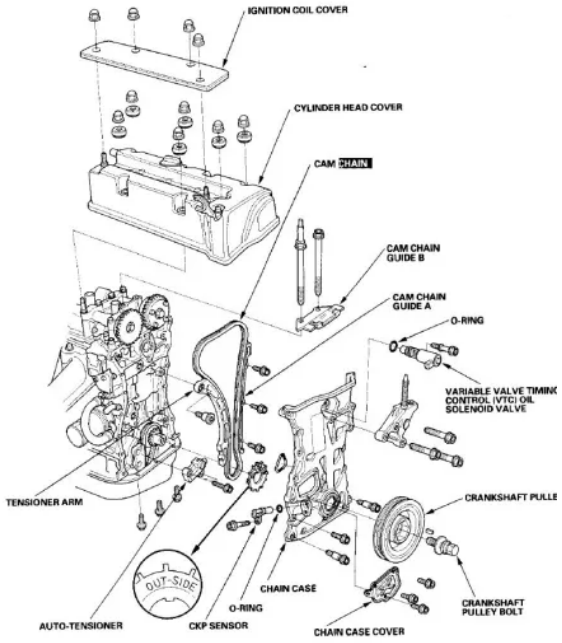
ENGINEERING SPECIFICATION DOCUMENT

K24/K20 Frankenstein Hybrid Engine Long Block Engineering Specification



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Contents

1 Purpose

This document defines the **functional, geometric, and component-level requirements** for the **K24/K20 Frankenstein hybrid engine**, consisting of a K24-series bottom end combined with a K20-series VTEC cylinder head for increased high-RPM breathing and improved overall torque curve.

The purpose of this specification is to:

- Define all interfaces between the K24 block and K20 head.
- Document oil, coolant, and timing system modifications required for proper hybrid operation.
- Provide machine shop requirements for block preparation.
- Provide component selection guidance for pistons, rods, cams, gaskets, and sensors.
- Ensure the final engine is suitable for track-oriented use with future forced induction potential.

This document is intended to support engine assembly, machining, and tuning while serving as a repeatable blueprint for future revisions of the hybrid engine program.

2 System Overview

2.1 Target Configuration

- **Bottom End:** Honda K24A2 (TSX) or equivalent K24-series block.
- **Cylinder Head:** Honda K20A2 / K20Z1 (performance VTEC head).
- **Oiling System:** K20A2 oil pump conversion with balance shaft delete.
- **Timing System:** K20A2 timing chain system adapted to K24 deck height.
- **Cooling System:** K24 pump housing with K20 head, hybrid coolant routing.
- **Intended Use:** Track-oriented K-series AWD platform.
- **Future Compatibility:** Capable of supporting NA or boosted configurations.

2.2 Performance Goals

- Strong midrange torque from K24 displacement.
- High-RPM breathing from K20 performance head.
- Daily-driveable reliability with motorsport-appropriate safety margins.
- Headroom for future power increases (boost, cams) without redoing core long block.

3 Interface Definitions

This section defines the required compatibility interfaces between the block, head, oiling system, sensors, cooling passages, and timing components.

3.1 Block–Head Interface

- **Block:** K24A2 (99 mm bore spacing, ≈ 231 mm deck height).
- **Head:** K20A2 or K20Z1 (VTEC performance head, improved airflow vs. K24 head).
- **Head Gasket:**
  - Must match bore size (87–88 mm typical).

  - Must support desired compression ratio.
  - MLS surfaces on block and head required (RA $< 30\,\mu m$).

3.2 Oil Passage Interface

K24 and K20 heads have different oil feed locations and priorities.

- The VTEC oil feed for the K20 head must be supplied via:
  - Correct K20-style head gasket with VTEC oil feed passage open.
- Unused or mismatched rear oil passages in the block/head must be **plugged or restricted** to prevent cross-bleed or pressure loss.
- External oil feed lines may be considered for advanced configurations but are not assumed for the base build.

3.3 Timing System Interface

The increased K24 deck height requires timing adaptations:

- K20 timing chain.
- K20 chain guides and tensioner.
- K24 crank gear.
- Cam gears: K20A2/K20Z1 style.

3.4 Cooling System Interface

- Coolant passage alignment between K24 block and K20 head must be verified.
- K24 water pump housing is compatible with K20 head in the base configuration.
- Optional coolant bypass modifications can be used to improve warmup and reduce hot spots.

