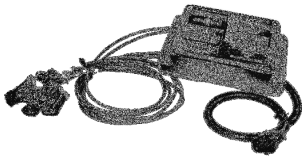

MGM Brakes
A Division of Indian Head Industries

SERVICE DATA BULLETIN

SUBJECT: GEN 2 e-STROKE Brake Monitoring System **EB 06-004**

INTRODUCTION

The purpose of the e-STROKE Brake Monitoring System is to enhance the operational safety of commercial vehicles. The e-STROKE System accomplishes this by providing a simple and objective means for checking the operation and adjustment of each brake, allowing the operator to perform the necessary Stationary Vehicle Inspection quicker and more accurately, plus gives maintenance personnel enhanced brake inspection and diagnostic capabilities.

Additionally, by providing continuous, real-time monitoring of brake actuator stroke, e-STROKE can detect anomalies in brake function during dynamic, real world operation that may not be detected during routine maintenance and inspections.

Whether the vehicle is undergoing a daily Stationary Vehicle Inspection, or driving down the road, e-STROKE has the ability to detect defects that include: inoperative brakes, out of adjustment brakes, dragging brakes, and other brake related problems affecting brake stroke. By identifying precisely where the problem is located, troubleshooting and repairs can be done much more efficiently.

The e-STROKE System is designed to meet specific installation requirements, with 2 and 3 axle configurations designed for Truck/Tractor/Bus installations and 1, 2 and 3 axle configurations designed for trailer installations. The e-STROKE System is compliant with both SAE J1455 and J1113 standards, as well as MGM Brakes own testing requirements. This testing insures the system will operate anytime, anywhere and in any weather.

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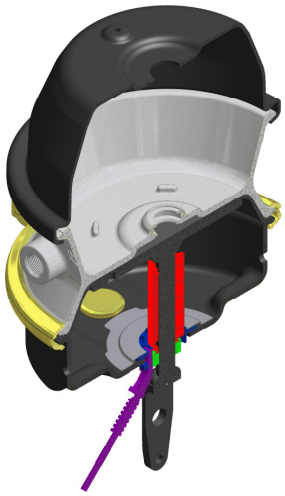
SYSTEM COMPONENTS

Brake Actuators



MGM Brakes e-STROKE brake actuators are denoted by an “ESH” suffix on the part number. Each actuator is assembled with a specified sensor angle orientation, similar to the port and clamp band angle of a standard actuator, and is calibrated at MGM Brakes Manufacturing Facility to insure accuracy. Proper specification of the sensor angle should orient the sensor pigtail toward the centerline of the vehicle, away from the wheel end.

e-STROKE actuator components are not field serviceable, with the exception of single/piggy-back or service diaphragm replacement. For service information, refer to the MGM Service Manual relating to the actuator to be serviced. Reference EB 03-005 and EB 03-006. *DO NOT attempt to rotate, slide or otherwise adjust the magnetic sleeve, sleeve clamp, or the sensor stone shield.*

GEN 2 Chassis Communication Module (CCM)

The Chassis Communication Module (CCM) is the “brains” of the e-STROKE system. The CCM provides regulated power to the actuator sensors and the pressure transducer. The actuator sensor and pressure transducer inputs are continuously monitored by the CCM to determine whether the stroke of each of the actuators is in proportion to the air pressure applied by the brake system.

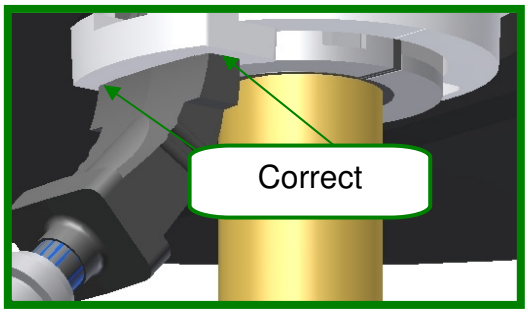
The CCM is a sealed, non-serviceable unit that can be mounted either inside or outside the vehicle. CCM operation requires 9 to 32 V electrical power connections. A warning device output is provided on the CCM to energize an external warning light or audible alarm during active brake fault conditions. Use of a warning device is not required and is left to the discretion of the installer. Additionally, a SAE J1708/J1587 communications port is provided. The CCM will broadcast the corresponding SAE assigned brake fault identifier. For a complete listing of the SAE J1587 assignments refer to the Diagnostic Codes section.

