Component Procedures: Starting System

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Parts and Labor (itype_189)

Labor

Operation	Qualifier Path	Skill	Std Hrs	Wty Hrs
Remove & Replace	Ignition Lock > Ignition Lock Cylinder, R&R	B	0.7	0.0
Remove & Replace	Ignition Lock > Ignition Switch, R&R	B	0.7	0.0
Remove & Replace	Starter > Starter Relay, R&R	B	0.3	0.0
Remove & Replace	Starter > Starter, R&R > With 3.6l	B	1.3	0.0
Remove & Replace	Starter > Starter, R&R > Without 3.6l	B	0.9	0.0
Inspect	Starter > Starter Motor Circuit, Inspect	B	0.5	0.0
Test	Starter > Starter Draw, Test	B	0.3	0.0

Starting System (Article 11917)

Starter Motor Operation (Without KL9)

The starter motors are non-repairable. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the crank signal is removed, the starter relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

Enhanced Starter Motor Operation (KL9)

The Engine Stop/Start system in GM vehicles automatically turns off the engine when the vehicle comes to a stop under certain driving conditions, and can quickly restart the engine in about 0.3 seconds when commanded to do so.

In order to smoothly restart the engine as quickly as possible while managing the greater number of engine starts, the Stop/Start system uses an enhanced starter motor that operates differently from a conventional starter motor. It has a high performance electric motor and a stronger pinion engagement mechanism than a conventional starter. It also has independent control of the pinion and motor.

The enhanced starter motor continues using the typical pinion engagement mechanism with a starter solenoid that drives the pinion gear to engage or disengage the flywheel of the engine. When engaged, the starter motor can rotate the engine flywheel and, in turn, the crankshaft.

On the enhanced starter of a Stop/Start system the operation is done in two separate functions inside the solenoid, Starter Motor and Pinion Actuator. Each function controlled individually by the ECM. There are two separate relays to control the two separate parts of the enhanced solenoid:

- KR27 Starter Motor Relay
- KR27C Starter Pinion Actuator Relay

The two individually-controlled relays allow for smooth engagement of the pinion gear into the flywheel with minimum noise and wear.

When the vehicle is coming to a stop, just before the engine stops rotating (at approximately 50 RPM) during stop/start operation, the ECM energizes the Starter Pinion Solenoid Actuator Relay to easily push the pinion gear into the flywheel gear without gear clash. (Fig. 8) When the engine stops rotating during Stop/Start operation (Auto Stop mode), the starter pinion gear is fully engaged, ready for the starter motor to become energized to quickly start the engine again.

A secondary need for the starter pinion to be driven into the flywheel gear before the engine stops rotating

is to address quickly changing demands on the engine. For example, when a driver is slowing nearly to a stop — and the Stop/Start system is preparing for Auto Stop mode — but suddenly decides to release the brake and accelerate

In this situation, the engine has already stopped rotating, or nearly so. A conventional starter cannot restart the engine until the engine has completely stopped. However, with the enhanced starter, the starter pinion gear is fully engaged and ready to begin rotating the engine even before it fully stops turning. Otherwise, the engine would actually have to stop rotating before the pinion can engage smoothly to begin a restart.

To prevent a lag in engine operation, the ECM uses predictive speed matching of the flywheel gear speed and the pinion gear speed to engage the pinion gear into the flywheel gear without gear clash before the engine fully stops. By predicting how long it takes the starter motor to spin up using an algorithm, the pinion gear speed can be matched to the flywheel gear speed. The result is an almost instant restart that is possible at extremely low engine speeds.

Ignition Switch

Keyless Start

When the Ignition mode switch is placed in the crank position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the crank position. The BCM then sends a serial data message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the brake pedal is applied and for manual transmission the clutch is fully depressed or for automatic transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

Key Start

When the ignition sw itch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 V to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

All New Technical Service Bulletins (itype_432)

Tsbs

- Diagnostic Tip - Unable to Learn RKE Transmitters (PIT4945H, 2019/02/19)
- Key Code Security Rules and Information on GM KeyCode Look-Up Application (U.S. Only) (10-00-89-009G, 2025/07/23)

All Technical Service Bulletins (itype_100)

