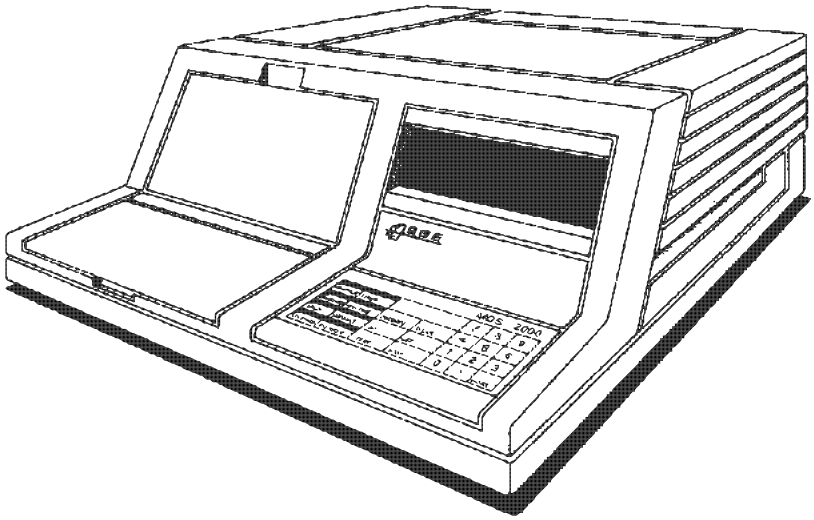
MULTIDIMENSIONAL CAPILLARY GC SYSTEM

Installation and Operating Instructions



The MDS 2000 was tested in accordance with the EN55011 Group 1, class B emission requirement, EN 50082-1 immunity requirements and EN 61010-1.
The test sample complied with both EMI and EMC test requirements as required by the European EMC Directive 89/336/EEC and Low Voltage Directive as required by 72/23 EEC.

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Publication No. MN-0009-E
Rev:03 5/97

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1.0 WARRANTY.

This MDS system is guaranteed against faults in materials or workmanship for a period of twelve months from the date of invoice.

This warranty implies free repair and or replacement of defective goods only, upon proper written proof and, where authorised, return of the defective product.

THIS UNIT HAS BEEN DESIGNED TO FULFIL THE PURPOSE OF COLUMN MULTIDIMENSIONAL SWITCHING AND THIS WARRANTY IS VOID IF THE INSTRUMENT IS USED FOR ANY UNRELATED PURPOSES. SGE RESERVES THE RIGHT TO REFUSE FREE SERVICE UNDER WARRANTY ON ANY UNIT WHICH HAS BEEN ABUSED OR TAMPERED WITH IN ANY WAY.

No other warranty or representation is expressed or implied by SGE for its products with respect to merchantability, fitness for any incidental, consequential, or compensatory damages arising from use of or in conjunction with its products. The maximum liability for breach of warranty shall be the invoice price of the said products.

The MDS 2000 does not have any user serviceable parts. All servicing should only be performed by qualified service personnel.

2.0 INTRODUCTION.

The SGE Multidimensional Chromatography System provides an inexpensive means of upgrading dual amplifier and detector Gas Chromatographs (packed or capillary) for multidimensional chromatography.

With the MDS-2000, two gas chromatography columns are used in series to create two separation dimensions giving enhanced resolution capacity. Where existing capillary columns cannot provide the necessary resolution of components present in a sample group, that group may be switched to another capillary column more suited to the separation. This avoids the use of very long columns and complex temperature profiles. Apart from the ability to resolve peaks that were previously unresolvable, shorter analysis times and extended column life can be expected.

All switching on the MDS-2000 is controlled by a powerful programmeable onboard microprocessor. The MDS-2000 can also be controlled from external devices using either contact closures, 5 Volt TTL logic or by RS232 interfacing with a personal computer.

3.0 SPECIFICATIONS.

3.1. Power Requirements.

Input Voltage:	100-250 Vac
Input Frequency:	50-60 Hz
Maximum Power:	110 VA
Fuse Rating:	110 Vac-1.25 A(T)
	220 Vac-800 mA(T)

3.2. Technical Dimensions.

length:	395 mm
width:	340 mm
height:	145 mm
weight:	6.2 kg

3.3. Enviromental Conditions.

operating temperature:	0-40°C
operating humidity:	15-80% (Relative)

3.4. Gas Supplies.

The MDS 2000 will require the supply of a high purity carrier gas and a suitable make up gas.

3.5. Safety.

Warning This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equiptment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents.

Attention Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant causer des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers posés par les circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents.

Avvertenza Questo simbolo di avvertenza indica un pericolo. La situazione portrebbe causare infortuni alle persone. Prima di lavorare su qualsiasi apparecchiatura, occorre conoscere i pericoli relativi ai circuiti elettrici ed essere al corrente delle pratiche standard per la prevenzione di incidenti.

Warnung Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu einer Körperverletzung führen könnte. Bevor Sie mit der Arbeit an iregendeinem Gerät beginnen, seien Sie sich der mit elektrischen Stromkreisen verbundenen Gefahren und der Standardpraktiken zur Vermeidung von Unfällen bewußt.

¡Atención! Este símbolo de aviso significa peligro. Existe riesgo para su integridad física. Antes de manipular cualquier eqipo, considerar los riesgos que entraña la corriente eléctrica y familiarizarse con los procedimientos estándar de prevención de accidentes.

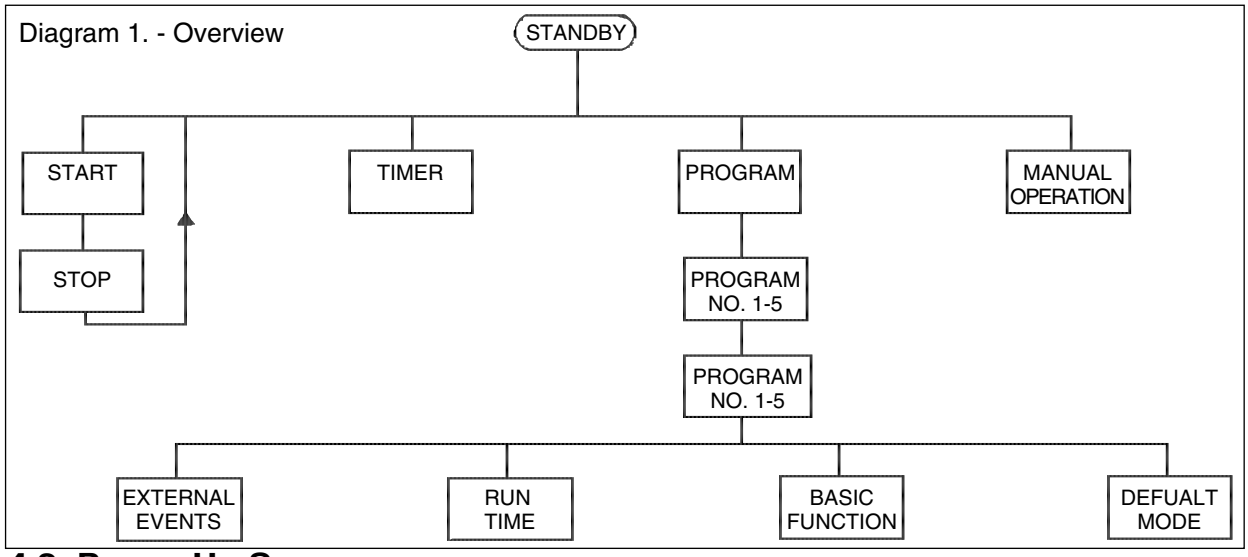
4.0 MDS SOFTWARE OPERATION.

4.1. General.

The Multidimensional Unit allows control in the following ways:

1.Manual Operation - enables manual use of the Basic Functions.
2.Programmeable Operation - allows selection and useage of programmeable parameters.
3.Timer Operation - allows calculation of flow velocity. An overview of the system is given in Diagram 1 below.

