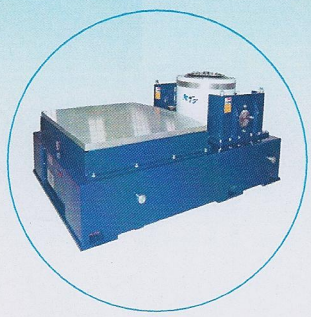
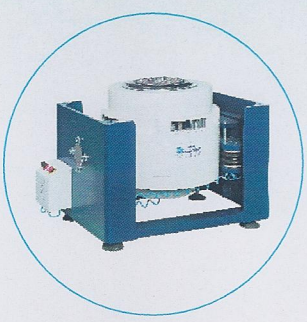
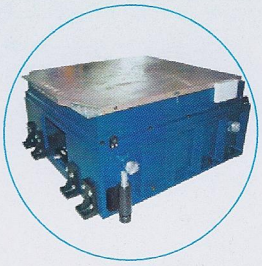
ets solutions

ADVANCING TECHNOLOGY IN DYNAMIC TESTING

GT SERIES SLIP TABLE
OPERATING & MAINTENANCE MANUAL







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Figures and Tables

Chapter 1 Introduction

1.1 General

The manual describes the installation, operation and maintenance of the ETS Solutions GT Series Slip Table System which includes stand-alone and unibase system. And the manual is used for both. It should be read in conjunction with the appropriate shaker system manual.

The ETS Solutions GT Series Slip Table System, guided oil film tables are designed with guided V-groove bearings, combined with magnesium slip plate. Oil is supplied through the granite block port holes and is dispersed throughout the underside of the slip plate. The oil film provides a low friction slip surface and a damping medium for restraint of resonances, pitch and roll moments.

The unibase series slip table has a common pedestal with a shaker, see Figure 1-1. This arrangement allows the shaker to be used normally in the vertical axis, or rotated to the horizontal axis and coupled, via a magnesium driver bar, to the slip table. The stand-alone series slip table has a separated pedestal supported by adjusting leveling feet, see Figure 1-2. The adjusting leveling feet can adjust the height of table in certain range to couple with the shaker table. This unique design allows for the locating of horizontal test tables with any vertical shaker from ETS Solutions or other manufacturer.

Note: The manual describes all recommended procedures that are normally required for proper system installation and use of a standard GT series slip table system. However, due to options or unexpected situations, these instructions may not accurately describe all conditions. If a problem occurs that cannot be solved by use of this manual, contact the ETS Solutions Service Department.

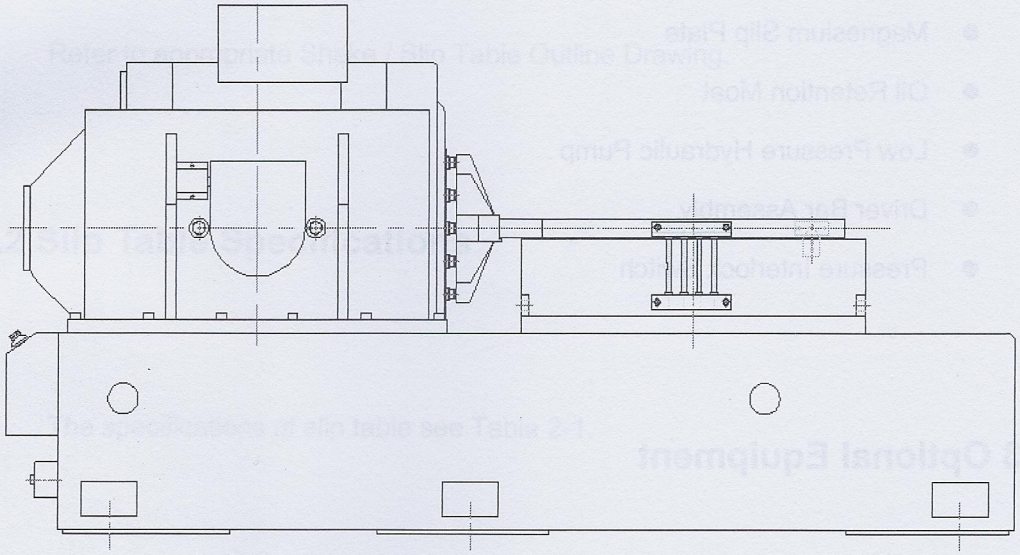


Figure 1-1 Shaker Assembly with Unibase Slip Table

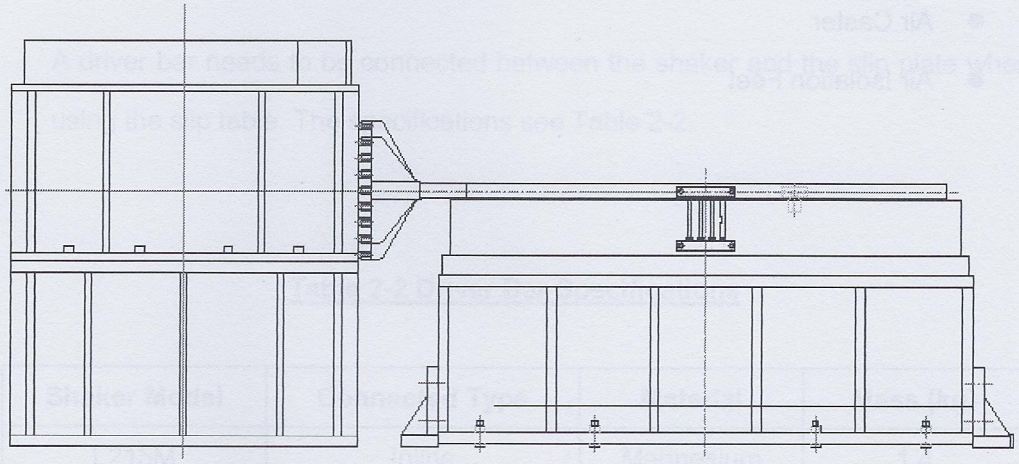


Figure 1-2 Shaker Assembly with Stand-alone Slip Table

1.2 GT Series Slip Table System consists of

- V-groove Bearing Assembly
- Pedestal
- Precision Granite Block
- Magnesium Slip Plate
- Oil Retention Moat
- Low Pressure Hydraulic Pump
- Driver Bar Assembly
- Pressure Interlock Switch

1.3 Optional Equipment

- Thermal Barrier
- Electrical Rotation Unit
- Air Caster
- Air Isolation Feet

Chapter 2 Specification

2.1 Dimension

Refer to appropriate Shake / Slip Table Outline Drawing.

2.2 Slip Table Specifications

The specifications of slip table see Table 2-1.

2.3 Driver Bar

A driver bar needs to be connected between the shaker and the slip plate when using the slip table. The specifications see Table 2-2.

