

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE	
				Nm	LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

* Bolts are specially heat-treated.

DO NOT substitute with inferior grade bolts.

Table CC

Disconnect Driveshaft

3. With all support straps securely in place, disconnect the driveshaft from the coupling shaft by removing the bearing retainers and bolts or stamped straps and bolts. Reference bolt specifications, Table CC, above. If bearing retainers are not damaged, they can be reused. Stamped straps **CANNOT** be reused. **DO NOT** reuse the bolts. Discard bolts. ▲ See warning, below.

▲ WARNING

DO NOT reuse bearing retainer bolts or damaged bearing retainers, stamped straps or stamped strap bolts, or use inferior grade bolts. Reuse of bearing retainer bolts or damaged bearing retainers, stamped straps or stamped strap bolts, or use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow driveshaft to rest on support strap.



Photo 83

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 9. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

If the effected center bearing has not been reached, proceed to step 5 to remove coupling shaft(s) to reach coupling shaft with effected center bearing.

Remove Coupling Shaft(s)

5. **Be sure the third support strap is in place as illustrated in Figure V, page 95.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap. (See photo 83, above.)

6. **Be sure the fourth support strap is in place as illustrated in Figure V, page 95.** Remove bearing retainers or stamped straps and bolts on end yoke. Reference bolt specifications Table CC, left. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, step 3.

7. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once coupling shaft is free, remove coupling shaft from support straps and take to a work bench area. ▲ See warning, below.

▲ **WARNING**

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. Repeat steps 5-7 as necessary to obtain access to the effected center bearing. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

Inspect Center Bearing End Yoke

9. Inspect the center bearing end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. ▲ See warning, below.

▲ **WARNING**

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. Check the center bearing end yoke for looseness, backlash and broken back. Take hold of center bearing end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any movement in the center bearing end yoke relative to the midship tube

shaft to which it is connected. If any of these conditions are present, the center bearing end yoke or midship tube shaft must be replaced. ▲ See warning, below.

▲ **WARNING**

A loose end fitting can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11. Inspect the center bearing end yoke cross hole surfaces for damage or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth. ▲ See warning, below.

▲ **WARNING**

***DO NOT** deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

12. Inspect the center bearing end yoke for distorted cross holes using the appropriate Spicer alignment bar. Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and yoke must be replaced. ▲ See warning, step 9.

Note – If effected center bearing was in the final coupling shaft, repeat same inspection steps on front end yoke prior to reinstallation of final coupling shaft into vehicle.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE	
				Nm	Lb. Ft.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525 Lb.Ft.
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL170	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL250	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.

* A 1 5/8" socket may be used.

Table DD

Remove Midship Nut on Center Bearing Yoke

13. Remove midship nut. Reference midship nut specifications Table DD, above. (See photo 84, below.) Discard nut. If washer is damaged, discard and replace. Otherwise, reuse washer. ⚠ See warning, below.

⚠ WARNING

DO NOT reuse midship nut. Reuse of midship nut can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.



Photo 84



Photo 85

Mark Center Bearing End Yoke Counterbore

Caution – The following step is an additional marking process to that described in step one. Be sure to mark as directed.

14. Mark the counterbore of end yoke to midship “nose” with marking stick, paint marker or other legible marking device. This assures proper reassembly of the center bearing end yoke in its original phased position. (See photo 85, above.) ⚠ See warning, below.

⚠ WARNING

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Coupling Shaft With Effected Center Bearing

15. Remove center bearing bracket bolts. (See photo 86, page 99.) Allow coupling shaft to rest on support strap.

Remove Coupling Shaft With Effected Center Bearing

16. Remove bearing retainers or stamped straps and bolts from end yoke. Discard bolts and stamped straps. ▲ See warning, below.

▲ WARNING

DO NOT reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

17. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the coupling shaft is free, remove from support straps and take it to a work bench area. ▲ See warning, below.

▲ WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Center Bearing End Yoke

18. Using a puller, follow the tool manufacturer's instructions to remove the Quick Disconnect™ yoke. (See photo 87, center right.) The yoke has a press fit and should **NOT** be removed with a hammer. If the yoke is loose enough to be removed by hand, the entire coupling shaft must be replaced. Remove and discard slinger from the yoke. ▲ See warning, below.

▲ WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.



Photo 86



Photo 87

Inspect Center Bearing End Yoke Splines

19. Visually inspect the splines of the center bearing end yoke. If the yoke splines are damaged, missing or twisted, the yoke must be replaced. If the yoke hub is cracked, the yoke must be replaced ▲ See warning, step 18.

Inspect Midship

20. Visually inspect the midship splines and threads. If the splines or threads are damaged, missing or twisted, replacement of the entire coupling shaft is necessary.

▲ See warning, step 18.

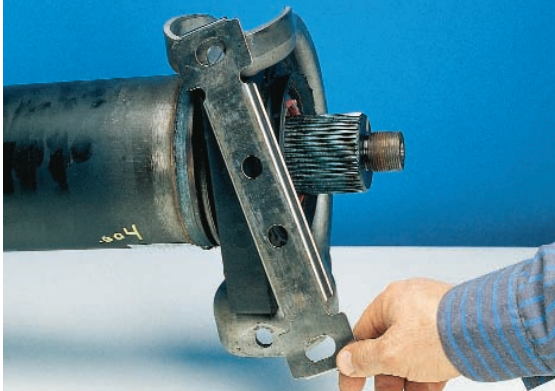


Photo 88

Remove Center Bearing

21. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove metal retainer and discard. (See photo 88, above.)

22. Remove and discard center bearing bracket. (See photo 89, top right.) Remove and discard rubber cushion. (See photo 90, right.)

23. Using a puller, follow the tool manufacturer's instructions to remove the bearing assembly from the midship. (See photo 91, right.) Discard the center bearing.

Inspect Midship Bearing Diameter

24. Inspect midship for wear on the bearing diameter. If the midship is damaged from a seized bearing, replacement of the entire coupling shaft is necessary. (See photo 92, right.)

▲ See warning, below.

▲ WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

25. If no damage is apparent, remove slinger and proceed to installation of center bearing, Quick Disconnect™ Yoke Style, pages 128 to 132.



Photo 89



Photo 90



Photo 91



Photo 92

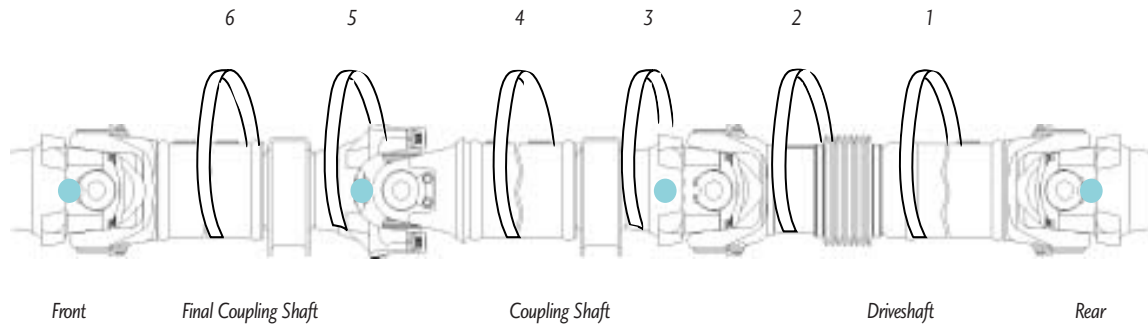


Figure W, S.A.E.

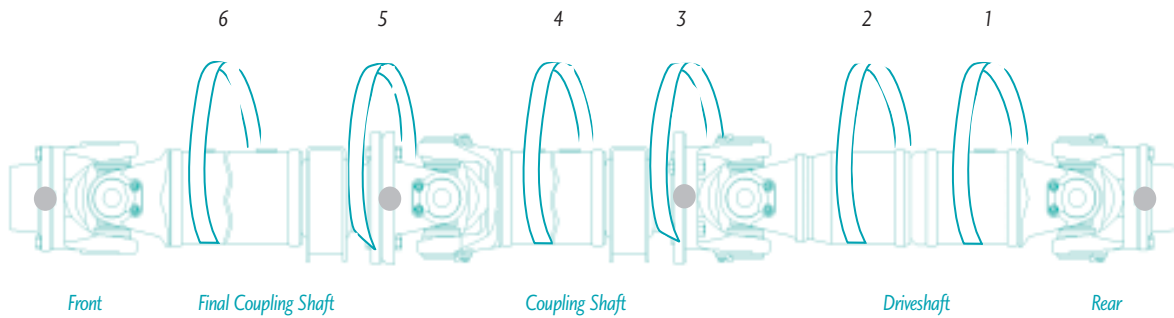


Figure X, DIN and T-Type

COMPANION FLANGE/FLANGE YOKE (S.A.E., **DIN** AND **T-TYPE** STYLE)

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from the **rear** end forward. The driveshaft will need to be disconnected in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Mark Driveshaft (“Phasing Marks”)

1. It is imperative to mark all mating components of the driveshaft, as illustrated in Figure W or X, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all flange positions, spline positions, and shaft locations. This assures

proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ **WARNING**

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end forward, position support straps 1 through 6 (as needed) as illustrated in Figure W or X, above. ▲ See warning, below.

▲ **WARNING**

ALWAYS use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE	
					Nm	FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

*Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.

† Approved Spicer hardware.

Note-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware.

Refer to the original equipment service manual for bolt part numbers.

Table EE

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support straps to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support straps. ⚠ See warning, below.

⚠ WARNING

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

3. With support straps securely in place, disconnect the driveshaft from the coupling shaft by removing the companion flange bolts. Reference hardware specifications, Table EE, above. **DO NOT** reuse companion flange bolts, washers or nuts. ⚠ See warning, top right. Allow driveshaft to rest on the support straps.

⚠ WARNING

DO NOT reuse companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 9. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

If the effected center bearing has not been reached, proceed to step 5 to remove coupling shaft(s) to reach coupling shaft with effected center bearing.



Photo 93

Disconnect Coupling Shaft

5. Be sure the third support strap is in place as illustrated in Figure W or X, page 101. Remove the center bearing bracket bolts and allow the shaft to rest on the support strap. (See photo 93, above.)

Remove Coupling Shaft

6. Be sure the fourth support strap is in place as illustrated in Figure W or X, page 101. Remove companion flange, bolts, washers and nuts. Reference hardware specifications, Table EE, page 102. Discard companion flange bolts, washers and nuts. ▲ See warning, below.

▲ WARNING

DO NOT reuse companion flange bolts, washers or nuts, or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

7. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take to a work bench area.

▲ See warning, below.

▲ WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. Repeat steps 5-7 as necessary to obtain access to the effected center bearing. **DO NOT** at this point remove coupling shaft, with the effected center bearing, from the vehicle.

Inspect Center Bearing Flange

9. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. ▲ See warning, step 10.

10. Visually inspect the center bearing flange. Check the flange for looseness, backlash and broken back. Take hold of center bearing flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any movement. If any of these conditions are present, the entire shaft must be replaced. ▲ See warning, below.

▲ WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Note – If effected center bearing was in the final coupling shaft, repeat the same inspection steps on front flange prior to reinstallation of final coupling shaft into vehicle.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE	
				Nm	LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525 Lb.Ft.
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL170	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL250	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.

* A 1 5/8" socket may be used.

Table FF

Remove Midship Nut on Center Bearing Flange

11. Remove and discard midship nut. Reference midship nut specifications, Table FF, above. If washer is damaged, discard and replace. Otherwise, reuse washer. ▲ See warning, below.

▲ WARNING

DO NOT reuse midship nut. Reuse of midship nut can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Mark Center Bearing Flange Counterbore

Caution – The following step is an additional marking process to that described in step 1. Be sure to mark as directed.

12. Mark the counterbore of the companion flange to midship “nose” with a marking stick, paint marker or other legible marking device. This assures proper reassembly of the companion flange in its original phased position. ▲ See warning, below.

▲ WARNING

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Coupling Shaft With Effected Center Bearing

13. Remove center bearing bracket bolts and allow shaft to rest on support strap.

Remove Coupling Shaft With Effected Center Bearing

14. Remove and discard flange bolts, washers and nuts at end fitting. ▲ See warning, below.

▲ WARNING

DO NOT reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

15. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, remove coupling shaft from support straps and take it to a work bench area.

▲ See warning, below.

▲ WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

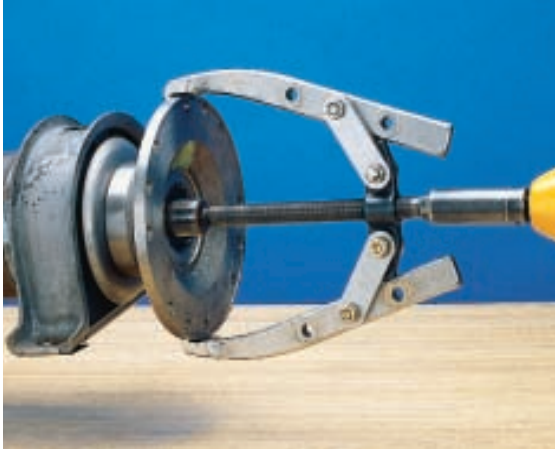


Photo 94

Remove Center Bearing Companion Flange

16. Using a puller, follow the tool manufacturer's instructions to remove the center bearing companion flange. (See photo 94, above.) Flange has a press fit and should **NOT** be removed with a hammer. If flange is loose enough to be removed by hand, the entire coupling shaft should be replaced. ▲ See warning, below. Remove and discard the slinger from the flange.

▲ **WARNING**

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Inspect Center Bearing Flange

17. Visually inspect the center bearing companion flange splines and bolt hole threads or through holes. If the splines are damaged, missing or twisted, the entire coupling shaft should be replaced. If the center bearing flange hub is cracked, the pilots have damage or burrs, or bolt hole threads or through holes are damaged, replace the center bearing flange. ▲ See warning, step 16.



Photo 95

Inspect Midship

18. Visually inspect the midship splines and threads. If splines or threads are damaged, missing or twisted, replacement of the entire coupling shaft is necessary. ▲ See warning, below.

▲ **WARNING**

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Remove Center Bearing

19. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove the metal retainer and discard. (See photo 95, above.)



Photo 96

Remove and discard the center bearing bracket. (See photo 96, above.) Remove and discard the rubber cushion. (See photo 97, top right.)

20. Using a puller, follow the tool manufacturer's instructions to remove the bearing assembly from the midship. (See photo 98, center right.) Discard the center bearing.

Inspect Midship Bearing Diameter

21. Inspect midship for wear on bearing diameter. If midship is damaged from a seized bearing, replacement of entire coupling shaft is necessary. (See photo 99, bottom right.)

▲ See warning, below.

WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

22. If no damage is apparent, remove slinger and discard. Proceed to installation of center bearing companion flange/flange yoke (S.A.E., DIN and T-Type) style, pages 128 to 132.



Photo 97

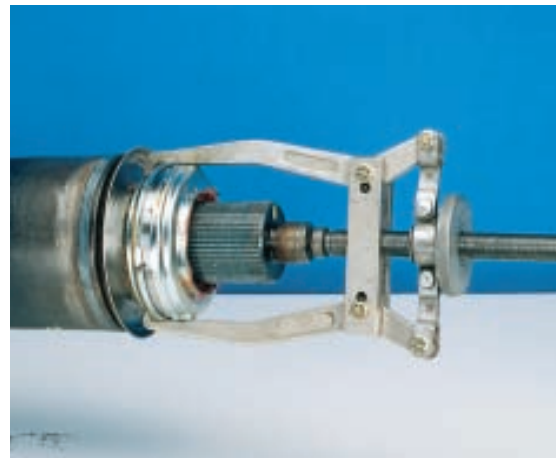


Photo 98

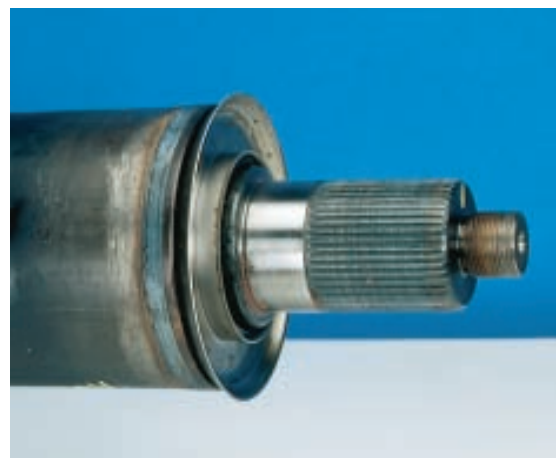


Photo 99

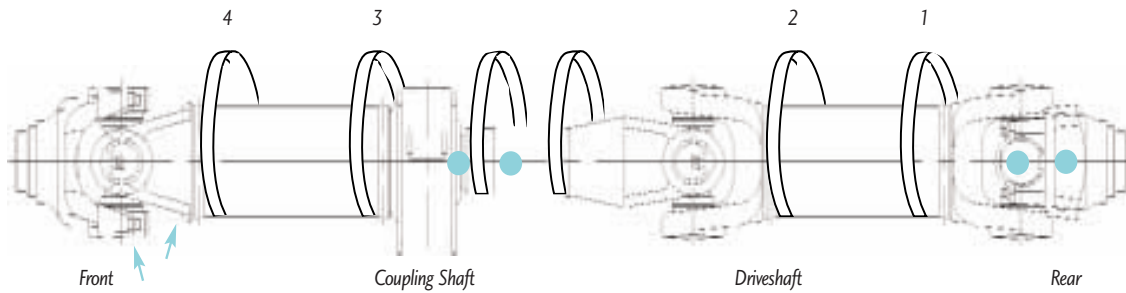


Figure Y, Quick Disconnect

OUTBOARD SLIP STYLE SPICER LIFE SERIES 55, 70, 90 & 100

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from **rear** end forward. The driveshaft will need to be disconnected **first** in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Mark Driveshaft (“Phasing Marks”)

1. It is imperative to mark all mating components of a driveshaft, as illustrated in Figure Y above. Mark driveshaft with a marking stick, paint marker or other legible marking device.

Quick Disconnect™ Style

Be sure to mark all bearing positions, spline positions, shaft locations, bearing retainers (if applicable) and stamped straps.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

Be sure to mark all flange positions, spline positions and shaft locations.

This assures proper reassembly of the driveshaft into the vehicle, in its original position. **▲** See warning, below.

▲ WARNING

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching

components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end forward, position support straps 1 through 4 (as needed) as illustrated in Figure Y, above. **▲** See warning, below.

▲ WARNING

ALWAYS use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support strap to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support strap. **▲** See warning, below.

▲ WARNING

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Quick Disconnect™ Style

Proceed to step 3.

Companion Flange/Flange Yoke Style

(S.A.E., DIN and T-Type) Style Proceed to step 10.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE	
				Nm	LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

* Bolts are specially heat-treated.
DO NOT substitute with inferior grade bolts.

Table GG

Disconnect Driveshaft Quick Disconnect™ Style

3. With support straps securely in place, remove bearing retainers or stamped straps and bolts at **rear** end. Reference bolt specifications, Table GG, above. If bearing retainers are not damaged, they can be reused. **DO NOT** reuse stamped straps or any bolts. ⚠ See warning, below.

WARNING

DO NOT reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers or use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow driveshaft to rest on support strap.

Remove Driveshaft

5. Slide driveshaft off of outboard midship tube shaft at slip yoke. Remove driveshaft from vehicle and take to work bench area. ⚠ See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 17.

If the effected center bearing has not been reached, proceed to step 6 to remove coupling shaft(s).

Disconnect Coupling Shaft

6. **Be sure the third support strap is in place as illustrated in Figure Y, page 107.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap.

Remove Coupling Shaft

7. **Be sure the fourth support strap is in place as illustrated in Figure Y, page 107.** Remove bearing retainers or stamped straps and bolts on end yoke. Reference bolt specifications, Table GG, top left. Discard bolts. Discard stamped straps (if applicable). ⚠ See warning, step 3.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE	
					Nm	FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75


*Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.

† Approved Spicer Hardware.

Note-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware.

Refer to the original equipment service manual for bolt part numbers.

Table HH


8. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take it to a work bench area.  See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

9. Repeat steps 6-8 as necessary to obtain access to the effected center bearing, once the effected centering bearing has been reached. **DO NOT** at this point remove coupling shaft from vehicle. It will be necessary to continue with pages 98-100, steps 13 to 25, for Quick Disconnect™ style.

Disconnect Driveshaft – Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style


10. With support straps securely in place, remove and discard companion flange bolts, washers and nuts from rear end. Reference companion flange bolt torque specifications, Table HH, above. **DO NOT** reuse companion flange bolts, washers and nuts.  See warning, below.

WARNING

DO NOT reuse companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

12. Slide driveshaft off outboard midship shaft at slip yoke. Remove driveshaft from vehicle and take to work bench area.  See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.


If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 17.

If the effected center bearing has not been reached, proceed to step 13 to remove coupling shaft(s).

Disconnect Coupling Shaft


13. **Be sure the third support strap is in place as illustrated in Figure Y, page 107.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap.

Remove Coupling Shaft

14. **Be sure the fourth support strap is in place as illustrated in Figure Y, page 107.** Remove companion flange bolts, washers and nuts on flange. Reference bolt specifications, Table HH, page 109. Discard bolts, washers and nuts.  See warning, below.

WARNING


***DO NOT** reuse companion flange bolts, washers or nuts, or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

15. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take to a work bench area.  See warning, step 12.

16. Repeat steps 13-15 as necessary to obtain access to the effected center bearing. Once the effected center bearing has been reached, **DO NOT** now remove coupling shaft from vehicle.

At this point it will be necessary to continue with pages 104-106, steps 11-22, for companion flanger/flanger yoke style.

Inspect Midship Tube Shaft

17. Visually inspect midship tube shaft, looking for wear on spline surface. If splines are damaged, missing or twisted, or Glidecote® is missing, replacement of entire coupling shaft is necessary.  See warning, below.

WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Remove Coupling Shaft With Effected Center Bearing – Quick Disconnect Style

Proceed to step 18.

Remove Coupling Shaft With Effected Center Bearing – Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

Proceed to step 20.

Quick Disconnect™ Style

18. Remove center bearing bracket bolts. Allow coupling shaft to rest on support strap.

Remove bearing retainers or stamped straps and bolts at end yoke. Discard bolts. If bearing retainers are not damaged, they **CAN** be reused. **DO NOT** reuse stamped straps or any bolts. ▲ See warning, below.

▲ **WARNING**

DO NOT reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

19. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the coupling shaft is free, remove from support straps and take it to a work bench area. ▲ See warning, below. Proceed to step 22.

▲ **WARNING**

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

20. Remove center bearing bracket bolts and allow shaft to rest on support strap.

Remove and discard flange bolts, washers and nuts at flange.

▲ See warning, below.

▲ **WARNING**

DO NOT reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

21. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, remove coupling shaft from support straps and take it to a work bench area.

▲ See warning, step 19. Proceed to step 22.



Photo 100

Remove Center Bearing

22. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove metal retainer and discard. Remove and discard center bearing bracket. (See photo 100, above.) Remove and discard rubber cushion. (See photo 101, top right.)

23. Using a puller, follow tool manufacturer's instructions to remove the bearing assembly from the midship tube shaft. (See photo 102, center right.) Discard center bearing.

Inspect Midship Tube Shaft Bearing Diameter

24. Inspect the midship tube shaft for wear on the bearing diameter. If the midship tube shaft is damaged, replacement of the entire coupling shaft is necessary. (See photo 103, bottom right.) ▲ See warning, below.

▲ WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

25. If no damage is apparent, remove slinger and discard. Proceed to installation of center bearing outboard slip style driveshafts, pages 128-132.