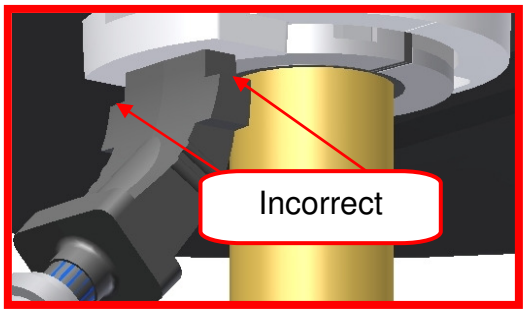
The CCM displays the current fault condition of each actuator via a LED embedded into the face of the unit. Also, a system status LED is provided to indicate proper operation of the CCM. A listing of fault blink codes is provided on the CCM face. Refer to the Troubleshooting Guide when addressing e-STROKE faults.

e-STROKE Sensor and Strain Relief Bracket

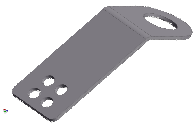
The e-STROKE sensor is a non-serviceable, replaceable component constructed with an over-molded sensor device and the connection pigtail. Care must be taken during installation to insert the sensor into the stone guard sensor port with the proper alignment. The sensor end must be inserted perpendicular to the face of the stone guard until the sensor is completely seated.

Failure to fully seat the sensor will directly influence the system accuracy.





A stainless steel strain relief bracket is provided with the actuator to provide a means for securing the sensor pigtail to the vehicle to prevent the sensor from being inadvertently pulled out of the stone guard sensor port during normal vehicle operation. The strain relief bracket should be installed on the upper mounting stud of the actuator facing toward the centerline of the vehicle.



Pressure Transducer

The pressure transducer is a sealed non-serviceable unit that provides the e-STROKE CCM with information about the pressure the driver is applying to the brake system. A brake fault will be indicated when the actuator stroke is not in proportion to air pressure applied by the brake system. For example, if the driver applies the brake treadle and an actuator does not move from the fully retracted position, the e-STROKE system will determine that brake is “non-functional”.

Wiring and Connectors

All MGM e-STROKE harnesses are designed to meet or exceed SAE guidelines. Connectors are sealed, Metri-Pack series connectors.

SYSTEM OPERATION

Power-Up Sequence

After the vehicle ignition has been activated, the CCM will enter start-up mode. During this time, the software version will be indicated via a blink code on the System Status LED. Until, the CCM has completed the self diagnostic test, all actuator specific LEDS will remain blank.

Stationary Vehicle Inspection Mode

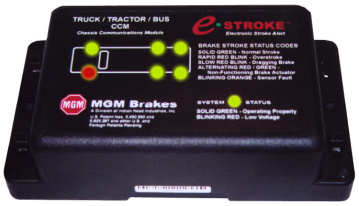
Upon initial power-up, the CCM operates in Stationary Vehicle Inspection Mode until five minutes have elapsed or until the operator makes a second brake application. For a proper Inspection, the operator should first properly chock the wheels and release the parking brake. The air reservoirs should be adjusted to between 90 and 100 psi (as indicated by the dash gauges) by allowing the compressor to build pressure or cycling the brakes to reduce system pressure. Next, the engine and ignition should be turned off to maintain the appropriate testing pressure. The ignition switch is then placed back into the run position without starting the engine. This will put the CCM in the Stationary Inspection Mode. Next, the operator should fully depress and release the brake treadle. Monitor the CCM for over-stroke, dragging, or non-functioning indications.

While in the Stationary Inspection Mode, over-stroke or non-functioning indications observed during the first brake application will be displayed and held for five minutes even after the operator releases the brakes. The intention of this feature is to allow the Technician to perform a "Stationary" brake application and then observe if there are any fault indications on a CCM that is not visible from the driver's seat.