3.5 Sensor and ECU Interface

- **Crank Sensor:** K24 (block-mounted).
- **Cam Sensors:** K20 head.
- **ECU:** Hondata K-Pro or equivalent standalone capable of hybrid crank/cam configuration and custom calibration.

4 Geometry and Compression Requirements

4.1 Deck Height and Head Geometry

- K24 deck height is taller than K20 by $\approx 19.5\,mm$.
- K20 head combustion chamber volume and piston dome/dish shape determine compression.
- Piston-to-valve clearance must be checked with chosen cams and head gasket thickness.

4.2 Compression Ratio Targets

Piston Type	Head Chamber (cc)	Gasket Thickness (mm)	CR Estimate
OEM K20A2 Pistons	50.5	0.58	$\approx 11.0{:}1$
OEM K24A2 Pistons	50.5	0.68	$\approx 10.2{:}1$
Forged High-Comp (Flat)	50.5	0.68	12.0–12.8:1
Forged Boost Pistons	50.5	0.68	9.0–10.0:1

Table 1: Compression ratio estimates for common piston/gasket options.

4.3 Piston and Rod Geometry

- Rod length: K24 OEM or aftermarket forged rods of equivalent length.
- Wrist pin diameter must match piston selection.
- Clearance checks:
  - Piston-to-valve,
  - Piston-to-head (quench),
  - Rod-to-block at BDC with long-stroke K24 crank.

5 Oil System Architecture and Routing

5.1 Oil Flow Concept

- K24 block main oil gallery feeds:
  - Main bearings,
  - Rod bearings,
  - VTEC oil feed passage to K20 head (via appropriate gasket and passages),
  - Oil filter housing and external gallery as per OEM.
- K20A2 oil pump conversion provides:
  - Higher RPM capability,
  - Elimination of balance shafts,
  - Improved reliability at elevated engine speeds.

5.2 Oil Pressure and Flow Targets

- **Target Hot Oil Pressure:**
  - Idle (hot): 20–30 psi.
  - High RPM (hot): 70–80 psi (approx. 10 psi per 1000 rpm rule-of-thumb).
- Bearing clearances must be selected to achieve these pressures with chosen oil weight (e.g., 5W-30 or 5W-40).

5.3 Oil Port Plugging and Restriction

- Rear oil ports not used by K20 head should be:
  - Tapped and plugged, or

  - Plugged with press-in plugs per machinist guidance.
- Any external VTEC or gallery feeds must use AN fittings rated for oil temperature and pressure.

5.4 Oil Control and Sump Management

- Baffled or aftermarket oil pan recommended for sustained high-G track use.
- Windage tray and scraper should be retained or upgraded to control aeration.
- Oil pickup must be correctly positioned relative to pan floor.

6 Cooling Passage Alignment and Modifications

6.1 Block and Head Coolant Passages

- K24 block and K20 head share overall bore spacing but differ in some water jacket details.
- Head gasket selection must ensure no open coolant holes directly into non-matched areas.

6.2 Required Checks and Modifications

- Visually compare block deck coolant ports and head underside ports with gasket in place.
- Block any coolant passages that:
  - Are not supported by head casting,
  - Would create unintended hot spots or steam pockets.
- Verify:
  - Thermostat housing orientation,
  - Coolant outlet location,
  - Heater core feed/return if retained.

6.3 Cooling System Integration

- Radiator selection must match expected power and track use.
- Auxiliary oil cooler recommended for high duty cycle.
- Bleed points at high spots (head, radiator) to simplify burping.

7 Cylinder Head Airflow and Manifold Compatibility

7.1 Intake Port Strategy

- K20A2 head offers high-flow intake ports suitable for high-RPM operation.
- Intake manifold options:
  - OEM-style K20A2 manifold for street torque and drivability.
  - RBC/RRC-style for higher RPM focus.
  - ITBs for future race configurations (not baseline).
- Gasket matching of manifold to head is recommended to avoid step transitions.

7.2 Exhaust Port and Header

- Use K20-pattern header flange to match port spacing and shape.
- Primary tube diameter and length should be selected based on target power and RPM (e.g., 4-2-1 for midrange, 4-1 for top-end).

7.3 Flow Bench and Porting (Optional)

- Mild port clean-up and valve bowl blending recommended.
- Full porting and oversized valves optional for later stages; not required for baseline reliable build.

