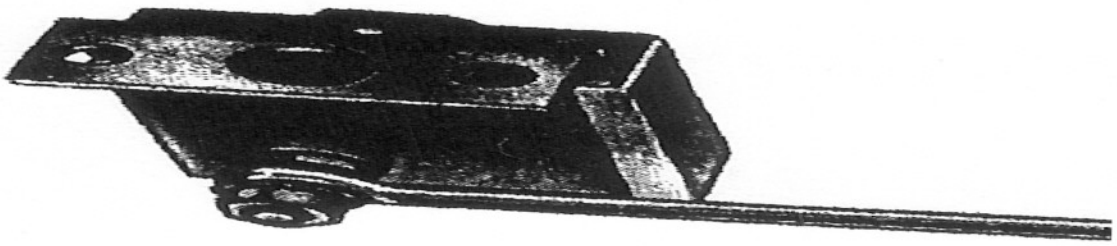
BENDIX CRUISE CONT



* Clutch Switch

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* Brake Switch th
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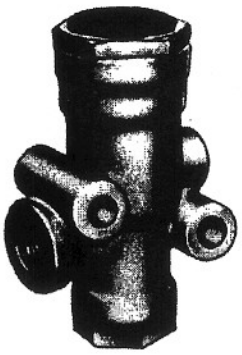
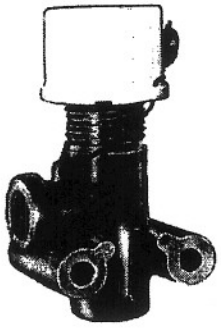


* TR-3 Inversion Valve

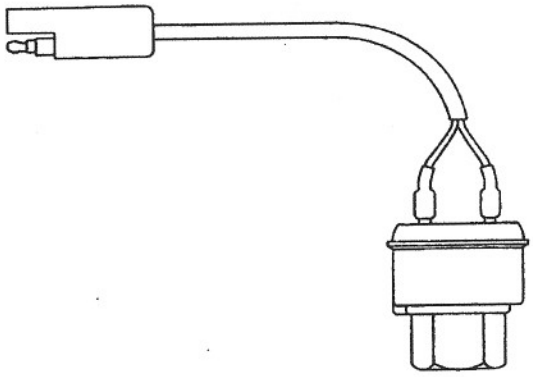
This valve provides pneumatic back up to the electrical brake signal, (stop light switch). The trip pressure is higher than the stop light switch so it takes a harder brake application to operate it. Whenever the brake pedal is depressed enough to put approximately 14 PSI into the brake system, the inversion valve will open and exhaust air from the actuator (CC-5). Once the brake pedal is released, the TR-3 closes allowing the system to regain pressure. Since the brake electrical signal is ignored in Throttle mode, system disengagement only occurs during the time that the brake pedal is depressed.

The location of the TR-3 is not critical so long as it does not get excessive road spray. It should be mounted with the rubber exhaust seal pointing downward. It also must not be mounted on the engine. The TR-3 is often located near the CA-1.



* RV-1 or RV-3 Pressure Reducing Valve

This serves to reduce the system supply pressure to either 60, 80 or 100 PSI. If pressure exceeds 100 PSI, the solenoids can lock up. A setting of 60 PSI is generally used, but higher pressures may be necessary if there is unusually high resistance to throttle movement. This can be due to a very strong throttle return spring, for example.

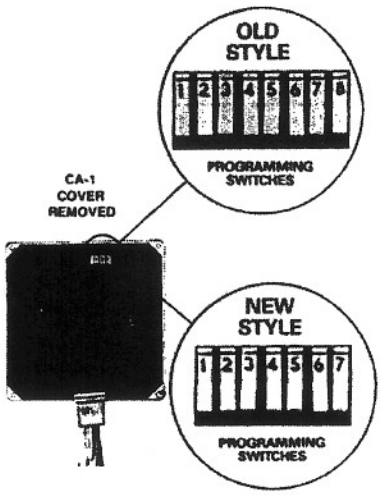


* Speed Sender

Various speed signal sources are compatible with the system. Any device which can supply a signal between 4 Hz/MPH and 18 Hz/MPH with amplitude from 1 to 100 volts peak to peak will suffice. Above ground signals as well as those which swing above and below ground are acceptable. The particular shape of the waveform is not important either, so long as it is clean, (not modulated by noise or other signals).