Photo 101

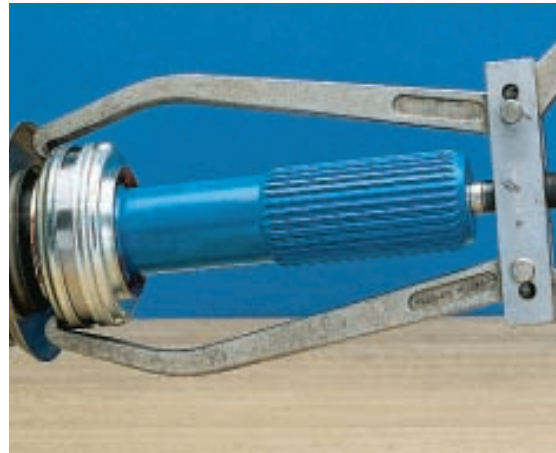


Photo 102



Photo 103

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SPICER LIFE SERIES™ INSPECTION

Before You Get Started

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. ▲ See warning, below.



WARNING

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.
2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.
3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.
4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. ▲ See warning, below.



WARNING

Failure to release all parking brakes and failure to place transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. ▲ See warning, step 4.

7. **CAUTION** – Spicer Life Series™ driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series™ driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

Note – Spicer Life Series™ 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

DRIVESHAFT ASSEMBLY INSPECTION PROCEDURES

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Spicer Life Series™ driveshafts should be carefully inspected at recommended original equipment vehicle manufacturers' service intervals and/or at Spicer recommended lubrication intervals as shown in Table A, below.

Note – The following procedures are to be performed **prior to** any lubrication of universal joints or slip members. The addition of lubricant can mask the looseness in a component that is beginning to show wear and may be in need of replacement.

END FITTINGS

1. Visually inspect all input and output end-fitting retaining nuts or bolts for any gaps between mating surfaces. If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for proper fastener specifications. ▲ See warning, below.

▲ WARNING

A loose end-fitting retaining nut or bolt can result in



Photo 1

driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

2. Check all input and output end fittings for looseness or broken back. Take hold of the end fitting with both hands. Try to move it vertically and horizontally to feel any looseness. (See photo 1, above.)

There should **NOT** be any movement in the end fittings

UNIVERSAL JOINT MAXIMUM LUBRICATION INTERVALS

SERIES	CITY	ON-HWY.	LINEHAUL	OFF-HWY.*	INDUSTRIAL*
SPL 250, 170 & 140	25,000 Mi.	100,000 Mi.	100,000 Mi.	25,000 Mi.	500 Hrs.
	40,000 Km.	160,000 Km.	160,000 Km.	40,000 Km.	
	or	or	or	or	
	3 Months	6 Months	6 Months	3 Months	
	(whichever comes first)	(whichever comes first)	(whichever comes first)	(whichever comes first)	
SPL 100, 90, 70 & 55	8,000 Mi.	15,000 Mi.	15,000 Mi.	8,000 Mi.	500 Hrs.
	12,800 Km.	24,000 Km.	24,000 Km.	12,800 Km.	
	or	or	or	or	
	3 Months	3 Months	3 Months	3 Months	
	(whichever comes first)	(whichever comes first)	(whichever comes first)	(whichever comes first)	

City is defined as all applications that require a minimum of 90% of operation time within city limits.

On-highway is defined as all applications requiring less than 10% of operating time on gravel, dirt or unpaved roads.

Off-highway is defined as all applications requiring more than 10% of operating time on gravel, dirt or unpaved roads.

Linehaul is defined as 100% of operation time on smooth concrete or asphalt.

* *Relubrication intervals for off-highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, relubrication on industrial applications should occur every 500 hours for normal service and every 250 hours for continuous service or severe environmental conditions.*

Table A

relative to the output or input shafts to which they are connected. ▲ See warning, below.

▲ WARNING

A loose end fitting can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, consult transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for proper end fitting specifications.

3. If the end fittings are tight, check for excessive radial looseness of the transmission output shaft and axle input and output shaft splines relative to the end fitting.

Take hold of the end fitting with both hands, rotate left to right, feeling for play or backlash. If radial looseness is evident, end fittings or input or output shafts may be in need of replacement. (See photo 2, below.) ▲ See warning, below.

▲ WARNING

A loose end fitting, due to transmission or axle input and/or output shaft spline wear or end fitting spline wear, can result in driveline failure. Driveline failure can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.



Photo 2

4. Visually inspect for damaged bearing retainers or stamped straps, loose bearing retainer bolts or strap bolts, loose companion flange bolts and nuts, loose or missing spring tabs or spring tab bolts, damaged tangs on end fittings, damaged or missing snap rings, and rotating bearing cups. ▲ See warning, below.

If any of these situations are evident, replacement of the components is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures.

▲ WARNING

Loose, missing or damaged bearing retainers or stamped straps, retaining nuts, bolts, spring tabs or spring tab bolts, end-fitting tangs, snap rings, or rotating bearing cups can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.



Photo 3

UNIVERSAL JOINTS

5. Check for excessive looseness across the ends of the universal joint bearing cup assemblies and trunnions. Take hold of the inboard yoke on the driveshaft with both hands. Try to move yoke vertically and horizontally. (See photo 3, above.)

There should be less than .006 in. (.15mm) movement in the universal joint kit relative to the inboard or outboard yokes. If looseness is greater than .006 in. (.15mm), the universal joint kit must be replaced. ▲ See warning, below.

▲ WARNING

Excessive looseness across ends of universal joint bearing cup assemblies can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

6. Visually inspect all universal joint kits in the driveshaft assembly.



Photo 4, Reliable Style

Reliable Style

7. Check for the presence of all grease zerk (nipple) fittings. (See photo 4, above). Grease zerk (nipple) fittings should not be missing, loose or fractured. ▲ See warning, below.

▲ WARNING

A missing, loose or fractured grease zerk (nipple) fitting eliminates the ability to relubricate the universal joint. Neglecting to properly relubricate or inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If grease zerk (nipple) fitting is loose, tighten to required specifications. (See Table B, below.)

If grease zerk (nipple) fitting is fractured, replace grease zerk (nipple) fitting and tighten to required specifications. (See Table B, below.)

UNIVERSAL JOINT GREASE ZERK (NIPPLE) FITTING SPECIFICATIONS

SERIES	GREASE ZERK P/N	MIN. ZERK TORQUE	
		Nm	FT. LB.
SPL90, SPL100, SPL140, SPL170 SPL250	232830	20.5	15.0

Table B



Photo 5, Permanently Lubricated Plug Style

If grease zerk ([nipple](#)) fitting is missing, the entire universal joint kit needs to be replaced. Refer to the removal and installation sections of this manual for proper replacement procedures.

Permanently Lubricated Plug Style

8. Permanently lubricated plug style universal joint kits do not contain grease zerk ([nipple](#)) fittings, only a plug. (See photo 5, above.) Make sure plug is not missing, loose or fractured.

If the plug is loose, tighten to required specifications. (See Table B, step 7.) ▲ See warning, below.

▲ WARNING

A missing, loose or fractured plug allows contaminants to invade the universal joint kit. Invasion of contaminants into the universal joint kit can degrade lubricant and can cause universal joint damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.



Photo 6, Permanently Lubricated Net-Form Style

If a plug is missing or fractured, the entire universal joint kit needs to be replaced. Refer to the removal and installation sections of this manual for proper replacement procedures.

▲ See warning, step 8.

Permanently Lubricated Net-Formed Style

9. Net-formed universal joints do not contain grease zerk ([nipple](#)) fittings or plugs and are not relubable. (See photo 6, above.)

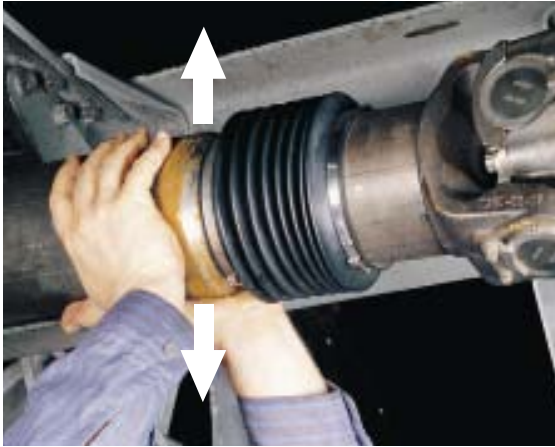


Photo 7

SLIP MEMBER ASSEMBLY

10. Check the slip member assembly for excessive radial looseness. Using a dial indicator, take hold of the tubing near the slip member with both hands and try to move vertically, up and down relative to the ground. There should be limited looseness in the slip member assembly. (See photo 7, above.) ▲ See warning, below.

If looseness is greater than .012 in. (.30mm) or greater as read on dial indicator, replacement of the slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures.

▲ **WARNING**

Excessive radial looseness can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.



Photo 8

Reliable Style

11. For an inboard and outboard slip yoke assembly design, check to be sure the slip yoke welch plug is not loose, missing or damaged. (See photo 8, above.) ▲ See warning, below.

If any of these situations are evident, replacement of the slip yoke and professional rebalancing of the driveshaft is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

▲ **WARNING**

A loose, missing or damaged welch plug allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.



Photo 9

12. Visually inspect for the presence of the grease zerk (nipple) fitting, if applicable, on the slip yoke. (See photo 9, above.) Grease zerk (nipple) fittings should not be missing, loose or fractured. ⚠ See warning, below.

⚠ WARNING

A missing, loose or fractured grease zerk (nipple) fitting eliminates the ability to relubricate the slip member assembly. Neglecting to properly relubricate or inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If grease zerk (nipple) fitting is loose, tighten to required specifications. (See Table C, below.)

SLIP MEMBER GREASE ZERK (NIPPLE) FITTING SPECIFICATIONS

SERIES	GREASE ZERK P/N	THREAD SIZE	ZERK TORQUE	
			Nm	IN. LB.
SPL90	500174-1	0.25"-28	3.5-6.2	31-55

Table C

If grease zerk (nipple) fitting is missing or fractured, the slip members may need to be replaced. Be sure to follow step 10 for inspection of radial looseness in slip member assembly.



Photo 10

If slip member assembly is within acceptable limits as stated in step 10, (page 14) install new grease zerk (nipple) fitting and tighten to required specifications. (See Table C, below). Be sure to completely relubricate slip member assembly with recommended lubricant. See lubrication section of this manual for proper procedures.

Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

13. Check the slip yoke seal. (See photo 10, above.) Make sure the seal is properly attached to the slip yoke and is not loose or damaged. ⚠ See warning, below.

If any of these situations are evident, replacement of slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

⚠ WARNING

A loose or damaged slip yoke seal allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Permanently Lubricated Style

14. Check yoke shaft boot (see photo 11, below) or [seal can](#). Make sure the boot or [seal can](#) is properly attached to the yoke shaft and tube sleeve and no damage or looseness is apparent. Visually inspect boot for tears. Inspect boot or [seal can](#) for punctures. Inspect boot clamps for damage.

▲ See warning, below.



Photo 11

If any of these situations are evident, replacement of slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for permanently lubricated slip members.

▲ WARNING

A loose or damaged slip member boot or [seal can](#) allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and can cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

TUBING

15. Check the driveshaft for bent or dented tubing. If either of these situations is evident, replacement of the complete driveshaft assembly or tube is necessary. ▲ See warning, below.

▲ WARNING

Bent or dented tubing can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

16. Make certain there is no buildup of foreign material on the driveshaft. ▲ See warning, below.

▲ WARNING

Buildup of foreign material on a driveshaft can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If found, buildup should be removed carefully to avoid damaging the driveshaft. (See Table D, below.)

REMOVAL OF FOREIGN MATERIAL

FOREIGN MATERIAL TYPE	REMOVAL METHOD
Asphalt, Tar or Undercoating	Mineral spirits or any appropriate solvent
Mud	Rinse off with water

Table D



Photo 12

CENTER BEARINGS

17. Visually inspect all center bearings, end-fitting midship nuts for any gaps between the mating surfaces. (See photo 12, above.) **▲** See warning, below.

Be sure to repeat steps 2 and 3, for all center bearing end fittings for broken back and backlash.

▲ WARNING

A loose center bearing end-fitting midship nut can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present and steps 2 and 3 have been followed, see Table E, top right, for proper torque specifications and refer to the removal section of this manual for proper driveshaft removal procedures.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE	
				Nm	LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525
SPL170	250-74-11	230123-6	41mm*	644-712	475-525
SPL250	250-74-11	230123-6	41mm*	644-712	475-525

* A 1 5/8" socket may be used.

Table E

18. Inspect the center bearing bracket bolts for looseness. (See photo 13, below.) **▲** See warning, below.



Photo 13

If looseness is evident, retighten center bearing bracket bolts. Consult the vehicle manufacturers' specifications for proper bolt torque. Check the alignment of the bracket before tightening the bolts. Bracket should not be skewed.

▲ WARNING

Loose center bearing bracket bolt(s) can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

19. Visually inspect the center bearing rubber cushion for damage. Make sure the slingers are not rubbing against the rubber cushion. Verify that the rubber cushion is properly seated in the metal bracket. ▲ See warning, below.

If any of these situations are evident, replacement of the center bearing assembly is necessary. Refer to the removal and installation sections in this manual for proper center bearing replacement instructions.

 **WARNING**

Damaged center bearings or center bearing components can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

SPICER LIFE SERIES™ FEATURES & BENEFITS

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

This manual encompasses inspection, lubrication, removal and installation procedures for Spicer Life Series™ 55, 70, 90, 100, 140, 170 and 250 driveshaft assemblies.

IMPORTANT FEATURES OF A SPICER LIFE SERIES™ DRIVESHAFT

Spicer offers a complete range of driveshaft solutions to meet the full spectrum of needs in medium and heavy duty applications. The Spicer Life Series™ driveshafts have been designed and developed to stand up to the wear and tear of heavy hauling tasks. They are the first driveshafts in the industry to be compatible with advancing powertrain specifications for higher engine torque and lower axle ratios. No one does more than Spicer in meeting the needs of the marketplace.

Spicer Life Series™ driveshafts offer:

- Longer life
- Lower lifetime maintenance
- Increased strength for higher engine torque and lower axle ratios
- Smaller driveshaft rotating diameter

A driveshaft that transmits high torque loads must be durable and strong. Spicer uses forged steel and high strength cast yokes to provide the necessary rigidity to maintain bearing alignment under torque loads. Spicer Life Series Quick Disconnect™ end yokes reduce the time to remove or install the driveshaft, equating up to a 75% labor savings for service. [Applications requiring flange connections, S.A.E., DIN and cross-serrated T-Flanges are available.](#) A new cold-formed, bearing retainer provides structural rigidity and reduces bearing movement which may result from overloading. New patented spring tabs, found

on heavy duty Spicer Life Series™ assemblies and bearing retainers, increase bearing retention, reduce wear and optimize bearing capacity.

Spicer Life Series™ award winning* universal joint kits are specifically designed to give extended driveshaft life. Flat-ended needle bearings are used to withstand oscillating loads while the driveshaft is rotating and to eliminate skewing in the bearing cup. Thrust washers significantly reduce end galling on trunnion ends and lower universal joint operating temperature. Synthetic rubber seals and plastic seal guards provide lubricant retention and help prevent the entry of foreign material, significantly increasing universal joint life. The centrally located grease zerk ([nipple](#)) fitting increases the strength of the journal cross and allows more torque carrying capacity.

High-strength steel tubing is used to provide maximum torque carrying capacity at minimum practical weight. Increased tube diameter allows a higher critical speed and longer one-piece driveshafts. This increased stiffness also improves noise, vibration and harshness. New slip member booting or [alternative seal can](#) offers better protection against environmental contaminants, increases component life, and is lubricated for the life of the product.

The new integral tube sleeve and yoke shaft design, found on heavy duty Spicer Life Series™ designs, along with larger diameter involute splines, creates greater strength and torsional stiffness with less weight. This new design leads to improved balance and less slip effort, resulting in reduced noise and vibration for the entire driveshaft system. Spicer Glidecote®, found in all slip member assemblies, reduces friction, thereby lowering thrust loads under high torque. This nylon coating also prevents spline wear and extends life.



**Spicer Driveshaft Division won the Automotive News PACE award for this bearing's innovative design, product and process technology.*

GLOSSARY

Balancing – A procedure by which the mass distribution of a rotating body is checked and, if necessary, altered in order to ensure that the vibration at a frequency corresponding to an operating speed at the supporting bearings is within specified limits.

Ball Yoke – See Tube Yoke.

Bearing Cross Hole – See Cross Hole.

Bearing Cup Assembly – Consists of a bearing cup with needle rollers generally held in place by a seal guard and bearing seal. Sometimes the assembly includes a thrust washer.

Bearing Cup – A cup-shaped member used as the bearing bore of a bearing cup assembly and for positioning a thrust end of a cross trunnion.

Bearing Retainer – A heavy, formed metal cap, used solely in Spicer Life Series[®] to retain a bearing cup assembly in Quick Disconnect[™] end yoke or flange yoke designs.

Bearing Seal – A flexible member of a bearing cup assembly which prevents the escape of lubricant from or entry of foreign matter into a bearing.

Bearing Strap – A narrow, stamped metal plate used to retain a bearing cup assembly in a half-round end yoke or flange yoke design.

Boot – A flexible member which prevents the escape of lubricant from or entry of foreign matter into the slip spline members.

Boot Clamp – A thin adjustable band used to hold the boot in position on the slip spline members.

Boot Seal – See Boot.

Center Bearing – Consists of a rolling element bearing isolated in rubber and a bracket configuration for attachment to the vehicle frame.

Companion Flange – A fixed flange member that attaches a driveshaft to another drivetrain component.

Coupling Shaft – The coupling member or members of a multiple-piece driveline which consists of a universal joint, tube, center bearing, and a slip or fixed spline shaft.

Coupling Shaft Length (Center Line to Center Line or CL to CL) – The distance between the outermost universal joint centers on a driveshaft. Coupling shafts with fixed centers, it is the nominal dimension.

Cross – See Journal Cross.

Cross Hole – A through hole in each lug ear of a yoke used to locate a bearing cup assembly.

Deflector – See Slinger.

Driveline – An assembly of one or more coupling shafts and a driveshaft with provisions for axial movement, which transmits torque and/or rotary motion at a fixed or varying angular relationship from one drivetrain component to another.

Driveshaft – An assembly of one or two universal joints connected to a tubular shaft member which accommodates axial movement.

Driveshaft Length (Center Line to Center Line or ζ to ζ) – The distance between the outermost universal joint centers on a driveshaft. On driveshafts with variable length centers, it is usually measured in the compressed or installed lengths.

Ear – One of two projecting parts of a yoke symmetrically located with respect to the yoke's rotational axis.

End Fitting – An end yoke or companion flange (including S.A.E., DIN and T-Type styles) that attaches a driveshaft to another drivetrain component.

End Yoke – A Quick Disconnect™ yoke that attaches a driveshaft to another drivetrain component.

Flange Yoke – A full-round or Quick Disconnect™ style yoke which attaches a driveshaft to a companion flange.

Flinger – See Slinger.

Glidecote® – The blue, nylon, wear-resistant coating on Spicer yoke shafts and tube shafts.

Grease Zerk (Nipple) Fitting – The fitting on the shoulder or center of a journal cross or on a relubable slip spline that allows for lubrication.

Quick Disconnect™ Cross Hole – A semicircular hole located on the end of each lug ear of some end yoke and flange yoke designs used to locate a bearing cup assembly.

Inboard Yokes – Yokes that make up the ends of a driveshaft or coupling shaft assembly, i.e. tube yokes, slip yokes, yoke shafts, and center bearing end yokes.

Installation Height Tools – Round, indexing tools that are supplied with all Spicer Life Series® replacement universal joint kits to ensure proper bearing cup assembly installation specifications.

Journal Cross – The core component of a universal joint which is an intermediate drive member with four equally spaced trunnions in the same plane.

Lug Ear – See Ear.

Midship Shaft – A machined element consisting of spline teeth, a pilot for a center bearing and a piloting hub that attaches to the tube of a coupling shaft assembly.

Needle Rollers – One of the rolling elements of a bearing cup assembly.

Outboard Yokes – Yokes that are not a part of a driveshaft or coupling shaft assembly, i.e. transmission, axle, transfer case end yokes and/or companion flanges.

Phase Angle – The relative rotational position of each yoke on a driveshaft or driveline.

Pillow Block – Consists usually of a rolling element bearing and a bracket configuration for attachment.

Pressure Relief Hole – A hole in the welch plug of Spicer slip yokes that allows air to escape from the slip member assembly.

Purge – The act of flushing old grease and contaminants from universal joint kits and slip member assemblies with fresh grease.

Retaining Ring – See Snap Ring.

Retaining Ring Groove – See Snap Ring Groove.

Round Bearing Assembly – See Bearing Cup Assembly.

Seal Can – A metal “can” that permanently seals the slip member on a driveshaft. Usually found on European-style driveshaft assemblies.

Seal Guard – A covering member used to protect a bearing seal on the bearing cup assembly.

Serrated Flange – See [T-Flange](#).

Shaft Support Bearing – See Center Bearing.

Slinger – A stamped metal or non-metal ring which prevents the entry of foreign matter into a center bearing, transmission, axle or transfer case.

Slip – The total permissible length of axial travel.

Slip Yoke – A yoke which accommodates axial movement.

Slip Yoke Plug – See Welch Plug.

Slip Yoke Seal – Pop-on or threaded ring that contains a seal that protects the slip member assembly from environmental contaminants and retains lubricant.

Snap Ring – A removable member used as a shoulder to retain and position a bearing cup assembly in a yoke cross hole.

Snap Ring Groove – A groove used to locate a snap ring.

Spline – A machined element consisting of integral keys (spline teeth) or keyways (spaces) equally spaced around a circle or portion thereof.

Spline Sleeve – A patented tubular-type, machined element consisting of internal splines which is attached to a tube or tube yoke in a driveshaft assembly. Found only in Spicer Life Series® driveshaft assemblies.

Spring Tab – A patented stamped metal plate that takes the place of a bearing plate and acts as a structural member by reducing looseness in a universal joint kit. Found only on Spicer Life Series® driveshaft assemblies.

Stub Shaft – See Tube Shaft.

Tang – A nib of metal found on Quick Disconnect™ end yoke and/or flange yoke style cross holes, used to locate a bearing cup assembly.

T-Flange – A companion flange and flange yoke design which has a serrated flange face. Found most often in European applications.

T-Type Flange – See T-Flange.

Thrust Washer – A washer found in the bottom of a bearing cup assembly that reduces needle roller friction, bearing heat and guards against end galling on the journal cross trunnions.

Tube – The tubular connecting member of a driveshaft. Pipe or piping is not an equivalent.

Tubing – See Tube.

Tube O. D. (outside diameter) – The outside diameter of a tube.



Tube Yoke – A inboard yoke with a piloting hub for attachment to a tube or spline sleeve.

Tube Shaft – A machined element consisting of spline teeth and a piloting hub that attaches to the tube of a driveshaft assembly.

Trunnion(s) – Any of the four projecting journals of a cross.

Universal Joint – A mechanical device which can transmit torque and/or rotary motion from one shaft to another at fixed or varying angles of intersection of the shaft axes. Consisting usually of a journal cross, grease zerk (nipple) fitting and four bearing cup assemblies.

Universal Joint Kit – See Universal Joint.

U-Joint – See Universal Joint.

Welch Plug – A plug in the slip yoke face that seals off one end of the spline opening. Also known as a slip yoke plug.

Weld Yoke – See Tube Yoke.

Yoke Lug Ear Cross Hole – See Cross Hole.

Yoke Shaft – A slip member yoke with a male machined spline used for axial movement.