Diagram 1. - Overview



4.2. Power Up Sequence.

When the MDU is first turned ON, a number of system diagnostics are automatically performed. These include checking the integrity of the system Read Write Memory (RAM), the Non-volatile Memory (NVRAM), and resetting all device control circuitry. If any malfunction is detected by the diagnostic software, an attempt is made to isolate the problem and work around it. However, if the malfunction is in a critical component of the MDU, a fault message will be displayed and the unit will shut down.

4.3. Standby Mode.

After diagnostic checks have been completed, the system is placed in the STANDBY MODE, and is ready for operator input.

a.If a valid Program is contained within the Non Volatile Memory (NVRAM), the MDU will display the following:-

```
PRE          .0  MID   .0
ACTIVE PROGRAM    : 1
```

This Program may be executed by selecting ***START*** or by an external trigger input. To terminate the Program, STOP is pressed. While the Program is running an on-going clock will display time elapsed. STANDBY can be selected by pressing ***CLEAR*** on the keyboard.

b.If no program is present, the display will read:

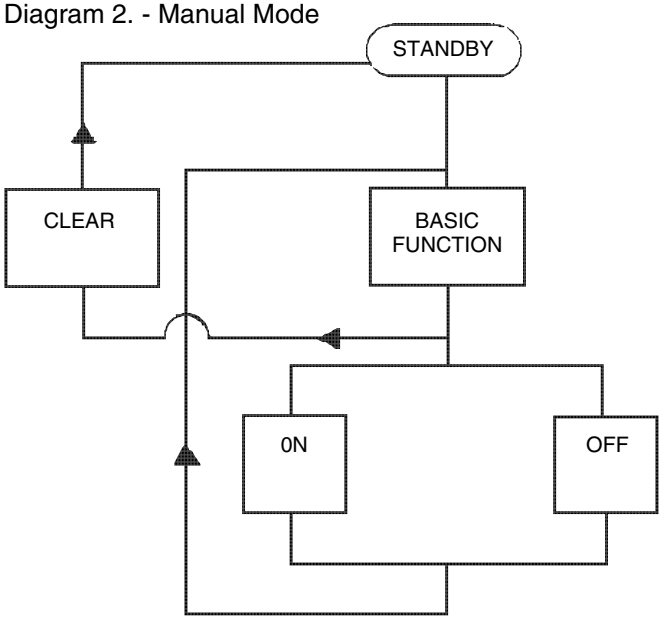
```
PRE          .0 MID  .0
STANDBY PROG      1
```

4.4. Manual Mode.

Manual control of the basic functions HEARTCUT, BACKFLUSH, COLD TRAP and SPLIT is available from the STANDBY Mode.

For example a typical operator sequence may be to switch the SPLIT on.

Diagram 2. - Manual Mode



KEY	DISPLAY
SPLIT	PRE .0 MID . 0 RUNTIME 00:00

The Split L.E.D, located beneath the Split key, will flash indicating it has been selected.

ON	PRE .0 MID .0 RUN TIME 00:01

The Split L.E.D will be illuminated constantly, indicating it is ON.

Time elapsed is indicated by an on-going Timer displayed once the first Basic Function has been selected ON.

All four Basic Functions may be switched ON at one time.To exit the Manual Mode, the operator selects ***CLEAR***. This will reset all Basic Functions to Default Values, terminate the timer and return the MDU to the STANDBY MODE.

4.5. Timer Mode.

The Timer Mode makes possible the calculation of Flow. A volume of 0 to 999.99ml may be entered to enable calculation. The Timer mode is accessed from the STANDBY MODE.

A typical operator sequence would be as follows, where a flow is calculated over a 10ml volume and converted to ml/min. This is also illustrated by the flow chart in Diagram 3.

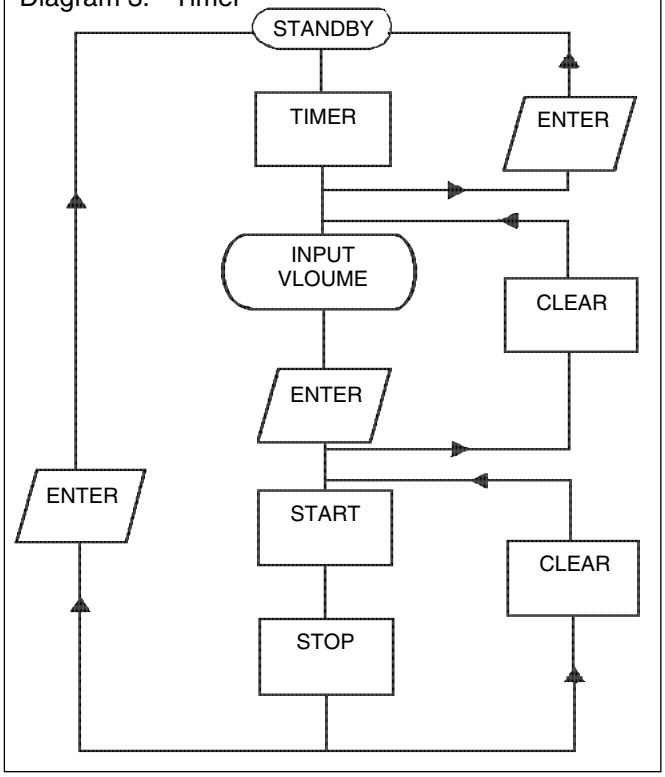
KEY	DISPLAY
1.***TIMER***	t = 00 : 00 INPUT VOL :
2. ***1 0***	t = 00 : 00 INPUT VOL : 10 _
3. ***ENTER***	t = 00 : 00 VOL = 10 . 00
4. ***START***	t = 00 : 01 VOL = 10 . 00
5. ***STOP***	t = 00 : 28 35 . 71ml/min. (calculated flow)

6.***ENTER*** - returns the MDU to the STANDBY display. Step 3 may become:

3.***CLEAR*** - clears and allows re-entry of a new volume. Step 6 may become:

6.***CLEAR*** - sets the timer to zero and returns the operator to Step 3 display.

Diagram 3. - Timer



4.6. Program Mode.

The Program Mode allows the operator to set up to 5 Program scenarios. These include Run Times, Basic Function On/Off times and Default conditions, as well as External Event Control.

As the MDU has it's own built in timer, separate from that of the intergrator/GC, it is adviseable to check the correlation of both timers over a typical run period. This will allow precise manipulation of the analysis within the GC itself.

4.6.1. Selecting a Program.

From STANDBY MODE select ***PROGRAM.*** The MDU display will respond with :

```
INPUT PROG NO.
SELECT       1 - 5 _
```

The operator then keys in a number from 1 to 5, e.g. 2 and the display replies with :

```
PROGRAM 2
SELECT FUNCTION
```

If at this point the operator wishes to action the Program, pressing ***ENTER*** will return the MDU to ***STANDBY MODE.*** (The display will indicate that Program 2 has been selected). The operator is able to select ***START*** thus executing Program 2. It will run either for the length of time set within the Program, until ***STOP*** is manually selected, or until a signal is received from an external device.

NOTE:The MDU display must be in STANDBY MODE for a start command to action a program.

Alternatively, the operator is able to create a new Program, setting whichever parameters chosen as the following text explains.