After utilizing the Stationary Inspection Mode, the operator must simply make a second brake application to start normal operation (continuous brake monitoring). Upon releasing the brakes, the operator should monitor the CCM for any brakes to appear as dragging.

Continuous Brake Monitoring

During operation of the vehicle, the e-STROKE system continuously monitors the stroke of each actuator to ensure it is appropriate for the current brake application pressure. If any actuator is determined to be over-stroked, dragging, non-functioning, or have a sensor issue, the wheel specific LED will change from constant green to the appropriate blink code.



Concurrently, the warning device driver will energize the external warning device (if installed) and the appropriate SAE J1587 fault message will be broadcast on the SAE J1708 bus. Once, the fault condition is no longer true, the wheel specific LED will revert back to solid green, the warning device will de-energize, and the SAE J1587 fault code will be broadcast as inactive.

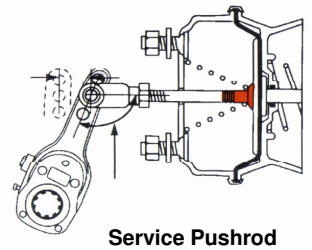
UNDERSTANDING BRAKE DIAGNOSTICS

In order to simplify the fundamental logic used to determine brake faults, the actuator sensors should be considered as method to determine whether the actuator pushrod is fully retracted, within the normal operating stroke range, or beyond the SAE J1953 adjustment indication threshold. At the same time, the pressure transducer provides an indication as to what region of stroke the actuator should be within. For a single actuator the resulting logic can be expressed in the table below.

Fault Description	Service Brake Air Pressure	Pushrod Stroke Position
Dragging Brake	No Pressure	Pushrod not fully returned
Non-Functioning Brake	Service Pressure Applied	Pushrod remains fully returned
Over-Stroke	Service Pressure Applied	Pushrod beyond stroke limit

Absolute vs. Relative Stroke

When following up on an e-STROKE fault indication with a brake inspection, it is important to understand that the e-STROKE system monitors absolute stroke of the actuator pushrod. Absolute stroke is measured from the absolute minimum stroke: i.e. actuator pushrod has fully retracted to zero stroke. It is possible to incorrectly set-up actuators and slack adjusters so that the actuator pushrod is not capable of retracting to zero stroke. In this case, the actuator pushrod will be pre-stroked an indeterminate amount.



Service Pushrod Fully Retracted

When measuring stroke in this condition, the inspector will observe only the relative difference between the non pressurized and applied positions. This is known as relative stroke. It is important to consider that the travel limit on a brake actuator is based on absolute stroke, not relative stroke.

For example, the actuator pushrod may be pre-stroked 1/2 in. from absolute zero stroke when the actuator is not pressurized. With the brakes applied, an inspector may observe a 1-3/4 in. relative travel and incorrectly conclude that the brake is within adjustment limits for a 2-1/2 in. stroke actuator. However, the e-STROKE system will observe 2-1/4 in. of absolute stroke and correctly indicate a brake out of adjustment.

To avoid this scenario, it is critical to rule out the influence of pre-stroked actuators. By removing the clevis pin, an inspector can confidently determine if an actuator has been properly set-up to return to absolute zero stroke if the rod moves further into the chamber when the pin is removed.

CAUTION MUST BE USED WHEN REMOVING THE CLEVIS PIN. ACTUATOR PUSHROD MOVEMENT MAY OCCUR. ENSURE THAT THE POWER SPRING IS PROPERLY CAGED IF SO EQUIPPED.

Dragging Indication

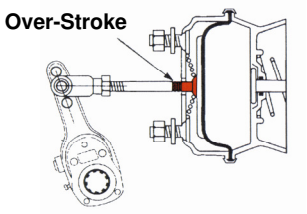
The CCM indicates a dragging brake if an actuator is stroked beyond the first ¼ in.[1] of absolute stroke AND the Pressure Transducer indicates that the operator has released the brakes.

