterisk (*) identifies a reference family only; verify the current edition and applicability before certification or compliance claims.

Table ID T13 • Original merged cells are retained in this PDF and in the HTML source.

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Mechanical envelope and dimensional tolerances

All dimensions in mm unless otherwise indicated; datum A = shaft axis

SYNTHETIC DATA

Feature group	Feature / datum	Nominal	Upper dev.	Lower dev.	Inspection tool	Geometric control	
						Tolerance	Reference
Housing	Outer diameter ØD	245.00	+0.10	−0.10	CMM	0.08	A
	Overall length L	312.0	+0.5	−0.5	Height gauge	0.20	B
	Mounting foot width	82.0	+0.2	−0.2	Caliper	0.15	A-B
	Pilot diameter ØP	160.00	+0.02	0.00	Air gauge	0.015	A
Shaft	Shaft extension Ød	45.000	0.000	−0.016	Micrometer	0.008	A
	Keyway width b	14.00	+0.018	0.000	Gauge blocks	0.02	A
	Runout at bearing seat	—	—	—	Dial indicator	0.010	A
	Threaded end	M36 × 1.5-6g	—	—	Thread ring	Class 6g	ISO metric
Air gap	Radial air gap δ	0.90	+0.08	−0.08	Feeler / CMM	0.05	A
	Concentricity rotor/stator	—	—	—	CMM	Ø0.04	A

Note: Do not infer a manufacturing tolerance from a nominal-only dimension. "—" means no separate tolerance is specified in this table.

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Bearing arrangement, fits and lubrication

Drive-end (DE) and non-drive-end (NDE) assembly data

SYNTHETIC DATA

Assembly end	Component	Designation / value	Fit / clearance	Lubricant	Service data
DE	Deep-groove bearing	6209-C3	k5 / H6	Polyurea NLGI-2	Sealed for life
	Bore / OD	45 / 85 mm	k5 / H6	—	Radial load ≤ 4.2 kN
	Dynamic / static rating	35.1 / 21.6 kN	—	—	C / C_0
	Reference life $L_{10}h$	≥ 30 000 h	—	—	n = 6 000 r/min
NDE	Cylindrical roller bearing	NU208-E	j5 / H6	Polyurea NLGI-2	Sealed for life
	Bore / OD	40 / 80 mm	j5 / H6	—	Axial float 0.4-0.7 mm
	Grease temperature	$T_{g,max}$ = 150 °C	—	—	Peak 10 min
Assembly	Axial preload (DE)	80 ± 15 N	—	—	Shim controlled; axial
	End-play at 20 °C	0.05-0.12 mm	—	—	Axial, assembled

Note: Bearing life estimate follows $L_{10} = (C/P)^p \times 10^6$ revolutions; p = 3 for ball bearings and 10/3 for roller bearings.

Table ID T15 • Original merged cells are retained in this PDF and in the HTML source.

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Rotor and permanent-magnet material data

Nominal supplier-grade properties; magnetic data at stated test conditions

SYNTHETIC DATA

Material zone	Property	Symbol	Value	Unit	Test temperature [°C]	Tolerance / class	Remark
Permanent magnet	Grade	—	N42SH	—	20	SH	Sintered NdFeB
	Remanence	B_r	1.30-1.34	T	20	± 0.02 T	Along easy axis
	Intrinsic coercivity	H_{cj}	≥ 1 592	kA/m	20	Minimum	Hcj
	Reversible coefficient	α_{Br}	−0.11	%/K	20-120	Typical	Reversible
Rotor core	Steel grade	—	35PN230	—	20	M270-like	Lamination
	Density	ρ	7 650	kg/m³	20	± 2%	Nominal
	Electrical resistivity	ρ_e	4.7×10^{-7}	Ω·m	20	± 10%	Longitudinal
Shaft	Steel grade	—	42CrMo4 QT	—	20	EN 10083	Quenched / tempered
	Yield strength	$R_{p0.2}$	≥ 750	MPa	20	Minimum	Axial specimen

Note: Material names and values are illustrative. Supplier certificates and batch traceability override this synthetic table.

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Vibration and acoustic order spectrum

Radial acceleration measured at housing, DE horizontal axis; no-load sweep

SYNTHETIC DATA

Speed band	Order	Frequency relation	Amplitude a_{rms}		Limit		Evaluation
			Value	Unit	Value	Unit	
0-3 000	1×	n/60	0.42	mm/s	1.8	mm/s	RMS, 10 Hz HPF
	2×	2n/60	0.18	mm/s	1.0	mm/s	RMS
	48× slot pass	48n/60	0.09	mm/s	0.60	mm/s	Order tracking
3 000-8 000	1×	n/60	0.61	mm/s	2.2	mm/s	10 s dwell
	2×	2n/60	0.24	mm/s	1.2	mm/s	10 s dwell
8 000-12 000	1×	n/60	0.88	mm/s	2.8	mm/s	5 s dwell
	Electrical tone at 800 Hz	$12\times f_e$	9.6	m/s²	15	m/s²	FFT, Hanning
All speeds	Sound pressure level	L_{pA}	68.5	dB(A)	72	dB(A)	1 m, hemi-anechoic

Note: The 48× slot-pass label denotes a mechanical order referenced to rotor speed; electrical orders are separately referenced to f_e.