Table 2-2 Driver Bar Specifications

Shaker Model	Connected Type	Material	Mass (kg)
L215M	Inline	Magnesium	1.4
L315M	Inline	Magnesium	1.4
L323A	Inline	Magnesium	2.8

L620M	Inline	Magnesium	2.2
M124M	Inline	Magnesium	4.6
M232A	Inline	Magnesium	5.8
M437A	Inline	Magnesium	8.0
M544A	Inline	Magnesium	19.7
M748A	Inline	Magnesium	19.7
LS232A	Inline	Magnesium	5.8
LS437A	Inline	Magnesium	8.0
LS444M	Inline	Magnesium	8.0
H1248A	Inline	Magnesium	19.7
H1859A	Inline	Magnesium	50

Table 2-1 Slip Table Specifications

Slip Table Model	Shaker Model	Working Area (mm*mm)	Thickness (mm)	Usable Frequency (Hz)	Slip Plate Mass (kg)	Bearing Qty.	Mass Per Bearing (kg)	Static Max. Payload (kg)	Overturning Moment		
									Pitch (Nm)	Roll (Nm)	Yaw (Nm)
GT300M	L215M	300*300	25	2,000	6	1	0.58	300	1,036	1,036	203
GT400M	L215M	400*400	25	2,000	9	1	0.58	300	1,295	1,295	203
	L315M										
	L323A										
	L620M										
GT500M	L315M	500*500	40	2,000	22	1	0.58	400	2,529	2,529	203
	L323A										
	L620M										
	M124M										
	M232A										
GT600M	L323A	600*600	40	2,000	31	1	0.58	550	4,370	4,370	203
	L620M										
	M124M										
	M232A										
	M337A										
	M437A										
GT700M	M124M	700*700	40	2,000	41	2	0.58	800	8,536	8,536	203
	M232A										
	M337A										
	M437A										

Slip Table Model	Shaker Model	Working Area (mm*mm)	Thickness (mm)	Usable Frequency (Hz)	Slip Plate Mass (kg)	Bearing Qty.	Mass Per Bearing (kg)	Static Max. Payload (kg)	Overturning Moment		
									Pitch (Nm)	Roll (Nm)	Yaw (Nm)
GT800M	M124M M232A M337A M437A M544A M748A	800*800	40	2,000	52	2	0.58	900	11,642	11,642	203
GT900M	M232A M337A M437A M544A M748A	900*900	40	2,000	65	2	0.58	1,100	14,749	14,749	203
GT1000M	M437A M544A M748A	1000*1000	50	2,000	99	2	0.58	1,200	20,232	20,232	203
GT1100M	M544A M748A	1100*1100	50	2,000	124	2	0.58	1,200	27,192	27,192	203
GT1200M	M544A M748A	1100*1100	50	2,000	141	2	0.58	1,200	34,961	34,961	203
Note: The actual values obtained for pitch, roll and yaw may be restricted by the nature of test load and fixture.											

2.4 Low Pressure Hydraulic Pump

The hydraulic pump operates on 380 VAC, three-phase, 50 Hz or as per order.

The units working voltage range is marked on the motor's serial number plate.

Pressure Pump Type .....Gear

Pressure Pump Operating Pressure .....0.1 MPa (14.5 lbf/in^2)

Pressure Pump Delivery Rate .....50 Hz, 4 L/min @ 0.1 MPa

Recommended Oil Type .....Shell Tellus 32 or equivalent

Filtration, Pressure .....10 micron

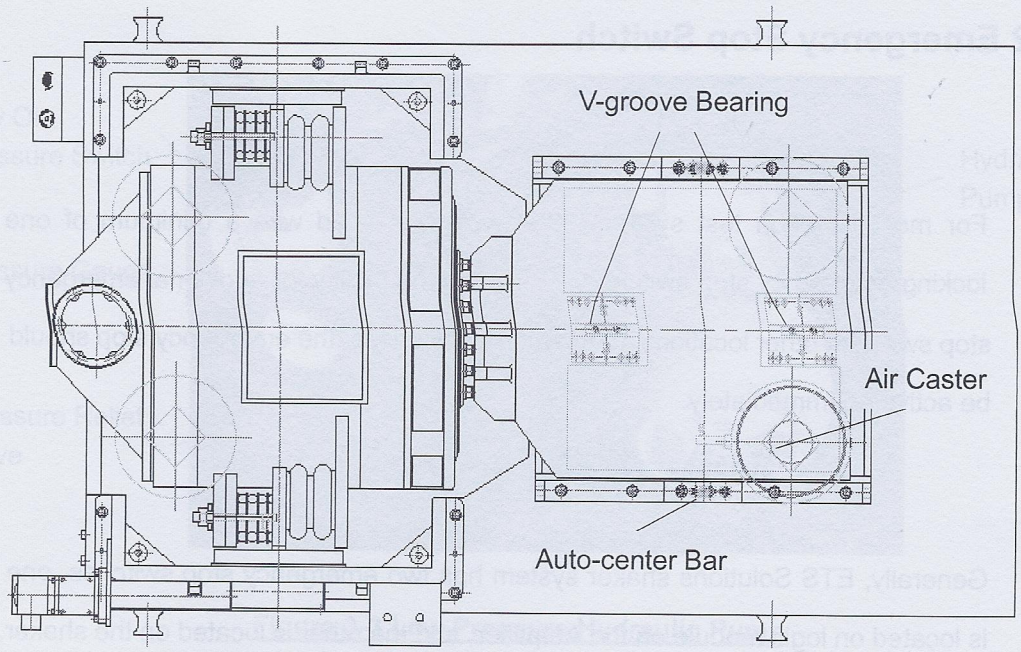
Chapter 3 Description

3.1 Slip Table

The slip table consists of a magnesium slip plate which slides on an oil film, supported by a granite block. The granite is mounted on a precision finished steel plate. The slip plate is coupled to the horizontally rotated shaker via a magnesium driver bar.

The guided oil film slip tables are designed with guided V-groove bearings; see Figure 3-1, combined with magnesium slip plate. Hydraulic oil, at low pressure, is supplied through the granite block port holes and is dispersed throughout the underside of the slip plate. The oil film provides a low friction slip surface and a damping medium for restraint of resonances, pitch and roll moments.

The granite block is surrounded by an oil retention moat, see Figure 3-2. The oil, after being fed to the bearings and slip plate/granite block interface, is collected in the moat prior to circulation by hydraulic pump. The moat is fitted with a filter screen. At the end of the slip table remote from the driver bar, the filter screen also acts as a drip tray to prevent oil splash. **It is important that no tools etc. are laid on this tray as on full stroke, damage could be done to the slip plate. This tray must not be removed while the shaker/slip table is being operated otherwise serious injury could be caused.**



Note: Quantities of the bearings, air casters and auto-center bars maybe different to different system.