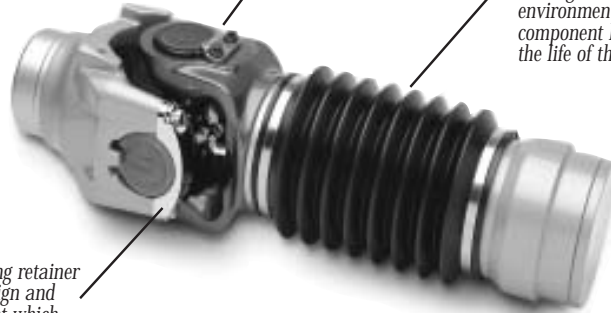
Spicer Life Series™ Driveshaft – Quick Reference

SPICER®



New patented spring tabs increase bearing retention, reduce wear and optimize bearing capacity.

Permanently lubricated spline with booting offers protection against environmental contaminants, increases component life and is lubricated for the life of the product.



A new cold-formed bearing retainer replaces the old strap design and reduces bearing movement which may result from overloading.

Maximum Lubrication* Cycles

Type of Service	Distance	Time
City	25,000 Mi./40,000 Km	or 6 months whichever comes first
On Highway	100,000 Mi./160,000 Km	or 6 months whichever comes first
On/Off Highway	25,000 Mi./40,000 Km	or 6 months whichever comes first
Highway/Industrial	500 hours for normal service and severe environmental conditions	250 hours for continuous service or whichever comes first

*Spicer recommends use of a high quality N.L.G.I., E.P. GRADE 2 lubricating grease

Bearing Retainer* Bolt Torque Specifications

Series	Socket Size	Bolt Torque	Assembly P/N
SPL140	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	140-70-18X
SPL170	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	170-70-18X
SPL250	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	250-70-18X

*Spicer Life Series™ bearing retainers **MAY BE RE-USED** if not damaged. Spicer Life Series bearing retainer bolts **MAY NOT BE** re-used. Order bolt P/N 12-73-125M for all series.

Spring Tab Bolt* Torque Specifications

Series	Socket Size	Bolt Torque	Assembly P/N
SPL140	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X
SPL170	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X
SPL250	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X

*Spicer Life Series™ spring tabs and bolts **MAY NOT BE** re-used. Order assembly part number.

Midship Nut Torque Specifications

Series	Nut P/N*	Nut Torque	Washer P/N
SPL140	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6
SPL170	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6
SPL250	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6

*Wrench size 41mm

Boot Clamp Torque Specifications

Series	Clamp P/N	Clamp Torque	Assembly P/N
SPL140	232757	136-180 Nm/100-130 Lb. Ft.	212046X
SPL170	232493	136-180 Nm/100-130 Lb. Ft.	211959X
SPL170*	232702	136-180 Nm/100-130 Lb. Ft.	211987X
SPL250	232493	136-180 Nm/100-130 Lb. Ft.	211959X

*Used in high angle interaxle positions only.

SPICER®



Spicer Life Series™ Part Number Interchange

Description	Spicer Life Series Part Number	PACCAR	Navistar	Volvo	Freightliner	Mack
Spicer Life 170 U-Joint Kit	SPL170X		2500678C91	3947697	SP SPL170X	2104 SPL170X
Spicer Life 170 Bearing Retainer Kit	170-70-18X		2500674C91	3947699		2104 1707018X
Spicer Life Series Bearing Retainer Bolt	12-73-125M	12-73-125M	3513117C1	8082078	SP 12 73 125M	41AM7
Spicer Life Series Spring Tab Kit	211941X					
Spicer Life Series Boot Kit	211959X		2500671C91	3947801		
Spicer Life Series Boot Clip	232493			3947802		
Spicer Life Series Boot Kit	211987X		2500684C91	3947803		
Spicer Life Series Boot Clip	232702			3947804		
Spicer Life Series 170 Coupling Shaft End Yoke	170-4-11-1		2500658C1			2104 1704111
Eaton Tandem Axle	170-4-241-1X	170-4-241-X		8081933		176MU41P12 170MU51P36
Eaton Tandem Axle	170-4-161-1X					
Eaton Tandem Axle	170-4-201-1X	170-4-201-1X	3513133C91	8081927		176MU41P11 170MU51P25
Eaton Tandem Axle	170-4-221-1X	170-4-221-1X	3513134C91		SP 170-4-221-1X	
Eaton Tandem Axle	170-4-261-1X	170-4-261-1X				
Eaton Tandem Axle	170-4-281-1X	170-4-281-1X	3513135C91	8081932		176MU41P13 170MU51P37
Fuller Transmission	170-4-481-1X	170-4-481-1X	3513675C91	8081923		176MU41P20 176MU51P5
Fuller Transmission	170-4-521-1X	170-4-521-1X	3514642C91	8081924		176MU41P21 170MU51P6
Fuller Transmission	170-4-461-1X					170MU51P8
Rockwell Single Axle	170-4-671-1X	170-4-671-1X	3513842C91	8081937		176MU41P18 170MU51P31
Rockwell Single Axle	170-4-721-1X	170-4-721-1X	3514643C91	8081926		176MU41P22 170MU51P18
Spicer Single Axle	170-4-901-1X	170-4-901-1X	3517065C91			

Spicer Life Series™ Part Number Interchange

Description	Spicer Life Series Part Number	PACCAR	Navistar	Volvo	Freightliner	Mack
Spicer Life 250 U-Joint Kit	SPL250X		2500680C91	3947698	SP SPL250X	2104 SPL250X
Spicer Life 250 Bearing Retainer Kit	250-70-18X		2500675C91	3947800	SP 250 70 18X	2104 2507018X
Spicer Life Series Bearing Retainer Bolt	12-73-125M	12-73-125M	3513117C91	8082078	SP 12 73 125M	41AM7
Spicer Life Series Spring Tab Kit	211941X					
Spicer Life Series Boot Kit	211959X		2500671C91	3947801		
Spicer Life Series Boot Clip	232493			3947802		
Spicer Life Series 250 Coupling Shaft End Yoke	250-4-21-1			3947962		2104 2504211
Fuller Transmission	250-4-241-1X	250-4-241-1X	3513838C91	8081941		1NPN61008 181MU41P9 125MU53P6
Rockwell Tandem Axle	250-4-351-1X	250-4-351-1X	351839C91	3969891 8081943	SP 250 4 351 1X	181MU41P7 125MU53P16
Fuller Transmission	250-4-561-1	250-4-561-1	3519832C1			
Eaton Tandem Axle	250-4-61-1X					
Mack Transmission	250-4-621-1X					181MU41P4 125MU53P3
Eaton Tandem Axles	250-4-81-1X	250-4-81-1X	3517493C91	8081944		181MU41P5 125MU53P22

Spicer Life Series™ Part Numbering System for Driveshaft Assemblies

SPICER®



Assemblies:	AAABBCDEEE-FFFF
	AAA = Series
	BB = Description (see below)
	C = End Fitting on Slip End (Bearing End for Coupling Shaft)
	D = End Fitting on Tight End
	EEE = Spicer Sequential Number
	FFFF = Tube Length (In millimeters)

Example:	250DS25001-1234M*
	Series = 250 (SPL250)
	Description = DS (Driveshaft)
	End Fitting (Slip) = 2 (Flange Yoke)
	End Fitting (Tight) = 5 (Journal Cross)
	Sequence No. = 001 of 999
	Tube Length = 1234 Millimeters
	*M denotes millimeters

Description:	Driveshaft = DS
	Coupling Shaft = CS
	Short Couple = SC
	Jack Shaft = JS
	Steering Shaft = ST
	Double Cardan Shaft = DC
	System Balance = SB
	Individual Joint = IJ
	Double Joint = DJ
	Dyno Shaft = DY
	Other = NA

End Fittings:	No Fittings/Other = 0
	Companion Flange = 1
	Flange Yoke = 2
	Slip Yoke = 3
	End Yoke = 4
	Journal = 5

Spicer Life Series™ Part Numbering System for Components

Components:	AAA-BB-CCCC-DE*
	AAA = Series
	BB = Part Description (see below)
	CCCC = Spicer Sequential Number
	D = Denotes Half Round
	E = Denotes Assembly

*D and/or E may or may not be present in the component part number.

Description:	Companion Flange = 1
	Flange Yoke = 2
	Slip Yoke = 3
	End Yoke = 4
	Tube Yoke = 28
	Yoke Shaft = 82

Example:	250-4-241-1X*
	Series = 250 (SPL250)
	Description = 4 (End Yoke)
	Sequence Number = 241 (11-9999)
	Half Round = 1
	Assembly = X

*The part number used in this example is a Spicer Life Series™ 250 half round end yoke assembly.

Coolant Heaters

Thermo 230.036

Thermo 300.066

Diesel - 24 Volts

Installation Instructions
Operating Instructions

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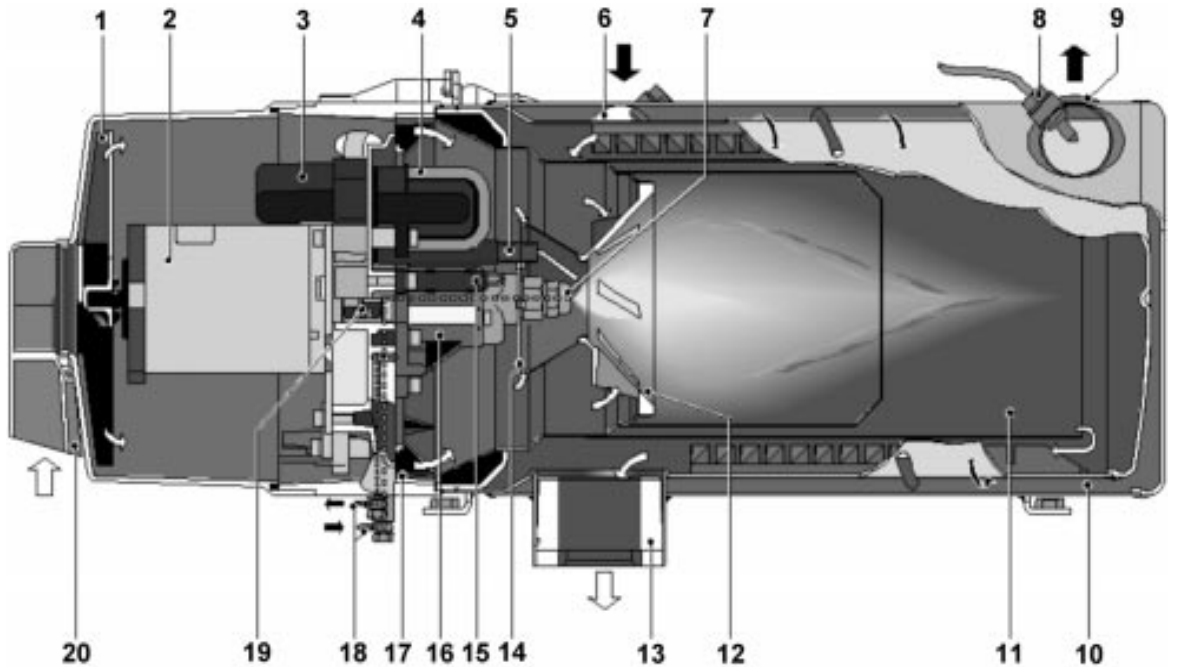
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PART # 907 507
Rev. 11.15.98
Subject to modification

1. Introduction

1.1 General Description



- | | | | |
|----------------------------|---------------------------|-------------------------------------|--------------------------|
| 1 Combustion air fan | 7 Fuel nozzle | 13 Exhaust pipe | 18 Fuel supply / return |
| 2 Motor | 8 Temperature sensor | 14 Photo disc | 19 Coupler |
| 3 Electronic control unit | 9 Overheat thermostat | 15 Flame detector | 20 Combustion air intake |
| 4 Electronic ignition coil | 10 Heat exchanger | 16 Fuel pump w/ solenoid valve | |
| 5 Ignition electrodes | 11 Combustion chamber | 17 Combustion air adjusting shutter | |
| 6 Water pipes | 12 Combustion air swirler | | |

Fig. 101: Webasto Thermo 230/300 Heater

The Webasto Thermo 230 and 300 Heaters for use on diesel powered transit buses and coaches are designed to:

1. **Preheat Engine block** of liquid cooled engines to ensure reliable starting in cold weather and to reduce cold start wear and emissions (white smoke).
2. **Boost heating levels** with the engine running. The heater will boost the heating system in cold weather when an engine is running at light loads, even at high speeds or idling. The heat rejection of modern diesel engines to the coolant, especially in buses, is often not adequate to heat the vehicle's interior.
3. **Increase Driver Visibility** in poor weather conditions by providing higher levels of heat for quick defrosting/defogging of windshield and side glass.

1.2 Legal provisions

Heater installation must be performed in accordance with the manufacturer`s installation instructions.

Any deviations from these instructions are only permitted with written approval from Webasto Thermosystems.

Installations not complying with the installation instructions will release Webasto Thermosystems from any product liability.

OEM installations must be approved by Webasto Thermosystems.

1.3 Meaning of Warning, Caution and Note

WARNING

This heading is used to highlight that non-compliance with instructions or procedures may cause accidents leading to severe injury or death.

CAUTION

This heading is used to highlight that non-compliance with instructions or procedures may cause damage to equipment.

NOTE

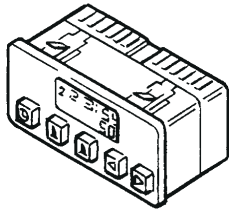
This heading is used to highlight and draw specific attention to information.

2. Operating your Webasto Heater

Before switching the Webasto water heater on, set vehicle heating system to the “heat” position and open any shut off valves. Depending on the type of control installed in the of the vehicle, the heater can be operated by the following methods.

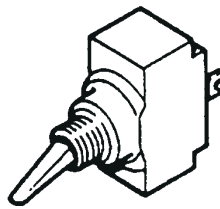
2.1 Switching On

Using a timer:



Timer

Using a switch:



Switch

Upon actuation of the “instant heat” button the “operation indicator” on the timer lights up.

Or

When the switch is used for switching “ON” the Webasto heater, the operation indicator integrated in the switch is illuminated.

The heater motor and coolant circulating pump begin to run. After approximately 10-25 seconds the solenoid valve opens and fuel is sprayed into the combustion chamber. At the same time, the electronic ignition coil produces high voltage (8000 V) and the mixture of fuel and air in the combustion chamber is ignited by a spark produced at the tip of the ignition electrodes. The flame is detected by the photo cell, then the electronic ignition coil stops producing high voltage and combustion continues by itself (spark on electrodes is only required to ignite the flame). At this point the heater is working and produces heat.

The Webasto heater will cycle on and off until:

1. The Webasto heater is switched off.
2. Time has elapsed on the timer.
3. The vehicle battery voltage drops below 20.0V.
4. The Webasto heater runs out of fuel.
5. A fault lock out occurs, indicated by the operating indicator light being off during the cool down cycle (i.e. overheat).

WARNING

Due to the danger of poisoning and asphyxiation the heater must not be operated in enclosed spaces such as garages or workshops without adequate exhaust extraction.

WARNING

The heater must be switched “OFF” while refueling and at fueling stations.

WARNING

Do not operate any Webasto heater in an area where toxic or explosive materials or fumes may be present.

2.2 Switching Off

When heating is no longer required, switch the Webasto heater off. The solenoid valve interrupts the fuel supply, combustion stops and the indicator light turns off. The Combustion air fan and the water pump remain on for another 2-3 minutes (after run cycle) purging the combustion chamber of any fumes.

NOTE

Restarting the Webasto during the after-run period is allowed.

2.3 Engine Pre-heating

1. Set the timer 30 min. to 1 hr. before you want to start engine. The heater will start up at set time. (See timer operating instructions beginning on page 203).
Or switch the toggle switch or “instant on” switch on your timer in the vehicle dash to “ON”. The heater will start up.
2. When time is elapsed on your timer or engine preheat is no longer required, switch the Webasto heater “OFF”. The heater will go through the after-run cycle.

2.4 Boost Heating for Engine and Passenger Compartment

1. Switch the toggle switch (or the “instant on” button of the timer) in the vehicle dash to “ON”. The heater will heat the coolant to a temperature of 185°F (85°C). Above this temperature only the water pump will run.
2. When boost heating is no longer required, switch the Webasto heater “OFF”. The heater will begin a brief after-run (cool-down) cycle.

2.5 Operation with 7-Day Digital Timer Model 1531

The “Digital Timer with 3 time settings” permits the Webasto heater to be switched on and off instantly, or automatically at 3 programmable starting times.

The operating time of the heater can be pre-selected.

It is possible to program 3 different heating programs according to your individual needs.

Only one preset starting time can be activated at any one time.

When the vehicle’s ignition is switched on, the current time of the day and the day of the week are displayed.

Programmed Heater Operation

Three memory locations numbered 1 to 3 are available. Each memory location can be assigned a given time together with the day of the week.

Pre-selected Starting Times

The pre-selected starting time is the time at which the heater switches itself on automatically.

We recommend that memory locations 1 and 2 be used for presetting starting times within 24 hours of setting the timer.

Memory location 3 can be used for a starting time within the next 7 days of setting the timer.

Operating Time

The period of time during which the heater is in operation is referred to as operating time. The heater remains in operation for as long as the operating time has been preset.

Heater operation can be pre-selected for any time from as little as 1 minute to a maximum of 120 minutes (factory preset is 60 minutes).

Remaining Operating Time

The remaining operating time refers to the period of time the heater still continues to remain in operation. It can only be changed while heater is in operation.

NOTE

If the ignition is switched off while the heater is in operation, the remaining operating time of 5 minutes flashes on the display and the heater continues to operate for this period of time.

Setting the Digital Timer

After the power has been connected, all symbols on the digital display are flashing. The time of the day and the day of the week must be set. All flashing displays and symbols of the timer can be set by means of the ◀ and ▶ buttons.

If the buttons are not pressed within 5 seconds, the currently displayed time or function will be stored.

When the ◀ and ▶ buttons are pressed for more than 2 seconds, the quick digit advance mode is activated.

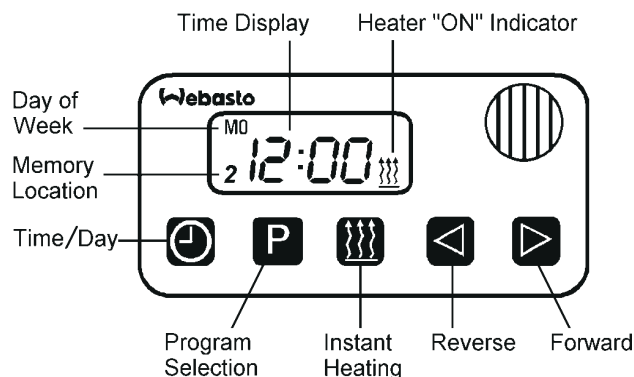

























Fig. 201: 7-Day Digital Timer – Model 1531

2.6 7-Day Digital Timer Programming and Operating Instructions

Setting the time and day of the week	Press the  button for more than 2 seconds. Time display flashes. Press the  or  button to set time of day. Wait 5 seconds. Time is now stored. Day of week flashes. Press  or  button to set day of week. Wait 5 seconds. Day of week is now stored.
Viewing the time	With ignition "ON": Continuous display of current time and day of the week. With ignition "OFF": Briefly press  button. Display of current time and weekday appears for 5 seconds.
Switching heater on for instant heater operation	With ignition "ON": Press  button. Heater is switched on (continuous heating) and continues to operate until  button is pressed again or ignition is switched off. With ignition "OFF": Press  button. Heater is switched on for the preset operating time (the factory-set heater operating duration is 60 minutes).
Switching the heater off	Press  button. Heater starts its after-run cycle and is switched off thereafter.
Programming heater starting time	Press  button. Memory location number flashes. Press  or  button to preset starting time. Wait 5 seconds. Preset starting time is now stored. Day of week flashes. Press  or  button to set day of week. Wait 5 seconds. Day of week is now stored. The number of memory location remains on the display. The timer is now in the programmed mode and switches heater on at the preset time.
Recalling pre-selected times	Press  button until the desired memory location number is displayed. Read off preset time.
Canceling pre-selected times	Press  button repeatedly until no more memory location number is visible on the display.
Programming duration of operating time	The heater must be switched off. Press the  button. Operating time flashes. Press  or  button to set operating duration time (between 1 and 120 minutes).
Setting the remaining operating time	Heater must be in operation. Press  button. Remaining operating time flashes. Press  or  button to set remaining operating time. Wait 5 seconds. Remaining operating time is now stored.

NOTE

If the ignition is switched off while the heater is in operation, the remaining operating time of 5 minutes flashes on the display and the heater continues to operate for this period of time.

NOTE


We recommend that memory locations 1 and 2 be used for presetting starting times within 24 hours of setting the timer. Memory location 3 can be used for a starting time within the next 7 days of setting the timer. By repeatedly pressing  button, starting time 1, 2 or 3 can be preset.