8 Valvetrain Requirements and Specifications

8.1 Valve Springs and Retainers

- Upgraded dual valve springs recommended for:
  - Elevated RPM limit,
  - Aftermarket high-lift cams,
  - Boosted applications.
- Titanium retainers optional for reduced valvetrain mass.

8.2 Camshaft Selection

- Baseline option: OEM K20A2/K20Z1 cams.
- Stage 1–2 aftermarket cams for NA builds.
- Forced induction cams to be chosen based on turbo size and desired powerband.

8.3 Valvetrain Geometry and Clearances

- Valve lash must be set per cam manufacturer specification.
- Coil bind clearance to be verified at maximum valve lift plus safety margin.

9 Fuel Delivery Requirements

9.1 Injector Sizing

- NA builds:
  - $\approx$ 300–550 cc/min injectors depending on power.
- Boosted builds:
  - $\approx$ 750–1300 cc/min injectors depending on target HP and fuel (pump gas vs. E85).

9.2 Fuel System Components

- High-flow in-tank pump (e.g., 255 l/h or greater).
- Adjustable fuel pressure regulator (if not returnless).
- K-series compatible fuel rail.

9.3 Fuel Pressure and Control

- Base pressure typically 43.5 psi (3 bar) with vacuum reference.
- ECU calibration must reflect injector dead times and base pressure.

10 Ignition System Specification and Requirements

10.1 Coils and Control

- Use OEM K-series coil-on-plug (COP) ignition as baseline.
- Optionally upgrade to higher energy coils (e.g., R35 style) in high boost applications.

10.2 Spark Plug Specification

- Heat range:
  - NA: OEM or one step colder.
  - Boost: one to two steps colder than OEM.
- Gap:
  - NA: $\approx$ 0.8–0.9 mm.
  - Boost: reduced gap as needed to prevent blowout.

11 ECU and Sensor Integration Requirements

11.1 Required Sensors

- Crank position sensor (K24 block).
- Cam position sensors (K20 head).
- MAP sensor sized for expected boost (1, 3, or 4 bar).
- IAT sensor in intake manifold or charge pipe.
- ECT sensor in head.
- Wideband O2 for tuning.

11.2 ECU Requirements

- Capable of:
  - Fully programmable fuel and ignition maps,
  - VTEC engagement control,
  - Rev limit and boost control (if forced induction),
  - Data logging.

12 Accessory Drive and Mounting Configuration

12.1 Accessory Layout

- Alternator retained; power steering and AC may be deleted for track use.
- Belt routing must be updated to reflect removed accessories.

12.2 Brackets and Pulleys

- Use K-series swap bracket kit suitable for chassis.
- Verify crank pulley to chassis clearance.
- Underdrive or fluid damped pulleys optional but must be compatible with engine management.

13 Failure Modes and Reliability Considerations

13.1 Common Hybrid Issues

- Oil pressure loss due to improper pump conversion or gallery plugging.
- Head gasket failure from poor surface prep or improper torque sequence.
- Timing chain tensioner failure at high RPM or with excessive chain slack.
- Valve float if valve springs are inadequate for cam and RPM.

13.2 Mitigation Strategies

- Use quality components and follow torque specs.
- Perform thorough mock-up and clearance checks.
- Use upgraded valve springs when increasing RPM limit.
- Monitor oil pressure and AFR during tuning and initial operation.

14 Tuning Requirements and Base Calibration Guidelines

14.1 Base Targets (NA Example)

- Idle: 750–950 rpm, lambda ≈ 1.0.
- Cruise: lambda 1.0–1.05.
- WOT: lambda 0.86–0.90 (NA pump gas).
- VTEC crossover: initially $\approx$ 4500–5200 rpm, then tuned on dyno.

14.2 Boosted Considerations

- Conservative ignition timing and richer AFR (e.g., 0.78–0.82 lambda).
- Careful knock monitoring and IAT management.

14.3 Dyno and Data Logging

- Professional dyno tuning strongly recommended.
- Use data logs to verify:
  - Oil pressure,
  - AFR,
  - Knock activity,
  - Coolant and IAT temperatures.

15 Machine Shop Requirements

15.1 Block Work

- Bore and hone cylinders (matched to piston manufacturer clearance).
- Deck surface preparation (MLS-ready finish).
- Plug or modify rear oil holes as required by hybrid layout.
- Balance rotating assembly (crank, rods, pistons, damper, flywheel).

15.2 Cylinder Head Work

- Valve job (3-angle or 5-angle).
- Surface deck if necessary.
- Check and adjust valve guide clearance.