Figure 3-1 Location of V-groove Bearing and Securing Screws

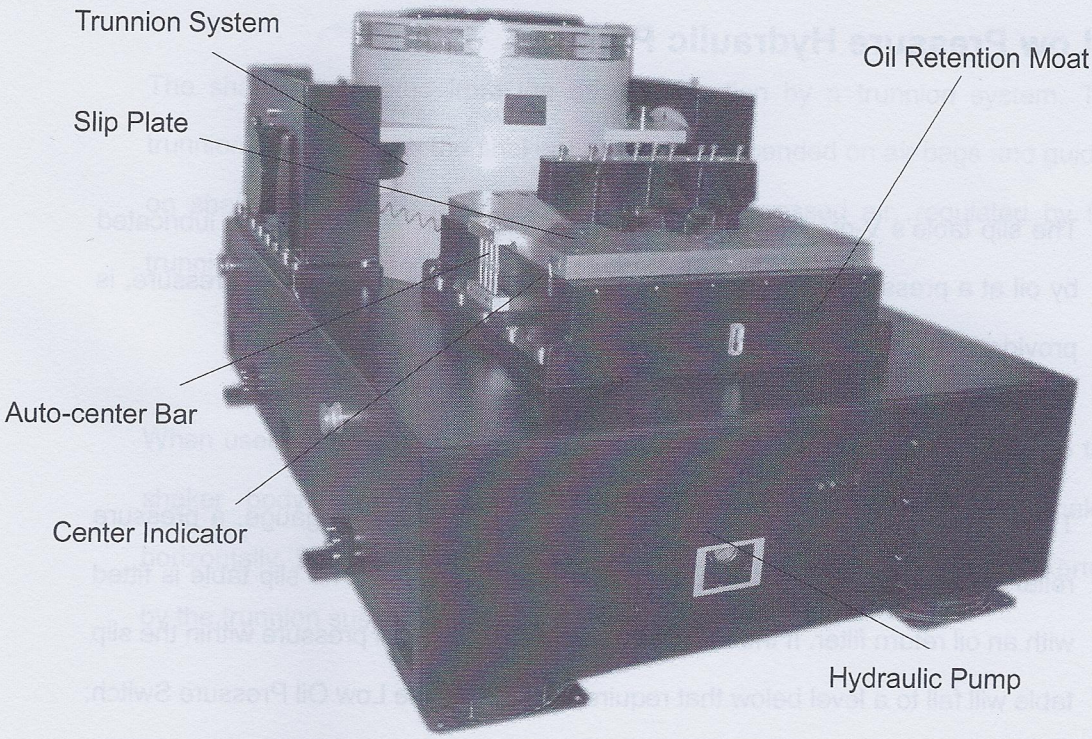


Figure 3-2 Shaker System with Unibase Slip Table

3.2 Emergency Stop Switch

For most vibration test systems, the system is fitted with a minimum of one locking emergency stop switch, and includes the facility for additional emergency stop switch at other locations. If an emergency arises, the emergency stop should be activated immediately.

Generally, ETS Solutions shaker system has two emergency stop switches, one is located on logic module on the Amplifier, and the other is located on the shaker. There is another emergency stop switch if remote control panel is supplied. The system will automatically shut down if any emergency stop switch is pressed.

3.3 Low Pressure Hydraulic Pump

The slip table's V-groove bearings and slip plate/granite interface are lubricated by oil at a pressure of 0.1 MPa (14.5 lbf/in^2). The oil, at the required pressure, is provided by a hydraulic pump, see Figure 3-2.

The hydraulic circuit contains a hydraulic pump, a pressure gauge, a pressure relief valve and a low oil pressure switch, see Figure 3-3. The slip table is fitted with an oil return filter. If the filter becomes blocked, the oil pressure within the slip table will fall to a level below that required to operate the Low Oil Pressure Switch; this switch is used to activate the amplifier's interlock circuit if the pressure falls below 0.06 MPa (8.7 lbf/in^2).

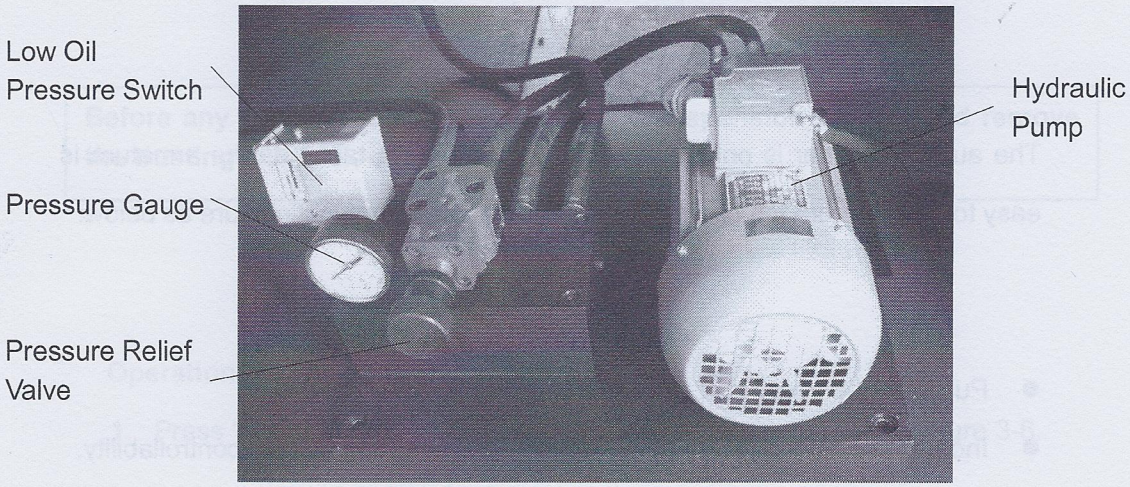


Figure 3-3 Low Pressure Hydraulic Pump

3.4 Trunnion System

The shaker is isolated from the base fabrication by a trunnion system. The trunnion system allows the shaker body to be suspended on air bags and guided on shafts. The air bags are supplied with compressed air, regulated by the trunnion control located on Servo Control Console (SCC-1).

When used in the vertical axis, the trunnion control is adjusted to centralize the shaker body between the trunnion assemblies. When using the shaker horizontally, the air bags require sufficient pressure to oppose the force exerted by the trunnion suspension return springs.

3.5 Auto-center Bar

The auto-center bar is only applicable for the GT slip table, as the armature is easy to deviate from the central position during tests. Its functions are as below:

- Pull back the position of slip table and keep it in the center
- Increase the slip table damping, which is good for the system controllability.

3.6 Electrical Rotation Unit (Option)

For easy rotation, an electrical rotation unit is designed to rotate the shaker. This rotation unit mainly includes two parts, the motor and control box, see Figure 3-4.

Cables Connection

The system is shipped with one set of cables. The electrical rotation unit has the following cables to be connected, see Figure 3-5.

Cable Marking	Control Box	System Unit Connection
L, N	Power In	Outer Power Supply (220VAC, 50/60Hz, Single Phase)
Cable	Power Output	Connect to the motor

NOTICE

Before any rotation, lock out the shaker's suspension system and remove the trusting axis lock-out bolts at both sides.

