OpenVVVF

APPLICATION PROFILE - HAZARD ANALYSIS & RISK ASSESSMENT

Motorcycle Application Profile

> Motorcycle-specific HARA profile - operational situations, S/E/C ratings, and ASIL targets applied to the platform hazard set.

1. Introduction

This document is an **Application Profile** of the OpenVVVF HARA document set. It assigns motorcycle-specific Operational Situations, Severity/Exposure/Controllability ratings, and ASIL targets to the platform hazard set, Safety Goals, and Functional Safety Requirements defined in the Core Platform document.

- **Core document:** OV-SAF-HARA-CORE v5.8 (*OpenVVVF HARA - Core Platform*). This profile was assessed against Core v5.7; v5.8 is a documentation-only reorganization (fault-injection test plan extraction) with no technical change. It shall be reviewed on any Core revision.
- **Normative reference:** hazards H-01 through H-17, Safety Goals SG-01 through SG-15, and FSR-01 through FSR-22 are defined in the Core document and are **not** restated here. The Core compliance statement (Core §1.2) applies in full to this profile: ASIL ratings herein are **targets**, not claims of verified compliance.
- **Standard applied:** ISO 26262:2018 (methodology), as for the Core.
- **Status:** elaborated - this profile is the current reference S/E/C assessment for the platform.

2. Application Definition

High-performance electric 2-wheel motorcycles - Zero (102 V nominal), Energica (<320 V), and similar platforms. Combined traction inverter + VCU function. One-pedal regenerative braking (tractive effort rollback), not wheel-lock capable.

Table 1 - Application-Specific Parameters

Parameter	Value / Range
Vehicle type	Electric 2-wheel motorcycle
Max vehicle speed	150 mph (240 km/h)
Vehicle kerb weight	Up to 600 lbs (272 kg)
Driven wheels	1 (rear)
Operator controls	Twist throttle (dual pot + limit switch), friction brakes (independent), kickstand inte

3. Operational Situations

Table 2 - Operational Situations (Motorcycle)

ID	Operational Situation	Description
OS-01	Stationary, system active	Vehicle stopped, key-on, rider present, in gear
OS-02	Creep / low speed	Parking lot, driveway, traffic jam
OS-03	Urban driving	City streets, intersections
OS-04	Rural / arterial road	Secondary roads, moderate curves
OS-05	Highway cruising	Multi-lane highway, dense traffic
OS-06	High speed highway	Limited maneuvering space
OS-07	Hard acceleration	Wide open throttle
OS-08	Regenerative braking	Throttle rollback, one-pedal regen
OS-09	Combined braking	Mechanical brake + regen blend
OS-10	Cornering / lean	Banked turn, leaned over, on throttle
OS-10a	Cornering at limit / racetrack	High lean angle, maximum traction demand, rider rely
OS-11	Power-on sequence	Precharge, initialization
OS-12	Power-off / shutdown	Key-off, discharge
OS-13	Rain / wet road	Reduced traction
OS-14	High ambient temperature	Desert operation, >40 °C
OS-15	Low traction surface	Gravel, sand, wet leaves, paint
OS-16	Sustained grade / downhill descent	Long downhill, regen or coasting, gravity-fed speed

OS-10A (CORNERING AT LIMIT):

Distinct from OS-10: at full lean the rider actively uses tractive effort to modulate the cornering line with the rear tire at its traction limit. For this platform, loss of drive in this situation is freewheel and dynamically benign (Section 5); controllability for loss-of-power hazards here is **C2**. Unintended *application* of tractive effort at lean remains **C3** (Section 6).

4. Environmental Conditions

Ambient −20 °C to +50 °C; humidity 0–100% condensing; surfaces dry/wet/standing water/gravel/sand; altitude 0–3,000 m; motorcycle-mounted high vibration.

5. Profile-Specific Hazard

H-03A: LOSS OF TRACTIVE EFFORT DURING CORNERING AT LEAN

DYNAMICS ASSESSMENT (V1.1):

The fault response of this platform is six-switch-open (SSO): on fault, the motor produces zero torque in either direction - dynamically equivalent to pulling in the clutch. Unlike an ICE throttle chop, there is **no engine-braking torque**, hence no forward weight transfer, no rear-tire unloading, and no stand-up tendency. On loss of drive at lean, the rear tire's longitudinal friction demand vanishes and the full friction ellipse becomes available for lateral force. Mid-corner and corner-exit loss of drive is therefore **dynamically benign** for this architecture: the motorcycle coasts through the corner and decelerates gently. The dangerous direction at lean is the opposite one - *unintended* tractive effort (H-01/H-06, highside) - which is covered by SG-01 (ASIL D).

