# Comparative Analysis of Engine Starting System Architecture in Chevrolet Tracker and Chevrolet Onix Vehicles Based on Practical Electrical Investigation

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**Abstract**

*The increasing integration of electronically coordinated engine control systems in modern passenger vehicles has transformed conventional ignition and engine-starting mechanisms into multi-module mechatronic processes involving synchronized interaction between power distribution units, control modules, relays, and sensor networks [1]. Understanding the operational structure of these systems is essential for both diagnostic applications and the development of auxiliary electronic solutions compatible with original vehicle architectures [2].*

*This study presents a comparative investigation of the engine starting systems implemented in Chevrolet Tracker and Chevrolet Onix vehicles equipped with the common 1.2 Turbo powertrain platform. The analysis was performed through practical electrical investigation and functional tracing of signal propagation during the engine start sequence. Particular attention was given to the interaction between the Body Control Module (BCM K9), Engine Control Module (ECM K20), ignition control logic, starter relay activation, and battery power routing [3].*

*The results demonstrate a substantial degree of architectural similarity between both vehicles, confirming the use of a unified General Motors electrical platform. At the same time, several differences were identified in the organization of low-voltage energy storage management, battery monitoring integration, and auxiliary logic modules. These distinctions reflect model-specific adaptations associated with vehicle packaging and electrical energy optimization strategies [4].*

*The findings provide a clearer understanding of ignition-system behavior in GM compact vehicles and establish an engineering foundation for future development of non-invasive remote engine-start modules and other BCM-integrated automotive electronic solutions [5].*

Keywords: Engine starting system, ignition architecture, Chevrolet Tracker, Chevrolet Onix, ECM, BCM, automotive electronics, starter relay, electrical investigation.



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## 1. Introduction

Modern automotive ignition systems have evolved from mechanically actuated switching mechanisms into distributed electronic control architectures involving coordinated communication between multiple intelligent modules [1]. In contemporary vehicles, the engine start procedure is no longer defined solely by direct energizing of the starter motor; instead, it depends on a sequence of logical authorization steps performed by several control units, including the Engine Control Module (ECM), Body Control Module (BCM), transmission control systems, and battery management circuits [2].

This transformation has significantly improved operational safety, theft protection, and energy efficiency, while simultaneously increasing system complexity. For engineers developing auxiliary automotive electronics—particularly remote start modules—it has become essential to understand not only individual electrical connections but also the sequential logic governing ignition authorization and engine cranking [3].

Chevrolet Tracker and Chevrolet Onix represent an especially valuable case for comparative study because both vehicles are based on a shared General Motors platform and utilize the same 1.2 Turbo engine. Their common engineering foundation suggests substantial electrical similarity; however, practical observations indicate that implementation details may differ depending on vehicle class, body structure, and equipment configuration [4].

The objective of this research is to investigate the operational structure of the ignition and starting systems in both vehicles, reconstruct the functional sequence of engine startup, and identify common and model-specific architectural features.

## 2. Materials and Methods

The study was performed through practical electrical investigation and sequential functional interpretation of component interaction within the Chevrolet Tracker and Chevrolet Onix vehicle platforms. Rather than relying exclusively on theoretical documentation review, the analysis focused on reconstructing actual signal paths and identifying functional dependencies between components involved in the engine-starting process.

The examined subsystems included:

- battery power supply lines;
- ignition switch and Ignition Mode Switch (S38);
- Body Control Module (BCM K9);
- Engine Control Module (ECM K20);
- Starter Relay (KR27);
- Ignition Run/Crank Relay (KR93);
- Starter Motor (M64);
- transmission control interaction;
- battery monitoring and low-voltage management components [4].

For each vehicle, the complete start sequence was decomposed into individual operational stages, beginning with driver input and ending with successful engine cranking and transition to stable RUN mode. Functional comparison was then performed to identify shared logic structures and implementation differences [6].

## 3. Results and Discussion

### 3.1. Chevrolet Tracker Starting System Operation

Practical investigation of the Chevrolet Tracker starting system reveals a distributed ignition architecture centered around coordinated interaction between Body Control Module (BCM K9) and Engine Control Module (ECM K20) [3].

**Step 1: Driver Start Command Initiation**

The process begins when the driver activates the Ignition Mode Switch (S38). This action generates an electrical request interpreted by the Body Control Module (BCM K9), which acts as the primary supervisory controller for ignition-state transitions.

At this stage, the BCM evaluates multiple authorization conditions, including:

- vehicle access validation;
- transmission position status;
- brake pedal confirmation;
- system integrity conditions.

Only after these conditions are satisfied does the BCM initiate engine-start authorization [5].

**Step 2: BCM Activation of Ignition Run/Crank Relay**

Following successful validation, Body Control Module (BCM K9) sends a control signal to the Ignition Run/Crank Relay (KR93).

This relay energizes critical vehicle circuits required for startup, including:

- Engine Control Module (ECM K20) operating voltage;
- ignition coil supply;
- injector supply;
- auxiliary engine-control electronics.

The Ignition Run/Crank Relay effectively transitions the vehicle from passive standby mode into active engine-start preparation.

**Step 3: ECM Startup Logic Initialization**

Once powered, Engine Control Module (ECM K20) begins internal diagnostics and sensor verification.

Important monitored parameters include:

- crankshaft synchronization readiness;
- camshaft sensor availability;
- fuel system activation readiness;
- CAN communication stability.