Table 201: Digital Timer Instructions

3. Technical Data

3.1 Thermo 230/300 Heater Data

Heater		Thermo 230	Thermo 300
Design		Coolant Heater with High Pressure Fuel Nozzle	
Heat Output	BTU/hr (kW)	80,000 (23)	104,000 (30)
Fuel		Diesel #1, Diesel #2, Arctic and Kerosene	
Fuel Consumption max.	Kg/hr (US. gal/hr)	2.5 (0.8)	3.3 (1.2)
Rated Voltage	(V)	24	
Operating Voltage	(V)	20 ... 28	
Power Consumption without Water Pump	(W)	65	110
Permissible Ambient Temperature during Operation	°C (°F)	-40 ... +60 (-40 ... +140)	
Storage Temperature	°C (°F)	+85 max. (+185 max.)	
Minimum Capacity of Cooling System	l (US. gal)	10.0 (2.64)	
Permissible Operating Pressure of Coolant	bar (psi)	0.4 ... 2.0 (06 ... 29)	
CO ₂ in Exhaust Gas	% by Volume	10.5 ±0.5	
Dimensions of Heater	L	610 mm (24.01 in.)	
	W	246 mm (9.69 in.)	
	H	220 mm (8.66 in.)	
Weight of Heater including Control Unit	kg (lb)	19 (41.88)	

Table 301: Thermo 230/300 Heater Data

3.1.1 Thermo 230/300 Heater Dimensions

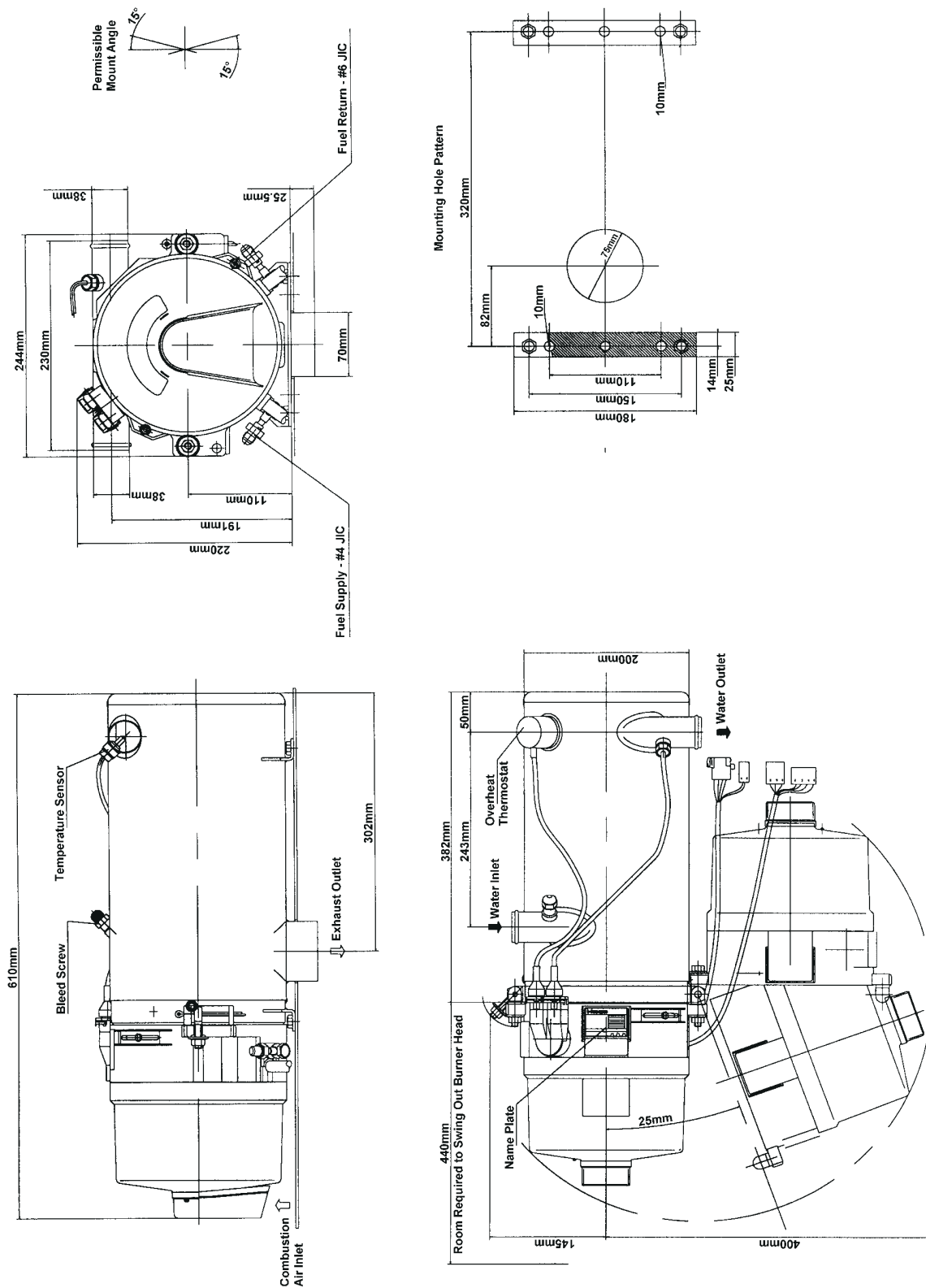


Fig. 301: Thermo 230/300 Heater Dimensions

3.2 Coolant Circulation Pump Data

Circulating Pump		U 4814	U 4851
Flow Rate l/hr	l/h (gal/min)	5200 (22.9) against 0.2 mbar	6000 (26.4) against 0.4 mbar
Rated Voltage	(V)	24	24
Operating Voltage Range	(V)	20 ... 28	18 ... 32
Power Consumption	(W)	104	209
Dimensions	L	221 mm (8.7 in.)	285 mm (11.22 in.)
	W	100 mm (3.94 in.)	115 mm (4.52 in.)
	H	105 mm (4.14 in.)	110 mm (4.33 in.)
Hose connection	mm (inch) O.D.	38.0 (1.5)	38.0 (1.5)
Weight	kg (lb)	2.1 (4.63)	2.7 (5.95)

Table 302: Coolant Circulation Pump Data

3.2.1 Coolant Circulation Pump Dimensions

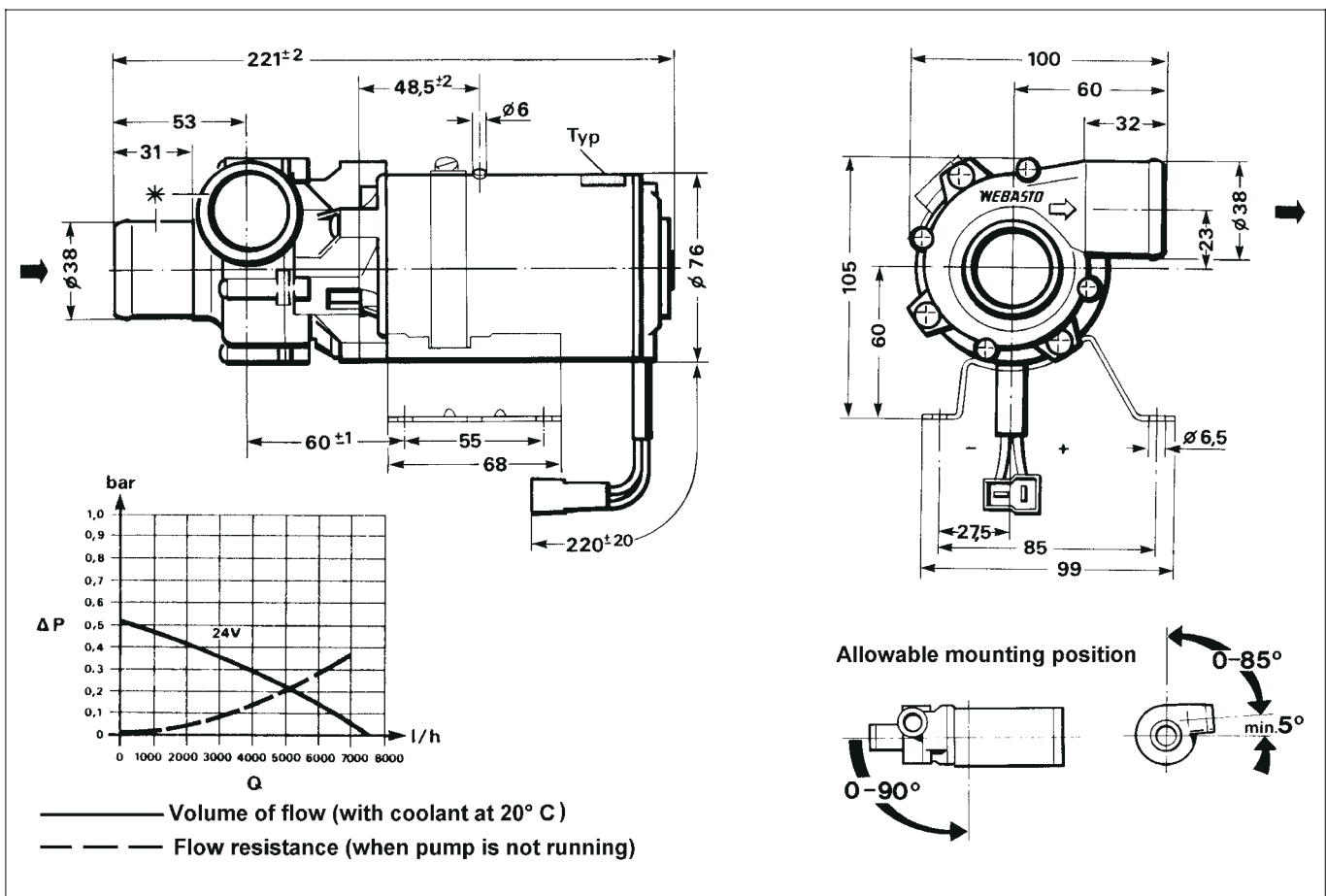


Fig. 302: Coolant Circulating Pump Assembly - U 4814

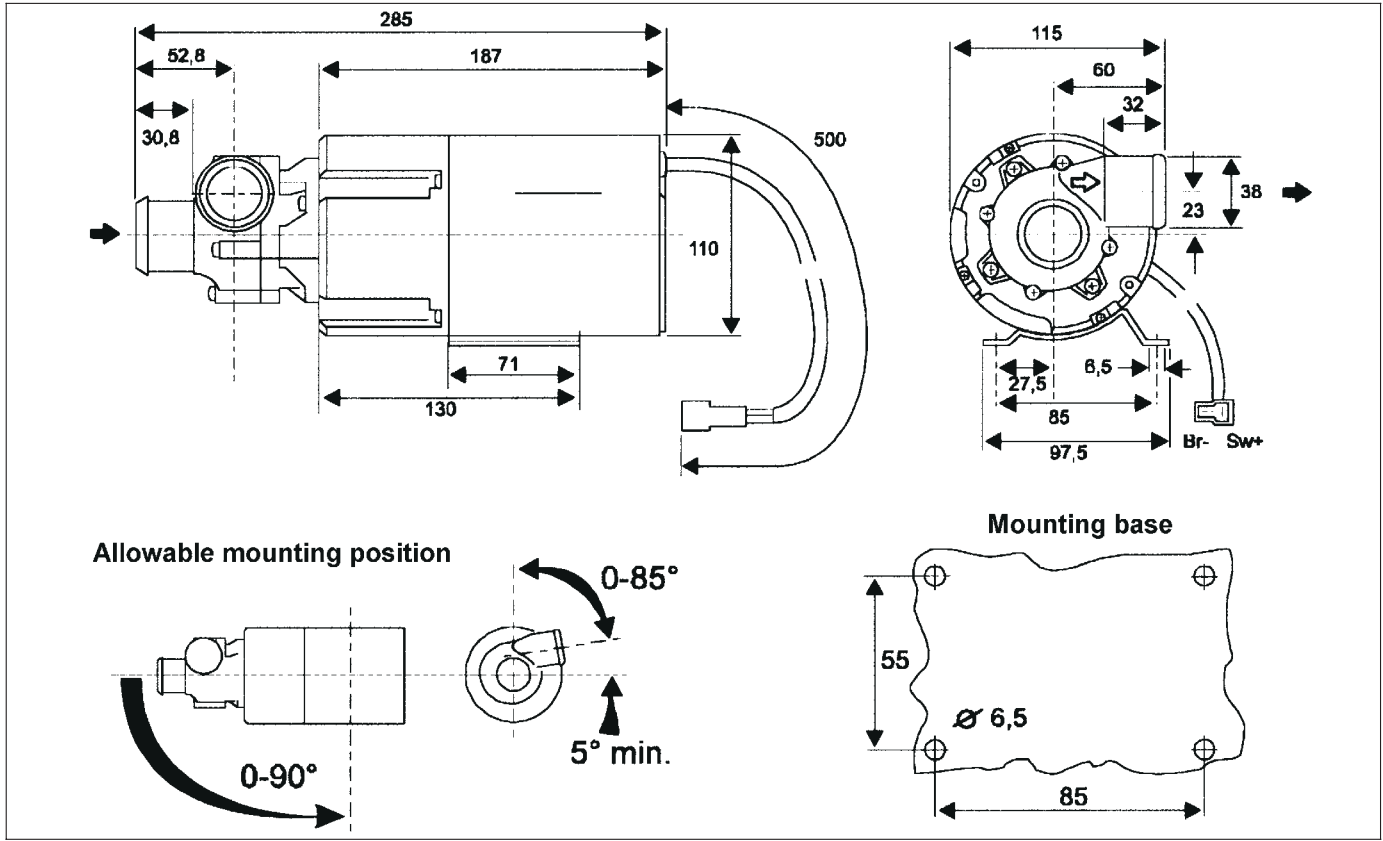


Fig. 303 Coolant Circulating Pump Assembly - U 4851

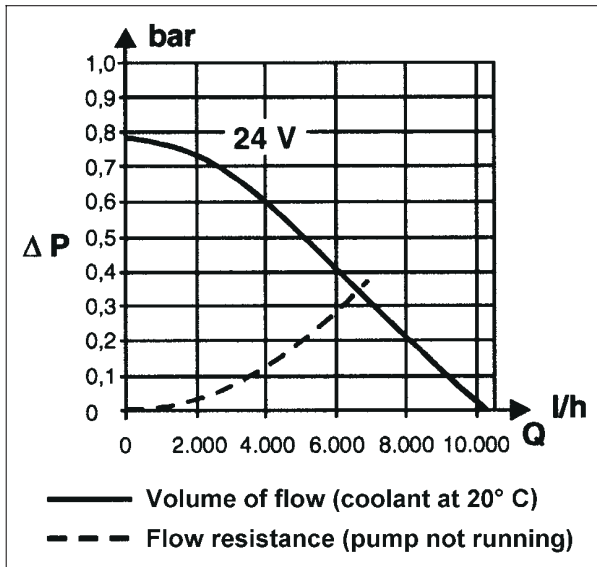


Fig. 304 Pump Operating Data - U 4851

4. Installation

4.1 General Information

Webasto will take you step by step through the installation process to ensure successful operation for years to come. The installation must be performed in accordance with the installation instructions provided in this manual.

IMPORTANT! The proposed heater installation must be approved by Webasto Thermosystems.

4.2 Installation Location

The heater and circulation pump are to be integrated into the coolant system (or into a separate heating circuit, if applicable) of the vehicle. The heater should be installed as low as possible in the coolant system to assure static bleeding of the heater and the circulating pump.

The heater is to be installed in a clean and dry environment, usually a separate compartment, accessible for service, typically towards the rear of the vehicle. The heater may also be located in the engine compartment. The installation enclosure must provide adequate ventilation for combustion air requirements [4 in² (20 cm²)]. When installing the heater, make certain that the clearances required for accessing the unit for servicing are observed (e.g. removal of the combustion chamber). See figure 301, page 302.

4.3 Mounting the Heater

1. Drill all required holes to dimensions shown in figure 301, page 302.
2. Bolt heater rigidly inside enclosure or engine compartment.

4.4 Exhaust Pipe Connection

Rigid exhaust pipe is recommended in installations where the use of an exhaust deflector is not suitable. The exhaust pipe must have a minimum internal diameter no less than 2 3/4" (70mm) and a length no greater than 16' (5m). The pipe may have several bends totaling no more than 270° overall. Do not cut and weld pipe to make 90° angled corners.

NOTE

This manual does not cover all possible installations. For special applications use this manual as a general guideline only. Contact Webasto Thermosystems directly at 1-800-555-4518.

WARNING

The heater must not be installed in either the driver's compartment or in the passenger area of vehicles.

NOTE

The circulating pump is not self priming.

WARNING

Exhaust pipes must be so routed that the possibility of exhaust fumes entering the vehicle is unlikely.

4 Installation

Thermo 230/300

1. Install exhaust deflector on heater exhaust outlet or install exhaust pipe.
2. Route the exhaust system so that the possibility of discharged exhaust gasses entering the vehicle is prevented.
3. Direct the discharge opening of the exhaust system in such a way as not to be pointed in the direction of travel, and so located that the possibility of clogging caused by snow, mud or debris is prevented.
4. Any condensation water collecting in the exhaust pipe must be discharged. If necessary, drill a drain hole at the lowest point to allow drainage.

NOTE

Route the exhaust system away from any parts of the vehicle that may be damaged by heat (i.e., brake lines, electrical wiring, hoses and fuel lines).

NOTE

Additional flexible exhaust tubing Webasto part number 479 721.

4.5 Combustion Air Supply

Never draw combustion air from inside the passenger area of a vehicle, or from areas where fumes and gasses can accumulate.

Where heater is installed in a sealed compartment, adequate ventilation for combustion air requirements [4 in² (20 cm²)] must be provided.

Combustion air can be drawn from a remote (protected) area in order to provide a clean air supply.

For installations requiring remotely drawn combustion air, use approved ducting with an unrestricted internal diameter no less than 2 1/4" (55mm) and a length no greater than 16' (5m). The ducting may have several bends totaling no more than 270° overall.

Approved combustion air ducting can be ordered through Webasto under part number 887 29A.

To connect combustion air intake ducting [2 1/4" (55mm)] to the heater, several types of fittings are available that snap directly onto the combustion air inlet of the heater.

For a straight connection, order a straight adapter under part number 101 377 and snap it onto the combustion air inlet and attach air ducting.

In the event there is insufficient room for a straight attachment, a 90° snap-on fitting (P.N. 101 404) and an adapter ring (P.N. 823 15A) are available. Simply snap them onto the combustion air inlet of the heater and attach ducting.

For installations where ducting is not required, the heater is factory equipped with a splash deflector that simply snaps onto the combustion air inlet.

WARNING

Never draw combustion air from inside the vehicle, or from areas where fumes or gasses can accumulate

CAUTION

Combustion air ducting must be non-restrictive. Do not connect to existing vehicle air ducting or filtration systems.

NOTE

Approved combustion air ducting can be ordered under Webasto part number 887 29A.

4.6 Plumbing Into the Coolant System

4.6.1 General Information

An efficient heating system must have an adequate supply of hot water to all heater cores. The amount of hot water available to a typical three or more heater core system depends on the water pumps capability and the amount of restriction within the coolant system.

Webasto high performance circulating pumps designed for extensive heating applications are available. Installing a Webasto heater and circulating pump in accordance with the following instructions will maximize the heating systems efficiency.

Coolant typically is routed out of the engine, through the Webasto coolant heater and then through the vehicle's heating system. A path for coolant flow must always be maintained while the Webasto heater is in operation. A bypass loop will be required if an uninterrupted coolant flow path cannot be assured due to valves being closed while the Webasto heater is in operation. The coolant circulating pump(s) must operate while the Webasto heater is "ON."

The coolant circulating pump must be mounted as low as possible in the vehicle's cooling system. A minimum of 10% of a good quality antifreeze should be maintained in the cooling system at all times. Heater and water pump fit 1.5" (38 mm) I.D. heater hose meeting SAE 20 R3 specifications. Silicone hose requires special hose clamps.

4.6.2 Engine and Passenger Compartment Heating

A: Heater Cores arranged in Series (fig. 401)

A series heating system works in this fashion:

Heated water (coolant) from the engine travels through the first heater core in the circuit, then on to the next heater core in circuit, and on to the next, etc. Each core adds some restriction, resulting in decreased water flow. Not only is water flow reduced, but also water temperature is reduced by each successive heater core resulting in the last core receiving water that is usually too cool to be effective.

WARNING

When working on the coolant system, allow the engine to cool down and open the radiator cap carefully.

CAUTION

The Webasto heater relies on coolant flow to transfer heat from the heater to the vehicle's heating system. The coolant pump(s) must be operating and there must be a path for coolant to flow or the heater will overheat.

NOTE

Heater hose must meet SAE 20 R3 specifications. Silicone hose requires special hose clamps. Hose clamps must be tightened to 45 in/lb. (5 Nm) torque.

SERIES PLUMBING

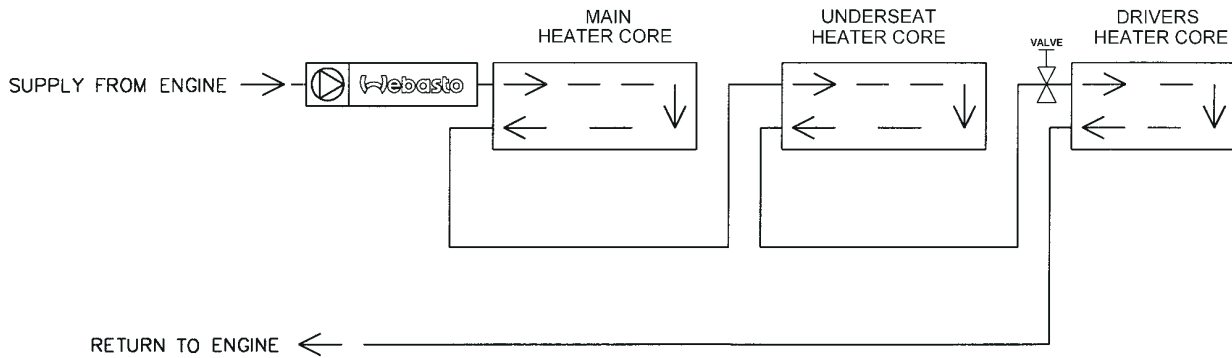


Fig. 401: Series Plumbing Circuit (Shown with heater installed)

CAUTION

A path for coolant to flow must be provided whenever the Webasto heater is operating.

B: Heater Cores arranged in Parallel (fig. 402)

A parallel heating system works in this fashion:

Heated water (coolant) from the engine travels through a common supply and return circuit, but unlike a series system, the heater cores are connected across the circuit at intervals along its length.

Each core shares the available coolant and heat equally, resulting in increased heating efficiency and decreased coolant restriction.

CAUTION

Water pump(s) must be operating when the Webasto heater is in operation..

PARALLEL PLUMBING

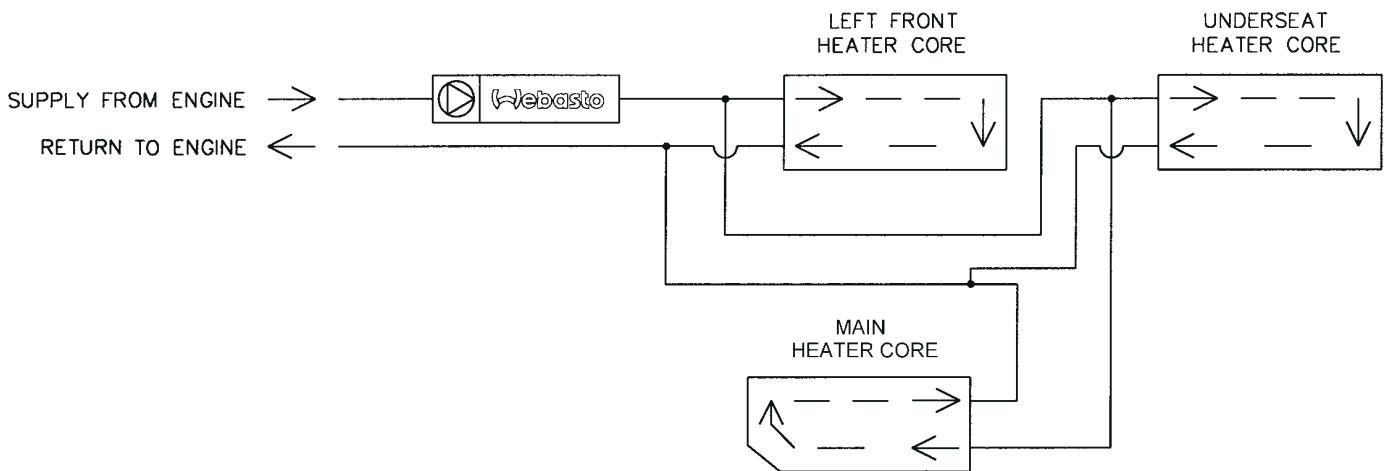


Fig. 402: Parallel Plumbing Circuit (Shown with heater installed)

A fuel fired Webasto heater used in conjunction with a high capacity coolant pump can significantly increase the available heat and coolant volume supplied to both series and parallel systems increasing interior heating efficiency. With the addition of a timer, the above systems can also provide pre-heating capability.

C: Engine pre-heating and/or Boost Heating Only (fig. 403)

This type of installation is used where engine pre-heating and or system boost heating is the primary requirement. The heater can be installed across the heating circuit before any of the vehicle heating cores or installed independently of the vehicles heating circuit by plumbing directly from and returning back into the engine. Depending on how the Webasto heater is controlled (timer, switch, vehicle system), heat can be supplied for engine pre-heating and maintaining higher operating temperatures. Interior heating efficiency will be enhanced by the higher operating temperatures provided by boost heating.

WARNING

When working on the coolant system, allow the engine to cool down and open the radiator cap carefully.