Tsbs

- Normal Characteristic - Heated Seat Operation After Performing A Remote Vehicle Start (RVS) (PIC5322D, 2015/05/29)
- Key & Transmitter Programming (PIC6401, 2020/02/03)
- Requesting a New Key Code for Customer with Lost or Stolen Keys (12-00-89-002E, 2021/11/17)
- N192223230 — Incorrect Service Ignition Key (N192223230, 2020/01/08)
- Information for Fleet Vehicles - Ignition Key, Fob and Key Rings Configuration (14-00-89-004D, 2017/10/23)
- 14294C – Ignition Key (14294C, 2021/03/23)
- Recall 14V346000: Ignition Key Replacement (NHTSA14V346000, 2014/06/20)
- Information on How to Prevent Inadvertent Vehicle Starting from Key Fob or OnStar Mobile Application (17-NA-244, 2017/07/25)
- Diagnostic Tip - Key Does Not Fold Or Will Not Stay Closed (PIC4788G, 2016/06/23)
- Key Cutting Procedure for Obtaining Replacement Key (09-00-89-029L, 2014/04/22)
- Key Code Security Rules and Information on GM KeyCode Look-Up Application (U.S. Only) (10-00-89-009G, 2025/07/23)
- Vehicles with Key Codes Improperly Handled by Third Party (44180-03, 2017/03/23)
- Intermittently Key Will Not Rotate in Door or Ignition Lock Cylinder (PI0091B, 2015/04/28)
- Information on Poor, Limited, Reduced Remote Keyless Entry (RKE) or Remote Vehicle Start (RVS) Range (PI1018A, 2015/02/05)
- Diagnostic Tip - Unable to Learn RKE Transmitters (PIT4945H, 2019/02/19)
- Information on Using MyBuick, MyCadillac, MyChevrolet, and MyGMC Phone Applications to Control GM Accessory Remote Start Kits (16-NA-355, 2018/10/22)

- Locks - Key Code Security Rules, Applications (Canada) (10-00-89-010C, 2013/07/12)
- Keyless Start Transmitter - Poor Appearence After Blade Removal (15-09-83-001A, 2015/07/20)

Customer Interest Bulletins (itype_109)

Tsbs
- Keyless Start Transmitter - Poor Appearence After Blade Removal (15-09-83-001A, 2015/07/20)

Repair Tips (itype_110)

Tsbs
- Locks - Key Code Security Rules, Applications (Canada) (10-00-89-010C, 2013/07/12)

Starter Solenoid Does Not Click (Article 11944)

Diagnostic Instructions
- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit Short to Ground Open/High Resistance Short to Voltage Signal Performance
B+ 1 1 — —
Signal 2 1 — —
Control Terminal 85 — 1 3 —
Control Terminal 87 1 1 3 —
Ground — 1 — —

1. Starter Solenoid Does Not Click 2. Cranks In Any Gear 3. Cranks All The Time

Circuit/System Description

When the ignition mode switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a serial data message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch is fully depressed or the automatic transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay . When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Reference Information

Schematic Reference
- Starting and Charging Schematics
- Automatic Transmission Controls Schematics
- Manual Transmission Schematics

Connector End View Reference
Component Connector End Views
Description and Operation
Starting System Description and Operation
Electrical Information Reference
- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference
Control Module References for scan tool information

Circuit/System Verification

Automatic Transmission
- Ignition ON, verify that no ignition, starter relay, brake pedal position sensor, theft deterrent, engine, or automatic transmission DTCs are set that would cause the ECM to disable engine starting.
- If DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
- Ignition ON, observe the scan tool BCM 5 V Ignition Switch (vehicles without push button start) or ECM Power Mode (vehicles with push button start) parameter. Place the ignition sw itch in the crank position, the parameter should display Crank Request.
- If not the specified value, refer to Power Mode Mismatch .
- Transmission in park , verify the scan tool TCM Internal Mode Switch parameter displays Park.
- If the TCM Internal Mode Switch parameter does not indicate Park. Refer to Transmission Internal Mode Switch Logic .

- Transmission range selector in park or neutral attempt to start the vehicle. The crank relay should click and the engine should begin cranking.
- If the starter relay does not click or the engine does not crank, refer to Circuit/System Testing.
- Ignition ON, observe the scan tool ECM Crankshaft Position Sensor Active Counter is not incrementing.
- If the Crankshaft Position Sensor Active Counter is incrementing, replace the Crankshaft Position Sensor.