Magnetic or the mechanical generator type senders, which are driven from transmission ports, are generally used. Driveshaft and drive wheel sensing is also acceptable. If a generator type is used (MINI-GEN), it should be driven directly. Driving it remotely through a cable can result in problems caused by cable wrap up. If it is mounted on the output of a ratio corrector or splitter, the weight and vibration can cause the coupling to break off. The MINI-GEN is available in a feed through and a non-feed through version. Splitters or extension sleeves are only required if space limitations will not allow the use of the feed through type. Also since Hertz rates do not need to be exact for Cruise Control, the slight correction obtained from the use of a ratio connection obtained from the use of a ratio corrector seldom is required. The magnetic pickup is preferred due to the reliability, (no mechanical wear), and ease of installation. For optimum adjustment, a magnetic sensor should be backed out 1/2 to 1-1/4 turns from touching the transmission gear.

The speed signal can be shared with other devices on the vehicle. The CA-1 has a fairly high input impedance (47 K Ohm), to minimize loading of the speed signal when it is shared by other devices. A dual output sender is recommended for optimum signal separation.



IV. DETAILS/PROGRAMMING

NOTE: THE FOLLOWING PROGRAMMING INSTRUCTIONS ARE FOR BOTH THE 8 STATION DIP SWITCH. AND THE 7 STATION DIP SWITCH. THE 7 STATION DIP NUMBERS WILL BE ***(BOLD)***

All CA-1s currently built contain a DIP switch for programming the Speed Signal (Hertz) rate, Top Set Limit, Throttle Mode Select, and Engine (Governor) type. The metal CA-1 enclosure must be removed before programming. Units intended for field programming will have the enclosure assembled with screws and nuts. There is a clear plastic waterproof cover over the switches, which must remain intact. It is flexible so each switch can be set with the cover in place. The field programmable CA-1s will have all switch positions, (except #1), put in the "on" position when received. Details of programming are given below. An instruction sheet, BWS-904 is also included with each programmable unit.

Turn the power to the CA-1 off while programming. The switches are only read on initial power up. Changing the switch setting while the system is powered will have no effect until the power is cycled off and on.

NOTE: On the 8 position DIP Switch position 1 is not used, its setting does not affect operation.

SPEED SIGNAL/HERTZ RATE, SWITCHES 5 ***(5)*** AND 6 ***(4)***

Vehicle speed information is fed to the CA-1 as a frequency that varies with speed. The range of frequencies varies between vehicles depending on factors such as tire size, the rear end ratio and the transmission. The speed signal rate for a given vehicle is generally given in Hertz/MPH or pulses/mile.

Calculations: $\frac{\text{PULSES/MILE}}{3600} = \text{HERTZ/MPH}$

In the formulas below:

T	=	Number of tire revolutions per mile, (drive wheel)
R	=	Rear end ratio (drive revs/driven revs)
G	=	# of teeth in the gear that passes the magnetic pick up

D = The ratio of the # of teeth-drive gear to the # of teeth-pencil gear (MINI-GEN)
P = # of poles in signal generator (30 for MINI-GEN)
C = Ratio of connector (drive revs/driven revs) if used, (1.0 if not used)
3600 = # of seconds in an hour

For a Magnetic Transmission Pick up: $\frac{TxRxG}{3600}$ = Hertz/MPH

Example: T= 475 revs/mile, R= 3.65, G= 16

$$\frac{475x3.65X16}{3600} = 7.7 \text{ Hz/MPH}$$

For a Mini Gen:

$$\frac{TxRxDxP}{Cx3600} = \text{Hertz/MPH}$$

Example: T= 475, R= 3.65, D= 7/14, P= 30, C= 1.012

$$\frac{475x3.65X7/14x30}{1.012x3600} = 7.14 \text{ Hz/MPH}$$

For a MINI-GEN, often the number of revolutions per mile is known for the transmission port (speedometer drive). This is usually 1,000 revs./mile for speedometer compatibility. Therefore, if there are 30 poles on the MINI-GEN and it is rotated 1,000 revs./mile, then there are (30 x 1,000) or 30,000 pulses per mile. Dividing by 3600 gives 8.33 Hertz/MPH.

For other sensing schemes, calculate the number of pulses that will occur in a mile. Remember, ratios are generally given in input revs/output revs., or (drive revs/driven revs). Knowing this will help determine whether to multiply or divide by the ratio. Mechanical drive pencil gears rations are usually given as # of teeth (drive gear) to # of teeth (driven gear). This is the inverse of drive revs/driven revs ratio.