4.6.2. Selecting and Editing a Basic Function.

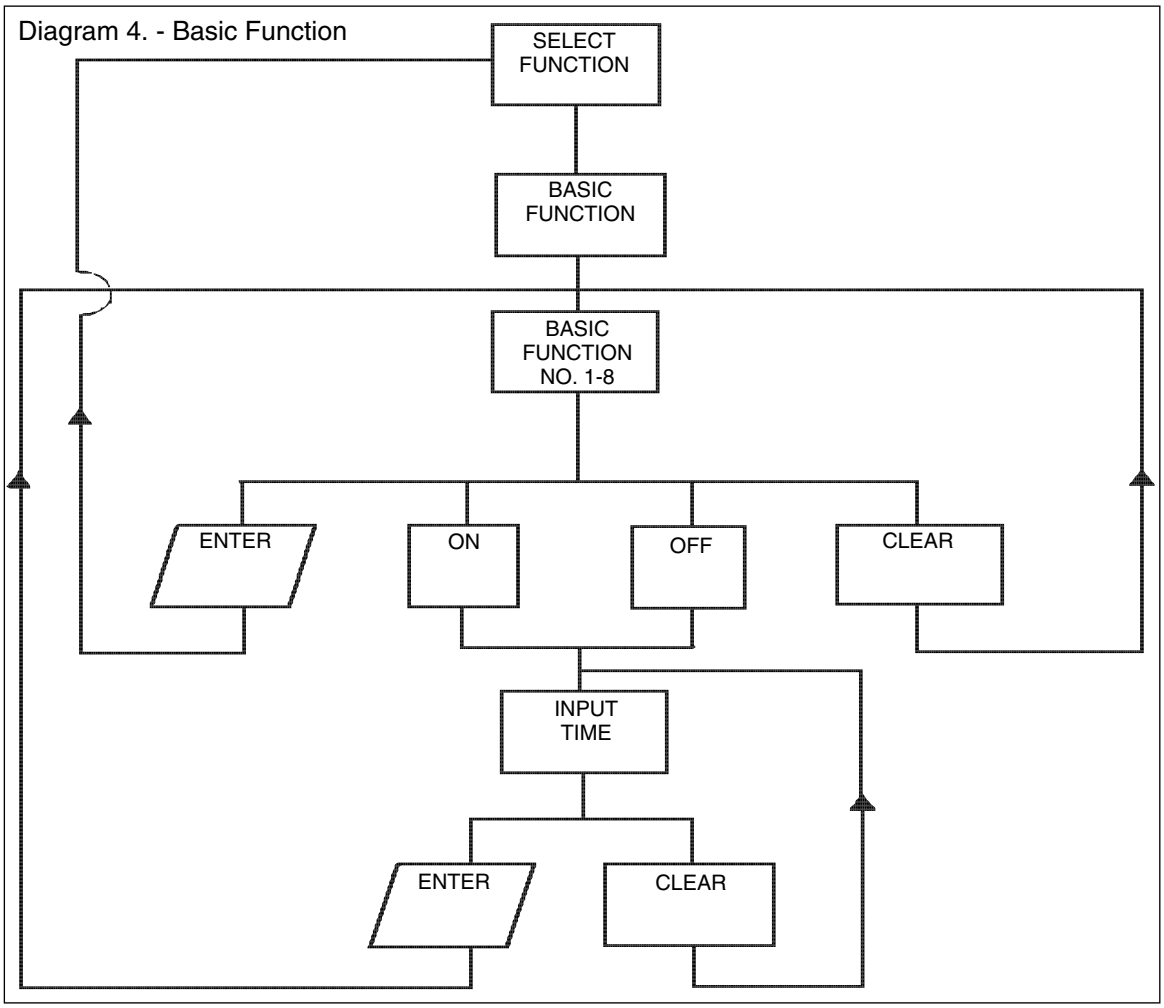
After a Program has been selected, the operator is able to select and edit the functions to be associated with that Program.
The four Basic Functions are:

HEARTCUT
BACKFLUSH
SPLIT
COLD TRAP

For each of these, the operator is able to enter up to eight ON and eight OFF times. These times relate to the actual time that the function solenoid will be turned ON and OFF as the Program proceeds.

NOTE: All times are entered in minutes to two decimal places.

Diagram 4. - Basic Function



Example: The operator is in Program 2, and wishes to set an ON time of 0.5 minutes and an OFF time of 1.2 minutes, for Heartcut Number 1.

	PROGRAM 2 SELECT FUNCTION
KEY	**DISPLAY**
HEARTCUT	PROGRAM 2 H/CUT No.1-8_
1	HEARTCUT No.1 ON .00 OFF .00
ON	HEARTCUT No.1 ON _ OFF .00
0.5	HEARTCUT No.1 ON 0.5 _ OFF .00

ENTER	PROGRAM 2 H/CUT No.1 - 8 _
1	HEARTCUT No.1 ON .50 OFF .00
OFF	HEARTCUT No.1 ON .50 OFF _
1 . 2	HEARTCUT No.1 ON .50 OFF 1.2 _
ENTER	PROGRAM 2 H/CUT No.1 - 8_

The ON and OFF times for HEARTCUT No. 1 in Program 2 are now set. This procedure is also illustrated in the flow diagram in Diagram 4. It would be repeated to program any Basic Function and its eight ON/OFF timing parameters.
The operator has three options from the example display above.

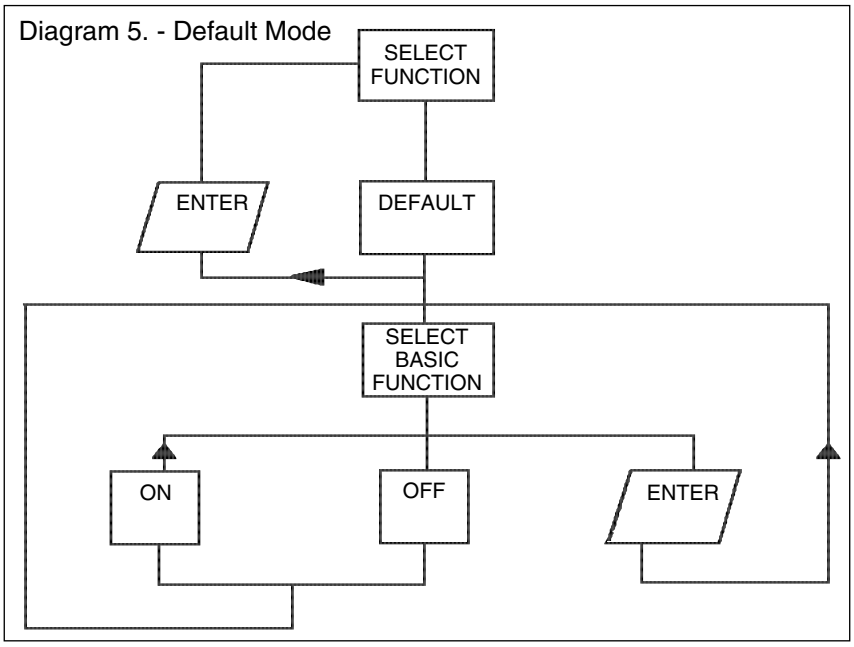
1.ENTER - returns the MDU to the SELECT FUNCTION display.
2.1 - view the ON/OFF times.
ENTER - retains the values set and then returns the MDU to the SELECT FUNCTION display.
3.1- view ON/OFF times.
CLEAR - will delete the ON/OFF times displayed, and return the operator to the FUNCTION NUMBER display.

4.7. Mode Functions.

In addition to the Basic Functions are the Mode Functions:
DEFAULT - allows the setting up of any special conditions required when starting a program.
RUN TIME - allows a specific run time to be set for a program.
EXTERNAL EVENT - allows control of external devices e.g. an integrator.

4.7.1. Default Mode.

Diagram 5. - Default Mode



Programming of the Default conditions is carried out in the Program Mode with the display reading :

PROGRAM 2 SELECT FUNCTION

Example: The operator wishes to set the COLD TRAP on prior to Program execution.