Manual Transmission

- Ignition ON, verify that no ignition, starter relay, clutch pedal position sensor, brake pedal position sensor, engine, or theft deterrent DTCs are set that would cause the ECM to disable engine starting.
- Ignition ON, observe the scan tool BCM 5 V Ignition Switch (vehicles without push button start) or ECM Power Mode (vehicles with push button start) parameter. Place the ignition switch in the crank position, the parameter should display Crank Request.
- Ignition ON, observe the scan tool ECM clutch pedal starter inhibit switch, verify the scan tool parameter displays Off/On while depressing and releasing the clutch pedal.
- If the clutch pedal starter inhibit parameter does not change. Refer to Clutch Pedal Position Learn for MG9 transmission and Clutch Pedal Position Learn for MV7 transmission.
- Clutch pedal fully depressed, attempt to start the vehicle. The crank relay should click and the engine should begin cranking.

Circuit/System Testing

- Ignition ON, with a scan tool verify the ECM Ignition 1 Signal parameter is greater than 10 V.
- If less than the specified range, test the ECM ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
- Ignition OFF, disconnect the starter relay.
- Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5.0 Ω between the relay ground circuit terminal 86 and ground.
- If greater than the specified range, test the ground circuit for an open/high resistance.
- Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
- If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 87 for a short to ground.
- Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.
- If the test lamp illuminates, test the control circuit for a short to voltage.
- Ensure the parking brake is applied and the transmission is in NEUTRAL on manual transmission or PARK on automatic transmissions. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the starter is activated.
- If the starter does not activate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter.
- Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
- With the transmission range selector in park/neutral, or the clutch pedal fully applied, place the ignition switch between the OFF and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.
- If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
- If all circuits test normal, test or replace the starter relay.

Component Testing

Relay Test

- Ignition OFF, disconnect the KR27 starter relay.
- Test for 60–180 Ω between terminals 85 and 86.
- If not within the specified range, replace the relay.
- Test for infinite resistance between the following terminals:
- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87
- If not the specified value, replace the relay.
- Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
- If greater than specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.
- Crankshaft Position Sensor Replacement for the 2.8L, 3.0L, 3.2L or 3.6L engines
- Crankshaft Position Sensor Replacement for the 4.8L, 5.3L, 6.0L, 6.2L or 7.0L engines
- Manual Shift Shaft Position Switch Replacement
- Electrical Relay Replacement
- Control Module References for ECM replacement, programming and setup

Starter Solenoid Clicks, Engine Does Not Crank (Article 11943)

Diagnostic Instructions
- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Reference Information
Schematic Reference
Starting and Charging Schematics
Connector End View Reference
Component Connector End Views
Description and Operation
Starting System Description and Operation
Electrical Information Reference
- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference
Control Module References for scan tool information

Circuit/System Verification
- Ignition OFF, measure and record the battery voltage at the C1 terminals. The voltage should be between 12.0–15.0 V.
- If not within the specified range, refer to Battery Inspection/Test .
- Remove the drive belts. Refer to one of the following:
- Drive Belt Tensioner Replacement - Accessory for the 6.2L engine
- Drive Belt Replacement - Accessory for the 6.2L engine
- Drive Belt Tensioner Replacement for the 3.0L or 3.6L engine
- Drive Belt Replacement for the 3.0L or 3.6L engine
- Using the appropriate tools, rotate the crankshaft by hand and verify the crankshaft rotates.
- If the crankshaft does not rotate, refer to one of the following:
- Engine Will Not Crank - Crankshaft Will Not Rotate for the 6.2L engine
- Engine Will Not Crank - Crankshaft Will Not Rotate for the 3.0L or 3.6L engine
- Ignition start, verify the engine does not crank.
- If the engine cranks, inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator .
- Verify that a test lamp illuminates between the M64 starter motor B+ terminal A X2 and ground .
- If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
- Test for less than 0.5 V between the positive battery cable and terminal A X2 at the M64 starter motor as ignition is switched to start position.
- If greater than the specified value, replace the positive battery cable .
- Test for less than 0.5 V between the negative battery cable and the M64 starter motor case as ignition is switched to start position.
- If greater than the specified value, replace the negative battery cable.
- If all circuits test normal, replace the M64 starter motor.