Remember - $\frac{\text{\# of teeth drive gear}}{\text{\# of teeth driven gear}}$ = driven (output) revolutions / drive (input) revolutions

In the MINI-GEN calculation example above, 7/14 is the (# of teeth drive gear/# of teeth driven gear). Therefore there are 7 output revs for every 14 input revs, or the driven gear is going half as fast as the drive gear.

Testing for Hertz Rate:

If the Hz rate cannot be calculated due to missing information, it can be arrived at by road testing. To do this it is necessary to note the lowest speed that the system will take a set at and the Hz rate that the CA-1 is programmed for.

The Minimum Set Frequency is:
84 Hz if CA-1 is set at 4.2 Hz/MPH

168 Hz if CA-1 is set at 8.4 Hz/MPH
336 Hz if CA-1 is set at 16.8 Hz/MPH

Example: The CA-1 is programmed for 8.4 Hz/MPH and it is found that the system will not take a set below 29 MPH.

Solution: Per the information above, 8.4 Hz/MPH corresponds to a minimum set frequency of 168 Hertz.

$$\frac{168 \text{ Hz}}{29 \text{ MPH}} = 5.8 \text{ Hz/MPH}$$

Therefore, since 5.8 is closer to 4.2 than 8.4, 4.2 Hz/MPH should be selected.

Programming:

Switches 5 *(4)*and 6 *(5)*control the Hertz rate selection. Select the Hertz rate that is closest to the actual Hertz rate of the vehicle. The table below gives the switch settings for the three rates which may be selected.

HERTZ RATE (HERTZ/MPH)	4.2	8.4	16.8
SWITCH 5 *(4)*	OFF	ON	ON
SWITCH 6 *(5)*	OFF	ON	OFF

It is important to select the proper Hertz rate. The CA-1 is based on an 8.4 Hz/MPH rate. If 16.8 Hz/MPH is selected, the first thing the Microprocessor does is to divide the input frequency by two. If the rate programmed is significantly wrong, problems can result such as surging, hunting or slow response.

TOP SET LIMIT, SWITCHES 2 *(1)*, 3 *(2)* AND 4 *(3)*

The Top Set Limit is not the highest speed that the vehicle can travel at, it is the highest speed that the Cruise Control can be set at. If the vehicle is exceeding the Top Set Limit when a Set is made, the CA-1 will recognize the Set, but it will not affect the Throttle until the vehicle speed has coasted down to the Top Set speed. The system will then maintain this speed.

There are 8 different Top Set Limits that can be programmed into the CA-1. These TSL's are actually maximum frequencies that the CA-1 will set at. Therefore, if the exact Hertz rate is known, the exact TSL in MPH can be calculated. Depending on the Hertz rate programmed into the CA-1, these 8 possible TSL frequencies will be different. With the table below it is very easy to find the actual TSL.

TOP SET LIMIT, SWITCHES 2 *(1)*, 3 *(2)* AND 4 *(3)*

SW4 *(SW3)*	SW3 *(SW2)*	SW2 *(SW1)*	CA-1 SET AT 4.2 HZ/MPH	CA-1SET AT 8.4 HZ/MPH	CA-1 SET AT 16.8 HZ/MPH	APPROX. SPEED
ON	ON	ON	402.0	804.0	1608.0	95.7 MPH
ON	ON	OFF	271.5	543.0	1086.0	64.6 MPH
ON	OFF	ON	262.5	525.0	1050.0	62.5 MPH
ON	OFF	OFF	252.0	504.0	1008.0	60.0 MPH
OFF	ON	ON	246.0	492.0	984.0	58.6 MPH
OFF	ON	OFF	232.5	465.0	930.0	55.3 MPH
OFF	OFF	ON	225.0	450.0	900.0	53.5 MPH
OFF	OFF	OFF	215.0	430.0	860.0	51.2 MPH

* Note: The frequencies are exact for a given Hertz rate and TSL programming. The APPROX SPEED column will be the exact Top Set Limit if the true vehicle Hertz rate is the same as the programmed value.

To find the exact Top Set Limit speed, divide the appropriate TSL frequency by the actual vehicle Hertz Rate.

EXAMPLE:

SW4 *(3)*-ON, SW3 *(2)*-OFF, SW2- *(1)* ON, and the CA-1 is programmed for 16.8 Hz/MPH. The actual vehicle Hertz Rate is 15.4 Hz/MPH.

$$\text{(From chart) } \frac{1050.0}{\text{(known) } 15.4} = 68.18 \text{ MPH (true TSL)}$$

ENGINE TYPE/GOVERNOR, SWITCH 8 *(7)*

The CA-1 has the provision to be programmed for two different engine governor types. This feature is necessary because of the different engine responses between the two types. A brief description of their difference follows.