ENGINE PREHEAT/BOOST HEAT ONLY

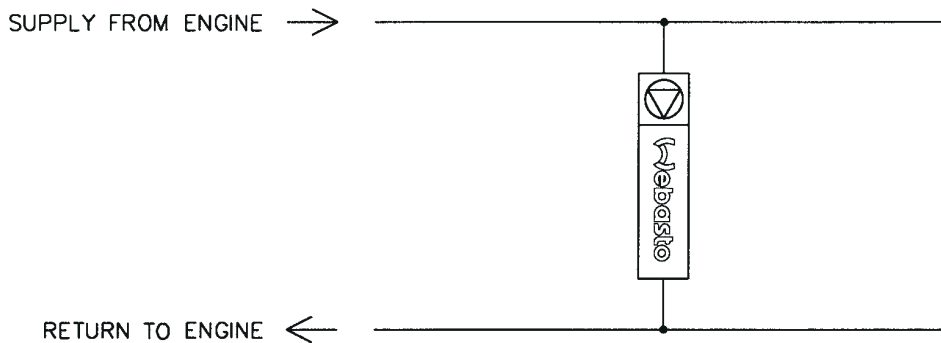


Fig. 403: Engine Preheat/Boost Heating Circuit

Instructions for options A, B or C (Typical installations)

On typical systems, the coolant supply will originate at the engine. From there, it will travel through the supply hose to the Webasto coolant pump (or vehicle manufacturer supplied boost pump), through the pump and into the fuel fired heater where the coolant is heated during operation. The heated coolant then leaves the heater at the outlet and continues on through the vehicles heating system and returns to the engine.

NOTE

Silicone hose requires special hose clamps.

NOTE

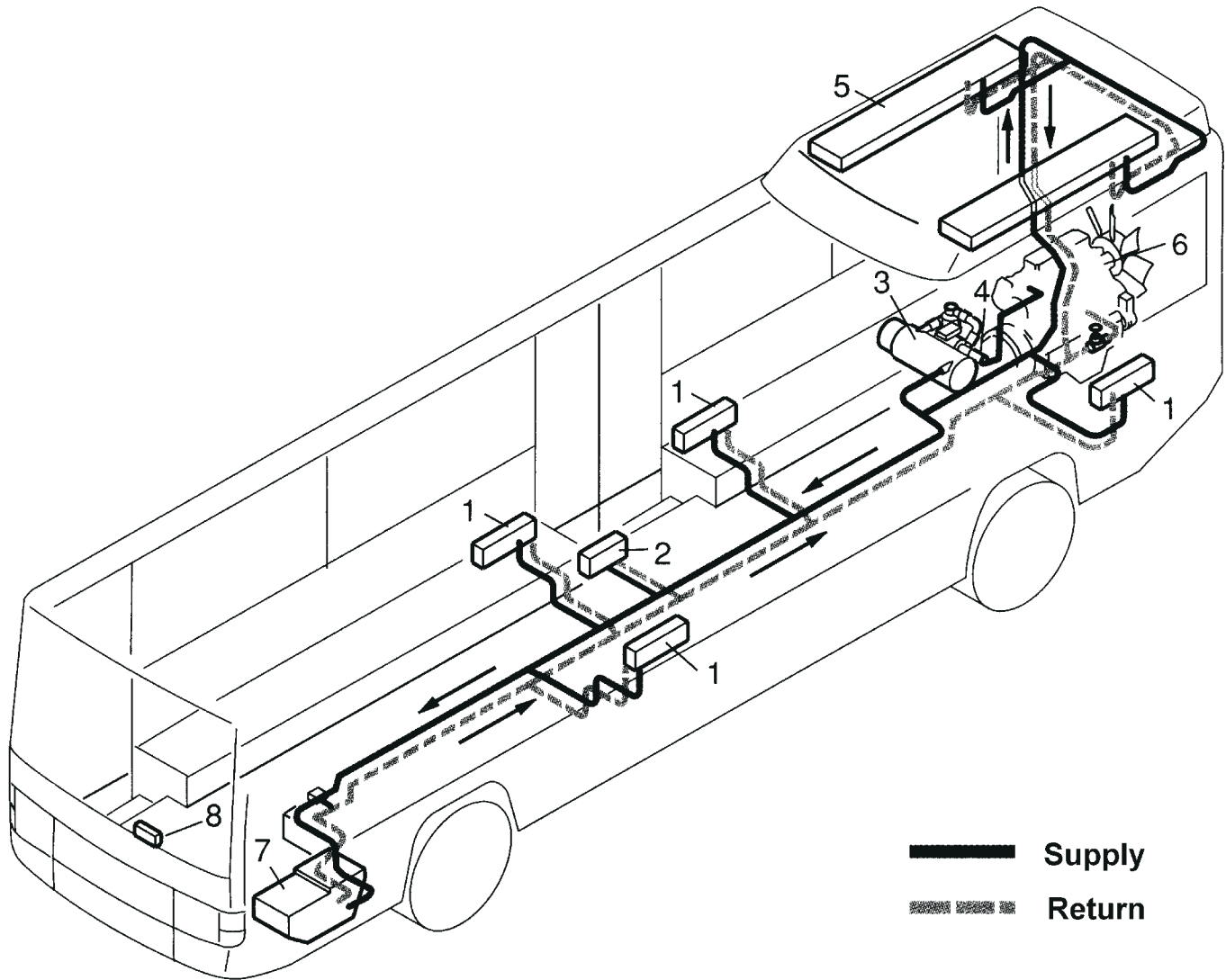
Heater hose must meet SAE 20 R3 specifications.

NOTE

Hose clamps must be tightened to 45 in/lb. (5 Nm) torque.

1. Identify the type of system you are working with to determine the appropriate type of installation as shown in figures 401, 402 or 403.
 - find and identify heating circuit supply hose. This is the starting point for determining the type of plumbing configuration you will choose.
2. Connect heater into the system according to the examples shown in figures 401, 402 or 403.

4.6.3 Example of a Heater Installation in a Bus



- | | |
|---------------------------|------------------------|
| 1 Heat Exchanger with Fan | 5 Heat Exchanger, Roof |
| 2 Stepwell Heater | 6 Vehicle Engine |
| 3 Webasto Coolant Heater | 7 Drivers Heater |
| 4 Circulation Pump | 8 Heater Control |

Fig. 404: Example of Heater Installation

4.7 Fuel System

4.7.1 General Description

The fuel is drawn from the vehicles fuel tank through a fuel standpipe. This standpipe can be utilized on vehicles with a spare threaded port as shown in figure 405. The Webasto heater utilizes 37° flare JIC fuel connection fittings. The fuel supply line fitting is a JIC #4 and the return line is a JIC #6.

4.7.2 Fuel Supply

IMPORTANT!

Keep the submerged end of fuel standpipe at least 2" from bottom of fuel tank.

The fuel standpipe and fuel line must be installed according to these instructions to insure proper heater operation.

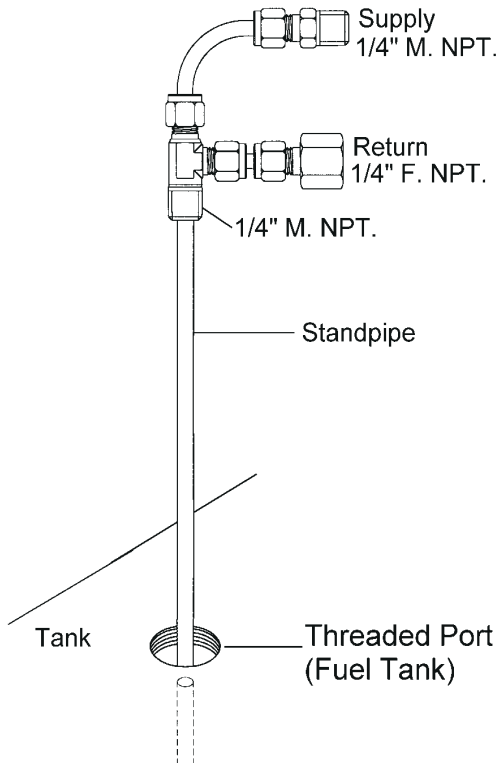


Fig. 405: Fuel Standpipe Installation

1. Cut fuel standpipe to length, approx. 2" off fuel tank bottom.
2. Install the fuel standpipe.

NOTE

The heater is equipped with an internal self priming fuel pump.

CAUTION

If the fuel tank is higher than the Webasto heater, the top of the tank may not be more than 20" above the heater.

NOTE

After fuel standpipe has been cut to length, remove any burrs.

- use 1/4" or 1/2" spare port on fuel tank (if available) and install fuel standpipe securely in fuel tank, use pipe thread sealant on all pipe threads.
- 3. Route and secure fuel lines from heater to fuel tank. Route according to applicable regulations. Use grommets to protect fuel lines whenever routed through holes.
- 4. Connect fuel lines to fuel standpipe and heater using 1/4" (6 mm) I.D. fuel line. Steel braided fuel lines are recommended for installations where the heater is located in the engine compartment.

CAUTION

Fuel line must be secured every 12" and kept away from hot exhaust and moving parts (drive shaft, wheels, etc.).

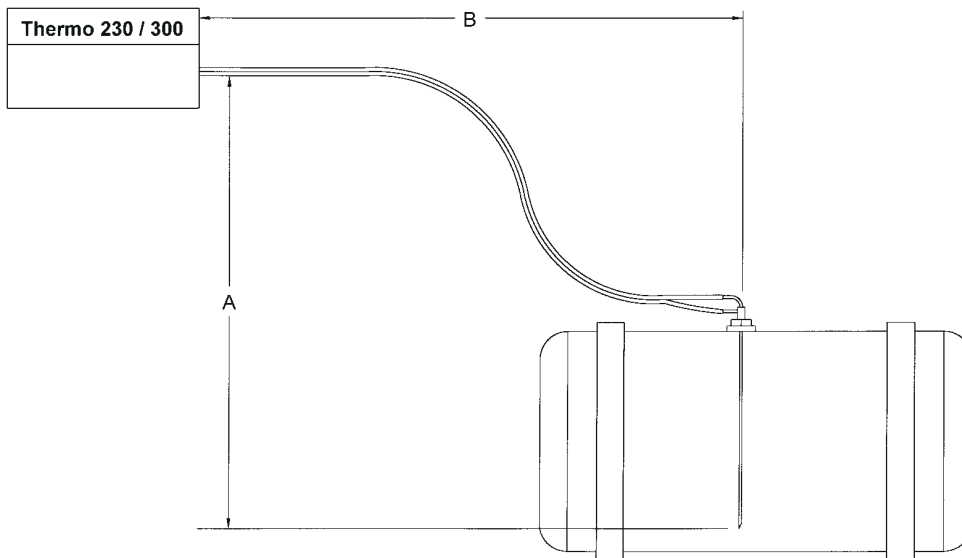


Fig. 406: Fuel Line Parameters

A = Suction height 6'6" (2,0 m)

A+B = Suction length and height not to exceed 33' (10 m)

4.7.3 Fuel Filter

The heater must be equipped with a fuel filter. Fuel filters require changing at least annually and in cases of dirty fuel more often.

The fuel filter assembly should be mounted near the heater.

After installation, before the heater is fired for the first time, the fuel system and filter will require priming. In most cases, this will be achieved by turning on the heater and allowing it to self prime. In some cases the fuel filter may require filling with CLEAN diesel fuel before installation to assist system priming.

NOTE

Change the fuel filter at least annually.

CAUTION

To prevent fuel nozzle failure, always use CLEAN fuel from a known CLEAN source for priming fuel systems and filters.

4.8 Wiring Connections

4.8.1 General Information

The control unit is equipped with low voltage protection, therefore it is imperative to keep vehicle batteries in good condition. Thermo 230/300 heaters are available in 24 volt configurations only.

NOTE
The Webasto heating system will not perform to your satisfaction with weak batteries.

CAUTION
If welding is done on the vehicle, the main battery cables must be disconnected from the battery to protect the battery to protect the electronic control unit.

4.8.2 Timer and Switch Connections

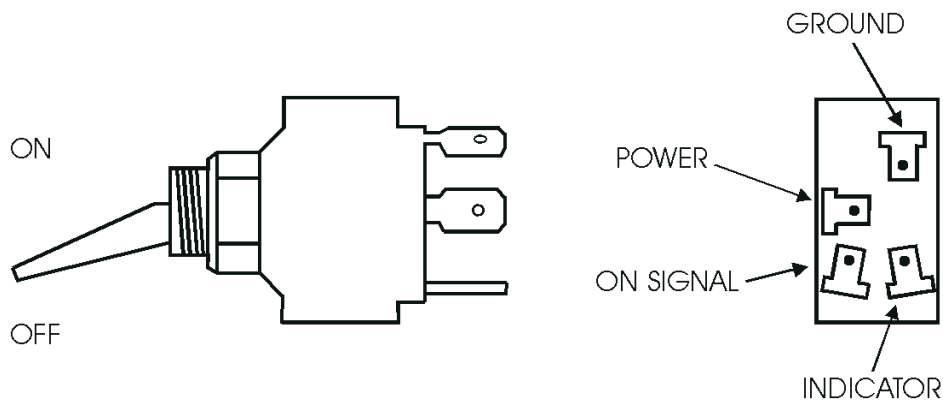


Fig. 407: On/Off Switch

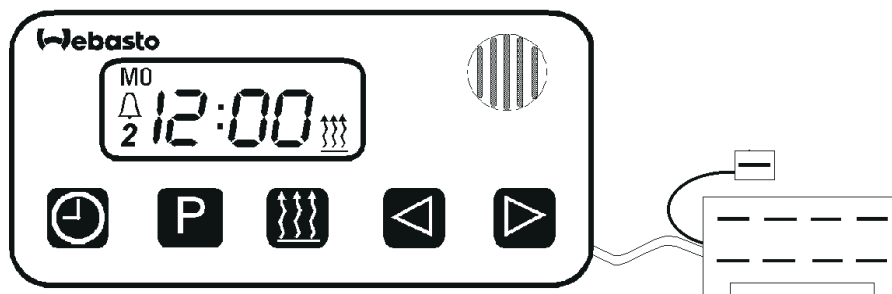


Fig. 408: 7-Day Digital Timer Model 1531

4.8.3 Timer or Switch Installation

1. Select a suitable location in the vehicle for the timer or On/Off switch.
2. Connect the harness to the timer, or switch.

4.8.4 Wiring Diagram - with Switch

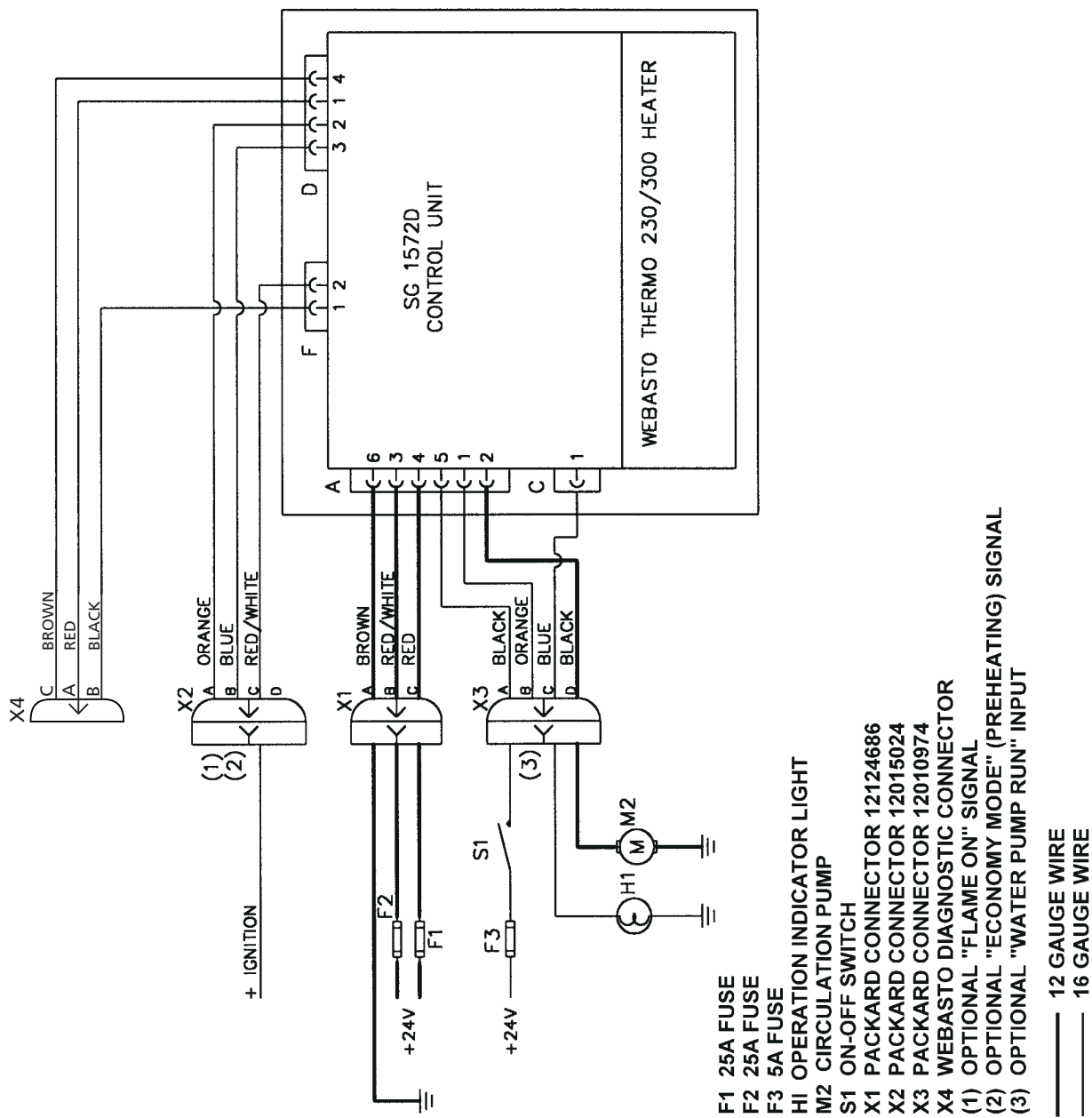


Fig. 409: Wiring Diagram with Switch

4.8.5 Wiring Diagram - with 7-Day Digital Timer Model 1531

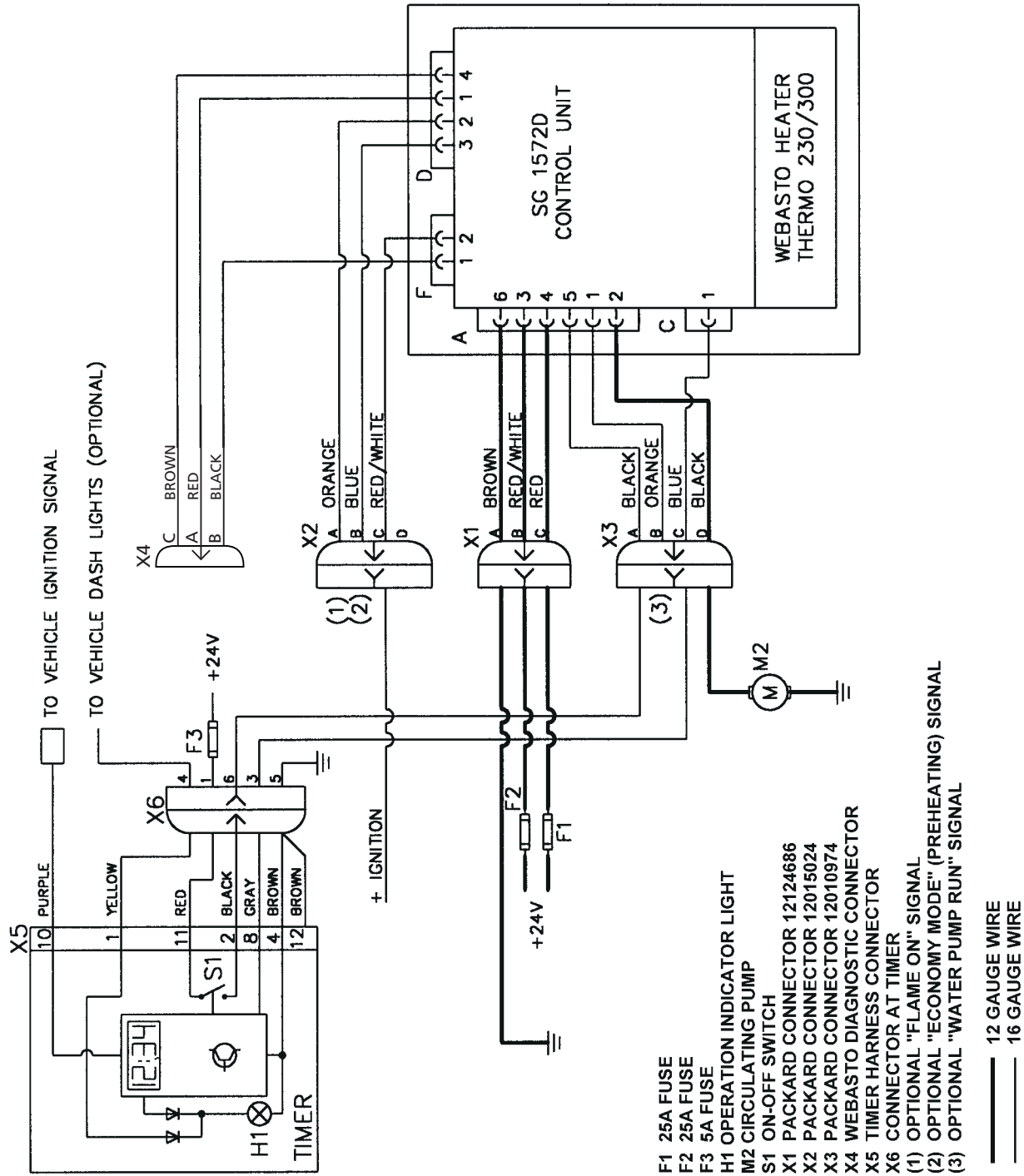


Fig. 410: Wiring Diagram with Timer Model 1531

4.9 Initial Operation

1. Check your installation for:
 - loose nuts and bolts.
 - exhaust pipe routing and clamp tightness.
 - loose hose clamps.
 - routing and securing of wiring and heater hoses.
 - kinked or pinched hoses.
 - battery connection and polarity.
2. Top off or refill cooling system with coolant as per engine manufacturers recommendations.
3. Open shut-off valves and driver's heater valve.
4. Set vehicle heater controls to maximum heat position.
5. Start the vehicle engine and run it at a fast idle for 10 minutes to purge air from the Webasto coolant heater and all of the heat exchangers. While the engine is running check:
 - hose connections for leaks.
 - coolant level in the expansion tank and add coolant as needed.
 - use bleeder valve on top of Webasto heat exchanger to purge out trapped air when necessary.
6. Switch on Webasto heater and check:
 - indicator light on.
 - circulating pump in operation.
 - heater fan motor in operation.
 - presence of combustion after approximately 25 seconds.
7. Shut off the engine.
8. Allow heater to run until coolant is hot and heater cycles off. During this period, monitor system for any coolant or fuel leaks.
9. Temperature differential between water inlet and outlet should not exceed 10° C (18° F) during heating operation.
10. Switch "OFF" Webasto heater.
11. Re-tighten hose clamps to 45 in/lb. (5 Nm) and inspect installation for leaks.
14. Install any panels and access covers removed during installation.

NOTE

Installation with long fuel lines may need a second start attempt to initially prime the fuel system. Cycle ON/OFF switch or timer to reset control unit.

NOTE

Coolant temperature must be below 158°F (70°C) to start up.

15. Complete the warranty card and send to Webasto Thermosystems (There is an area on the last page of this manual for recording information which is useful when calling for technical support).
16. Install the compartment cover if equipped. Installation is now complete.

NOTE

The engine temperature gauge may read a lower temperature depending on the location of the temperature sensor on the engine.

NOTE

Necessary information to complete warranty card and ensure full warranty coverage can be found on name plate.

5. Maintenance of the Heater

5.1 Annual Maintenance

The Webasto heater requires a minimum of maintenance to operate. To keep your heater in service the following maintenance procedures should be performed annually before each heating season:

Enclosure Area

- clean the heater and enclosure area from any accumulated debris or dust with compressed air
- inspect all components for wear and damage

Electrical System

- check wiring harnesses for damage, fix or replace if required
- check condition of the batteries and connections.
- load test batteries and replace if necessary.