Repair Instructions
Perform the Diagnostic Repair Verification after completing the diagnostic procedure.
- Battery Positive Cable Replacement
- Battery Negative Cable Replacement
- Starter Replacement

Engine Cranks Slowly (Article 11940)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Reference Information

Schematic Reference
Starting and Charging Schematics
Connector End View Reference
Component Connector End Views
Description and Operation
Starting System Description and Operation
Electrical Information Reference
- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
Scan Tool Reference
Control Module References for scan tool information

Circuit/System Verification

- Ignition OFF, measure and record the battery voltage at the C1 terminals. The voltage should be between 12.0–15.0 V.
- If not within the specified range, refer to Battery Inspection/Test .
- Verify that a test lamp illuminates between the M64 starter motor B+ terminal A X2 and ground .
- If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
- Test for less than 0.5 V between the positive battery cable and terminal A X2 at the M64 starter motor as ignition is switched to start position.
- If greater than the specified value, replace the positive battery cable .
- Test for less than 0.5 V between the negative battery cable and the M64 starter motor case as ignition is switched to start position.
- If greater than the specified value, replace the negative battery cable.
- Remove the drive belts. Refer to one of the following:
- Drive Belt Tensioner Replacement - Accessory for the 6.2L engine
- Drive Belt Replacement - Accessory for the 6.2L engine
- Drive Belt Tensioner Replacement for the 3.0L or 3.6L engine
- Drive Belt Replacement for the 3.0L or 3.6L engine
- Ignition start, verify the engine does not crank normal.
- If the engine cranks normal, inspect the engine and belt drive system for mechanical binding, seized generator etc.
- If all circuits test normal, replace the M64 starter motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.
- Battery Positive Cable Replacement
- Battery Negative Cable Replacement
- Starter Replacement

Starter Noise Diagnosis (Article 11942)

Circuit/System Testing

- Remove the flywheel inspection cover.
- Inspect the flywheel for the following:
- Loose flywheel bolts
- Chipped gear teeth
- Missing gear teeth
- Bent flywheel
- If not within specifications, secure the flywheel bolts or replace the flywheel.
- If all inspections were within specification, replace the starter motor .

Repair Instructions

- Fastener Specifications for the 2.8L, 3.0L, 3.2L, or 3.6L engines
- Fastener Specifications for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engines
- Flywheel Removal for the 2.8L, 3.0L, 3.2L, or 3.6L engines
- Flywheel Replacement for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engines
- Starter Replacement

Erratic Operation (itype_132)

Tsbs
- Diagnostic Tip - Unable to Learn RKE Transmitters (PIT4945H, 2019/02/19)
- Diagnostic Tip - Key Does Not Fold Or Will Not Stay Closed (PIC4788G, 2016/06/23)
- Keyless Start Transmitter - Poor Appearence After Blade Removal (15-09-83-001A, 2015/07/20)

Out of specification (itype_158)

Tsbs
- N192223230 — Incorrect Service Ignition Key (N192223230, 2020/01/08)

Poor performance (itype_162)

Tsbs
- Intermittently Key Will Not Rotate in Door or Ignition Lock Cylinder (PI0091B, 2015/04/28)
- Information on Poor, Limited, Reduced Remote Keyless Entry (RKE) or Remote Vehicle Start (RVS) Range (PI1018A, 2015/02/05)

Miscellaneous Information (itype_111)

Tsbs
- Normal Characteristic - Heated Seat Operation After Performing A Remote Vehicle Start (RVS) (PIC5322D, 2015/05/29)
- Information on Using MyBuick, MyCadillac, MyChevrolet, and MyGMC Phone Applications to Control GM Accessory Remote Start Kits (16-NA-355, 2018/10/22)
- Information for Fleet Vehicles - Ignition Key, Fob and Key Rings Configuration (14-00-89-004D, 2017/10/23)
- Information on How to Prevent Inadvertent Vehicle Starting from Key Fob or OnStar Mobile Application (17-NA-244, 2017/07/25)

OEM Policies and Procedures (itype_120)

Tsbs
- Key & Transmitter Programming (PIC6401, 2020/02/03)
- Requesting a New Key Code for Customer with Lost or Stolen Keys (12-00-89-002E, 2021/11/17)
- Key Cutting Procedure for Obtaining Replacement Key (09-00-89-029L, 2014/04/22)
- Key Code Security Rules and Information on GM KeyCode Look-Up Application (U.S. Only) (10-00-89-009G, 2025/07/23)

Safety (itype_107)

Tsbs
- N192223230 — Incorrect Service Ignition Key (N192223230, 2020/01/08)
- 14294C – Ignition Key (14294C, 2021/03/23)
- Recall 14V346000: Ignition Key Replacement (NHTSA14V346000, 2014/06/20)

Service Campaigns (itype_108)

Tsbs
- Vehicles with Key Codes Improperly Handled by Third Party (44180-03, 2017/03/23)