Switch 8 *(7)* ON – Min/Max Governor (CUMMINS and DDAD engines)

A Min/Max governor controls the minimum and maximum RPM that the engine can run by regulating fuel flow. If the normal operating RPM is between these limits, only the throttle, (not the governor), will affect the engine RPM and hence the vehicle speed.

These types of engines are easier to control in Cruise Control mode than the All Speed governor. However, under no load conditions, such as Throttle mode, these types of engines can run up against the maximum RPM with very little throttle movement. This makes it difficult to make fine adjustments at the higher RPMs.

Switch 8 *(7)* OFF – All Speed Governor (CAT and MACK engines)

An All Speed governor tries to maintain a given engine RPM based on throttle position, throughout the operating range. As the load on the engine increases, the governor will increase fuel flow to the engine in an attempt to

maintain the engine speed. Similarly, the Cruise Control increases throttle position, (fuel flow), as the load on the engine increases.

The All Speed governor and the Cruise Control can tend to either fight or assist each other if not accounted for in the design. Setting switch 8 ***(7)*** to the All Speed position dampens the response of the Cruise Control system to compensate for the affects of the governor.

System Response Differences:

Since the All Speed Cruise Control response is dampened in comparison to the Min/Max response, if the CA-1 is programmed for the wrong governor type, the Cruise Control will not respond correctly. For example, if a CA-1 programmed for All Speed is used with a Min/Max governor, the response may be sluggish and tight speed control will be difficult to maintain. On the other hand, if a CA-1 programmed for Min/Max is used with an All Speed governor, the system may respond too fast and overshoot. This can result in surging and hunting for the correct speed.

THROTTLE MODE SELECT, SWITCH 7 ***(6)***

When switch 7 ***(6)*** is in the ON position, the Stationary Throttle mode option will be selected.

V. MALFUNCTIONS/TROUBLESHOOTING

The purpose of this manual is to teach a basic understanding of the Cruise Control system. If this is accomplished, logical decisions can be made and steps taken to troubleshoot Cruise Control system in an efficient, successful manner. Merely following a series of steps without an understanding of the problem can be a waste of time and effort. If you do not know where to begin however, the procedure below can be used as a guideline for testing the entire system. It gives some simple checks to narrow the problem down quickly.

What You Need For Troubleshooting

A few basic items are listed below which will help make troubleshooting easier.

- This manual and/or SD-10-1. The "Bendix Cruise Control Application Data" booklet may also be of use.
- A hand held Volt/Ohm meter with probes
- At least one pair of clip leads
- A 12 volt, programmable CA-1 module with molded connectors, (550072)
- A 12 volt solenoid pack with molded connectors (101927)
- A Truck CC-5 with molded connectors (101950)
- A feed through MINI-GEN (102053)

The 12 volt, molded connector versions of the CA-1, CC-5 and Solenoids are most prevalent in the field. These can be used for temporary replacements to narrow down or confirm faulty components. But even if the system is 24 volt

or uses Packard 56 connectors, the system troubleshooting procedure described below may still be used with the exception of changing the CA-1 and Solenoids.

When changing components, be certain that the CA-1 and Solenoid voltages are the same as the vehicle voltage. 24 volt CA-1s have red grommets, 24 volt solenoids have red and black wires, and observe the following warning.

WARNING – NEVER SWAP CA-1s WITHOUT DOING THE FOLLOWING

When changing CA-1s, be aware that if the clutch switch circuit is shorted to ground due to a pinched wire or faulty clutch switch, the replacement CA-1 will also be damaged. Damage to the replacement CA-1 can also result if either solenoid coil is shorted. The sequence below will test for this.

1. Disconnect the inhibit/speed connector. On the truck harness side, check the resistance from pin 1 to ground and from pin 2 to ground with an ohm meter. They should be open circuits, (very high resistance).
2. Disconnect the solenoid connector. Check the resistance between socket 1 and pin 4, also between socket 2 and pin 3 of the solenoid package. Both these coil readings should be roughly 20 ohms (100 for 24 volt type). They must not be shorted or an open circuit.
3. A different CA-1 can now be connected without risking immediate damage.

