



Service Manual

6HBW23

Serial Number 22,000 and up

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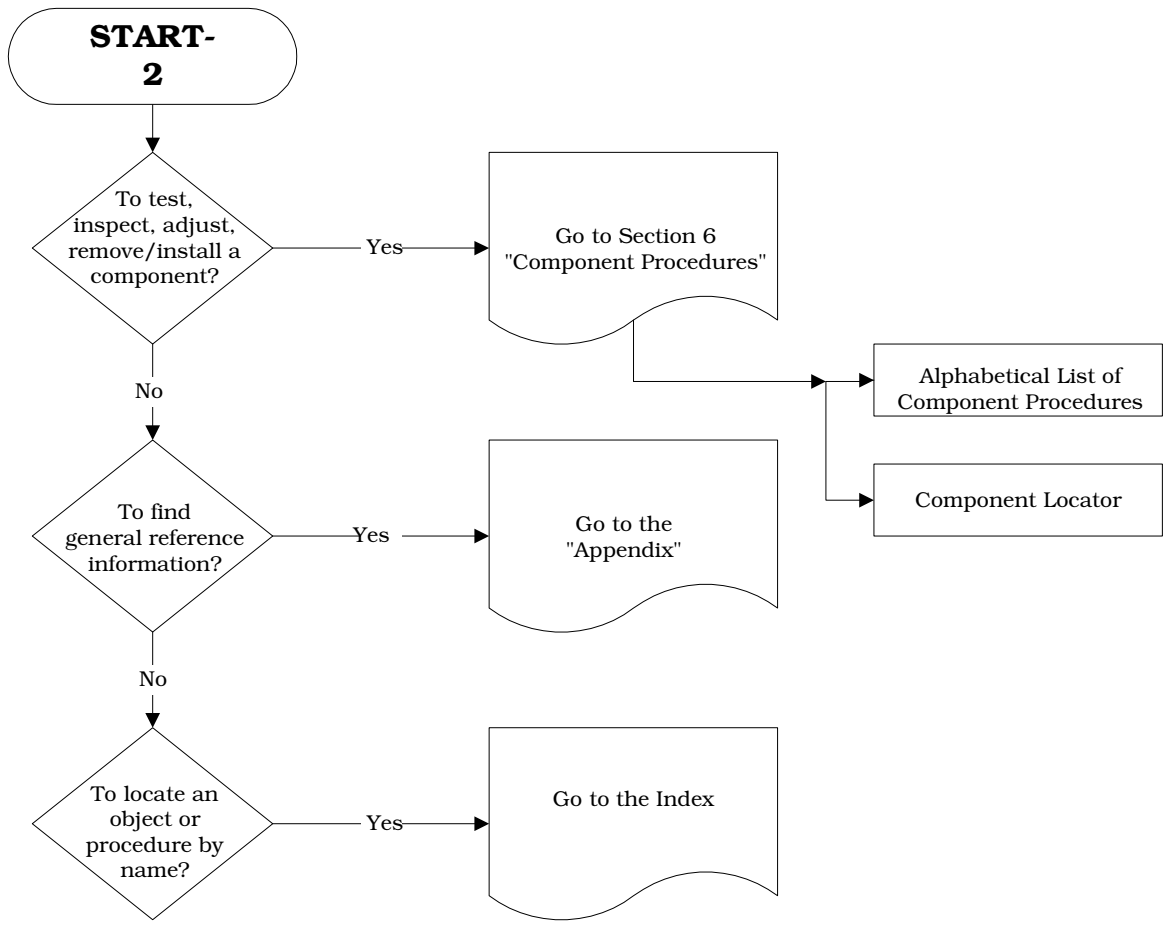
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START Page



Towing

Towing

To safely tow this truck:

1. Lower the forks and remove any load.
2. Press the red OFF key (●) on the keypad and disconnect the battery connector.
3. Using a suitable towing vehicle, lift the tractor end of the truck until the drive tire is no more than 1 in. (25.4 mm) off the floor.
4. Tow the truck slowly in the tractor-first direction.