Operation

1. Press 'Power' button to switch on the power, see Figure 3-4 & Figure 3-6.

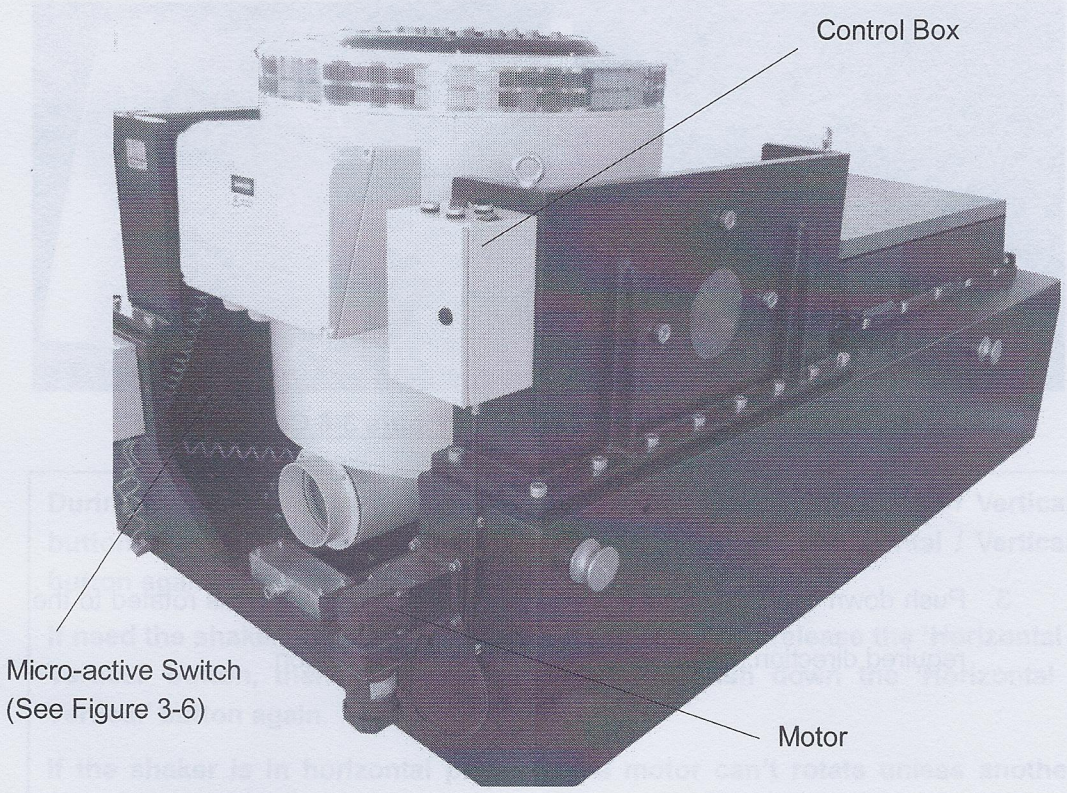


Figure 3-4 Slip Table System with Electrical Rotation Unit

2. Select the rotation direction, see Figure 3-6.

Power --- Power switch and it will illuminate when motor power supply is on.

H --- From vertical to horizontal.

V--- From horizontal to vertical

Stop --- Stop position.

Horizontal --- Push down the button to rotate the shaker to horizontal position.

Vertical --- Push down the button to rotate the shaker to vertical position.

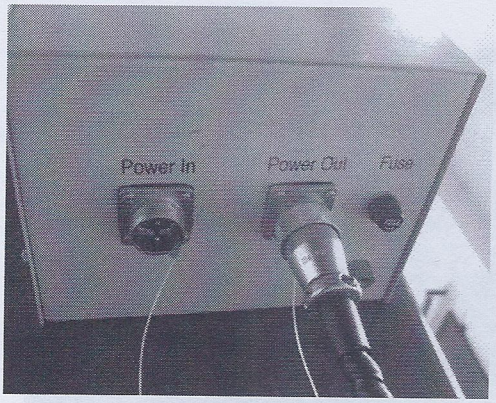


Figure 3-5 Control Box Interface

Figure 3-6 Control Panel

3. Push down the 'Horizontal / Vertical' button until the shaker is rotated to the required direction. Release the button to stop the rotation.

From vertical to horizontal position, when the shaker reaches to the horizontal position and it meet the limit bolt, the current of motor will become larger because the shaker can't continue to rotate. And then the fuse (2A), see Figure 3-4 at the bottom of the control box may burn and cause the motor automatically stop.

4. When the rotation is finished, please select the rotation position to 'Stop' position and power off the motor power supply.

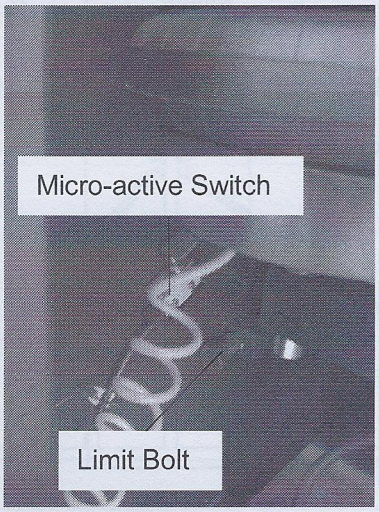


Figure 3-7 Micro-active Switch and Limit Bolt

NOTICE

During the rotation, the system will immediately stop if 'Horizontal / Vertical' button is released. If want to continue, push down the 'Horizontal / Vertical' button again.

If need the shaker rotate to the opposite direction, first release the 'Horizontal / Vertical' button, then select the direction and push down the 'Horizontal / Vertical' button again.

If the shaker is in horizontal position, the motor can't rotate unless another direction is selected.

Troubleshooting and Service

1. If the 'Power' switch is not illuminated, please check the outer power supply and the fuse.

2. If the shaker is not rotated when the 'Horizontal / Vertical' is pushed down, please check if the trusting axis lock-out bolts are removed.

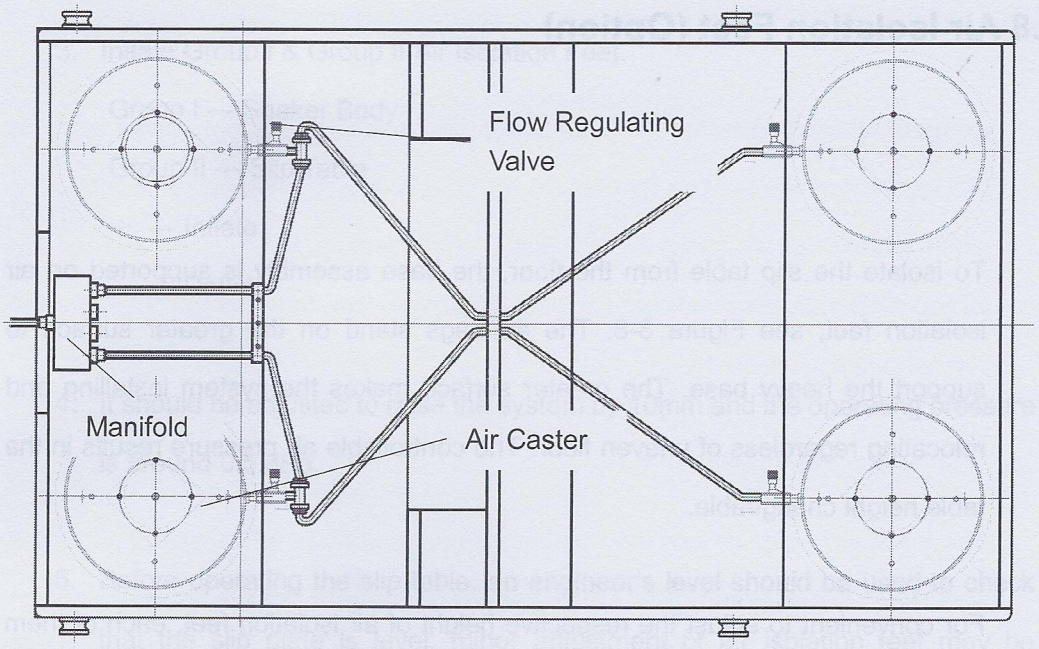
3. During rotation, if the rotating direction is not identical with the selected direction, please exchange 'U2' & 'Z2' cable connections inside the motor conjunction box.