KEY	DISPLAY
DEFAULT	DEFAULT MODE P2 SELECT FUNCTION
COLD TRAP	DEFAULT MODE P2 COLD TRAP OFF
ON	DEFAULT MODE P2 SELECT FUNCTION

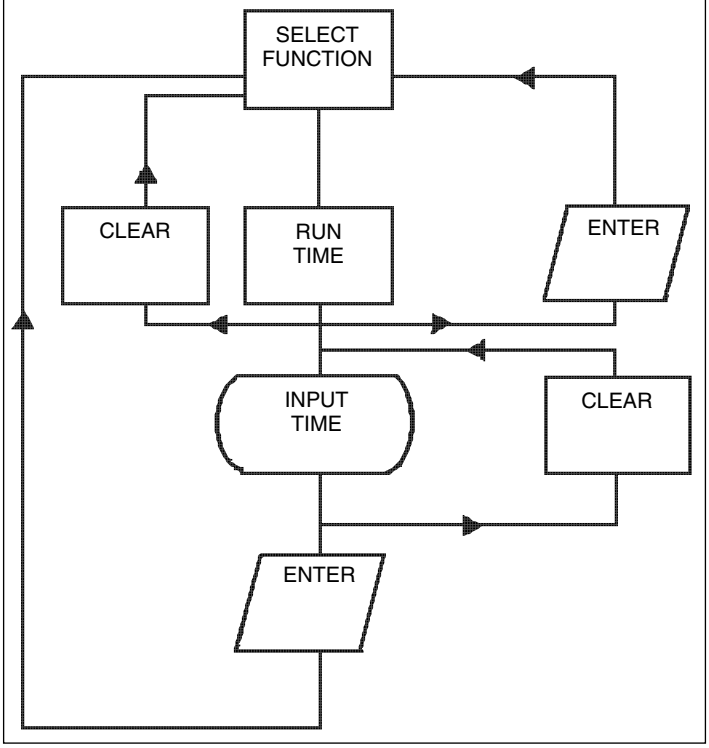
NOTE: The Cold Trap L.E.D will be indicating that it is ON.

The operator would set an OFF time for the Cold Trap within a Program Sequence. As it is already on prior to program execution, an ON time would not be required.

From the above display, the operator may either set another function or press ***ENTER*** to return the MDU to the SELECT FUNCTION display.

4.7.2. Run Time.

Diagram 6. - Run Time



This function allows the operator to set a specific length of time for a Program. When the time is complete, it will terminate all functions of a Program and any outputs being controlled by the External Event. Access to this function is gained, within a Program from the SELECT FUNCTION display, by selecting ***RUN TIME .*** A time of 0 to 999.99 minutes may be entered; again, this is in decimal form.

4.7.3. External Events.

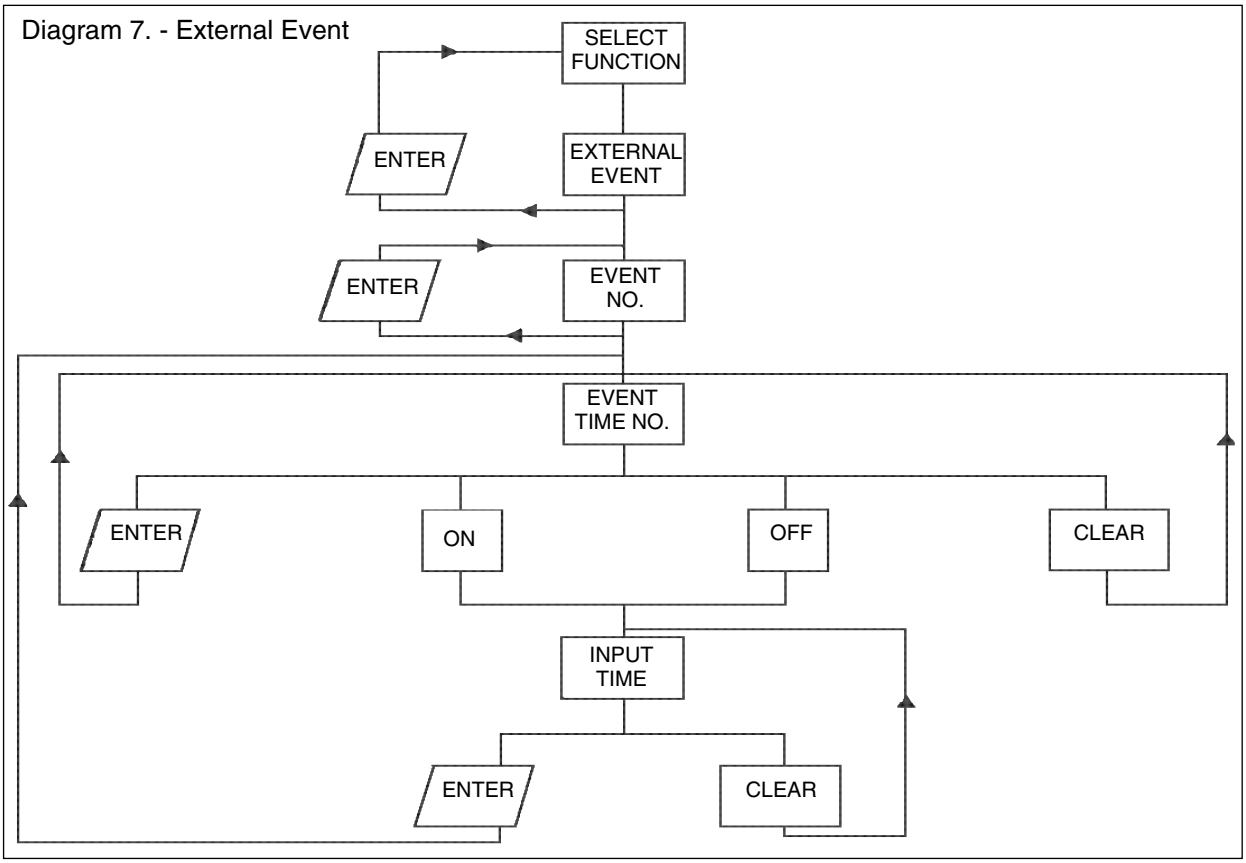
Within a Program, an operator is able to control up to four external devices through the External Events programming sequence. For each External Event, the operator is able to set up to eight ON and eight OFF times. A remote lead is supplied for connection to external devices. For further information regarding this, refer to Section 10.

Programming of the events is carried out in the Program Mode with the display reading :

	PROGRAM 2 - SELECT FUNCTION
KEY	**DISPLAY**
EXT EVENT	PROGRAM X EXT EVENT 1-4
1	PROG X EVENT 1 TIME 1-8
1	EVENT 1 TIME 1 ON .00 OFF .00

The basic programming of this follows the same format as the Basic Functions, as the flow diagram below illustrates.

Diagram 7. - External Event



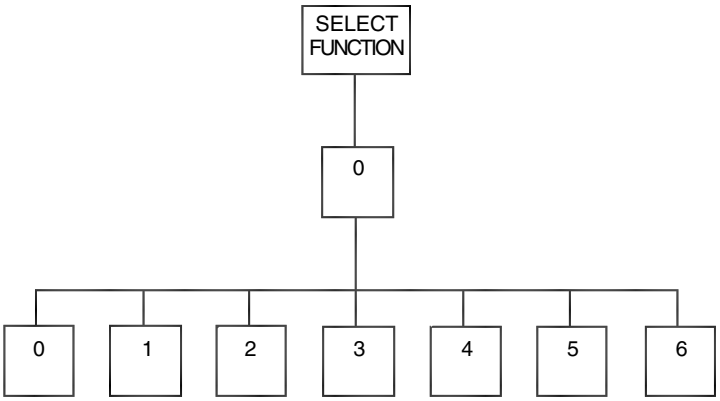
4.8. MDU Setup Mode.

The MDU Setup Mode provides access to the background functions available. It is entered from the SELECT FUNCTION display by selecting ***0***. The display will respond with the following:

SETUP MODE
SELECT 0-6

The operator then able to select a numerical key between 0 and 6 to access the following options:

Diagram 8. - MDV Set Up Mode



0 - Date - this may be viewed or altered.

1 - Time - this may be viewed or altered.

2 - Serial Communications Interface - allows Baud Rate and Parity to be set for computer communication.

3 - NVRAM - allows the operator to clear the entire Non Volatile Memory. ***(ENTER*** - clears the NVRAM; ***CLEAR*** - exits this option.)

WARNING: ALL PRESET PROGRAMS WILL BE LOST IF THIS FUNCTION IS USED.

4 - Transmit - allows all information relating to a selected Program to be transmitted to a host computer system or terminal.

WARNING: IF SELECTED WITHOUT CONNECTION TO COMPUTER, THE KEYBOARD WILL LOCK AND THE MDU WILL REQUIRE RESETTING.