Real world causes are numerous and require a qualified technician to inspect the brake system to determine the root cause. This includes but is not limited to:

- Broken parking brake spring preventing actuator from fully retracting
- Hanging brake shoes
- Mechanical set-up issues
- Malfunctioning slack adjuster
- Worn foundation brake components
- Malfunctioning pneumatic valves that allow pressure to build in actuator
- Spring brake engagement due to low parking brake system pressure
- Non-functioning pressure transducer

NOTE: Door interlock systems and parking brake applications are common examples where an actuator will be stroked into the operating region without pressure in the service circuit. Since these events happen when the vehicle is at rest, the e-STROKE system serves as a visual confirmation that the brakes are truly engaged. Operators must be instructed upon the proper interpretation of the e-STROKE system during interlock operation or parking.

Over-stroke Indication



An over-stroke fault indicates the actuator has stroked beyond the SAE J1953 adjustment indicator threshold. By design this is only applicable during brake applications. If an actuator would stroke beyond the threshold without pressure in the service circuit, the situation is still regarded as a "dragging" brake.

While an over-stroke fault from e-STROKE indicates that the brake may likely be out of adjustment and further investigation is warranted, it should be noted that there are certain conditions when an over-stroke fault can occur on a brake that is not out of adjustment per CVSA criteria.

Brake adjustment limits established by state and federal regulations (DOT and CVSA) are based on measuring actuator stroke with the vehicle stationary, the system air pressure (reservoir) is 90 to 100 psi and the brakes relatively cool. If brake stroke is measured outside of these "standard" conditions it may change. Wheel rotation, increased brake pressure and increased brake temperature will increase stroke. On a moving vehicle with hot brakes, a high pressure brake application can produce strokes that exceed the published adjustment limits even though the brake is properly adjusted.

If e-STROKE indicates an over-stroke condition on any brake, the brake adjustment should be verified using the CVSA test conditions (stationary vehicle, 90 to 100 psi and cool brake). If there are no over-stroke indications during the proper stationary adjustment test, e-STROKE confirms the actuators comply with the CVSA adjustment guidelines. However, over-stroke

[1] ¼ in. Dragging brake threshold is normal.

indications observed using the proper stationary adjustment test, should be verified with physical measurements to determine if the stroke explicitly exceeds the CVSA limits.

NOTE: When pushrod travel (actuator stroke) on a brake with an automatic adjuster is at or exceeds the readjustment limits, the need for repairs to the automatic adjuster or other foundation brake components are indicated. Adjustment of automatic brake adjusters, except as required at installation, is a dangerous practice as it gives the driver a false sense of security since the adjusters are likely to go out of adjustment again in the future, unless additional repairs are performed.

Non-Functioning Indication

A non-functioning brake fault occurs when an actuator fails to stroke beyond ¼ in.[1] and the operator applied sufficient service pressure to the unit. A brake inspection should be performed by a qualified technician to determine the root cause.

Typical issues include but are not limited to:

- Pinched, crimped, or broken air lines
- Defective air valves
- Leaking actuator diaphragm
- Lack of system pressure
- Removal of e-STROKE sensor from actuator

Actuator Sensor Fault

An actuator sensor fault indicates the sensor is no longer providing appropriate data to the CCM. A technician should inspect the wiring harness specific to this actuator sensor.

Typical Issues include but are not limited to:

- Damaged or defective sensor
- Chaffed or cut wiring harness with exposed wiring

SYSTEM TROUBLESHOOTING

Faults

Fault conditions may be caused by many different conditions, so when investigating an e-STROKE displayed fault condition, such as a non-functioning or dragging brake, it is necessary to first confirm whether the condition is true. If the vehicle braking system and foundation brakes have been found to be working properly, the e-STROKE Troubleshooting Guide should be followed to continue the fault analysis.