NOTICE

Before any shaker operation, the shaker's suspension system must be released and the thrusting axis lock-out bolts must be replaced and tightened.

3.7 Air Caster (Option)

The air casters allow the system to be floated on a cushion of compressed air, and enable the system to move easily, smoothly and omni-directional only with light hand pressure. The air casters consists of air casters and air circuit, see Figure 3-8.



Note: Quantities of air casters maybe different to different system.

Figure 3-8 Air Caster Air Circuit Schematic

Operation

1. Connect the air pipe to the manifold.

2. Open the compressed air supply, the pressure required is 0.6 MPa. Before use, four flow regulating valves don't need to be adjusted. And the four flow regulating valves are set before delivery.

3. Wait approximately one minute, and then it will be possible to move the shaker by hands.

3.8 Air Isolation Feet (Option)

To isolate the slip table from the floor, the base assembly is supported on air isolation feet, see Figure 3-8. The air bags stand on the greater surface to support the heavy base. The greater surface makes the system installing and relocating regardless of uneven floor. The controllable air pressure results in the table height changeable.

For convenient to adjust the respective height of air isolation feet, each of them has respective air tap. Air isolation feet quantities and arrangements vary according to the actual requirement.

CAUTION

Do not over-inflate the air isolation feet.

Do not lift the shaker when the air isolation feet are inflated.

Operation

1. Connect the air pipe to the main air supply at the bottom of SCC-1 box.

2. Open the compressed air supply, the pressure of compressed air is required 0.6 MPa.

3. Inflate Group I & Group II Air Isolation Feet.

   Group I --- Shaker Body

   Group II --- Slip Table

   + --- Inflate

   − --- Deflate

4. It should be adjusted to raise the system by 10mm and the operating pressure is around 0.5MPa.

5. Before operating the slip table, an engineer's level should be used to check that the slip plate is level; minor adjustment of air isolation feet may be required to achieve a perfectly level slip plate.

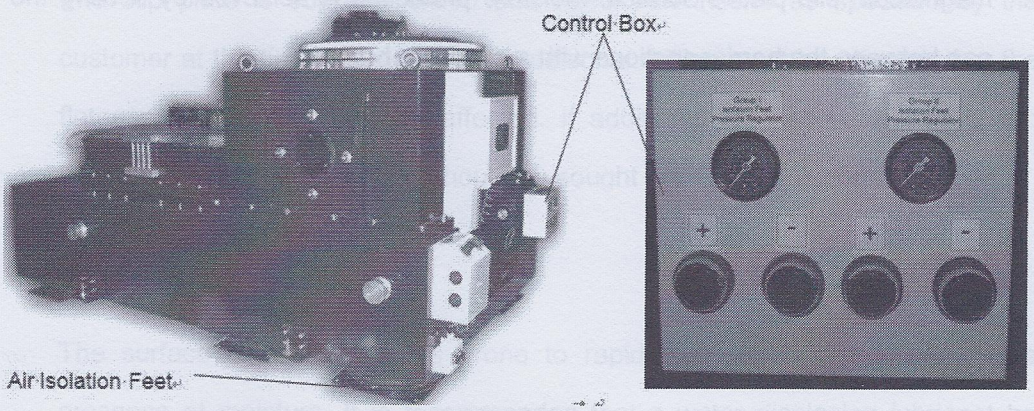


Figure 3-8 Air Isolation Feet Assembly

3.9 Thermal Barrier (Option)

A thermal barrier may be fitted to the slip table, to reduce thermal conductivity between the payloads and slip plate.

Users must be aware that the temperature limits for the thermal barrier apply to the barrier's material. The figures do not necessarily represent the permissible working temperature range of slip table. When testing payloads at high or low temperatures, measures must be taken to ensure that heat being transmitted to slip table is dispersed.

The thermal barrier covers the complete working surface of the slip plate and is secured to the slip plate using M6 screws. The thermal barrier is drilled with holes (in the pattern specified by the user) which align with the slip table inserts. Loads are secured using M10 screws (or by the user). If condensation is likely to form during testing, it is important to ensure that moisture cannot reach the magnesium slip plate's surface. Moisture protection is achieved by sealing the gap between the barrier sections with a clamping bar.

Chapter 4 Operation

4.1 General

This manual, intended for users of the equipment, refers to operation of the slip table. Details of shaker operation are contained in the appropriate shaker manual.

4.2 Slip Plate

The slip plate is supplied drilled and fitted with inserts as specified by the customer at the time of ordering. No additional drilling must be attempted or the flatness of the table may be affected. If additional load securing inserts are essential for operation, advice should be sought from ETS Solutions.

The surface of magnesium is prone to rapid oxidization, particularly in the presence of moisture. It is recommended that a water displacing lubricant be used at all times as a protective film.

Flatness of Payload Fixture

In order to avoid distortion of the magnesium slip plate, the payload fixture must be flat.

After mounting the payload to the slip plate, and before operating the table, a check should be made to ensure that the slip plate slides freely with only light hand pressure (this is carried out more easily if the slip plate is detached from the driver bar). If the slip plate does not move freely, the cause should be investigated and cured before operation commences.

CAUTION

The correct length load mounting screws must always be used. Overlength screws will bottom and cause damage to the slip plate.

CAUTION

Jigs made of soft materials (for example, wood), jigs having large clearance holes, or clamping systems which do not support the face of the magnesium around the insert, should not be used. Failure to comply can distort the slip plate.

Before Use Checks

1. Check that the hydraulic oil level indicator is in suitable position.

2. Check that the operating pressure of the hydraulic oil is correct (refer Section 2.4).

3. Check, using an engineer's level, that the slip plate is perfectly level.

4. Check that with the hydraulic pump switched on, the slip plate slides freely with only hand pressure applied (this is easier to check with the driver bar detached from the slip plate).

CAUTION

No attempt should be made to control the slip plate at, or near the driver bar at a sinusoidal frequency approaching the system resonance, or with a random input the bandwidth of which encompasses the system resonance. Under these conditions excessive levels of vibration may occur resulting in damage to the equipment.

4.3 Vibration Control

Normally, slip table acceleration levels should be controlled by an accelerometer mounted at the free end of the slip plate (at the end of the slip table remote from the driver bar). In some cases it may be necessary to attach the control accelerometer to the payload. Under these circumstances the choice of control point is extremely important.

The location of the control accelerometer at a nodal point on a flexible structure must be avoided as this can cause excessive levels of vibration resulting in damage to the payload and equipment.

4.4 Thermal Barrier

In order to operate a slip table in conjunction with a thermal chamber it is normal practice to fit a thermal barrier on the surface of the slip plate in order to reduce thermal transfer from the chamber to the slip plate. It is essential that the design of test loads takes into account the differential thermal expansion between the test load and the slip plate in order to prevent distortion occurring due to temperature (and hence dimensional) changes.

CAUTION

The oil film temperature at the slip plate/granite block interface (when using the recommended oil (Shell Tellus 32) must not be allowed to fall below +10 ℃, or rise above +45 ℃.

Operating the slip table with oil film temperatures at the magnesium/granite interface exceeding those values, can cause extensive damage.