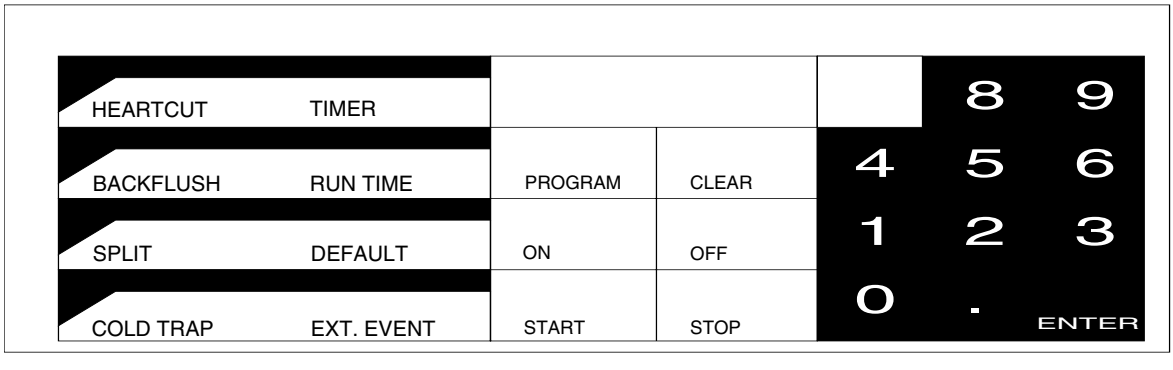
5 - Pressure Display - Selecting 5 will change the displayed units of pressure from psi to kPa, or kPa to psi. This is indicated in the STANDBY display by the shifting of the decimal point.

6 - Backlighting - Selection of 6 will switch the backlighting function ON or OFF.

4.9. Keyboards and Displays.

Diagram 9. - Keyboard

PRE .0 MID .0
STANDBY PROG 1



4.9.1. Basic Function Keys.

HEARTCUT , ***BACKFLUSH*** , ***SPLIT*** and ***COLD TRAP*** .

In manual mode, actioning these keys will allow control of these functions.
Within a program, they allow the selection and setting up of On/Off timing sequences.

4.9.2. Mode Function Keys.

PROGRAM - Allows entry into an existing or new Program.

DEFAULT , ***RUN TIME*** and ***EXTERNAL EVENT***.

These keys provide access to the additional functions which may be set within a Program.

4.9.3. Run Control Keys.

START and ***STOP*** .

Provide the means to manually execute a program.

4.9.4. Numerical and Modifier Keys.

Allow the operator to make changes within a Program and enter values.

5.0 INSTALLATION.

5.1. Capillary to Capillary System.

5.1.1. General.

These instructions apply for both capillary to capillary mid-point restrictors i.e. the MRC/0.2 for 0.22mm I.D. analytical columns and the MRC/0.3 for 0.32mm I.D. analytical columns.

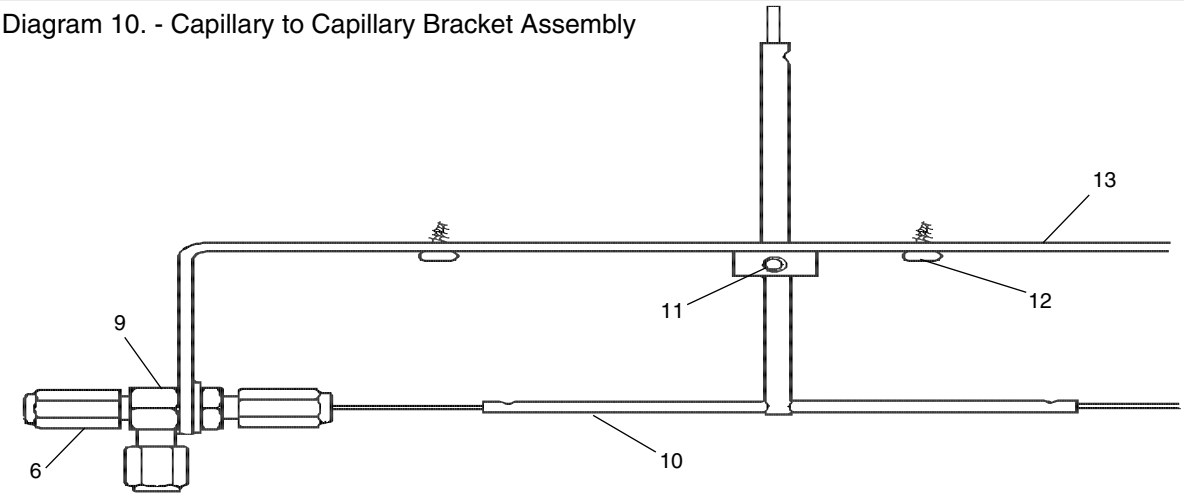
5.1.2. System Preparation.

It is recommended that the control module is located as close to the instrument oven as practical. This facilitates interconnection of the unit and oven hardware components.

5.1.3. Hardware Components.

1.Install the mid point mounting bracket (13) at a convenient location inside the gas chromatograph oven. Two sheet metal screws (12) have been provided to secure it in place. Use a 1/8" drill bit for drilling the necessary holes.

Diagram 10. - Capillary to Capillary Bracket Assembly



2.The mounting bracket (13) is supplied with a Cold Trap Tee (10) and a MRC/0.2 mid-point restrictor (9) fitted (Refer Diagram 10).

a.If the Cold Trap is to be used, the appropriate cryogenic valve needs to be attached to the Cold Trap Tee.

b.If Cold Trapping is not required, the Cold Trap Tee may be removed from the bracket by loosening the grub screw (11) and then sliding it out.

c.The mid-point restrictor (9) may be replaced with another of a different I.D., if an analytical column of different I.D. is to be used.

The type of capillary to capillary restrictor can be identified by the number stamped on the body of the restrictor tee.

Valve Body Mark	Analytical Column
0.5	0.32mm I.D.
0.4	0.22mm I.D.

3.Find a suitable position on the GC where the pneumatic valve (MPPVT-MDS) can be inserted through the oven wall and held in place by the supplied mounting bracket. A hole in the oven wall of approximately 5/16" is required.

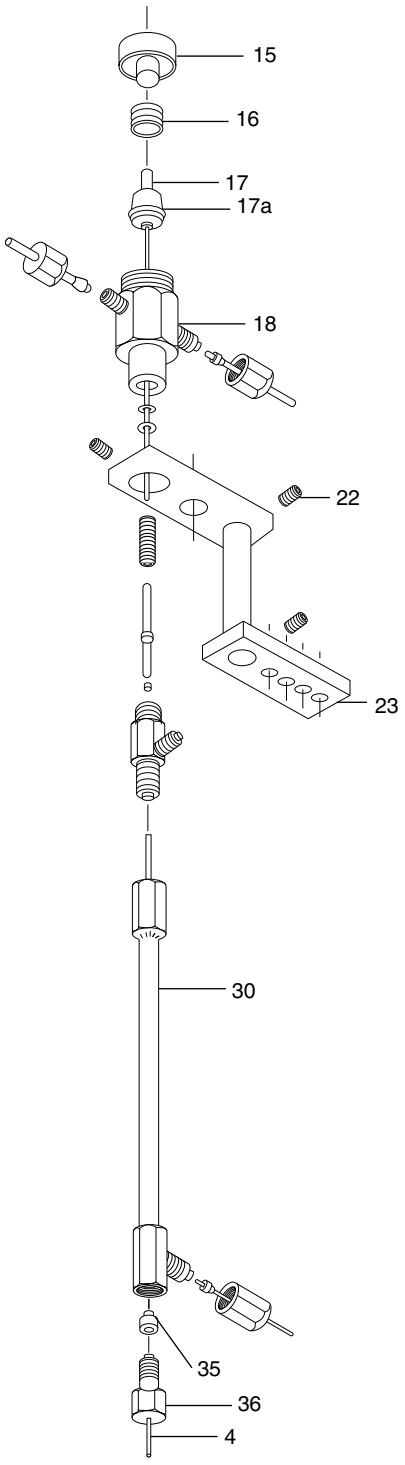
a.Disassemble the valve by unscrewing the valve stem (30). Pass the lower assembly of the valve through the hole in the oven wall (See Diagram 11).

b.Locate and attach the mounting bracket (23) to a suitable position on the outer oven wall, using the sheet metal screws provided.

c.Positioning of the valve and mounting bracket can be accomplished by loosening the grub screw (22).

d.Reattach the valve stem to the pneumatic head assembly.