Exhaust System

- check the exhaust system carefully for restrictions or corroded areas. Replace exhaust pipe if necessary.

Fuel System

- change fuel filter and inspect fuel lines for wear and damage. Repair or replace if necessary.

Burner System

- swing open burner head, clean flame detector (photo eye), pull out combustion chamber and inspect and clean heat exchanger. Replace nozzle if necessary (annually). Re-install combustion chamber and close up burner head.

Operation Test

- Run your heating system for at least 15 minutes.
- Check water and fuel connections for leakage. Re-tighten clamps and fittings if necessary.

NOTE

For major repairs and spare parts, return to your authorized Webasto Thermosystems servicing Specialist.

NOTE

The heater will not function properly with weak batteries.

NOTE

Operate your Webasto at least once a month for 10 minutes.

6. Basic Troubleshooting

6.1 General Information

This section describes troubleshooting procedures for the Thermo 230/300 coolant heater. Troubleshooting is normally limited to the isolation of defective components.

Before troubleshooting, check for and eliminate these defects:

- fuel supply (plugged fuel filter)
- corrosion on battery terminals
- blown fuses
- corrosion on electrical wiring, connections and fuses
- loose contacts, or improper crimping on connectors
- shut down initiated by temperature limiter thermostat (automatic reset)

CAUTION

Troubleshooting requires profound knowledge about structure and theory of operation of the heater components and should only be performed by skilled personnel.

NOTE

After any correction of a defect a functional test has to be performed in the vehicle.

NOTE

Coolant temperature must be below 158°F (70°C) to start up.

6.2 Operational Failure Symptoms (reading the flash code)

A flash code will be generated on the indicator light of the control (on / off) switch in the event of an operational failure. In order to make a correct analysis it's necessary to understand the flash code event. The flash code event is only visible during the after run (cool down) period of operation.

During the flash code event you will see the following:

Five quick flashes followed by a slower sequence of flashes, the slower sequence of flashes is the actual fault code. The first five quick flashes are only an indication that a fault code has been registered and will be displayed. Count only the slower sequence of flashes to obtain the current fault code.

For example (flashes = ✕):

Fault code 7X (F 07): ✕✕✕✕✕ ... ✕ ... ✕ ... ✕ ... ✕ ... ✕ ... ✕ ... ✕

The flash code sequence will be repeated during the Thermo 230/300 after run (cool down) period and will remain visible once heater stops in the lock out mode. Once the heater is cycled "OFF" and "ON" the fault code will no longer be visible on the indicator light but will be stored in memory.

6.2.1 Reading a Fault Code with 1531 "Comfort" Timer Installed

Where the Thermo 230/300 installation includes the model 1531 "Comfort" Digital Timer, you will be able to read the current failure fault code directly from the timer display. The flame indicator symbol will "flash" the present fault code once and will then convert the fault code to an alphanumeric display message.

For example: fault code 10 (overheat) will be visible on the timer display as "F 10".

Once the failure has been corrected, and the heater switch or timer is cycled "OFF" and "ON" and the heater successfully starts and runs with no further failures, the error code will disappear from the timer display.

CAUTION

Troubleshooting requires profound knowledge about structure and theory of operation of the heater components and may only be performed by skilled personnel.

NOTE

After any correction of a defect a functional test has to be performed in the vehicle.

6.2.2 Storing a Fault Code in Memory

Once the Thermo 230/300 completes the after run (cool down) period initiated by a failure event, the current flash code will be downloaded (stored) in memory.

The Thermo 230/300 can store up to ten fault codes.

Once the memory is "full", any additional fault code will replace the earliest code stored thereby continually updating the fault codes stored in memory with the four most recent faults.

6.3 Operational Failure Symptoms via Fault/Flash Code

The following table lists the possible faults which can be read by flashing code or read directly off of an appropriate timer or with the PC diagnostics kit.

Failure Symptom	Probable Cause	Check and Correct
1X Flash (F 01) No combustion after completion of start up sequence.	- Fuel system - Combustion air - Electronic ignition	- Fuel level - Type of fuel being used - Fuel filter - Fuel line connections (air bubbles in fuel lines) - fuel nozzle plugged - Air intake or exhaust, restricted or plugged - incorrect electrode gap
2X Flashes (F 02) Flame out during burner operation no restart possible	- Fuel supply (shortage of fuel)	- Restriction in the fuel system - Fuel filter - Fuel line connections (air bubbles in fuel lines) - Type of fuel being used
3X Flashes (F 03) Low voltage for more than 20 seconds	- Electrical system	- Load test batteries - Corrosion at connections - Loose connections
4X Flashes (F 04) Flame detector recognizes false flame signal during pre-start or shut-down cycle	- Defective flame detector	- Replace flame detector
5X Flashes (F 05) Flame detector	- Wiring - Defective flame detector	- Damaged wiring, open or short circuit - Replace flame detector
6X Flashes (F 06) Temperature sensor	- Wiring - Defective temperature sensor	- Damaged wiring, open or short circuit - Replace temperature detector
7X Flashes (F 07) Fuel solenoid valve	- Wiring - Defective solenoid valve	- Damaged or corroded wiring, open or short circuit - Replace solenoid valve
8X Flashes (F 08) Combustion air fan motor	- Wiring - Wrong RPM - Defective combustion air fan motor	- Damaged wiring, open or short circuit - Replace combustion air fan - Replace combustion air fan
9X Flashes (F 09) Circulation pump motor	- Wiring - Defective circulation pump motor	- Damaged wiring, open or short circuit - Replace circulation pump motor
10X Flashes (F 10) Temperature limiter	- Overheat condition - Coolant flow - Wiring - Defective temperature limiter	- Reset temperature limiter - Coolant level or flow restriction - Air trapped in coolant circuit - Damaged or corroded wiring, open or short circuit - Replace temperature limiter
11X Flashes (F 11) Electronic ignition coil	- Wiring - Defective electronic ignition coil	-Damaged wiring, open or short circuit -Replace electronic ignition coil
12X Flashes (F 12) Heater lock out	3 repeated faults/flame-outs or 5 repeated start attempts	Reinitialize control unit by switching heater on and disconnecting power.

Table 601: Operational Failure Symptoms (Control Unit SG 1572 D)

6.4 Reading and Removing Fault Codes Stored in Memory with the Webasto PC Diagnostics Kit and Adapter

It is possible to read and remove (reset) stored fault codes from the Thermo 230/300 memory.

This is achieved through the use of a diagnostic interface kit connected to the Thermo 230/300 and an IBM compatible computer having the necessary software installed.

The PC Diagnostic Interface Kit comes with software and instructions for use with Webasto heaters equipped with internal diagnostics capabilities such as the Thermo 230/300.

Order PC Diagnostics Kit under part number 925 42A and adapter under part number 208 65A.

System requirements:

- IBM compatible PC with 80286 processor or higher
- DOS version 3.0 or higher including *MS Windows (*Not required)
- at least 1 MB RAM
- hard disk with at least 3 MB space available
- 3 1/2 inch, 1.44 MB floppy disk drive for installation of program files
- VGA graphics board with 640 x 480 pixel resolution and at least 16 colors
- unused serial port
- monitor, keyboard (mouse or other pointing device recommended)

In addition to working with stored fault codes, the PC Diagnostics Kit allows you to do several other functions such as reading values while the heater is in operation or testing individual components. Printing out of fault codes is also available (User supplied printer required).

For further capabilities and detailed instructions for use with the Thermo 230/300 heater, see instruction manual supplied with the PC Diagnostics Kit.

CAUTION

Diagnostics equipment is intended for use by Webasto trained personnel at authorized Webasto Distributor, Dealer and End User service facilities.

7. WARRANTY POLICY *

Webasto Thermosystems Inc. and Webasto Thermosystems (Canada) Ltd., (herein after referred to as "Webasto") warrants their products and related component parts against defects in materials and workmanship for 24 months effective from installation date or vehicle registration date for O.E.M. installations. The warranty period may not however, exceed 36 months from the original date of delivery by Webasto.

During the warranty period the EXCLUSIVE REMEDY will be for Webasto to repair or replace those parts which are demonstrated to be defective in material or workmanship.

In the event of a defect covered by this warranty, only Webasto authorized distributors/dealers are permitted to perform warranty work. Call Webasto @ 1-800-Heater-1 (1-800-432-8371) or, in Canada @ 1-800-667-8900 for your closest Webasto authorized dealer.

Please complete and return the Webasto warranty registration card immediately upon installation or registration of new vehicle.

Webasto specifically excludes and limits from warranty the following:

- **Normal wear of service parts including:** *Fuel nozzles, filters and fuses.*
- **Improper installation,** *which is not in accordance with valid supplied installation instructions.*
- **Deterioration,** *due to normal wear and tear, corrosion, abuse, damage, accident, improper storage or operation.*
- **Modification,** *of a product by alteration, use of non genuine parts or repair by unauthorized personnel.*
- **Economic loss,** *for expenses related to travel, vehicle disassembly, personal injury or other incidental or consequential damages.*

* See official warranty for complete details



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DINEX G2A MULTIPLEX SYSTEM

FOR

COACHWORKS BUS



Rev. 1.0
08-30-02

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I/O CONTROLS CORPORATION

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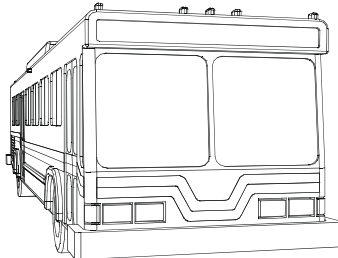
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1

Key Nomenclature

- Data Bus_____The multiple pair of common wires providing the multiple DATA path and/or power supply to link each network element. Similar to a telephone line.
- Module_____The network functional unit which contains the intelligent co-processor unit. The vital communications data link to IO devices, inputs and outputs.
- Bus Controller_____The communication traffic controller that directs and regulates communication between each functional unit on the data bus. Think of the Bus Controller as a telephone switchboard.
- Node_____An individual functional module in the network. The telephone receiver in a network.
- ID_____The unique address symbol (either a number or a character) which is assigned to each functional unit in the network. A telephone number.
- I/O_____Inputs (sensors and switches) and Outputs (actuators or lamp loads). These are the fundamental system functions.
- DNET_____The unique name for DINEX G2A system to be defined as UPLINK data port. Acting as Slave Function.
- CNET_____The unique name for DINEX G2A system to be defined as DOWNLINK data port. Acting as Controller Function.

- Clean Power_____ (Computer Power) The isolated power source for modules in the network. "Clean Power" avoids data corruption from a common power source such as battery or electrical interference.
- LED_____ A light emitting diode. A small semi-conductor lamp.
- Reset_____ Restart the system.
- Cellnet Controller_____ This CNC module has the capability to act as a subset of Master Bus Controller (G2A-MBC-32) which includes 32-inputs and power management function.
- HCNC_____ A high speed cell network controller.
- DIO_____ An intelligent slave module.
- Multiplex_____ A way of transmitting several lines of communication simultaneously on the same data link.
- Inputs_____ Switches and sensors, which supply information to the modules to perform an operation. A circuit is "active" when it is turned on. A circuit is "inactive" when it is turned off. The computer can make use of both "active" and "inactive" data to perform a specific function.
- Data_____ The information from module to module over Multiplex system.
- Outputs_____ All physical actions that are performed by the modules, such as turning on or off lights, solenoids and other devices.
- Ring Loop_____ Data bus structure in which the modules are connected to form a "ring."
- Ladder Charts_____ Ladder charts, circuits, or diagrams are logic diagrams. They are not schematics. The primary function of a ladder diagram is to show how devices are related one to the other.

2

- What is MULTIPLEX (MPX)?
- What will DINEX G2A Intelligent MPX do for me?
- DINEX G2A working in Buses
- Typical Module Locations

General Description

What is MULTIPLEX (MPX)?

- MPX simplifies the way electrical devices are hooked up together.
- MPX allows for two or more data transmissions to take place on the same wire.
- In the world of traditional wiring systems -- such as wiring harnesses, and relays -- as much as three miles of wires can be used. These harnesses run hundreds of signals, using hundreds of wires, just to keep a single transit vehicle operational.
- Instead of having three miles of complicated wiring harnesses and a number of failure prone connectors, multiplexing sends multiple signals at the same time through a common pair of wires to turn-on or turn-off various electrical devices.

Some of the problems encountered with the old technology are:

- Cumbersome systems,
- Relay based,
- Over-crowded -- making upgrading and maintenance difficult,
- Prone to connector and harness failure,
- Costly to troubleshoot and repair,
- Expensive vehicle downtime.

Multiplex hardware which makes-up the system is composed of:

- A separate power supply,
- Several control modules.
- And a unique cabling system made up of connectors and multi-stranded wires that run through a cable.

Some of the benefits of MPX are:

- A simple system,
- Reduced number of connectors,
- Immediate ease of troubleshooting,
- Reduced vehicle down-time,
- Ease of operation.

What will DINEX G2A Intelligent MPX do for me?

DINEX-G2A-MPX advances transit vehicle control techniques into the computer age.

- The DINEX-G2A-MPX system provides a reliable, cost-effective alternative to the old technologies.
- The DINEX-G2A-MPX system replaces relays, flashers, connectors, and outdated wiring harnesses.
- The DINEX-G2A-MPX system offers an intelligent network for the control, monitoring and data acquisition in transit bus and rail cars.
- The DINEX-G2A-MPX system's bottom line is to make your life easier and less costly.

How does DINEX-G2A-MPX system do all this?

- The DINEX-G2A-MPX is a microprocessor-based system. It uses multiplex data-bus architecture.
- The DINEX-G2A-MPX uses a small, compact, powerful module to perform full computer functions. This central module controls a family of small, lightweight microprocessor-based control and monitor functions.

DINEX G2A Working in Bus

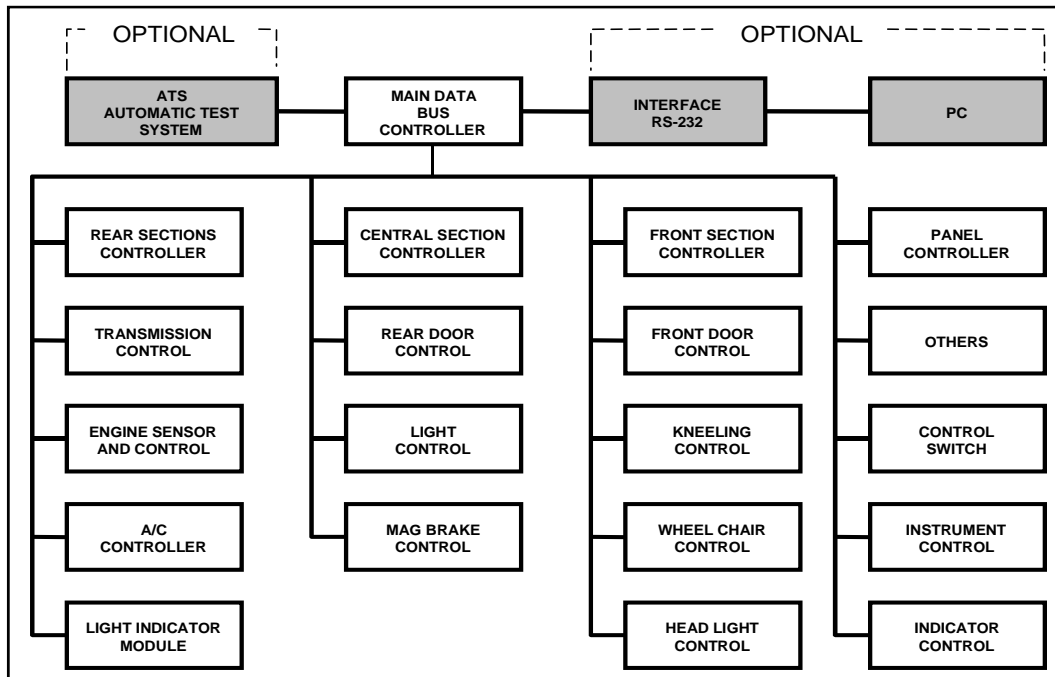
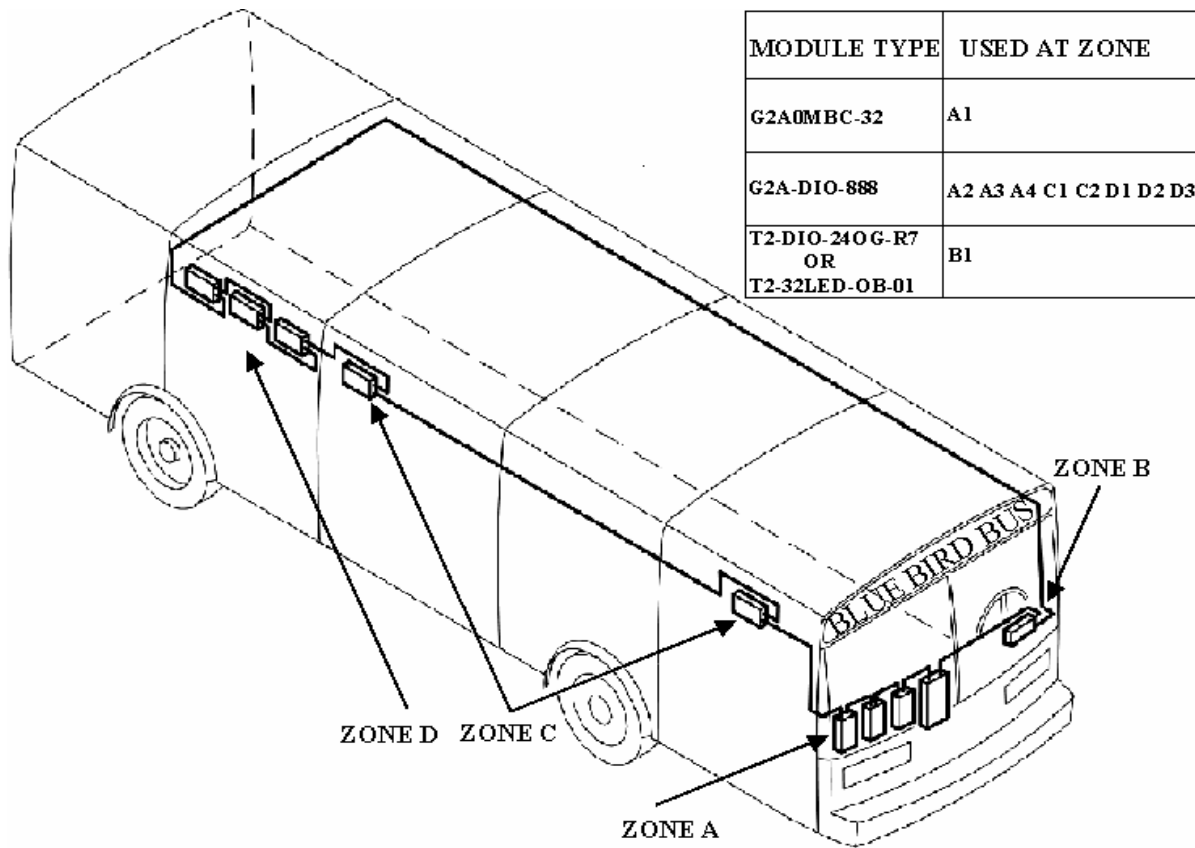


FIGURE: 2.1 – DINEX G2A SYSTEM

Typical Module Locations



(Some locations may vary due to customer options)

FIGURE: 2.2 – TYPICAL MODULE LOCATIONS

Modules are located in zones as near to the needed inputs and outputs as possible. The locations of the modules reduce the amount of “hard” wire necessary to reach the module. Some examples of zone locations are:

- Zone A: Door Area/ Main Panel
- Zone B: Above Driver
- Zone C: Front Door / Rear Door
- Zone D: Engine Area

3

- How the DINEX G2A System Works?
- Main Data Bus Controller with PMS Module:
G2A-MBC-32
- Intelligent Digital Input/Output Control Module:
G2A-DIO-888
- Intelligent Digital 24 Output GW module:
T2-DIO-24OG-R7
- 32 LED Indicator Panel:
T2-32LED-OB-01

Introduction To System Components

How the DINEX G2A System Works?

The inputs to the Main Bus Controller (MBC) Module are supplied by the driver operated controls and the various switches and sensors linked together in the system.

G2A-MBC-32 module can receive up to 32 inputs. It does not have outputs and feedback channels.

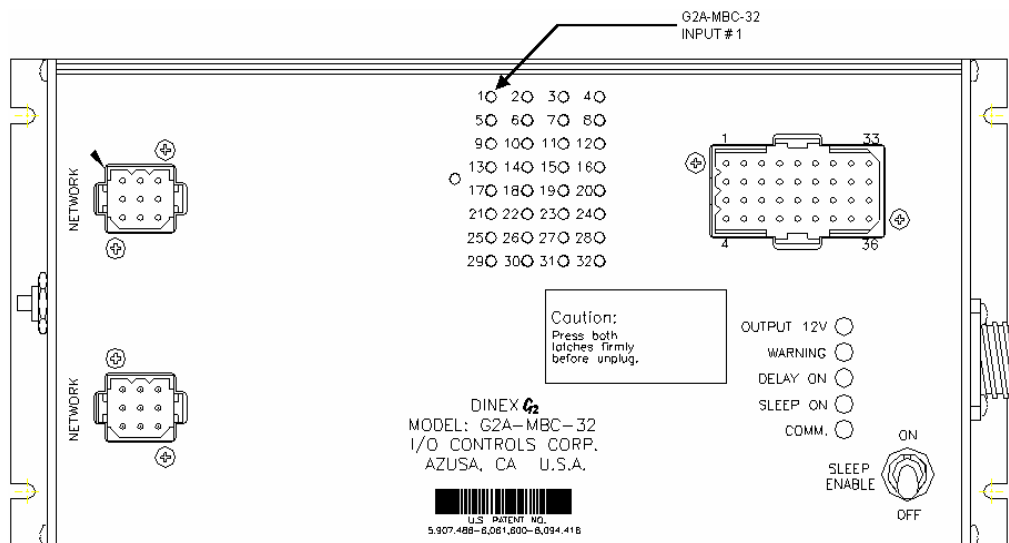


FIGURE: 3.1 -- G2A-MBC-32

When the driver turns on a switch, the inputs are activated and a signal goes to the MBC.

The MBC is the COMMAND CENTER or the switchboard.

The MBC receives inputs as an on or off signal and relays the signal to the module that executes the commands. After the module executes the command it keeps track of how the system is working. Each module in the system has a unique address.

The MBC uses the DATA CABLE to link up with the various modules required to do the job.

The DATA CABLE is made up of eight, small gauge wires. The twist pair wire keeps out all unwanted noise that might distort the data. Data travels through the cable at 115,200 BPS or 1/1,000,000th of a second.

The DATA CABLE talks to all components through a unique “loop” link-up. The MBC checks in with each module and issues instruction. As a check, it rechecks its inputs to verify that the job has been done.

LEDs tell the driver/operator if the modules are working as he has instructed. Single-controller systems are used in the Data Bus Cable. MBC is the only controller in a system and is the only programmable module among the system components.

The Main Bus Controller (MBC) is the general-in-command. It has the special built-in features, such as a computer, which tells all listeners what to do. After the MBC issues a command it tracks the work in progress.

The MBC communicates all instructions via a data cable to all modules in the network. Each module is identified by an address, like an employee, social security, or phone number. The MBC contacts modules by using this special ID number.

G2A-MBC-32 module can receive up to 32 inputs. The G2A-MBC-32 module does not have outputs and feedback channels.

Multiplex modules are each assigned a unique address. This address allows the MBC to communicate directly with each specific module. Each module has a sub-address that relates to a specific circuit.