The permissible working temperature range of a slip table is limited by the hydraulic oil used to lubricate the magnesium/granite interface and the guide bearings. When using the recommended oil (Shell Tellus 32，or equivalent) the working temperature of the slip table must be between +10 ℃ and +45 ℃.

A thermal barrier, fitted to the magnesium slip plate surface, reduces the thermal conductivity between the test load and the slip plate. This reduction, combined

with the heat sink effect of the slip table's granite block, allows larger duration tests (up to approximately 8 hours) to be performed.

Two important points must be noted regarding the use of thermal barriers:

1. If the slip table is used in cold conditions, condensation will form on the surface of the magnesium, drip into the moat and thus contaminate the oil.

2. The thermal expansion of the test load will be different to that of the magnesium slip plate; this can cause distortion due to the 'bi-metal' effect. Test jig design must take the different expansion rates into account. Failure to do so can cause seizure of the slip table.

If the slip table is to be used with test loads at temperatures outside the limits, or if the test time is to exceed 8 hours, it will be necessary to maintain the temperature of the magnesium slip plate within acceptable limits. This is achieved by the use of an external hot/cold oil supply unit combined with 'gun drilled' holes in the slip plate.

The working oil temperature and the diameter/length of the gun drilled holes will depend on individual circumstances. In all cases, ETS engineering department should be consulted so that the necessary calculations can be made.

Chapter 5 Maintenance

5.1 General

Maintenance Policy

This chapter details the procedures which must be employed when checking or replacing slip table components. General maintenance details, and those concerning the shaker, are detailed in the shaker system manual. **In particular, attention is drawn to the safety precautions and hazard warnings detailed within that manual.**

Maintenance can be undertaken by customers using the procedures detailed in this chapter. It is recommended however that ETS service engineers, who are specially trained in this type of work, be employed for all maintenance tasks. Further advice and details of spare parts can be obtained from:

The Service Department
ETS Solutions
No.8 Zijin South Road, National New Hi-Tech Industrial Park
Suzhou, Jiangsu Province
China
Tel: +86-512-66576316
Fax: +86-512-66576317
E-mail: service@etssolution.com.cn

Hydraulic Oil

Users should be aware that it is essential the hydraulic oil supply is maintained in a clean and uncontaminated condition at all times. The oil and filter must be renewed annually as a minimum requirement.

A periodical (for example, weekly) check should be made to establish the condition of the oil. This is achieved by taking a sample of the oil and passing it through a filter-paper, or clean cloth; the residue will indicate any contamination. Contamination is most likely to occur when the slip table is used in conjunction with a thermal chamber; condensation can form on the slip table's surface, drip into the moat and mix with the oil.

Torque Values

Bearing Housing to Slip Plate securing screws, Slip Plate to Driver Bar Securing screws and Driver Bar to Armature securing screws see Table 5-1 & 5-2.

Table 5-1 Metric Screws Torque

Screw Size	Tightening Torque (Nm)				
	Steel (Grade 6.8)	Steel (Grade 8.8)	Aluminum	H62 Copper Bolt	H62 Copper Nut
M4	2.8	3.7	3.5		
M5	5.6	7.4	6.2	2.3	4.55
M6	9.5	12.6	10.1	3.91	7.73
M8	23.2	30.5	23.2	9.49	18.75
M10	45.9	60.5	45.9	18.72	30.09
M12	80.1	105.6	80.1	32.83	64.75
M14	127.5	168.1	90.1	52.16	103.17
M16	198.7	262.4	134.6	81.50	161.08
M18	273.8	372.6		112.10	221.52
M20	388.8	529.2		158.76	313.99
M24	669.6	915.8			
M27	981.7	1336.5			
M30	1333.8	1819.8			

Table 5-2 Tightening Torque for Armature Payload Securing Screws

Screw Size	Tightening Torque	
M5	9.0 Nm	6.6 lbf in
M8	34 Nm	25 lbf ft
M10	57 Nm	42 lbf ft
M12	70 Nm	94 lbf ft
3/8-20BSF	34 Nm	25 lbf ft
3/8-16UNC	34 Nm	25 lbf ft
3/8-24UNF	34 Nm	25 lbf ft
1/2-20UNF	81 Nm	60 lbf ft

Note: The above table is based on cap head screws into stainless steel inserts.

5.2 Driver Bar - Fitting/Removal

This section details the procedures necessary to fit and remove the driver bar, include unibase and stand-alone slip table.

Three procedures are detailed in this section:

Initial Alignment: Details the procedure for fitting the driver bar during installation, following shaker maintenance, following removal of the slip plate, or at any time the slip plate and shaker armature are suspected of being out of alignment.

Fitting: Details the routine fitting of the driver bar; this method to be used only when the Initial Alignment is not required.

Removal: Details the removal of the driver bar.

WARNING

Do not attempt to rotate the shaker unless the trunnion trusting axis lock-out bolts are removed. Failure to comply with this warning can result in serious personal injury.

5.2.1 Unibase Slip Table Initial Alignment and Fitting

1. Fit all screws between driver bar and armature, but not tighten them.
2. Deflate the trunnion suspension air bags and tighten the lock-out bolts.
3. Remove the trunnion trusting axis lock-out bolts at two sides, rotate the shaker to the horizontal position.
4. Switch on the hydraulic power supply and wait for the oil to circulate. Slide the slip plate until it makes contact with the drive bar
5. Fit and tighten all the screws between slip plate and driver bar.
6. Detach the screws between slip plate and driver bar.

7. Rotate the shaker to about 45°, and tighten all screws between driver bar and armature.

8. Rotate the shaker to horizontal position, Check the alignment between the end of slip plate and driver bar. If the alignment is correct, please go to next step. If the alignment is incorrect, it may be necessary to adjust as follows:
   1) Detach the screws between slip plate and driver bar.
   2) Rotate the shaker to about 45°. Fit all screws between driver bar and armature, but not tighten them. Rotate the shaker to horizontal position.
   3) Fit and tighten all screws between driver bar and slip plate.
   4) Detach the screws between driver bar and slip plate.
   5) Rotate shaker to about 45°, and tighten all screws between armature and driver bar.
   6) Rotate the shaker to horizontal position, Check the alignment between the end of slip plate and driver bar.

9. Fit and tighten all screws between the drive bar and the slip plate. And check that the slip table moves freely when hand pressure is applied.

10. Unlock trunnion suspension system by removal of lock-out bolts.

11. Check the slip plate position from the center indicator. Adjust the load support suspension to ensure the armature is in its center position with respect to the field coil and shaker mechanical structure.
    If slip plate is still not in center position, deflate/inflate the trunnion system air bags.

12. After the rotation is finished, please re-install trunnion trusting axis lock-out bolts at both sides before any tests. Otherwise, it can result serious injury.

13. If perform low frequency tests with large displacement, please lock the trunnion suspension system.

WARNING

Trunnion trusting axis must be locked before any testing. Failure to comply with this warning can result in serious personal injury.

5.2.2 Stand-alone Slip Table Initial Alignment and Fitting

1. Fit all screws between driver bar and armature, but not tighten them.
2. Deflate the trunnion suspension air bags, fit and tighten the lock-out bolts.
3. Deflate the armature load support air bags and Lower the armature position.
4. Remove the trunnion trusting axis lock-out bolts at both sides. Rotate the shaker to the horizontal position.
5. Inflate the load support air bags to keep the armature at the center position.
6. Unlock the trunnion suspension systems by removal of the lock-out bolts. Inflate the trunnion suspension air bags to center position, which means the naked length of suspension guidance shaft at both ends are equal.