Diagram 11. - MPPVT/MOVPT MDS Valve



5.1.4. System Connections.
In making the various stainless steel tubing connections into the GC oven, it is important that neat, space conserving runs be utilized. The gas connections are mostly made using 1/16" stainless steel tubing and VSR/16 sealing rings.

Diagram 12 illustrates the full assembly.

1.Two 1/8" stainless steel supply lines are required to connect both the carrier and the make up to the appropriate connections on the rear of the unit. VSR/8 sealing rings are provided for sealing these connections.

2.Connect a short length of the wide bore fused silica (2VSD/420 I.D.) from the smaller 0.8 I.D. side arm of the MPPVT-MDS valve to the monitor detector.

Ensure the silica is inserted all the way into the valve side arm. The other end is terminated at a point within the heated zone of the detector.

3.From the Pre-Column outlet on the rear of the MDU unit, connect a 1/16" line to one end of a supplied AT-PCS adsorption tube. A 1/16" line is then joined between the other end of the adsorption tube and the injector carrier gas inlet.

The same procedure may be followed for connection between the SPLIT IN on the unit and the split on the injector.

4.1/16" Stainless steel lines are required between the following:

Gas Chromatograph	**Rear Panel**
MPPVT-MDS	MAKE-UP OUT
MRC/0.2 or MRC/0.3	MID POINT
MPPVT-MDS	H/CUT VALVE on
MPPVT-MDS	H/CUT VALVE off
and if in use	
COLD TRAP VALVE	COOLANT VALVE

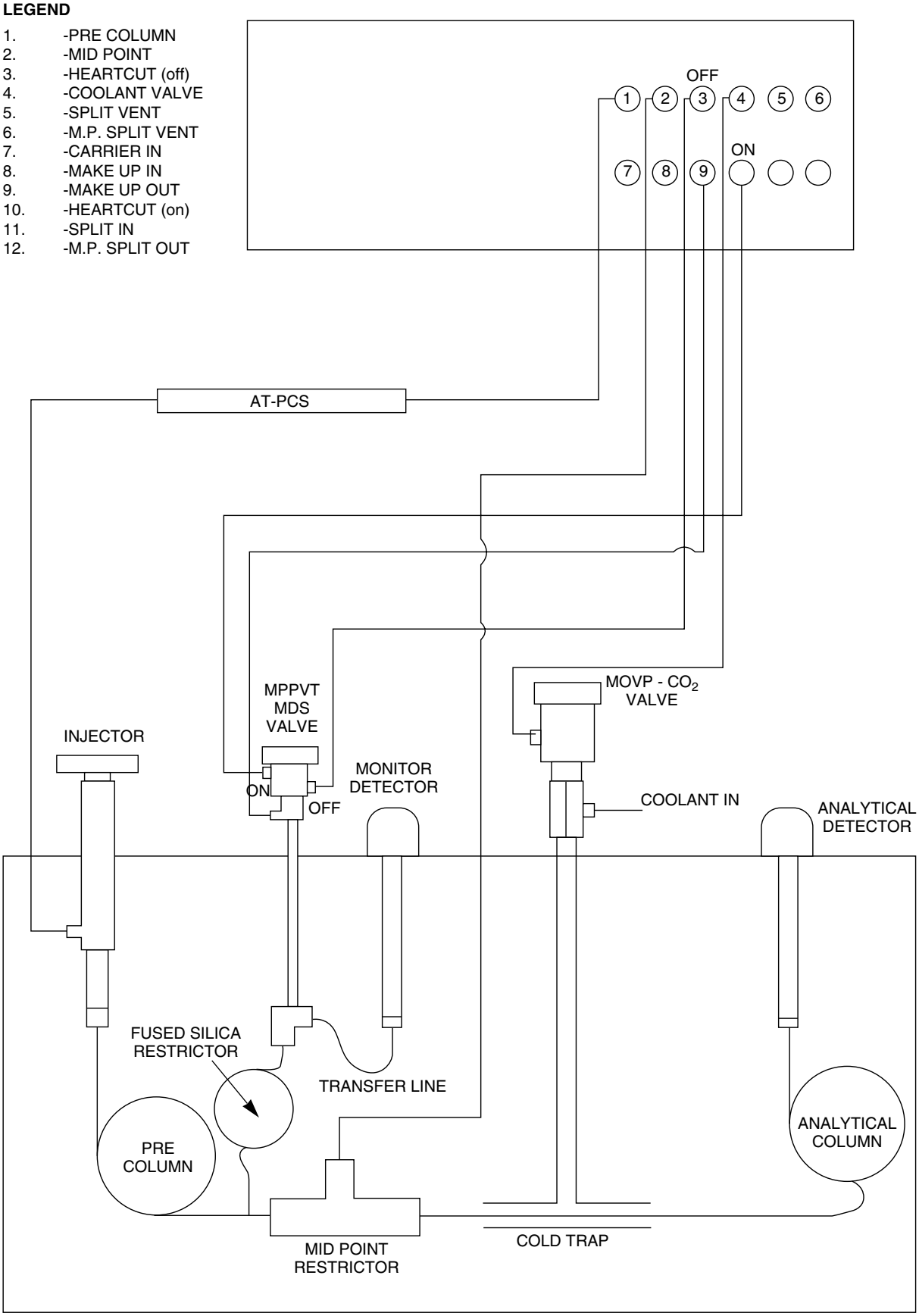
5.The Pre-column may be connected to the injector.

6.Select the appropriate fused silica restrictor and two hole ferrule to make a connection with the Pre-column to the inlet side of the mid-point restrictor.

Diagram 12. - Capillary to Capillary System

LEGEND

1. -PRE COLUMN
2. -MID POINT
3. -HEARTCUT (off)
4. -COOLANT VALVE
5. -SPLIT VENT
6. -M.P. SPLIT VENT
7. -CARRIER IN
8. -MAKE UP IN
9. -MAKE UP OUT
10. -HEARTCUT (on)
11. -SPLIT IN
12. -M.P. SPLIT OUT

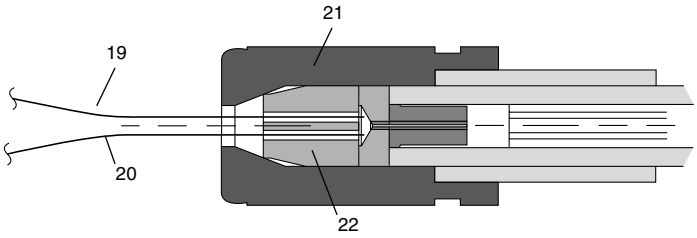


Pre-Column	Ferrule	Fused Silica Restrictor
0.22mm I.D	GVF2/004	2VSD 110 I.D. 320 O.D.
0.32mm I.D.	GVF2/004/005	2VSD 150 I.D. 320 O.D.

For the GVF2/004/005 two hole ferrule, one hole is smaller than the other. The smaller hole is intended for the narrow bore fused silica restrictor tubing.

a. Insert the ends of the pre-column (19) and restriction tubing (20) through the nut (21) and through the two hole graphitised vespel ferrule (22) (Refer Diagram 11).