Diagnostic Codes

SAE J1587 Brake Stroke Alert Fault Codes				
MID	**253**	Brake Stroke Alert (BSA)		
PID	**194**	Transmitter System Diagnostic Code		
FMI	**2**	Actuator Sensor Fault		
	4	Brake Over-Stroke		
	7	Dragging Brake		
	12	Non-Functioning Brake Actuator		
SID	**0**	Reserved	**19**	Trailer #2 Brake Stroke - Axle 1 Left
	1	Tractor Brake Stroke - Axle 1 Left	**20**	Trailer #2 Brake Stroke - Axle 1 Right
	2	Tractor Brake Stroke - Axle 1 Right	**21**	Trailer #2 Brake Stroke - Axle 2 Left
	3	Tractor Brake Stroke - Axle 2 Left	**22**	Trailer #2 Brake Stroke - Axle 2 Right
	4	Tractor Brake Stroke - Axle 2 Right	**23**	Trailer #2 Brake Stroke - Axle 3 Left
	5	Tractor Brake Stroke - Axle 3 Left	**24**	Trailer #2 Brake Stroke - Axle 3 Right
	6	Tractor Brake Stroke - Axle 3 Right	**25**	Trailer #2 Brake Stroke - Axle 4 Left
	7	Tractor Brake Stroke - Axle 4 Left	**26**	Trailer #2 Brake Stroke - Axle 4 Right
	8	Tractor Brake Stroke - Axle 4 Right	**27**	Trailer #2 Brake Stroke Monitor
	9	Tractor Brake Stroke Monitor	**28**	Trailer #3 Brake Stroke - Axle 1 Left
	10	Trailer #1 Brake Stroke - Axle 1 Left	**29**	Trailer #3 Brake Stroke - Axle 1 Right
	11	Trailer #1 Brake Stroke - Axle 1 Right	**30**	Trailer #3 Brake Stroke - Axle 2 Left
	12	Trailer #1 Brake Stroke - Axle 2 Left	**31**	Trailer #3 Brake Stroke - Axle 2 Right
	13	Trailer #1 Brake Stroke - Axle 2 Right	**32**	Trailer #3 Brake Stroke - Axle 3 Left
	14	Trailer #1 Brake Stroke - Axle 3 Left	**33**	Trailer #3 Brake Stroke - Axle 3 Right
	15	Trailer #1 Brake Stroke - Axle 3 Right	**34**	Trailer #3 Brake Stroke - Axle 4 Left
	16	Trailer #1 Brake Stroke - Axle 4 Left	**35**	Trailer #3 Brake Stroke - Axle 4 Right
	17	Trailer #1 Brake Stroke - Axle 4 Right	**36**	Trailer #3 Brake Stroke Monitor
	18	Trailer #1 Brake Stroke Monitor		
Checksum	**206**	End of Message		

SAE J1587 Fault Code Example:

Fault Condition: Dragging Brake on Tractor Axle 2 Right Wheel
Fault Code: 253 194 7 4 206

Fault Code Descriptive Summary:

Message Identifier (MID): 253 - Brake Stroke Alert (BSA)
Parameter Identifier (PID): 194 - Transmitter System Diagnostic Code
Failure Mode Identifier (FMI): 7 - Dragging Brake
Subsystem Identifier (SID): 4 - Tractor Brake Stroke - Axle 2 Right
Checksum: 206 - End of Message Indicator

System Wiring

As with all electrical systems on vehicles, damaged or incorrectly installed wiring can cause issues with the functionality of the system. If the system is displaying a faulty actuator condition and it has been verified that the actuator and vehicle braking system is working and adjusted properly then it is advisable to check the system wiring and verify that:

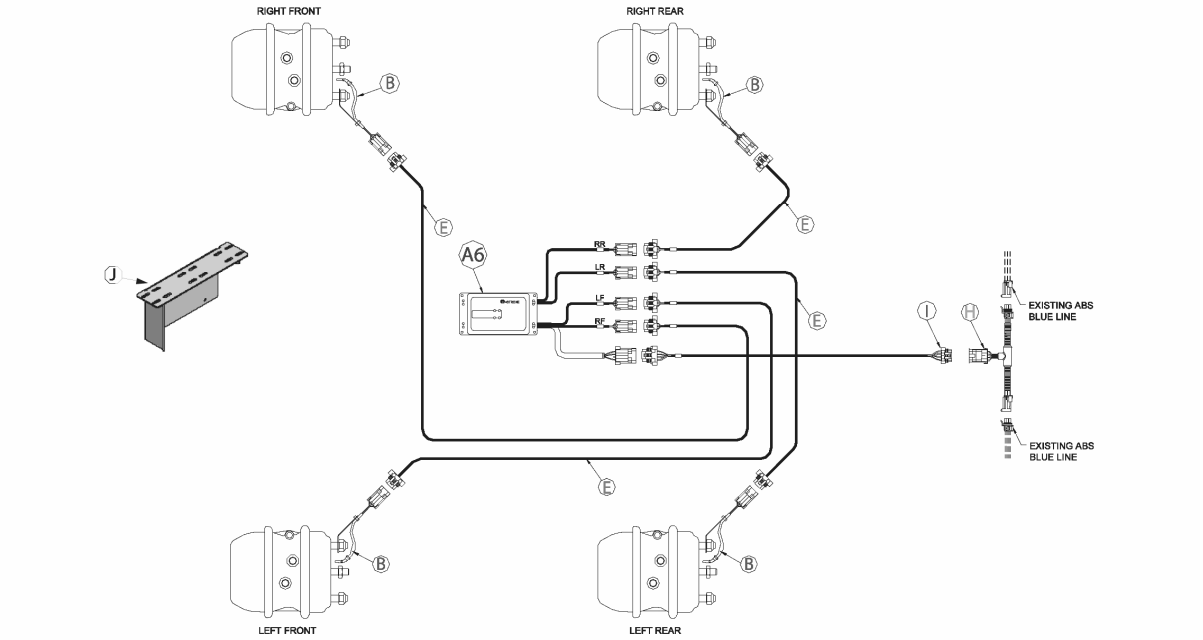
- All connectors are completely plugged together.
- No wires are being pulled, or pinched.
- Check connections for corrosion or bent terminals.
- No wires are cut or broken, and the insulation is intact.
- An adequate amount of slack in the wires around steering and suspension components to prevent tension in the wire.
- The power harness is connected securely to the vehicle power source.
- The sensor and pressure transducer supply power can be verified at the end of each wire harness by unplugging the sensor at the wire harness and measuring voltage between connector terminals A (Red wire, +5 VDC) and B (Black Wire, Ground).

Wiring/System Schematics are available for each of the following installation configurations:

- Single Axle Trailer
- Two Axle Trailer
- Three Axle Trailer
- Two Axle Truck/Bus
- Three Axle Truck/Bus
- Two Axle Tractor
- Three Axle Tractor

For more information regarding system wiring and components, please reference the appropriate MGM Brakes e-STROKE Installation Guide.

Typical System Schematic Two Axle Trailer



Troubleshooting Guide

Item	Problem Description	Brake System Condition	Solution*
1	System status LED does not come on	No actuation	A,B,C,D,E
2	System status LED does not come on and wheel LED's are solid orange.	All conditions	D,X
3	System status LED repeatedly flashes RED then Green, or is not a constant Green.	No actuation	D,C
4	CCM wheel LED flashes slow RED blink indicating dragging brake.	No actuation	O,H,K,P,L,S,T
5	All CCM wheel LED`s flash slow RED blink indicating dragging brake.	No actuation	L
6	All CCM wheel LED`s (for wheels with tandem parking brakes only) flash slow RED blink indicating dragging brake.	No actuation, parking brakes released	O
7	CCM wheel LED flashes rapid RED blink indicating over-stroke condition.	Actuate service brake to 95-100 psi	M,S,U
8	CCM wheel LED flashes rapid RED blink indicating over-stroke condition.	No actuation	G
9	CCM wheel LED flashes alternating RED/GREEN blink indicating non-functioning brake.	Service brake application over 15 psi	N,G
10	CCM wheel LED flashes ORANGE blink indicating a faulty sensor condition.	All conditions	F,I,J,Q,R
11	One or more, but not all, CCM wheel LED`s display a slow GREEN blink.	All conditions	V
12	One or more, but not all, CCM wheel LED`s do not light.	All conditions	W