The ECM must confirm operational readiness before permitting starter engagement [6].

**Step 4: Starter Relay Activation**

The critical ignition command is transmitted through X1-70 (Starter Enable Relay Control) from Engine Control Module (ECM K20) toward Starter Relay (KR27).

This relay closes the high-current path connecting battery voltage to Starter Motor (M64), initiating crankshaft rotation.

This stage represents the physical transition from electronic authorization to mechanical engine cranking.

**Step 5: Engine Detection and RUN Transition**

Once combustion begins, Engine Control Module (ECM K20) detects successful startup through rotational and sensor feedback.

The Starter Relay (KR27) is immediately deactivated, preventing mechanical overrun, while the Ignition Run/Crank Relay (KR93) remains energized to maintain normal engine operation.

### 3.2. Chevrolet Onix Starting System Operation

The Chevrolet Onix demonstrates a highly similar ignition sequence but includes additional electrical elements associated with energy-storage supervision and battery-state optimization [7].

**Step 1: Driver Start Request**

As in Chevrolet Tracker, ignition begins with driver input through the vehicle's electronic start interface.

Authorization logic is processed through coordinated interaction between Body Control Module (BCM K9) and Engine Control Module (ECM K20).

**Step 2: Battery Condition Monitoring**

A notable feature of Chevrolet Onix is the inclusion of Battery Sensor Module (B110).

Before allowing engine crank, the system evaluates:

- battery voltage;
- current flow;
- energy reserve condition.

This additional layer improves electrical reliability and protects low-voltage energy resources [7].

**Step 3: ECM and Logic Module Coordination**

The Onix system includes an additional A90 Logic block.

This module appears to participate in:

- electrical signal conditioning;
- data routing;
- energy-state communication with instrument displays.

Its presence indicates a more segmented control architecture compared to Chevrolet Tracker.

**Step 4: Starter Motor Activation**

Battery power is delivered to Starter Motor (M64) through Engine Control Module (ECM K20)-controlled logic, similar to Chevrolet Tracker.

Although relay representation differs functionally, the operational principle remains unchanged:

- authorization;
- relay closure;
- starter engagement;
- engine crank.

**Step 5: Charging System Integration**

Unlike Chevrolet Tracker's more isolated starting circuit, Chevrolet Onix integrates generator and charging-state interaction more explicitly through Generator (G13) and battery monitoring pathways.

This suggests stronger emphasis on intelligent energy management.

### 3.3. Comparative Analysis

Structural Similarities

The comparative investigation confirms substantial architectural commonality between both vehicles and validates the presence of a unified startup-control philosophy across the shared GM platform [8].

The identified similarities include:

- identical 1.2 Turbo engine platform;
- shared Engine Control Module (ECM K20) control philosophy;
- Body Control Module (BCM K9)-mediated ignition authorization;
- relay-based starter engagement;
- electronically controlled Run/Crank transition;
- dependence on inter-module communication;
- intelligent fault-prevention logic.

These similarities indicate a unified General Motors ignition-control strategy [8].

**Structural Differences**

Despite the shared platform, several important differences were identified.

**Battery Monitoring Integration**

Chevrolet Onix includes dedicated battery-state supervision through Battery Sensor Module (B110), while Chevrolet Tracker uses a simpler direct-power approach.

Additional Logic Layer

Chevrolet Onix employs A90 Logic, indicating extra signal-management abstraction not visible in Chevrolet Tracker.

**Energy Management Complexity**

The Onix architecture integrates charging and starting systems more tightly, likely to improve:

- battery lifespan;
- electrical efficiency;
- intelligent load balancing.

**Vehicle Packaging Influence**

Chevrolet Tracker's architecture appears optimized for SUV-oriented modularity and simpler serviceability, while Chevrolet Onix demonstrates more compact electrical consolidation.

Additionally, Chevrolet Tracker incorporates control logic associated with rear body functions such as the rear wiper and rear washer systems, which are absent in Chevrolet Onix due to differences in body configuration. These additional auxiliary circuits slightly expand the functional responsibilities of the Body Control Module (BCM K9) and reflect structural adaptations associated with SUV vehicle design [4].

## 4. Conclusion

This study investigated and compared the ignition and engine-starting systems of Chevrolet Tracker and Chevrolet Onix vehicles through practical electrical and functional analysis of their startup-control architecture [3], [4].

The results confirm that both vehicles employ a highly similar electronically controlled startup philosophy centered on coordinated interaction between Body Control Module (BCM K9) and Engine Control Module (ECM K20), relay-based power switching, and intelligent startup authorization. This commonality reflects the use of a shared General Motors engineering platform and demonstrates strong component-level standardization.

At the same time, Chevrolet Onix exhibits greater complexity in low-voltage energy supervision through dedicated battery monitoring and supplementary logic modules. These enhancements suggest a more advanced energy-management strategy aimed at improving electrical efficiency and long-term system stability.

Understanding these architectural similarities and differences is essential for the design of auxiliary automotive electronics, especially non-invasive remote-start solutions intended to preserve original vehicle functionality. The findings of this research provide a practical engineering basis for future development of intelligent BCM-compatible modules and contribute to broader understanding of modern automotive mechatronic integration.

Additionally, affordable auxiliary solutions developed on the basis of such electrical investigations may increase the technological attractiveness of locally produced vehicles and improve user comfort, making regional automotive products more adaptive and user-friendly in competitive markets.

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