Diagram 13 - Two Hole Ferrule Connection



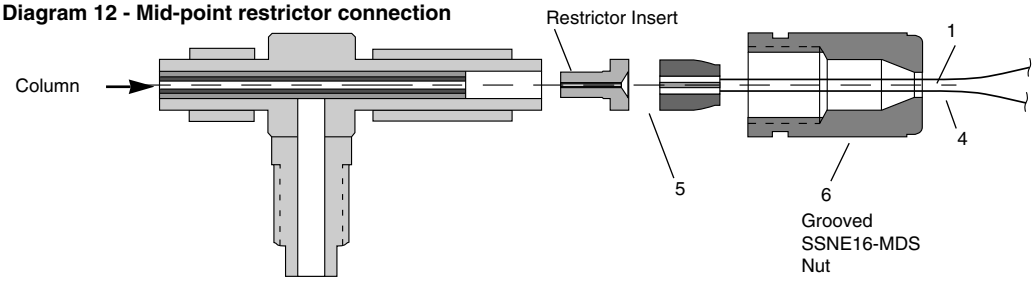
b. Check the front of the tubes to ensure that they are reasonably flat across their diameters.
If they are not, new breaks should be made to ensure that both tubes have clean square ends.

c. Place a small piece of tape across both tubes behind the connecting nut to hold this alignment until the connecting nut can be tightened.

d. Hold the tube ends in place while the nut and ferrule are moved up to the mid-point restrictor and tightened. Slight forward pressure is maintained on the two tubes to hold them in position until the ferrule has locked them in place. Tighten the nut until the connection is found to be leak free.

e. Insert the analytical column into the outlet end of the mid-point restrictor (refer to diagram 12) after passing it through the cold trap tee if applicable. Insert the column into the mid-point restrictor until it contacts at the inlet end. The column is then withdrawn approximately 1mm inside the extended nut and locked into place with a GVF/005 ferrule for 0.32mm ID analytical columns, or a GVF/004 ferrule for 0.22 / 0.25mm ID analytical columnn.

Diagram 12 - Mid-point restrictor connection



5.1.4. Balancing the Analytical Column and Fused Silica Restrictor.

1.Set the pre-column pressure as desired. This pressure is normally dependant upon the pre-column and analytical column length and internal diameter.

2.Check the flow from the end of the fused silica restrictor and the Analytical column. The object is to obtain an identical flow out of each. A soap bubble meter may be used to check the flow.
To obtain identical flow, reduce the length of the fused silica restrictor by small amounts.

NOTE: The timer function of the MDU mentioned in Section 4.5 may be used here.

3.Once the flows are the same, connect the fused silica restrictor tube to the bottom of the MPPVT-MDS valve. The fabrication procedure for this connection is indicated in Diagram 11 and detailed as follows:-

a.Remove the pneumatic head cap (15) and spring (16).

b.Pull the piston plunger shaft (17) up from the pneumatic body about 2cm.

c.Remove the male nut (36) from the valve stem and thread the end of the fused silica restrictor line (4) from the mid-point restrictor through the nut (36).
d.Thread the MPPVT-MDS valve seat (35) onto the fused silica restrictor line (4).

e.Make sure the end of the restrictor tube is cut square before inserting it up into the valve stem (30). The restrictor line will stop when it contacts the valve plunger. Finger tighten the nut (36).

f.Gently push the Piston plunger shaft (17) back into the pneumatic body (18). The skirt seal (17A) has to be compressed so that it will slide into the pneumatic body easily.

g.Reinstall the spring (16) and pneumatic head cap (15) and tighten.

h.With a spanner, commence tightening the male nut (36) until the seal can be felt starting to grip the restrictor line (4).

i.The restrictor should be pulled out a small amount (approximately 1mm) to prevent damage by the downward thrust of the valve plunger. The male nut (36) should then be tightened to lock the fused silica restrictor (4) in place and to make the connection leak tight.

j.The make up gas should be set to a value in the order of 30 ml/min., which can be measured at the detector exit with the other detector gases turned off.

4.The Analytical column may now be connected to the Analytical Detector.

5.Carry out a full leak check of all components.

5.1.5. Optimizing the Mid-Point Restrictor.

The pre-column is already set to the established pressure. With all connections made, it will be noted that the mid-point pressure will equilibrate.
With the system operating in Normal Mode (Heartcut function off), a series of methane or solvent split-mode injections are made while observing the output from both the monitor and analytical detectors (at high detector sensitivity settings).

1.Select ***SPLIT ON*** from the STANDBY mode.

2.Inject a sample of methane or another suitable solvent.

3.If the mid point pressure is set below optimum, splitting of the test peak will occur at the mid-point restrictor and the response will be recorded at both detectors.

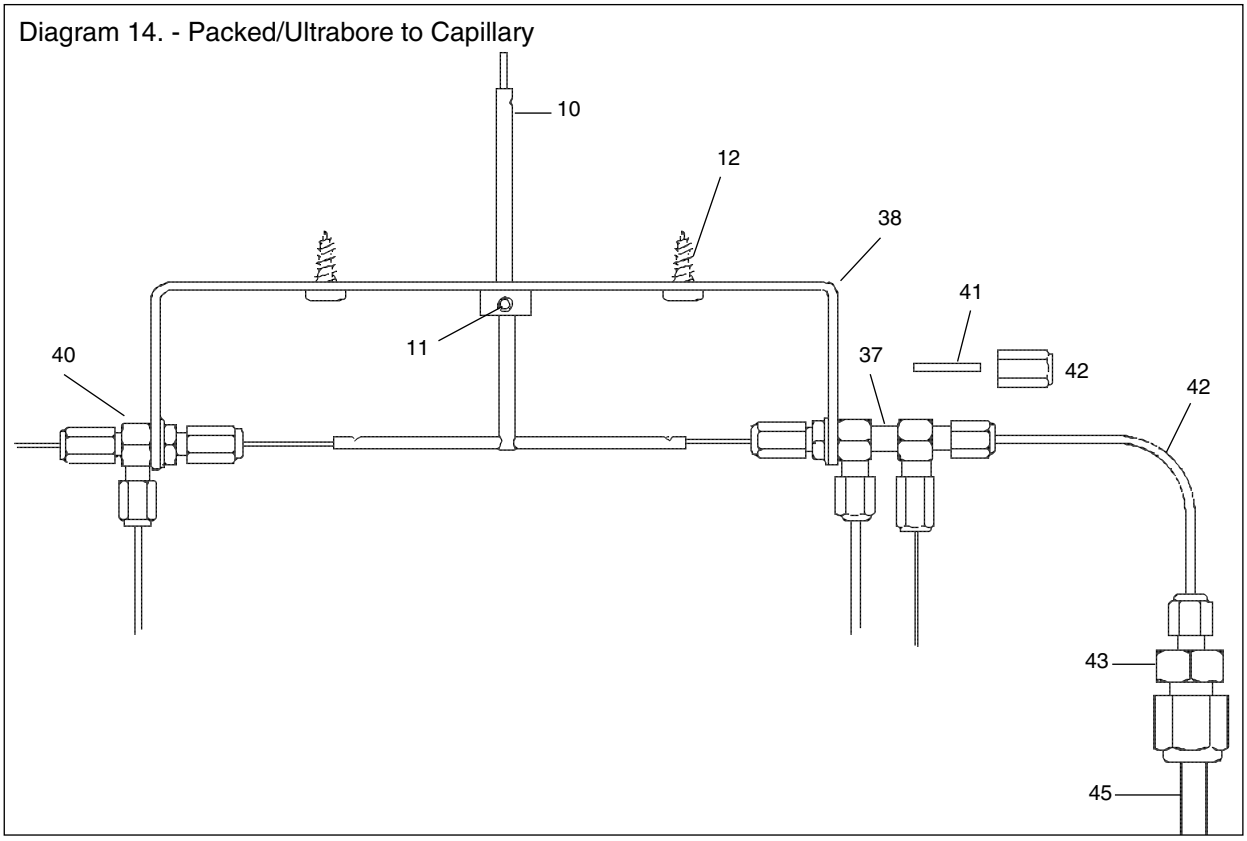
4.Increase the mid-point pressure slightly after each injection until the pressure differential is reached. This is indicated by the test peak not showing up at the analytical detector. The correct pressure combination for normal heartcut and backflush operation has now been obtained.

5.This pressure "tuning" operation should be required only once for any particular combination of pre and analytical columns.