NOTE: If a suitable towing vehicle is not available, the electromagnetic brake must be disabled to move this truck. See “Mechanically Releasing the Brake” on page 6-34.



Electrical Troubleshooting Guidelines

5. Use an ammeter to measure the leakage current to an unpainted, grounded surface on the frame at B+, B-, all fuses, and all motors. If the current is less than 0.001 ampere (1mA), the truck system passes. If the current exceeds 1mA, go to step 6.
6. To find the cause of the low resistance, disconnect the power cables from each motor or major subassembly one at a time, to determine if that item is causing the low resistance.

Control Handle Display and Programming

Code E114 - Traction Motor Speed Fault	
Reason	Controller detected stalled traction motor.
Possible Cause/ Corrective Action	Power amplifier may be bad. Traction motor stalled. Excessive traction motor load at low speed. Troubleshoot possible causes.
Code E140 - Checksum Error	
Reason	ETAC software detected that checksum was invalid.
Possible Cause/ Corrective Action	Internal ETAC fault (Control handle head) or bad software. Troubleshoot possible causes.
Code E141 - Software Problem	
Reason	ETAC found problem with software.
Possible Cause/ Corrective Action	Internal ETAC fault (Control handle head) or bad software; problem while downloading. Troubleshoot possible causes.
Code E142 - Power Amplifier Disable Error	
Reason	Power amplifier detected a major fault.
Possible Cause/ Corrective Action	Severe overvoltage (especially at main contactor close); high current at digital input. Wrong battery may be installed. Troubleshoot possible causes.
Code E150 - Drive Communication Error	
Reason	ETAC did not receive CAN data from the power amplifier.
Possible Cause/ Corrective Action	Broken CAN cable; bad connection, outside interference, or low voltage; bad power amplifier; ETAC internal error. Troubleshoot possible causes.
Code E151 - Drive Communication Tx Error	
Reason	ETAC could not send CAN data to the power amplifier.
Possible Cause/ Corrective Action	Broken CAN cable; bad connection, outside interference, or low voltage; bad power amplifier; ETAC internal error. Troubleshoot possible causes.
Code E157 - CAN-bus Off Error	
Reason	ETAC detected problem with the CAN-bus.
Possible Cause/ Corrective Action	CAN-bus problem, harness, or hardware problem; bad power amplifier; ETAC internal error. Troubleshoot possible causes.
Code E159 - Over Run Error	
Reason	ETAC detected problem with the CAN-bus.
Possible Cause/ Corrective Action	CAN-bus problem, harness, or hardware problem; bad power amplifier; ETAC internal error. Troubleshoot possible causes.
Code E160 - Error In Reversing Circuit	
Reason	ETAC detected problem with throttle position sensors, including the sensor used to initiate emergency reversing. See also Code C20.
Possible Cause/ Corrective Action	Bad ETAC. Troubleshoot possible causes.

Power Amplifier Fault Codes

Power Amplifier Fault Codes

An internal microcontroller automatically checks the function of the power amplifier. When this microcontroller detects a fault, the status LED on the bottom of the power amplifier flashes the appropriate code. See Table 5-7. Under normal operation, the LED flashes a single flash (heartbeat) at approx. one flash every five seconds. A double flash indicates a fault has been detected by the microcontroller.

Table 5-7 describes the fault codes that are shown on the status LED or read using the Programmable Maintenance Tool (PMT). See “Programmable Maintenance Tool (PMT)” on page 5-26. Correct faults by following the “Troubleshooting Flowcharts” on page 5-33.