15.3 Measurement Requirements

- Piston-to-wall clearance.
- Piston-to-valve clearance.
- Bearing clearances (rods and mains).
- Deck height and piston protrusion/flush.

16 Assembly Requirements

16.1 Bottom End Assembly

- Follow manufacturer/ARP torque specifications for main and rod fasteners.
- Verify crank endplay (thrust clearance).
- Install K20 oil pump conversion with correct chain and tension.

16.2 Head Assembly

- Install cams and torque cam caps in proper sequence.
- Verify timing marks alignment for crank and cams.
- Perform valve lash adjustment after initial heat cycles.

16.3 Hybrid Timing Setup

- Degree cams if using aftermarket profiles.
- Verify chain tension and tensioner operation prior to first start.

17 Tooling, Torque Specifications, and Measurement Requirements

17.1 Required Tools

- Quality torque wrench (range suitable for engine fasteners).
- Dial indicator for piston and cam degreeing.

- Micrometers and bore gauges for clearances (or rely on machine shop measurements).
- Degree wheel for cam timing (if degreeing cams).

17.2 Torque Specification Table (Placeholders)

Fastener Location	Torque [Nm]	Notes
Main bearing bolts/studs	_____	Per OEM/ARP
Rod bolts	_____	Per rod manufacturer
Head bolts/studs	_____	Sequence critical
Cam cap bolts	_____	Low torque, multiple passes
Flywheel bolts	_____	Threadlocker recommended
Clutch pressure plate	_____	Even cross pattern
Oil pump bolts	_____	Per OEM
Timing cover bolts	_____	Do not overtighten

Table 2: Torque specification placeholders to be populated from OEM/ARP data.

18 Validation and Testing

18.1 Static Validation

- Compression test before first fire.
- Leak-down test on all cylinders.
- Verify oil pressure using priming method before installing spark plugs.

18.2 Startup Procedure

- Crank with injectors unplugged or fuel disabled until oil pressure is established.
- First fire: hold 2000–3000 rpm for ring seating and oil flow.
- Monitor for leaks, abnormal noises, and timing chain sounds.

18.3 Post-Break-In

- Change oil and filter after 50–100 km.
- Recheck valve lash.
- Retorque critical fasteners where applicable (header, turbo manifold if used).

19 Bill of Materials (BOM)

Subsystem	Component	Brand/Type	Qty
Bottom End	K24A2 block	OEM Honda	1
Bottom End	Forged pistons (bore size)	TBD	4
Bottom End	Forged rods	TBD	4
Bottom End	Main bearings set	ACL/King	1
Bottom End	Rod bearings set	ACL/King	1
Oiling	K20A2 oil pump kit	OEM/Aftermarket	1
Oiling	Baffled oil pan	TBD	1
Head	K20A2 head	OEM Honda	1
Head	Valve springs + retainers	TBD	1 set
Timing	K20 timing chain	OEM	1
Timing	K20 chain guides	OEM	1 set
Timing	K20 tensioner	OEM/Upgraded	1
Seals/Gaskets	Head gasket (bore matched)	Cometic/OEM	1
Seals/Gaskets	Full gasket/seal kit	OEM/Aftermarket	1
Fuel	Injectors (size as required)	TBD	4
Ignition	COP coils	OEM/Upgraded	4
Sensors	MAP, IAT, wideband O2	TBD	1 set
ECU	Programmable ECU	Hondata/Standalone	1

Table 3: High-level bill of materials for the K24/K20 hybrid engine.

20 Cost Estimates

Item	USD	CAD	Actual (KC)
K24A2 Long Block (used)	TBD	TBD	_____
K20A2 Cylinder Head	TBD	TBD	_____
Forged Pistons/Rods	TBD	TBD	_____
Oil Pump Conversion Kit	TBD	TBD	_____
Valve Springs/Retainers	TBD	TBD	_____
Machine Shop Labor	TBD	TBD	_____
ECU and Sensors	TBD	TBD	_____
Fuel System Upgrades	TBD	TBD	_____

Table 4: Engine build budget with placeholders.

21 Future Revisions

- Add detailed oil and coolant passage diagrams (CAD-based).
- Add flow bench data and porting specifications, if performed.

- Populate torque table with exact OEM/ARP values.
- Populate BOM with final chosen brands and part numbers.
- Add dyno results and calibration notes once engine is tuned.