7. Switch on the hydraulic power supply and wait for the oil to circulate. Slide the slip plate to center position as indicated and switch off the hydraulic power supply.

8. Adjust and check slip table location and alignment. Adjust the slip plate level by three adjusting leveling feet with wrench, see Figure 5-1. To keep the slip plate end surface to align with driver bar, adjust the slip table horizontal location and the connections between armature and driver bar. A engineer's level should be used to check that the slip plate is level.

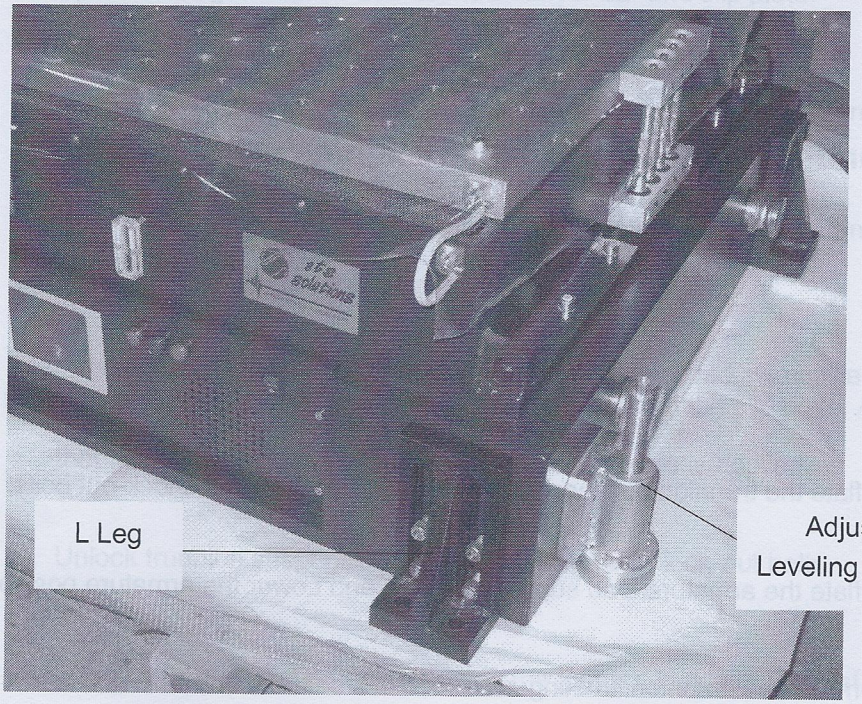


Figure 5-1 Slip Table Adjusting Leveling Feet and L Leg

9. Lock the trunnion suspension system.

10. Power on the hydraulic power supply and wait for the oil to circulate. Slide the slip plate until it makes contact with the driver bar. Fit and tighten all screws between slip plate and driver bar, and make any necessary adjustment as above Step 8.

11. Loosen the fixing screws of three L legs (refer to Figure 5-1) to drop the legs down to foundation. And then tighten the fixing screws.

12. Detach the connection between the drive bar and the slip plate.

13. Rotate the shaker to about 45°. Tighten all screws between driver bar and armature.

14. Rotate the shaker to horizontal position, Check the alignment between the end of slip plate and driver bar. If the alignment is correct, please go to next step. If the alignment is incorrect, it may be necessary to adjust as follows:
    1) Detach the screws between slip plate and driver bar.
    2) Rotate the shaker to about 45°. Fit all screws between driver bar and armature, but not tighten them. Rotate the shaker to horizontal position.
    3) Fit and tighten all screws between driver bar and slip plate.
    4) Detach the screws between driver bar and slip plate.
    5) Rotate shaker to about 45°, and tighten all screws between armature and driver bar.
    6) Rotate the shaker to horizontal position, Check the alignment between the end of slip plate and driver bar.

15. Fit and tighten all screws between the drive bar and the slip plate. And check that the slip table moves freely when hand pressure is applied.

16. Unlock trunnion suspension system by removal of lock-out bolts.

17. Check the slip plate position from the center indicator. Adjust the load support suspension to ensure the armature is in its center position with respect to the field coil and shaker mechanical structure.

18. If slip plate is still not in center position, deflate/inflate the trunnion system air bags.

19. After the rotation is finished, please re-install trunnion trusting axis lock-out bolts at both sides before any tests. Otherwise, it can result serious injury.

20. If perform low frequency tests with large displacement, please lock the trunnion suspension system.

21. If necessary, please fix the slip table to foundation through the holes on L legs.

5.2.3 Removal

1. Switch on the hydraulic pump and wait for the oil to circulate.

2. Remove the screws securing the slip plate to the driver bar.

3. Slide the slip plate away from the shaker.

4. Switch off the hydraulic pump.

5. Lock-out the shakers suspension system. Rotate the vibrator to the vertical position.

6. Remove the screws securing the driver bar to the armature.

5.3 Slip Plate Removal/Fitting

Removal of the slip plate is necessary to gain access to the V-groove bearings. The slip plate must be removed / fitted as per the procedures detailed in this Section.

CAUTION

The slip plate must not be lifted from the granite block. The plate must be removed using a sliding action. Failure to observe this caution can cause distortion of the slip plate.

Removal

1. Detach the driver bar from the slip plate as detailed in Section 5.2.3.
2. Remove the two earth cables at the end of slip plate.
3. Remove the auto-center bars if supplied, see Figure 3-4.
4. Remove the center indicator, see Figure 3-2.
5. Remove the screws and washers which secure the slip plate to the bearings.
6. Using only a sliding action, carefully remove the slip plate.
7. Inspect the 'O' Rings for damage. Replace if necessary.

Fitting

1. Dry the 'O' Ring grooves to prevent damage to the 'O' Rings.
2. Using a set of alignment studs, position the slip plate on the bearings so that the mounting holes align with the bearings' inserts.
3. Secure the slip plate to the bearings using screws and washers. And tighten them.
4. Re-fit the auto-center bars if supplied.

5. Re-fit the center indicator.

6. Re-fit the two earth cables.

7. Fit the driver bar to the slip plate as detailed in Section 5.2.1 or 5.2.2.

5.4 V-groove Bearing Replacement

This section details the procedures for replacing the V-groove bearings. Before this task is undertaken it should be noted that the assembly and alignment of the bearings requires tooling specially designed for the purpose.

NOTICE

The bearing assemblies and mounting brackets are manufactured as matched sets; the assemblies should be suitably marked to prevent incorrect assembly.

1. Remove the driver bar as detailed in Section 5.2.3.

2. Remove the slip plate as detailed in Section 5.3.

3. Remove the old V-groove bearings.

4. Fit the bearing assembly:
   - Slide the bearing housing to one end of its stroke.
   - Rotate the bearing housing until the upper surface is parallel with the granite surface.
   - Measure the height of the bearing housing above the granite surface.
   - Repeat with the housing at the other end of the stroke.
   - Adjust shim thickness.

5. Adjust bearing alignment:
   - Clamp a straight-edge to the granite surface. Using a dial indicator, adjust the straight-edge until it is parallel with the existing bearing.
   - Fit the new bearing. Using a bearing adjustment jig, adjust the bearing until parallel with the straight-edge.