Table 5-7. Fault Codes

Fault Code		PMT Display	Possible Cause	Explanation
LED OFF	■	N/A	Open circuit at power amplifier +24Vdc logic input due to wire, fuse, or bad power amplifier.	Power amplifier does not have voltage at +24Vdc logic power supply input.
Solid ON	□	N/A	Bad power amplifier.	Power amplifier is not functioning correctly.
Single flash	□	NO KNOWN FAULTS	N/A	Normal “heartbeat”, everything is okay.
1, 1	□ □	CURRENT SHUNT FAULT	See “Code E202 - Power Amplifier Sensor Error” on page 5-15.	
1, 2	□ □ □	HW FAILSAFE	See “Code E214 - Power Amplifier CAN Time-out” on page 5-15 if ETAC is keyed ON.	Power amplifier is reporting that it is not receiving CAN messages from the ETAC, or that selftest failed.
			Otherwise, the controller is reporting it is not receiving CAN messages from the ETAC, which is normal when the truck is not turned ON.	
1, 3	□ □ □	M- SHORTED	See “Code E201 - M- Error” on page 5-15.	
1, 4	□ □ □ □	SRO	Bad power amplifier or ETAC.	Power amplifier is not setup or functioning properly.
2, 1	□ □ □	THROTTLE FAULT 1	Bad power amplifier.	
2, 2	□ □ □	EMR REV WIRING		
2, 3	□ □ □ □	HPD	Bad power amplifier or ETAC.	
2, 4	□ □ □ □ □	THROTTLE FAULT 2	Bad power amplifier.	
3, 1	□ □ □ □	CONT COIL/FLD SHORT	See “Code E106 - Digital Output or Field Overcurrent” on page 5-13.	
3, 2	□ □ □ □ □	MAIN CONT WELDED	Bad power amplifier or ETAC.	Power amplifier is not setup or functioning properly.
3, 3	□ □ □ □ □ □	FIELD OPEN	See “Code E200 - Field Open” on page 5-15.	

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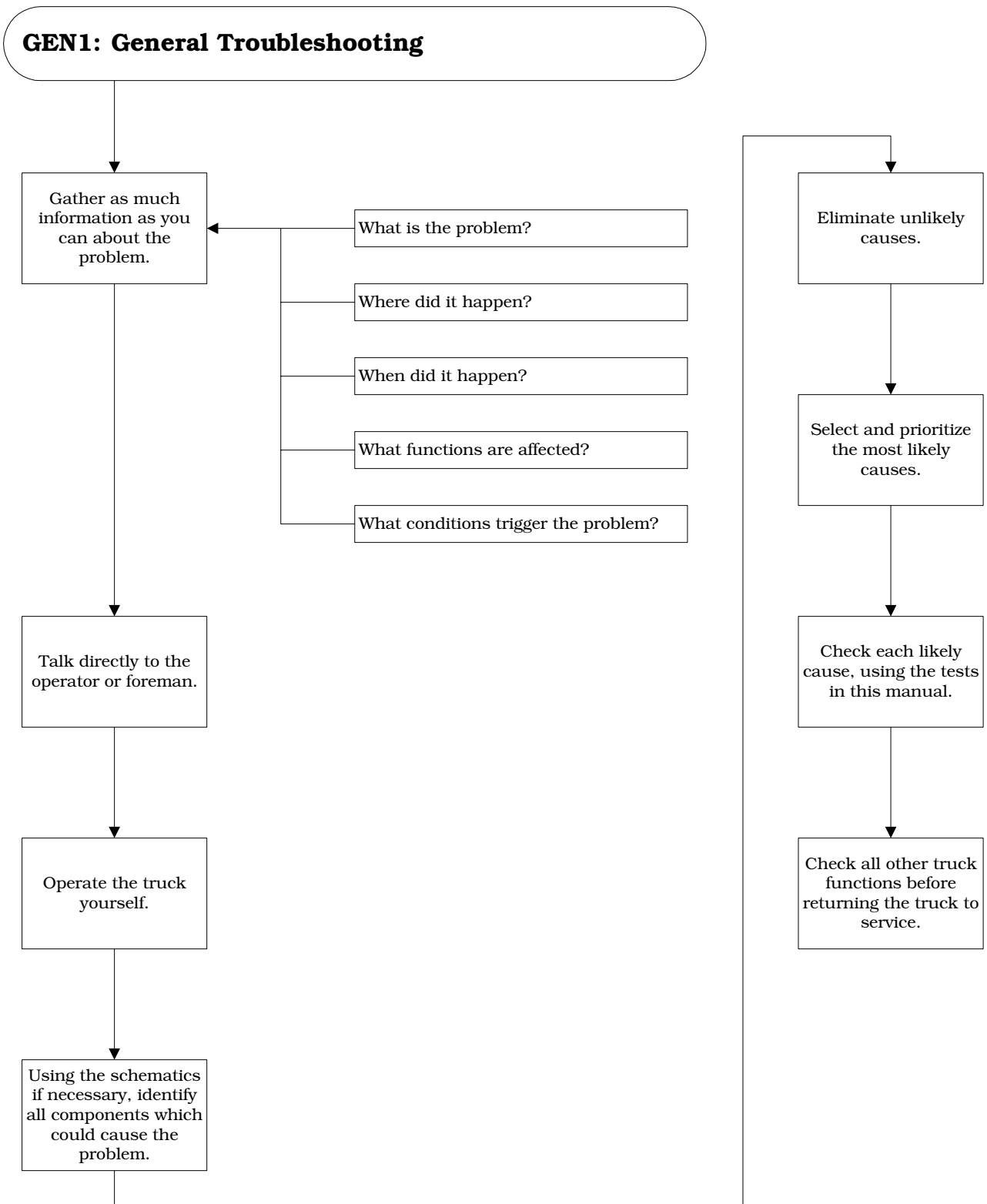
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Troubleshooting Flowcharts