System Troubleshooting

Remember the basic requirements for operation, and the functions of each component as described earlier. If there is power to the CA-1 and control switches, a good ground to the CA-1, a complete circuit through the clutch switch, no voltage on the brake input and a speed signal, the system should work. The procedures, which follow, can troubleshoot a system that does not operate at all. Incorrect operation is covered in a later section.

* Most of the system can be checked in Throttle mode, (if it is programmed). The vehicle does not need to be running to check Throttle mode. Watching the throttle linkage move and hearing the solenoids cycle is enough indication.

If the CA-1 is not programmed for Throttle mode, either reprogram the CA-1 to include it, swap CA-1s with the test unit (Note: warning above on swapping CA-1s), or follow the procedure below for systems with inoperative Throttle mode.

********** If Throttle mode works but Cruise Control does not **********

1. Check the presence of speed signal. Rolling the vehicle while the throttle is advanced can do this. Any speed input will disengage the Throttle mode. It may be easier to check this by seeing if Throttle mode works while the vehicle is being driven. If multiple Resumes slowly increase the throttle while driving, then you can be sure that there is no speed signal input.

If this is the case, check the sender with an ohm meter by disconnecting the Inhibit/Speed connector and measuring the resistance to ground from pin 3 (wire harness side). It should be roughly between 100 and 3,000 ohms. Be certain that it is not a shorted or open circuit. Raise the rear of the vehicle. With a voltmeter between pin 3 and ground (AC position), rotate the tire and see that the meter shows some deflection. The amplitude read will vary with the sender type, speed of rotation, and the meter used. It should show some deflection

however, if there is a speed signal present. If an Oscilloscope is available, confirm that there is at least 1 volt peak-peak.

If the resistance reads correctly but there is still no signal, check the following. Note the air gap if a Magnetic sensor is used. Screw the sensor in until it touches the gear in the transmission, then back it off 1/2 to 1-1/4 turns. If a MINI-GEN is being used, see that the drive tang is not damaged or missing.

2. Recall that a constant brake electrical signal will disable Cruise mode but not Throttle mode. If it is determined that the speed signal is correct, then verify that there is not a false brake signal. Disconnect the Control connector (refer to connector diagrams at end). If power is present when the brake pedal is not depressed then check the vehicle brake circuit.

********** If neither Cruise nor Throttle modes work **********

Note: If the throttle does not move, but you can hear the solenoids cycle, see step 8. If Throttle works erratically, refer to step 9.

1. Does the power switch light up. Maybe the fuse is open or a connection is broken. If the fuse or circuit breaker is open, find out why before replacing or resetting it. Follow the procedure outlined above in the warning about changing CA-1s. Check to see if the clutch circuit has an intermittent short by moving the wire harness and tapping on the clutch switch. If that procedure indicates that the clutch circuit and Solenoids are normal, replace the fuse or reset the breaker. If they open again then try replacing the CA-1.
2. If the power switch lights and the CA-1 is programmed for throttle mode, perhaps the Set and Resume wires are reversed. This can be tested by testing to see if the switches work in reverse for Throttle mode, (SET – increase, RESUME – decrease).
3. Check to see that all connectors are fully seated.
4. Verify that the green wire to the CA-1 has a good connection to vehicle ground. An ohm meter can be used to check the wire harness ground to the vehicle ground. It should be no more than a couple ohms.
5. Visually check the clutch switch to see that it is actuated when the clutch pedal is relaxed. Disconnect the Inhibit/Speed connector at the CA-1. With an ohm meter, verify that there is low resistance through the clutch circuit, (from pins 1 and 2-wire harness side), when the pedal is at rest. With the power switch on, verify that there is power on socket 2 (clutch switch electrical power) on the CA-1 side of Inhibit/Speed connector. Clutch switch power from the CA-1 also confirms that the power switch circuit is intact. Refer to the connector diagrams at the end for pin/connector identification.
6. Disconnect the Control connector. On the wire harness side, check for power on socket 4 (brake/stop lamp); it should not be there unless the brake pedal is being pressed. See that there is power on pin 1 (Set) while the Set switch is being pressed, and power on socket 2 (Resume) while the Resume switch is being pressed, (wire harness side). If neither has power, the jumper form the power switch to the control switch is probably disconnected.
7. Disconnect the solenoids from the CA-1. Check the resistance from socket 1 to pin 4, and the resistance from socket 2 to pin 3 of the solenoid connector. If either reading is less than 15 ohms or greater than 150 ohms, replace the