*Key on next page

Troubleshooting Guide Key

Key	Test to Perform and/or Action to Take
A	Make sure ignition switch is turned on.
B	Test for open circuit at fuse located at the power source connection in the CCM Power Supply Cable. Replace fuse as needed.
C	Check CCM Power Cable for electrical shorts, cut wires, or damaged connectors. Replace damaged cable with approved MGM CCM Power Cable.
D	Test vehicle system voltage. Voltage must be between 10-30 volts DC.
E	Make certain all connectors are properly plugged in so the connector body tabs are locked
F	Inspect brake actuator sensor to ensure it is completely inserted into the stone shield all the way to the sensor stop tabs.
G	Service pressure transducer may be faulty.
H	Brake actuator push-rod must be perpendicular to the bottom of the non-pressure housing within ±3°. If greater than 3°, check to be sure actuator mounting bolts are in correct bracket holes (or if centered in bracket holes). Install actuator into correct holes or loosen and reposition until push-rod is aligned.
I	Inspect brake actuator sensor and connector for physical damage. Replace sensor as needed.
J	Measure continuity of brake actuator sensor with digital meter: RED (positive) to BLACK (negative) wires. Replace sensor if damaged.
K	Inspect brake actuator for improperly cut push-rod (too short). When yoke pin removed, push-rod should not retract.
L	Make sure there is no pressure in the service brake system. Check for faulty system air valve or for air leaking past push-rod air seal in at least one of the vehicle's parking brakes.
M	Measure stroke of the actuator to validate over-stroke condition.
N	Inspect brake actuator for movement when service brake is applied. If no movement detected, check for ruptured diaphragm, system air leak, or faulty ABS valve.
O	Make sure parking brake system air pressure is at least 95 psi.
P	Check for rusted or worn foundation brake components.
Q	Unplug brake actuator sensor assembly at wheel and plug in new sensor. If LED stops flashing ORANGE, install new sensor.
R	Unplug brake actuator sensor harness and connect new sensor harness. If LED stops flashing ORANGE, install new sensor harness.
S	Check brakes for damage to sleeve on push-rod. Damaged or loose sleeve will inadvertently affect unit calibration. Replace with new brake if either is detected.
T	With parking brakes released and no air pressure applied to service brakes, inspect plastic sleeve on push-rod. If push-rod angle is greater than ±3°, the plastic sleeve may hang up on the plastic stone shield inside the unit. This can prevent the push-rod from fully retracting to zero stroke position. To repair, refer to "H" above.
U	Automatic slack adjuster may need to be adjusted or replaced. Be sure service brake is not applied and parking brake is released and push-rod is fully retracted to zero stroke.
V	Faulty CCM wheel LED - RED side only is burned out.
W	Faulty CCM wheel LED - LED is completely burned out.
X	Faulty CCM - Power supply.

Glossary of Terms

ABS	Anti-Lock Braking System
Absolute Stroke	Actuator pushrod stroke relative to actuator true zero stroke
CCM	Chassis Communications Module
Checksum	SAE J1587 end of message indicator
CVSA	Commercial Vehicle Safety Alliance
DOT	Department of Transportation
FMI	SAE J1587 Failure Mode Identifier
LED	Light Emitting Diode (on CCM)
Metri-Pack Connectors	Electrical connectors used in heavy duty vehicle and automotive applications
MID	SAE J1587 Message Identifier (Example MID 253 = Brake)
PID	SAE J1587 Parameter Identifier
Piggyback	Repair kit for Spring Brake or Parking Brake Chamber
Relative Stroke	Actuator pushrod stroke starting from unknown actuator stroke
SAE	Society of Automotive Engineers
SAE J1455	Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design (heavy duty trucks)
SAE J1113	Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (except aircraft)
SAE J1587	SAE/TMC Electronic Data Interchange between Microcomputer Systems in Heavy-Duty Vehicle Applications
SAE J1708	Serial Data Communication between Microcomputer Systems in Heavy-Duty Vehicle Applications
SAE J1953	Brake-Stroke Indicator Design Guidelines for Cam or Disc Air Brake Actuators
SID	SAE J1587 subsystem identifier