S

Switches

Arm Angle	6-24
General	6-49
Key Switch (Optional)	6-26
Lift-Limit	6-25
Master Control ON/OFF	6-23

W

Wheels

Load	6-45
Wiring Harness	6-11

Fuses

Fuses

NOTE: For replacement parts information refer to Parts Catalog.

Under extreme operating conditions, fuses (F50, F51) protect the electrical circuits and components from excessive current or voltage overloads.

Test/Inspection

Examine each fuse for signs of overheating, discoloration, cracking, or other physical damage. Replace the fuse if you find damage. See Figure 6-7.

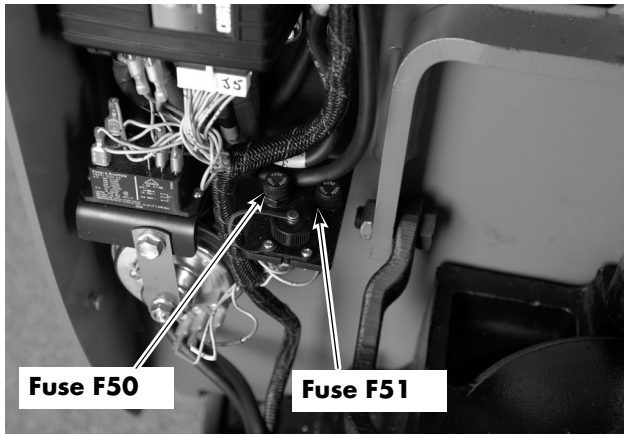


Figure 6-7. Fuse/Circuit Breaker Location

To test a fuse, remove it or isolate it from the electrical circuit. Do this by removing the fuse from the truck or by removing all the connections from one side of the fuse.

Use an ohmmeter set to Rx1 scale and measure the resistance across the fuse. The resistance must be less than 1 ohm.

Master Control Relay



Drive Unit

3. If the outside edge of the hub is not flush with the edge of the metal insert in the old tire, measure how far the hub is recessed inside the tire. The new tire must be placed in the same position the old tire was installed on the hub. You can use a spacer (slightly smaller in diameter than the inside diameter of the tire insert and the same thickness as the depth of the recess) to obtain the correct amount of recession.
4. Position the hub assembly with the old tire on top of the circular ram so the outside of the wheel is positioned upward. The outside edge of the hub has a chamfer to help guide the new tire on the wheel. The chamfered edge must always be the leading edge when a tire is pressed on the hub.
5. Center the hub assembly on top of the ram and make sure they mate squarely.
6. Position the new tire with its chamfered insert facing the hub. Align the new tire and the hub so they are concentric.
7. Begin pressing the new tire on the hub and the old tire off the wheel. Run the press slowly for the first few inches of travel because this is the critical step of the operation. If the tire starts to cock, stop the press immediately and realign the tire. Use a soft-headed mallet to realign the tire on the hub.