Most DIO modules can control up to eight output circuits and receive eight more inputs, and, optionally, 8 feedback channels.

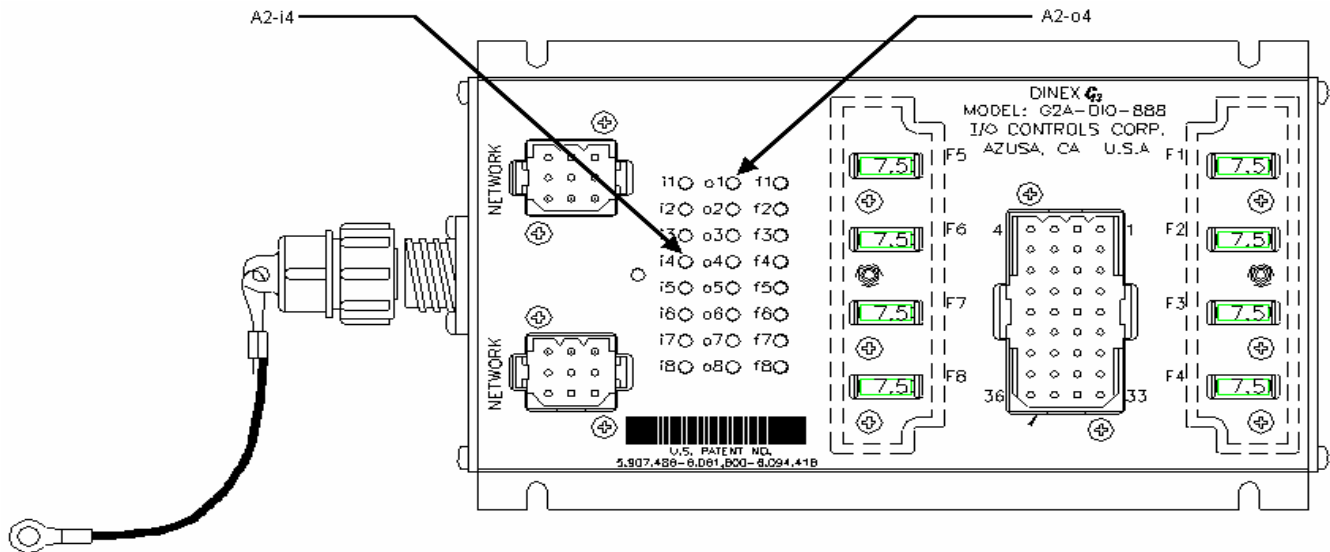


FIGURE: 3.2 -- G2A-DIO-888

For example, in the figure of G2A-DIO-888 above,

A = module location on the bus

4 = module number

i4 = input point on the module

Thus, MBC-1 = input from master switch/run position

A2-i4 = input from interlock stop light pressure switch

A2-o1 = output to stop light lamps

The loop and how it works:

The MBC uses the main data bus cable to communicate with all the modules in turn, one after the other.

The MBC only addresses each module -- using its unique address -- one at a time, telling it what to do and then the MBC rechecks its inputs to verify the job has been done as ordered.

The Main Bus Controller with PMS Module G2A-MBC-32

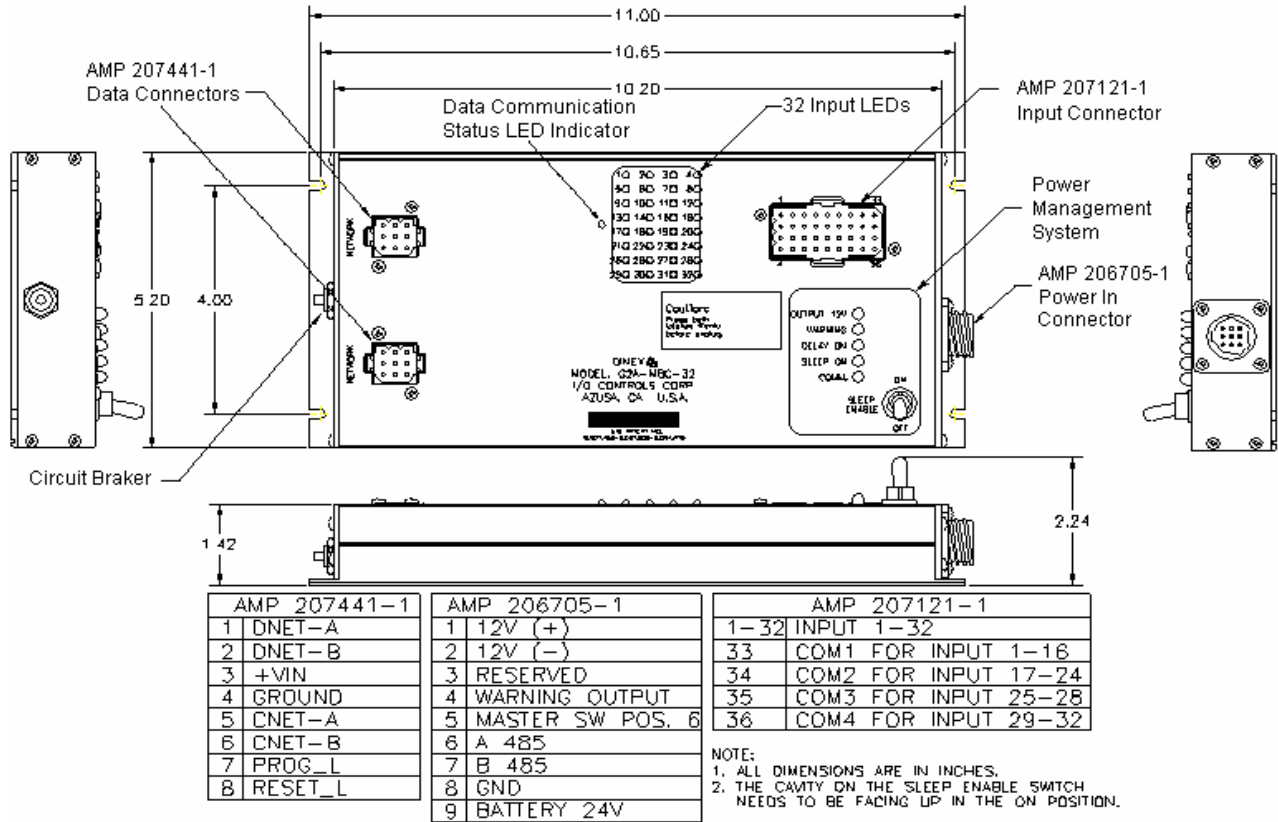


FIGURE: 3.3 -- G2A-MBC-32 MODULE DIAGRAM

The Main Bus Controller – G2A-MBC-32 -- is the top-level device. It is the command post for what’s happening throughout the operating system.

- The Main Bus Controller controls and monitors up to 16 modules in a single level of data bus.
- It interfaces with 32 inputs and contains its own power management unit for entire system.
- It interfaces with switches, such as limit switches, temperature and pressure switches, and can directly control other modules.
- LED status indicators are provided on all input points.
- It stores instructions for control and monitor.
- It supports Automatic Test Equipment.
- All I/O points are optically isolated.
- It replaces relays with solid state, electrical switching.
- The MBC is simple to replace in the field.
- It has Built-In Self Test functions in software.

Intelligent Digital Input/Output Control Module G2A-DIO-888

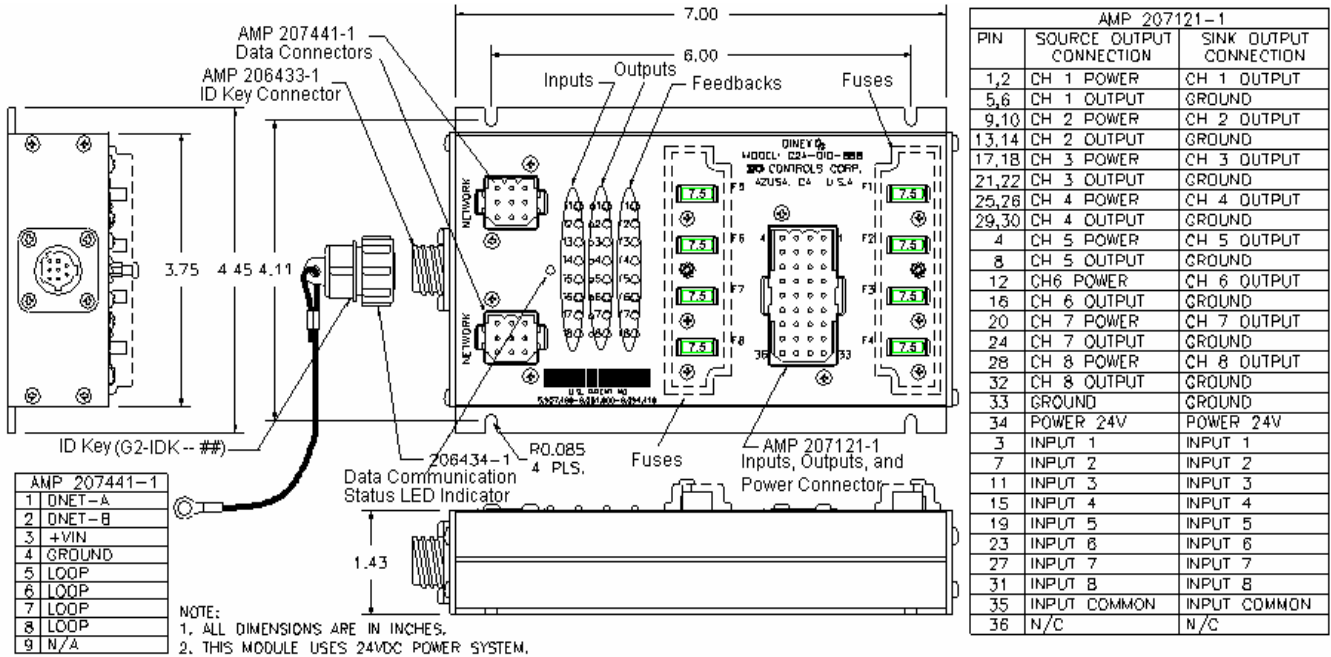


FIGURE: 3.4 -- G2A-DIO-888 MODULE DIAGRAM

- DIO normally can only handle 8 inputs, 8 feedbacks and 8 outputs.
- Special DIO units allow additional input controls (up to 32 inputs total).
- Replace like devices with like devices. **READ THE LABELS** first before replacing one unit with another.
- DIOs are on/off units only and are not programmable.
- Feed-back circuits are used for BIST (Built-In Self Test)

**Intelligent Digital 24 Outputs Gateway Module
T2-DIO-24OG-R7**

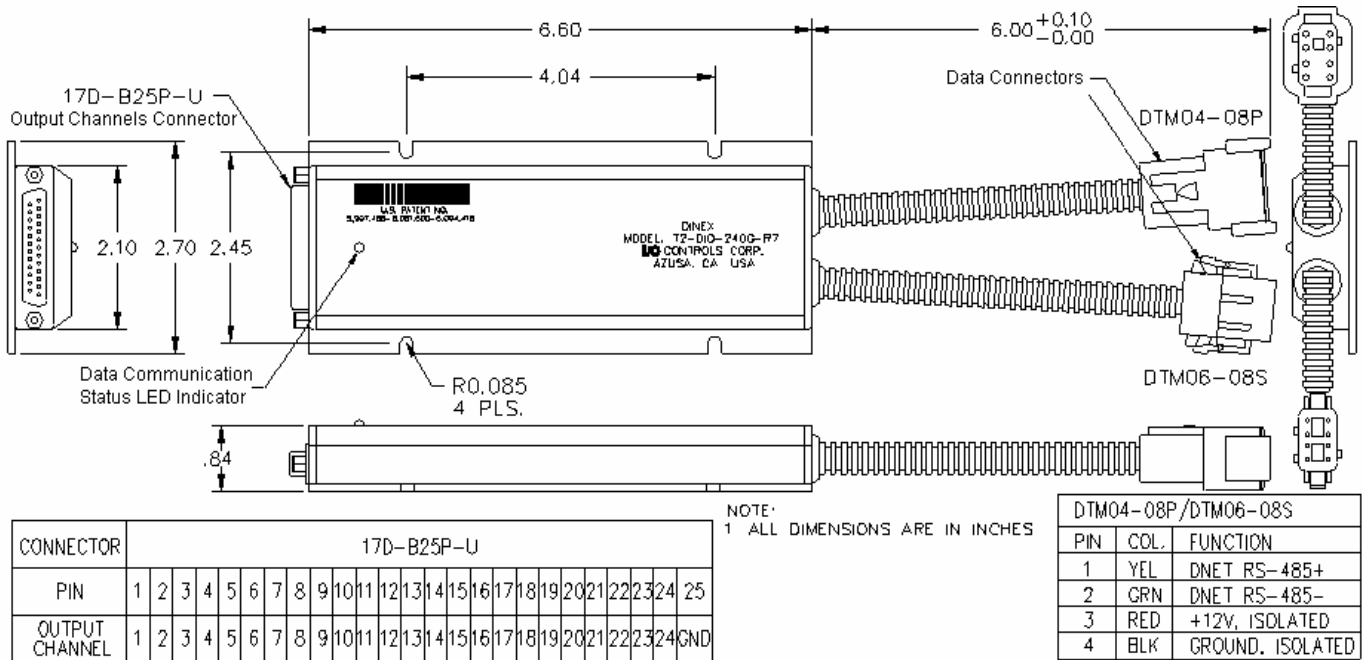


FIGURE: 3.5 -- T2-DIO-24OG-R7 MODULE DIAGRAM

- For driving LED modules.
- Total 24 outputs
- LEDs on the instrument panel are the outputs.
- Acts as gateway on DINEX network and other host systems.

32LED Indicator Panel T2-32LED-OB-01

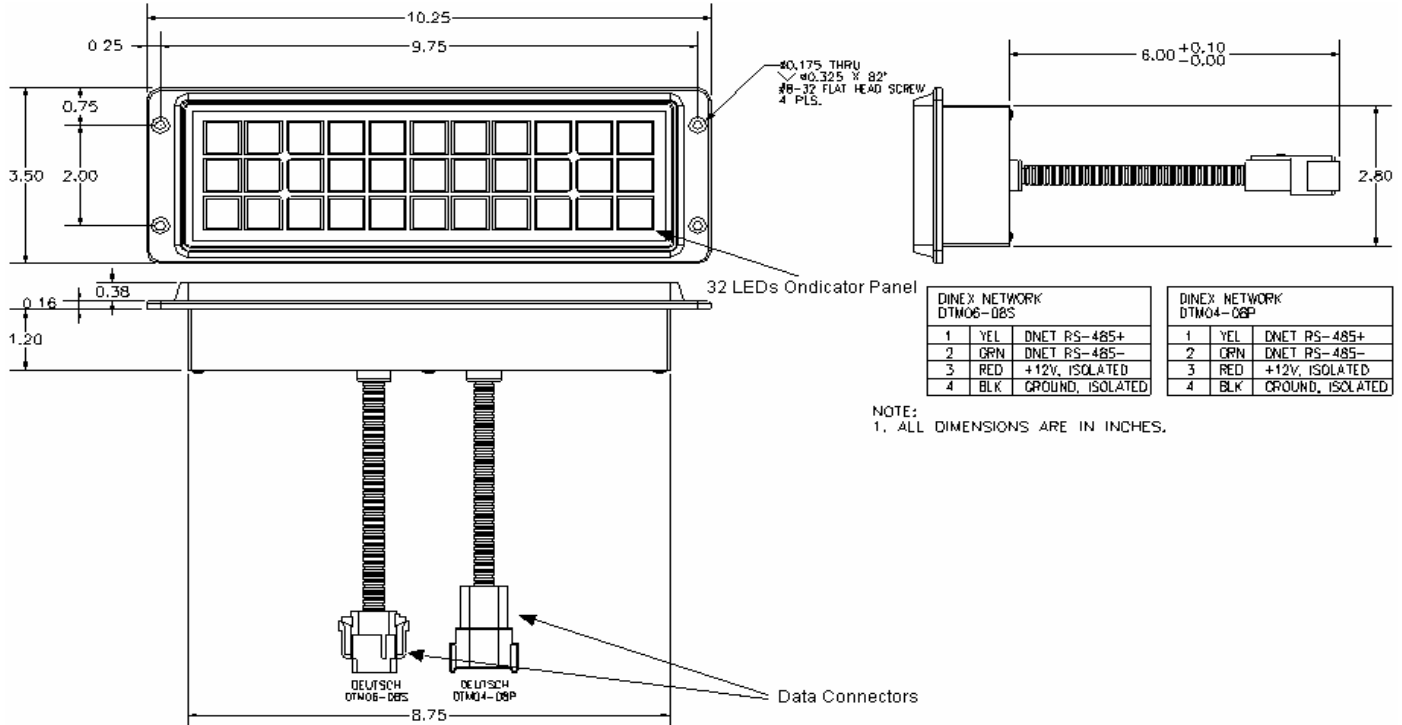


FIGURE: 3.6 -- T2-32LED-OB-01 PANEL DIAGRAM

- Instrument Panel LEDs are multiplexing modules.
- Total 32 LED indicators.
- LEDs on the instrument panel are the outputs.
- Each indicator contains multiple LED elements.
- The LED cluster can be removed/replaced as a unit or LEDs can be removed/replaced individually.
- Replacement LEDs are not labeled (each label is a separate piece).
- First indication that an LED is failing maybe a dimming of the LED.

4

- Dinx G2A System “Tree” Structure
- Dinx G2A System Ring-Loop Hookup Structure
- Dual Voltage Capability

How Is It All Hooked Together ?

Dinx G2A System “Tree” Structure

The Dinx G2A System “Tree” hierarchy and data bus layout is shown below:

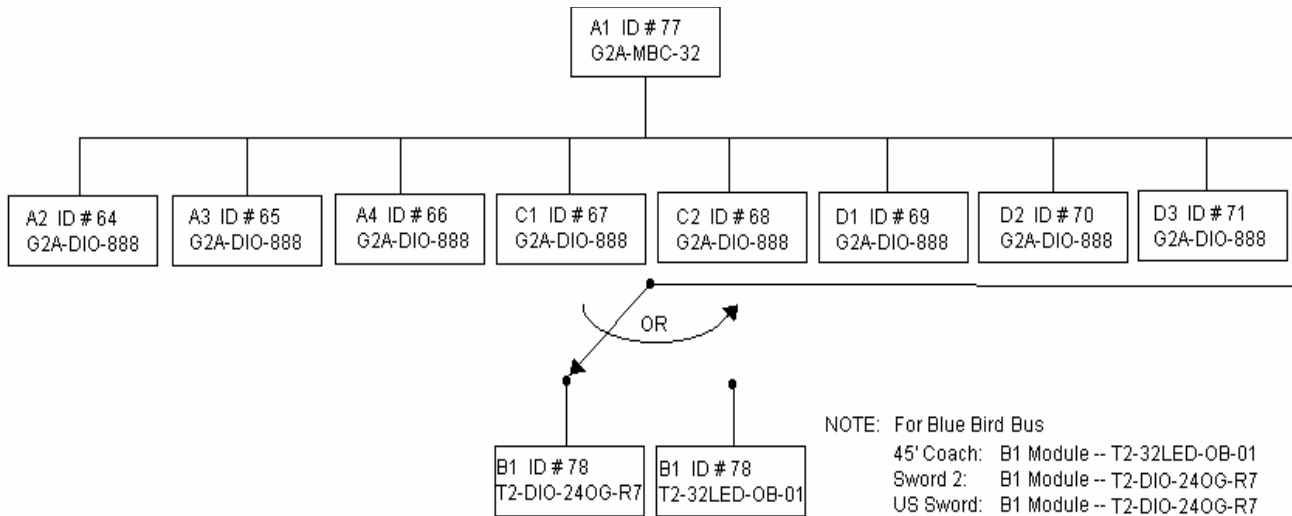


FIGURE: 4.1 – DINEX G2A SYSTEM “TREE” STRUCTURE DIAGRAM

G2A-MBC-32 = MAIN BUS CONTROLLER MODULE WITH PMS
G2A-DIO-888 = DIGITAL INPUT/OUTPUT MODULE
T2-DIO-24OG-R7 = 24 OUTPUTS GATEWAY MODULE
T2-32LED-OB-01 = DASHBOARD LAMP CLUSTER OR TELL-TALE PANEL

Dinex G2A System Ring-Loop Hookup Structure

The Dinex G2A System – Ring-Loop Hookup Structure shown below:

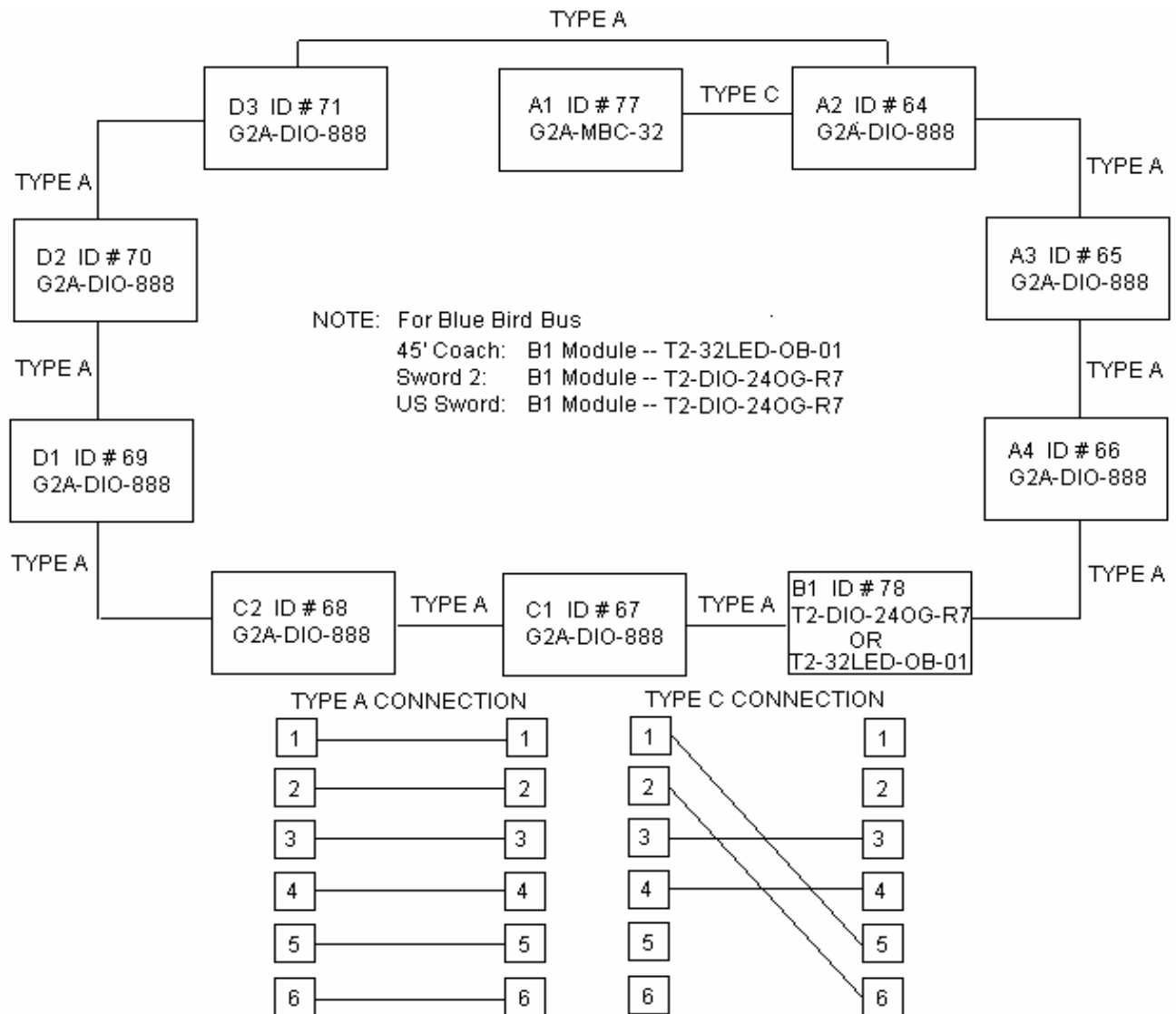


FIGURE: 4.2 – DINEX G2A SYSTEM RING-LOOP HOOKUP DIAGRAM

Dual Voltage Capability

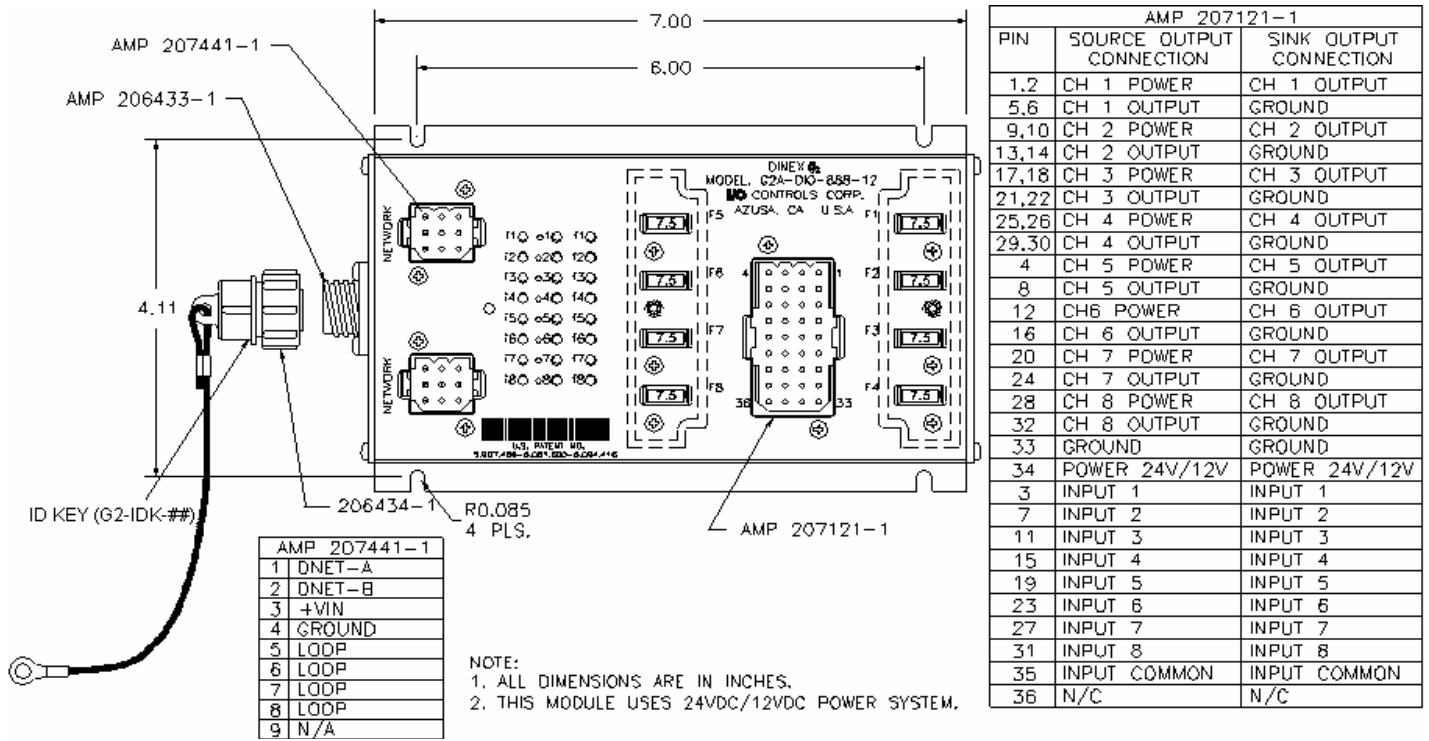


FIGURE: 4.3 – INPUTS, OUTPUTS, & POWER CONNECTION DIAGRAM

NOTE: When removing wires from panel power studs, be sure to tag and reinstall removed wires to the same location.

- DIO modules have split circuits to allow two different output circuit voltages (12 or 24 volts) from a single module.
- Power can be 12/12, 12/24, 24/12, 24/24 volts depending on the voltage requirements of circuits being controlled.
- Pin #35 supplies power to the eight inputs.
- “Inputs” to the multiplex system are grounded at a switch.
- Ground wire is in the AMP type connector PIN # 33

Dual Voltage Capability

- Three Basic Steps to Diagnosis and Troubleshooting
- Visual Inspection
- BIST (Built-In Self Test)

5

Diagnosis and Troubleshooting

Diagnosis and Troubleshooting

The DINEX G2A system is composed of a network of rugged modules connected to a single data bus. This data bus interfaces with DINEX G2A modules. The DINEX G2A modules interface with sensors, switches, actuators and vehicle control devices.

The simplified wiring of the DINEX G2A network control system makes troubleshooting relatively simple in most cases.

Three Basic Steps to Diagnosis and Troubleshooting:

- Visual Inspection
- I/O Test Kit Verification
- Software Testing and Programming
- BIST (Built-In Self Test)

1. Visual Inspection

Eighty-five percent of failed circuits can be diagnosed by using modules' LEDs -- failures usually related to defective parts, i.e., bulbs, switches, etc. This chapter discusses in depth how to diagnose and troubleshoot through visual inspection

2 I/O Test Kit Verification

Note: If the three steps fail to locate or solve the faults, then the module is suspect. The module must be returned to the manufacturer for repair.

The I/O Control Test Kit provides for the testing of modules and the communication network. The I/O Control Test Kit will assist you in diagnosing those faults not found during visual inspection. *The next chapter will introduce these test kits in more details.*

3. Software Testing and Programming

No internal repairs are permitted unless authorized by the factory.

Software Testing provides a way of verifying module programming or programming of replacement modules. *Please refer to bus manufacturer's control logic diagrams/ladder charts for software testing and programming.*

4. BIST (Built-In Self Test)

The BIST may be invoked any time. It is a passive test which uses the feedback circuits to check the output circuits. It also checks the DINEX module communications.

Visual Inspection:

- Visual inspection of the LEDs on the DINEX G2A modules will normally lead to the identification of 85% of all faults.
- Use Ladder Logic Diagrams -- to identify the relationship and the hook-up of devices -- and,
- Electrical Schematics -- to trace the circuits linked to a malfunctioning module indicated by the LED -- is all that is required at the Visual Inspection Level.
- Input Circuit LEDs.
- Ground connection – Verify that pin 16 of the large round AMP connector has a good chassis ground connection.

All modules, except PMS and junction boxes, have green LEDs to monitor input circuits. Each input has its own address. The lighted green LED indicates active input

Note: Some vehicle options -- such as mirror heaters, air dryers, etc.-- will not turn on the amber LED until a preset temperature is reached.

■ Output Circuit LEDs

DIO-888s use two LEDs, amber and red, to monitor output. If the circuit is off, the amber LED is lighted. The circuit is complete and ready, but is not active.

A lighted red LED indicates that the circuit is active.
The amber LED is off.

LED marker lights will not turn on the amber LED's at all.

- Using LED on the modules to diagnose failed components.
- The “tools” necessary to diagnose faults are LEDs on the modules, “Ladder Charts” (or logic diagrams) and Electrical Schematics.
- When an LED does not indicate proper circuit operation, the electrical schematic can be used to trace the circuit from the module(s) to the input or output.
- Multiplex Test Equipment, Step 2, should not be necessary until, and only until, visual inspection has failed to indicate the failure or to confirm the functionality of the operation.

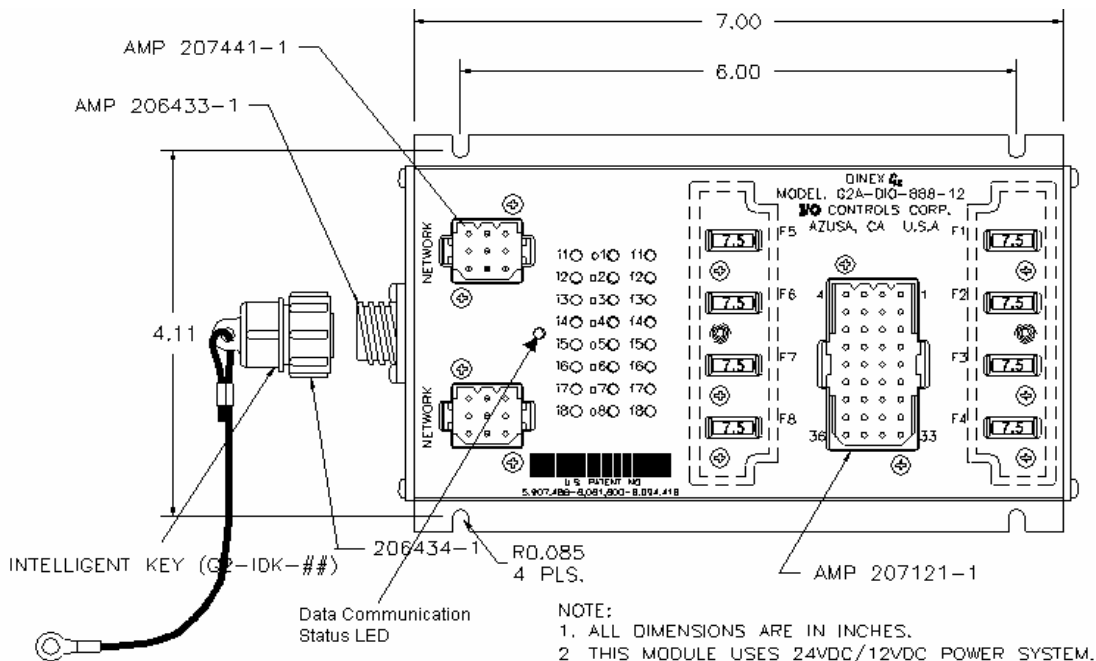
Checking the Input LEDs

- The MBC and DIO modules have green LEDs to monitor all inputs.
- Each input point has a unique location or sub-address. When the green LED is on, the input is ACTIVE.

LEDs Monitor Circuits

NOTE: During normal operation, the red and amber LEDs alternate off and on.

- With the circuit turned off: An amber LED comes on. (The amber LED indicates circuit integrity.) A circuit is complete and ready, but **IT DOES NOT MEAN THE CIRCUIT IS ACTIVE.**
- When the circuit is in use: A red LED will come on. This indicates that



the circuit is ACTIVE. The amber LED turns off.

FIGURE: 5.1 – DATA COMMUNICATION STATUS LED DIAGRAM

The Data Communications Status LED

NOTE: On some models, according to specification of each particular customer, the Data Communication Status LED is located on the left side panel of the module.

- The MBC, and DIO modules have Data Communications Status LED mounted on the left side of the face of the module, as shown in the figure above for a DIO module.
- The Data Link LED flashes at a rapid rate to indicate that the module is communicating.
- Modules in communication with DIOs respond with flashing LEDs. When multiple circuits respond, check the Data Link LED to see if it is flashing.

Tips on locating the site of a Failure using LEDs on the DIO modules

- If the load circuit is open -- i.e., bulb blown, burned solenoid, broken wire, etc.—the amber LED will not light up.
- If both amber and red LEDs are on when the circuit is active, check the fuse.
- If a module's red LED is out,
 - a) check the data communication status LED on the left side of the module
 - b) check cable for loose connections or damage,
 - c) or check the related input status.

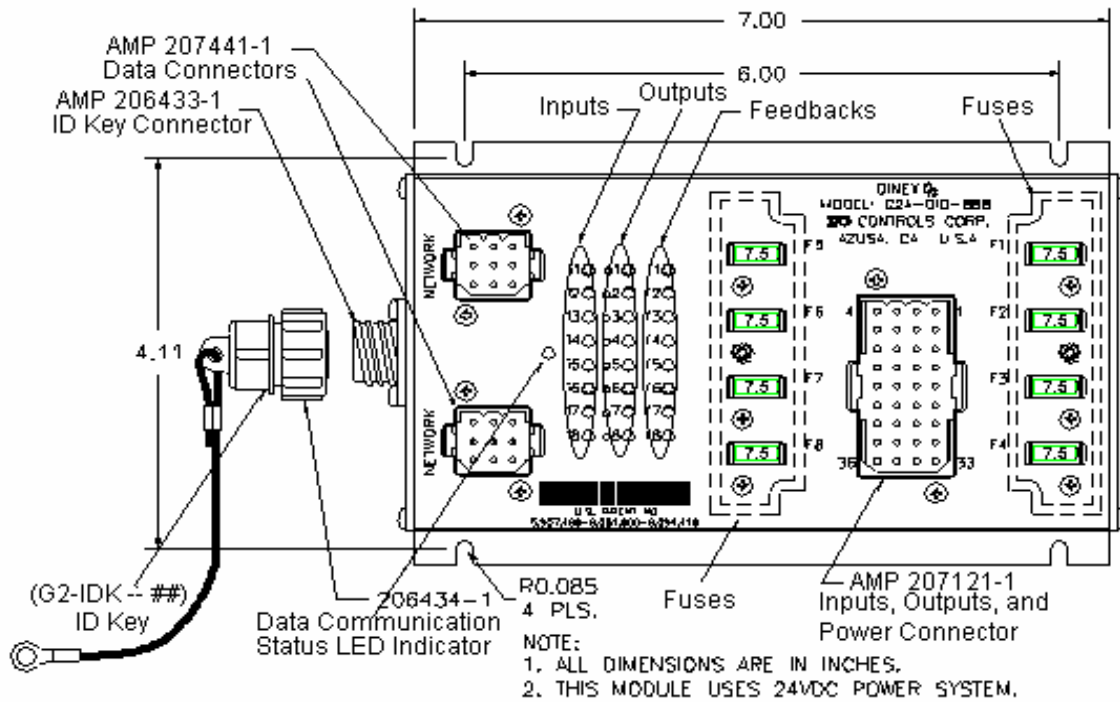


FIGURE: 5.2 –LEDS VISUAL INSPECTION DIAGRAM

Tips on locating the site of a Failure using LEDs on the DIO modules

- Internal circuits in the multiplex units (DIO) allow a small amount of current to flow to the output load -- even when the load is inactive.
- Current from the battery bus bar will pass through the amber LED, a large resistor, and the load to get to ground.
- A blown fuse will still allow current to flow through the amber LED and the red LED will be on because the circuit is trying to activate itself.

The No Connection Circuit

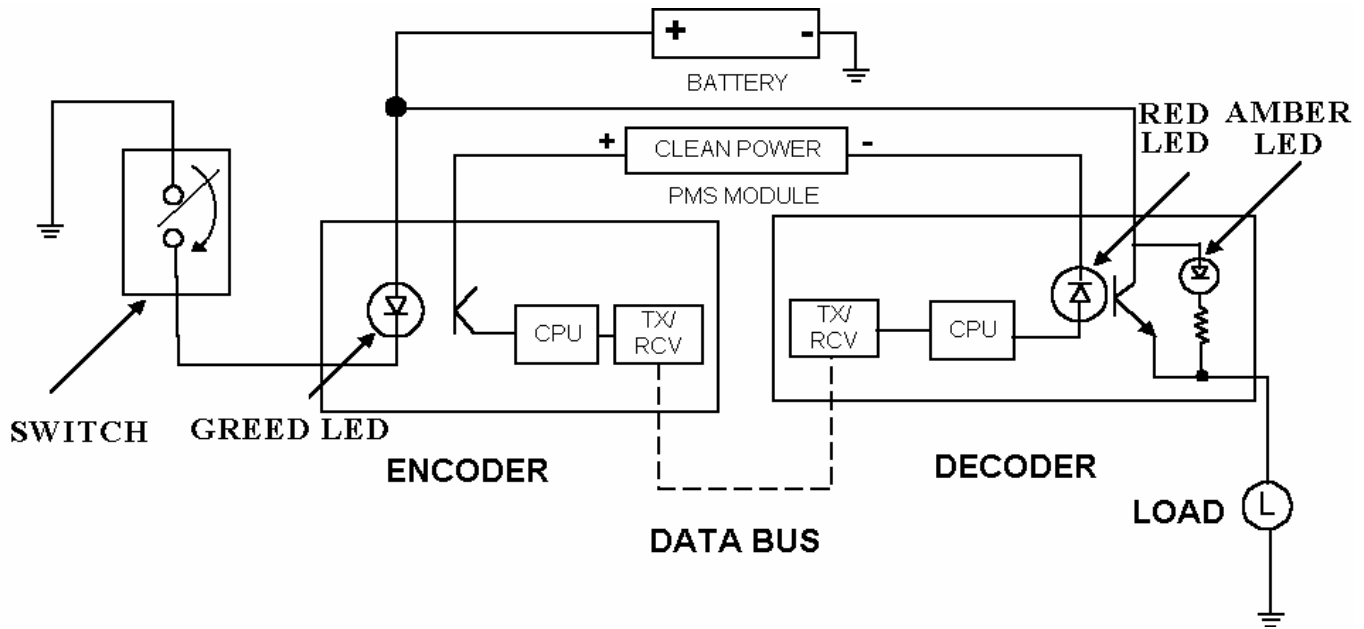


FIGURE: 5.3 – FUNCTIONAL DIAGRAM OF DINEX MPX SYSTEM

- The simplified circuit on the previous page shows that there are no direct links among input, the data bus, and the output.
 - The green LED turns on the sensor and switch inputs.
 - A light sensing (solar) transistor closes and a CPU sends out a signal on the data bus.
 - The receiving CPU lights the red LED.
 - Another light sensing transistor closes and completes the circuit from the battery to the load.
- No direct wire links eliminates the need for external diodes.
- Danger of voltage spikes damaging the data loop or modules is eliminated.

LADDER CHARTS

Understanding the Ladder Charts

Think of ladder charts as logic diagrams, see below:

Active And Inactive Inputs

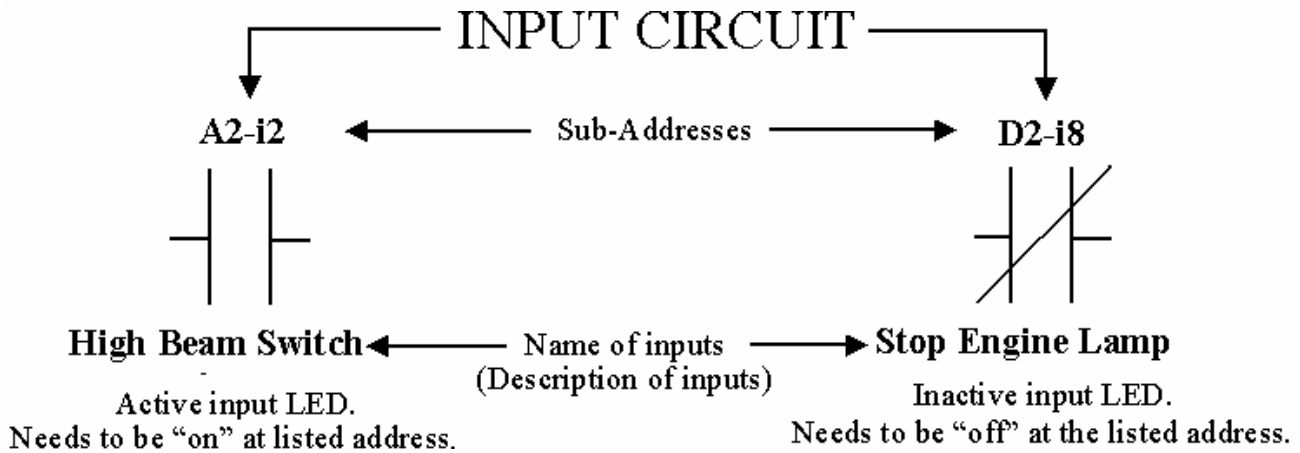


FIGURE: 5.4 – ACTIVE & INACTIVE COMPONENT DIAGRAM

- The MBC can be programmed to use open (inactive) or closed (active) switch input to determine a course of action.
- Imagine a relay that is normally open. Imagine the LED as a relay coil:

-With no power to the relay, the LED is off. The relay is in the normally open position.

-When power is applied, the LED is on and the relay is in the closed position. The current flows through the control load.

About Ladder Charts

- Simple charts make diagnosing circuits easy.
- All conditions must be met to complete an action.
- Charts indicate any parallel circuits for an action.

5-Diagnosis and Troubleshooting

What Do Ladder Charts Look Like?

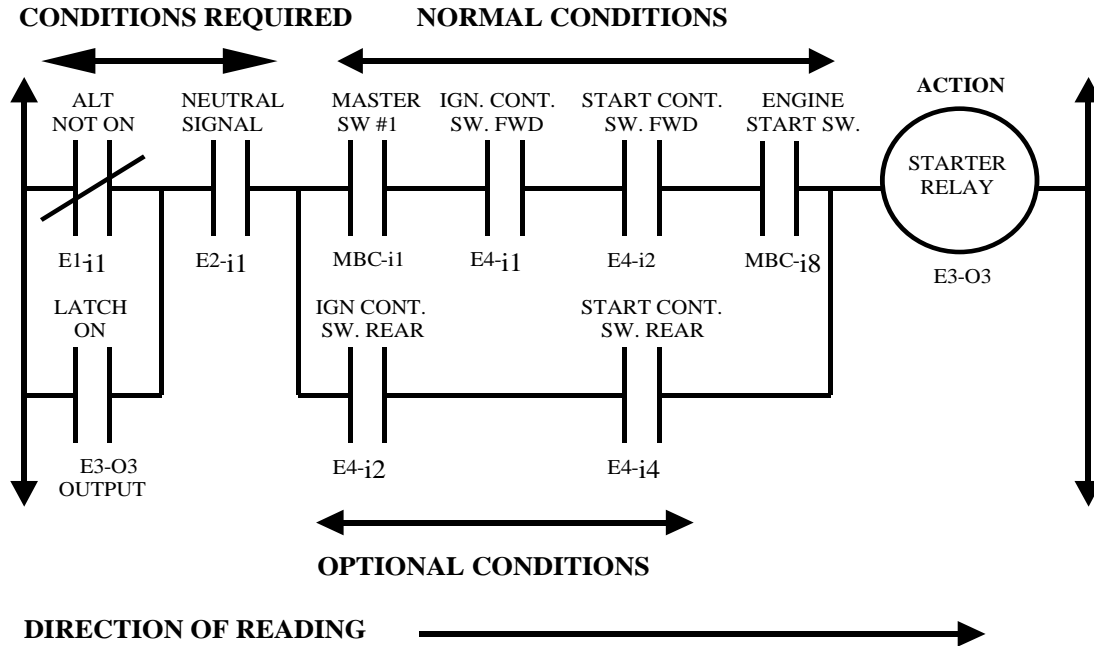


FIGURE: 5.5 – LADDER CHARTS DIAGRAM

More About Ladder Charts

- The Ladder Chart above shows each step necessary for a vehicle to be started.
 1. The alternator must not be charging.
 2. Vehicle is in neutral.
 3. From the front -- the master switch is on.
 4. From the rear -- the rear ignition and starter switches may be used.
 5. From the rear -- the ignition and starter control switches are set in front start position.
 6. Use the starter button.
 7. “Latch On” function circuit is set for starter relay.
 - a. Circuit remains complete as long as starter is cranking, even if alternator starts to charge.
 - b. Starter can not be re-engaged if alternator is charging.