6. Check that the bearing housing 'O' rings, and the 'O' ring grooves, are clean and dry. Fit the 'O' rings to the bearing housings.

7. Fit the slip plate as detailed in Section 5.3.

8. Switch on the hydraulic pump. When the oil is circulating, check that the slip plate moves freely when hand pressure is applied.

9. Fit the driver bar following the Initial alignment procedure as detailed in Section 5.2.1 or 5.2.2.

Chapter 6 Installation

WARNING

Incorrect lifting methods can cause serious personal injury, and damage to the equipment.

Attention is drawn to the safety precautions and hazard warnings contained within the preface to this manual.

Lethal voltages are present within the equipment cabinet. Before attempting to alter any links or connections the supply must be switched off at the incoming isolator.

If it is necessary to access the equipment with covers open and the amplifier switched on, precautions must be taken to ensure that only competent, ETS trained, electronic or electrical engineers are allowed to work on the equipment.

The slip table is shipped fully assembled. The installation mainly includes driver bar and hydraulic pump interconnection. The procedures detail in Section 5.2 (driver bar) and amplifier installation in Operating & Maintenance Manual (hydraulic pump).

This chapter details the procedures and checks which should be completed prior to initial use of the slip table. These checks must be completed after shaker installation checks, as detailed in the shaker manual, have been completed.

6.1 Installation Checks

1. Using Shell Tellus 32, or equivalent oil, fill the hydraulic oil into the oil retention moat.

2. Switch on the hydraulic pump. Check that the indicated pressure which is approximately 0.1 MPa.

3. Check that an oil film forms around the edge of the granite block.

4. Check that the slip plate moves freely between the end stops when hand pressure is applied.

5. Check that the low oil pressure switch.

6. Allow the hydraulic pump to operate for at least 15 minutes. Check for oil leaks. Check the correct oil pressure has been maintained and that the slip plate moves freely when hand pressure is applied.

7. Fit the driver bar, as detailed in Section 5.2.1 or 5.2.2, to the slip plate and armature.

8. Mount a control accelerometer at the end of the slip plate.

9. Calibrate the system using available means.

Chapter 7 Warning Labels

PROPRIETARY NOTICE

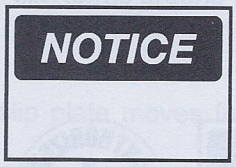
This manual contains proprietary information, which may not be duplicated in any manner without prior written approval from ETS Solutions (China) Ltd. The sole purpose of this manual is to provide the user with adequate information for safe, proper and efficient operation and maintenance of the equipment. Any other use of this document is prohibited.

CUSTOMER SERVICE

ETS Solutions maintains a staff of qualified, factory-trained service engineers with many years of experience in the installation, repair and calibration of test systems. Service representatives are available for consultation on special problems relating to the use of ETS Solutions equipment.

NOTICE

All ETS equipment is designed for safety operation. Guards, interlocks, protective devices are included on and within each subsystem. However, the installation and operation hazards may be present whenever servicing and operating is performed. The personnel to operate and service the system are expected to be trained and technically knowledgeable about the complete system, and potential hazards.



NOTE!

Please insure that this manual is reviewed and understood prior to installation, operation or maintenance of the equipment.

WARNING!

High voltage exists in some sections of this equipment. Any electrical servicing should be done by an experienced technician or electrician especially in event of troubleshooting the system in energized condition.

Appendix A—Shaker Air Duct Connection

This appendix describes how to connect the air duct correctly for shaker unit with slip table or operating in horizontal mode.

When shaker is in vertical position, the shaker air duct coupling must be connected in the position as shown on Figure 1. The shaker coupling outlet is located on the shaker bottom must be fitted with the outlet duct cover plate as Figure 1. The outlet duct cover plate is fitted with hex-head screws around the plate with a rubber gasket. Ensure the cover plate is screw tightly with the gasket and there is no air leakage.

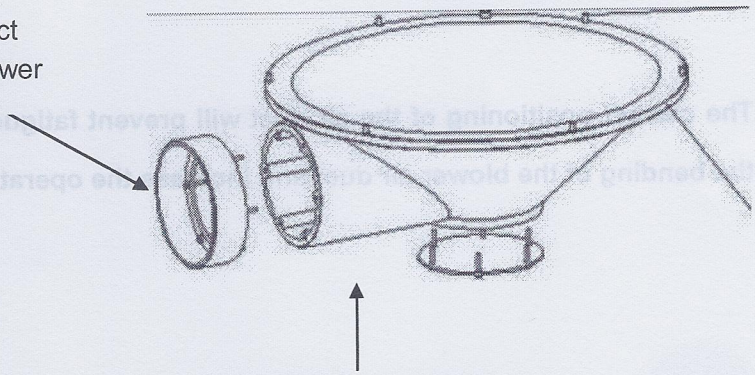


Figure 1 Shaker on Vertical Position

When the shaker is to be operated on the horizontal position, the blower air duct is to be removed from the shaker air duct coupling. Rotate the shaker from vertical to horizontal position as per procedure in the operating manual; unscrew the shaker air duct coupling and the outlet duct cover plate. Exchange the

position of the shaker air duct coupling and the outlet duct cover plate (refer to Figure 2). Reconnect the as air duct accordingly.

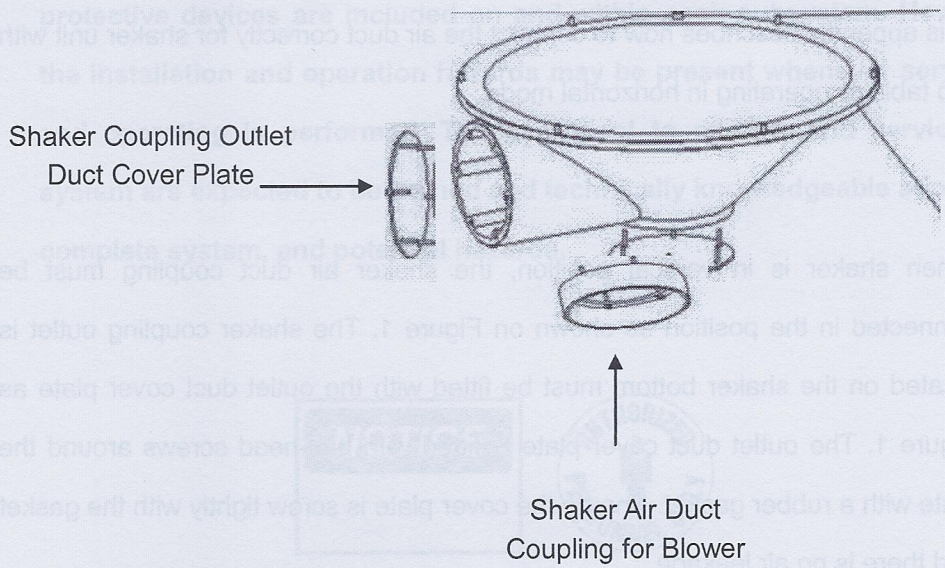


Figure 2 Shaker on Horizontal Position

The correct positioning of the air duct will prevent fatigue and stress over the bending of the blower air duct and increase the operating life span.