NOTE: If the new tire does not press on with a minimum pressure of 5 tons (68,947 kPa), replace the hub.

8. Release the press. Remove the wheel, tire assembly and the old tire from the press table. Inspect the wheel and tire assembly.
9. Install the wheel and tire assembly on the drive axle of the truck. Reinstall the five drive wheel mounting nuts. Torque to 55 ft. lbs. (75 Nm).

Drive Motor

Drive Motor

NOTE: For replacement parts information refer to Parts Catalog.

Brush Replacement

1. Press the red OFF (●) key on the keypad. Disconnect the battery connector.
2. Remove the tractor covers.
3. Remove any shields around the motor end cover to expose the brushes. See Figure 6-39.



Figure 6-39: Drive Motor Brush Shield

4. Lift the spring off the brush, pull the brush out of the holder.
5. Follow the brush replacement instructions. See “Drive Motor Brush Inspection” on page 6-35.
6. Replace the shields around the motor end that were removed in step 3.

Motor Disassembly

1. Press the red OFF (●) key on the keypad. Disconnect the battery connector.
2. Remove the tractor covers.
3. Disconnect the power cables from the terminal block on the drive motor, noting their correct position.
4. Follow steps 1 through 5 in “Disassembly” on page 6-28 to remove the top (pinion) gear attached to the motor armature shaft.

5. Remove the electromagnetic brake assembly by removing the three mounting bolts that secure the assembly to the motor end bell cover.
6. Remove the brake disc from the brake hub.
7. Remove the retaining ring that secures the brake hub. Remove the hub and woodruff key.
8. Remove the four screws and lock washers holding the brush end bell to the housing.
9. Separate the end bell from the motor housing. The armature will come out with the end bell.
10. To remove the end bell from the armature, remove the snap ring that holds the bearing in the end bell. If needed, press off the bearing and replace.

Installation

1. Thoroughly clean all parts with solvent or other non-corrosive cleaning fluid. Air dry all parts.

NOTE: Assemble the drive motor in a dirt-free area.

2. If previously removed, install the drive motor bearing, bearing shim, and seal in the gear case.

NOTE: The seal must be replaced any time the motor is removed from the housing.

The seal must be installed correctly with its open side and seal ring positioned *towards* the bearing.

3. Reinstall the end bell cover, with the brush plate attached, on the motor armature shaft.
4. Carefully slide the drive motor armature in the motor housing.
5. Attach the end bell cover to the motor housing with the four cap screws.
6. Install the pinion gear, woodruff key, and the retaining ring on the armature shaft.
7. Use Permatex gasket eliminator on the mating surface and install the gear case cover.

Hydraulic Components

Installation

1. Stand the pump assembly on end, with the adapter body facing up.
2. Set aside the pump drive coupling for later reuse.

NOTE: The coupling is the mechanical connection between the pump shaft and the electric motor armature shaft. It may have been removed with the motor.

3. Insert the pump drive coupling on the end of the pump shaft and fill coupling cavity with lubricant (Molybdenum anti-seize compound).
4. Rotate the pump or the motor shaft to align the motor shaft correctly with the coupling.
5. Install the new motor on the adapter body. Rotate the pump or the motor shaft if necessary to allow the motor to contact the adapter body.
6. Insert the screws into the motor end plate, through the motor, and into the adapter body.
7. Make sure the motor is mating flush with the adapter body. Torque screws to 36 to 45 in. lb. (4 to 5 Nm) maximum.
8. Install the start solenoid.
9. Install the hydraulic unit. See “Hydraulic Unit” on page 6-49.