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Control and protection calibration values

FOC current loops, speed loop, modulation and fault thresholds

SYNTHETIC DATA

Control block	Setting	Symbol	Nominal	Min.	Max.	Unit	Activation / qualifier
Current loop	d-axis bandwidth	$f_{ci,d}$	1 200	800	1 500	Hz	Small-signal, 20 °C
	q-axis bandwidth	$f_{ci,q}$	1 000	700	1 300	Hz	Small-signal
	Current limit	I_{lim}	520	0	520	A peak	10 s maximum
	PWM frequency	f_{PWM}	10	8	16	kHz	Center-aligned SVPWM
Speed loop	Bandwidth	f_{ω}	18	10	25	Hz	No load inertia J = 0.042 kg·m²
	Overspeed trip	n_{trip}	13 500	13 000	14 000	r/min	100 ms persistence
	Speed ramp	dn/dt	2 500	500	4 000	r/min/s	Thermal derating may reduce
Protection	Winding warning	T_{warn}	160	140	175	°C	Derate begins
	Winding shutdown	T_{trip}	185	175	195	°C	Latch; restart inhibited
	DC overvoltage	U_{OV}	930	910	950	V	20 ms debounce
	Resolver loss	$\Delta\theta_{err}$	> 12	—	—	°	Fault after 50 ms

Note: Controller settings are illustrative calibration values, not validated safety limits. Actual protection requires system-level hazard analysis.

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Sensor pinout and signal conditioning

Connector X3, 12-way; pin numbers are cavity identifiers

SYNTHETIC DATA

Connector	Pin	Signal name	Direction	Electrical level		Scaling / calibration	Diagnostic
				Range	Nominal		
Resolver	1	EXC+	Output	7.0	V rms	10 kHz ± 0.5%	Amplitude check
	2	EXC−	Output	7.0	V rms	Differential	Short detection
	3	SIN+	Input	0.5-3.5	V diff	k = 0.50 V/V	Open / short
	4	SIN−	Input	0.5-3.5	V diff	Offset < 20 mV	Open / short
	5	COS+	Input	0.5-3.5	V diff	k = 0.50 V/V	Open / short
	6	COS−	Input	0.5-3.5	V diff	Offset < 20 mV	Open / short
Temperature	7	NTC-W1	Input	0-5	V	R25 = 10 kΩ; B = 3 980 K	Range check
	8	NTC-CI	Input	0-5	V	R25 = 10 kΩ; B = 3 430 K	Range check
	9	NTC-CO	Input	0-5	V	R25 = 10 kΩ; B = 3 430 K	Range check
Supply / shield	10	+5V_S	Output	4.85-5.15	V DC	≤ 60 mA	Overcurrent
	11	AGND	Return	—	—	Star-ground	Continuity
	12	SHIELD	Chassis	—	—	360° clamp	Bond resistance < 10 mΩ

Note: Do not connect resolver excitation pins to the 5 V sensor supply. Pin mapping is fictional and must not be used for hardware wiring.

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Environmental, reliability and interface qualification

Synthetic qualification matrix; status codes apply to this sample revision only

SYNTHETIC DATA

Qualification group	Test / interface	Condition		Exposure / cycles	Acceptance criterion	Sample size n	Status
		Value	Unit				
Environment	Operating ambient	−40 to +85	°C	Continuous	Functional operation	5	PASS
	Thermal cycling	−40 ↔ +150	°C	500 cycles	No cracks; insulation drift ≤ 5%	3	PASS
	Humidity storage	85 / 85	%RH / °C	1 000 h	No corrosion	3	PASS
	Ingress protection	IP67	—	1 m / 30 min	No water ingress	3	PASS
Mechanical	Random vibration	10-2 000	Hz; 12.5 g rms	8 h / axis	No structural cracks	3	PASS
	Shock	50	g; 11 ms	18 pulses	No functional damage	3	PASS
	Overspeed proof	15 000	r/min	2 min	No permanent deformation	2	PASS
Reliability	Target service life	15 000	h	—	B10 ≥ 12 000 h	—	TARGET
	Weibull shape β	1.65	—	—	Estimated β parameter	10	EST.
	Field return target	≤ 50	ppm	per annum	≤ 50 ppm/year	—	TARGET
Interfaces	HV connector	HVP800-2P	—	800 V DC; 350 A cont.	Rated interface	—	RELEASED
	LV connector	X3-12	—	12-way sealed	IP67	—	RELEASED
	Communication	CAN FD	2 Mbit/s	data rate	ISO 11898-1*	—	RELEASED

Note: Status legend: PASS = sample met the stated criterion; TARGET = engineering target; EST. = estimated, not demonstrated. All qualification data are fictional.

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