RESIDUAL HARM PATH:

the retained hazard is **contextual, not dynamic**: (1) following traffic - a coasting, rapidly decelerating motorcycle (track: on the racing line at corner exit; road: in a live lane) creates a collision risk from closing-speed differential, severity up to S3 at track/highway speeds; (2) the startle transient at the limit, which may provoke rider error on low-grip surfaces. Track use typically involves full PPE (leathers, armor, helmet), which reduces likely harm in the track scenario; however, severity is rated on the worst reasonable outcome and PPE is neither part of the item nor enforceable - the street case (no PPE, intersections) must also be covered. **S3 is retained on the traffic-collision path; controllability C2 (recoverable; freewheel dynamics); exposure E2 (cornering at or near the limit is well under 10% of operating time even for a track-capable platform; E3 previously assigned was not defensible).**

V5.0 RESIDUAL-RISK STATEMENT:

Under the immediate-SSO philosophy (Core §2.3), every fault produces this event. The platform mitigations are detection speed (FSR-05 latency budget) and the cleanliness of the torque transition (S-04). The rider-level consequence is **accepted residual risk**, assessed as small for the reasons above, and shall be characterized by track testing (LIMIT-01) before racetrack use.

6. Controllability Considerations

Motorcycles are inherently less stable than 4-wheeled vehicles: two contact patches, simultaneous roll/pitch/yaw management, high CG relative to wheelbase, single driven wheel. Unintended acceleration/braking at highway speed is therefore **C3**. Loss of tractive effort during cornering at lean (OS-10a) was formerly rated C3 on ICE-dynamics intuition (engine-braking stand-up). For this platform, SSO is freewheel - there is no engine-braking torque - so loss of drive at lean is rated **C2** (Section 5). Unintended *application* of tractive effort at lean remains **C3**.

7. Risk Assessment and ASIL Assignment

Table 3 - Hazard Risk Assessment & ASIL Assignment (Motorcycle Profile)

Hazard	Worst OS	S	E	C	Target ASIL	Achievable Now	R
H-01	OS-06 (85–150 mph)	S3	E3	C3	D	D	U
H-02	OS-01 (stationary)	S2	E2	C2	B	B	R
H-03	OS-06 (highway)	S3	E3	C2	C	C	S
H-03a	OS-10a (corner at limit)	S3	E2	C2	A	A	M
H-04	OS-09 (braking)	S2	E3	C2	A	A	L
H-05	OS-13 (wet road)	S3	E3	C3	C	C	U
H-06	OS-06 (highway WOT)	S3	E3	C3	C	C	W
H-07	OS-14 (desert)	S3	E2	C2	B	B	T
H-08	OS-16 (downhill descent)	S3	E2	C3	C	C	E
H-09	OS-01 (crash/service)	S3	E1	C2	A	A	H
H-10	OS-16 (regen on descent)	S3	E2	C2	B	B	D
H-12	OS-07 (hard accel)	S3	E2	C3	C	C	S
H-13	OS-06 (fault at speed)	S3	E3	C3	D	D	S
H-14	OS-06 (highway)	S3	E3	C3	C	C	S
H-15	OS-06 (highway)	S3	E3	C3	D	D	S
H-16	OS-07 (hard accel)	S3	E2	C3	C	C	B
H-17	OS-07 (hard accel)	S3	E3	C3	C	C	C

8. References

Ref	Citation
OV-SAF-HARA-CORE	OpenVVVF HARA - Core Platform, v5.8 (doc_id OV-SAF-HARA-CORE). Norm
Cossalter	Cossalter, Lot, Massaro, *Motorcycle Dynamics* (chapter), 2014. Lean mechanic
NHTSA	*Motorcycle Safety*. https://www.nhtsa.gov/motorcycles. Accident causation con

9. Document History

Version	Date	Changes
1.0	2026-07-30	Initial standalone profile, split from the v5.0 combined document (Annex A the
1.1	2026-07-30	H-03a re-analyzed: SSO-is-freewheel dynamics assessment added (no engi
1.2	2026-07-30	OS-16 (sustained grade / downhill descent) added; H-08 and H-10 worst-OS
1.3	2026-07-31	H-11 row removed: HV contactor actuation, weld detection, and contactor-rel
1.4	2026-07-31	Table 3 H-03a row corrected to S3/E2/C2/ASIL A, matching the v1.1 re-analy
1.5	2026-07-31	Formatting and consistency cleanup: OS-10a/OS-16 table rows no longer bo
1.6	2026-07-31	Dynamics reference corrected: the lean-mechanics citation is now Cossalter,
1.7	2026-08-13	Core reference updated to v5.8 (documentation-only test-plan extraction; no