Hydraulic Fluid**Proper Level**

To prevent air from entering the lines, fill the fluid level (with the forks fully lowered) to within 1 in. (25.4 mm) below the fill port elbow. See Figure 6-43. The usable reservoir capacity is 0.8 qt. (0.75 L). Add the specified fluid if necessary. See “Lubrication Equivalency Chart” on page A-2.

Changing Fluid

Store and handle the hydraulic fluid with extreme care to prevent moisture and foreign matter from entering the hydraulic system.

Contaminated hydraulic fluid is the major cause of hydraulic system failures. Keep any service equipment, such as containers, funnels, and hand pumps, clean at all times. Cover them when not in use.

1. Lower the forks.
2. Press the red OFF (●) key on the keypad. Disconnect the battery connector.
3. Remove the upper tractor cover.
4. Disconnect the lift cylinder hose at the hydraulic cylinder. See Figure 6-49.

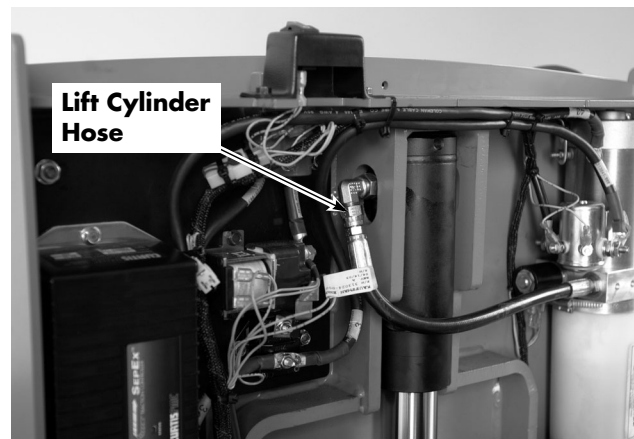


Figure 6-49. Hydraulic Connections

5. Insert the hose in a waste fluid container.

⚠ WARNING

Fluid is under pressure and may spray or splash. Point hose away from your body and hold firmly in waste fluid container.

6. Connect the battery connector and press the green ON (I) key on the keypad.
7. Run the hydraulic pump by pressing the lift button until all the hydraulic fluid is pumped from the system.
8. Press the red OFF (●) key on the keypad. Disconnect the battery connector.
9. Reconnect the lift cylinder hose.
10. Remove the vent plug and fill the reservoir to within 1 in. (25.4 mm) below the filler port elbow with the recommended

Decimal Equivalent Chart

4ths	8ths	16ths	32nds	64ths	To 3 Places	To 2 Places	MM Equivalent
				33/64	.516	.52	13.097
			17/32		.531	.53	13.494
				35/64	.547	.55	13.891
		9/16			.562	.56	14.288
				37/64	.578	.58	14.684
			19/32		.594	.59	15.081
				39/64	.609	.61	15.478
	5/8				.625	.62	15.875
				41/64	.641	.64	16.272
			21/32		.665	.66	16.669
				43/64	.672	.67	17.065
		11/16			.688	.69	17.462
				45/64	.703	.70	17.859
			23/32		.719	.72	18.256
				47/64	.734	.73	18.653
3/4					.750	.75	19.050
				49/64	.766	.77	19.447
			25/32		.781	.78	19.844
				51/64	.797	.80	20.241
		13/16			.812	.81	20.637
				53/64	.828	.83	21.034
			27/32		.844	.84	21.431
				55/64	.859	.86	21.828
	7/8				.875	.88	22.225
				57/64	.891	.89	22.622
			29/32		.906	.91	23.019
				59/64	.922	.92	23.416
		15/16			.938	.94	23.812
				61/64	.953	.95	24.209
			31/32		.969	.97	24.606
				63/64	.984	.98	25.003
					1.000	1.00	25.400

Table A-5. Decimal Equivalent Chart

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