5.2. Ultrabore to Capillary and Packed to Capillary.

5.2.1. General.

Diagram 14. - Packed/Ultrabore to Capillary



The MRCP/0.5 restrictor permits either partial or total transfer to be made from a 0.53mm I.D. capillary column or packed column onto a second capillary column. Due to the lower efficiency of 0.53mm capillary columns and packed columns it will be necessary to cold trap the transferred components in order to refocus them, prior to analyzing them on the second capillary column. A single cold trap step is adequate for most separations (i.e., utilizing the cold trap at the mid-point restrictor as supplied). This arrangement results in only a minimal loss in column efficiency when working with a 0.32mm I.D. second column. If this minimal efficiency loss is unacceptable, an optional second cold trap can be placed down stream of the mid-point split tee to focus the transferred components at the head of the capillary column. This will involve a two step cold trap operation when operating in total transfer mode.

5.2.2. Hardware Components.

1.The mounting bracket (38) is supplied with the MRC/0.5/MRP restrictor (37), the mid-point split tee (40), and the cold trap (10) fitted. The MRC-0.5/MRP restrictor fitted is for a Ultrabore to Capillary System. A small change to it is required to convert it to Packed to Capillary System. This is detailed in Section 5.2.3, Item 8.

2.The installation of the components follows the same procedure as for the Capillary to Capillary System detailed in Section 5.1.3.

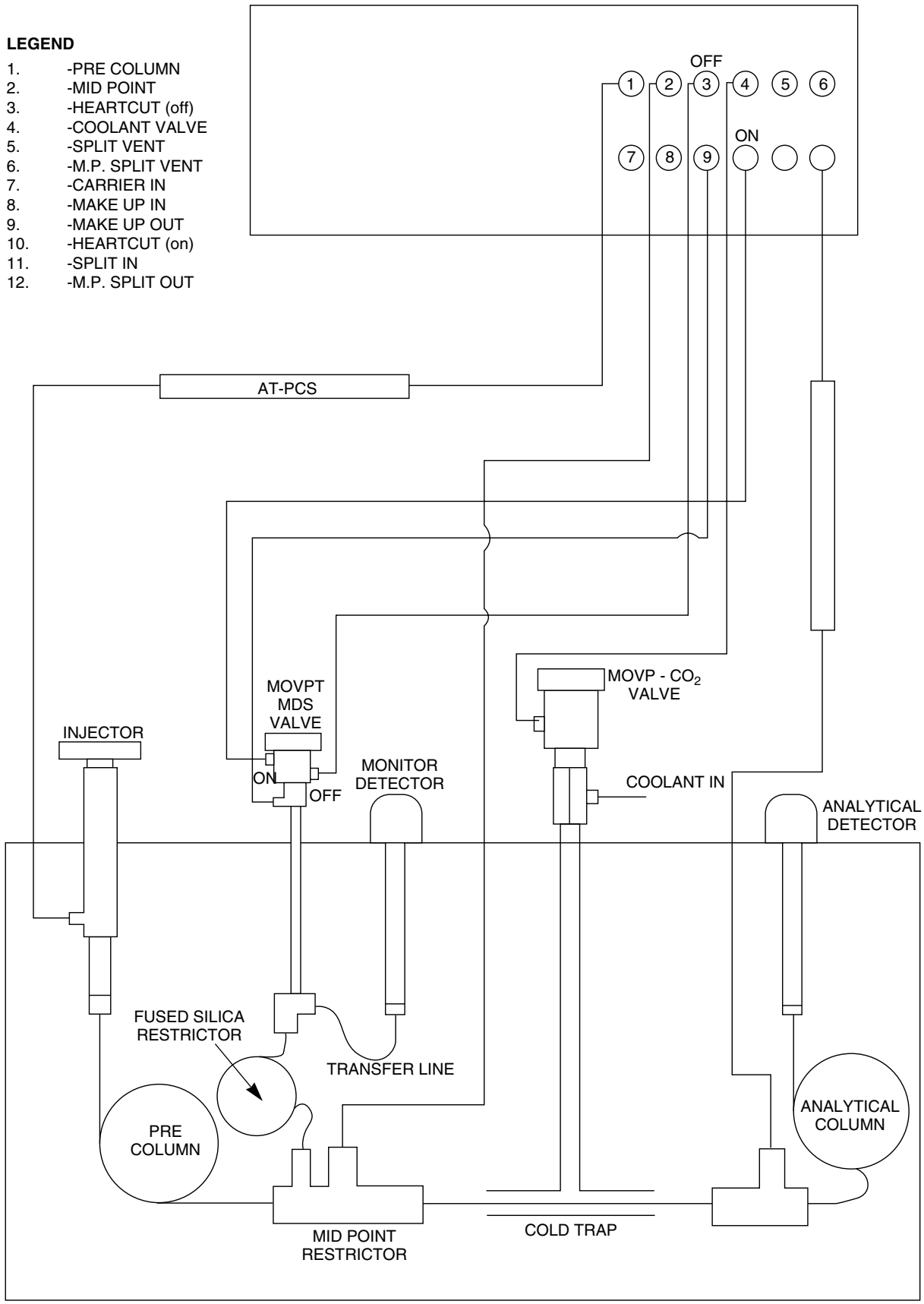
5.2.3. System Connections.

The system connections are mostly made using 1/16" stainless steel tubing and VSR/16 sealing rings. In making the various stainless steel tubing connections into the GC oven, it is important that neat, space conserving runs be utilized. Diagram 15 gives a full overview of all connections required.

1.Two 1/8" stainless steel lines are required to connect both the carrier and the make up lines to the appropriate connections on the rear of the unit. VSR/8 sealing rings are supplied to aid with these connections.

2.Connect a length of the wide bore fused silica (2VSD/420 I.D.) from the smaller 0.8 I.D. side arm of the MOVPT-MDS valve to the Monitor detector. Ensure the fused silica is inserted all the way into the valve side arm. The other end is then terminated at a point within the heated part of the detector.

Diagram 15. - Packed/Ultrabore Capillary System



3.1/16 " stainless steel lines are required between the following:-

Gas Chromatograph	Rear Panel
MPPVT-MDS Valve	MAKE UP OUT
MPPVT-MDS Valve on	H/CUT VALVE on
MOVP-CO2 Valve	COOLANT VALVE
MRC-0.5/MRP Restrictor	MID POINT
MPPVT-MDS Valve off	H/CUT VALVE off

4.From the PRE COLUMN outlet on the rear of the unit, connect a 1/16" line to one end of a supplied AT-PCS adsorption tube. A 1/16" line is then joined between the other end of the adsorption tube and the injector carrier gas inlet.

5.If only partial transfer of the eluent of the first column is required, i.e. the flow is split to reduce the sample size on the second column, then connect a stainless steel transfer line from the mid-point split connection on the mid-point split tee to an AT-PCS adsorption tube. From the adsorption tube, a line is then run to the M.P. SPLIT on the control module rear panel.

If the total transfer mode of operation is to be used, where all of the eluent at a particular time from the Pre column is to be passed into the second column, then it must be possible to shut off the split flow through the line. In this case, the transfer line from the mid-point split connection, via the AT-PCS, should be connected to the SPLIT IN on the rear panel of the MDU. This will permit the total transfer operation to be automated through the SPLIT control function which is normally a closed function. The mid-point split is then controlled by the INLET SPLIT needle valve in the pneumatics compartment, located at the front of the module.

6.The connection of the Analytical column is made at the mid-point split tee at the opposite end of the MRCP/0.5 using a GVF/005 ferrule. The column front is inserted into the end of the TEE connection until it contacts the end of the fused silica wide bore transfer tube. The column is then inserted approximately 2mm up into the end of the 0.53mm I.D. transfer tube and locked in place with the GVF/005 ferrule.

7.A length of the fused silica (BP1-CAP-PCS), supplied in the kit, is fitted by inserting it through the mid point split tee (40), nut and OGF/008 ferrule, through the cold trap (10) and into the restrictor (37). The fused silica transfer line should go all the way into the restrictor (37), pulled back approximately 1mm and then locked in position with SSNE/16 nuts which should contain OGF/008 ferrules.

8a.Ultrabore Column Connection.Prior to connecting the 0.53mm I.D. capillary column, ensure that the sleeve, which is a short piece of 1/16" O.D. x 0.8 I.D. GLT (41), is located in the pre column connection end of the restrictor (37). This locates the pre column correctly inside the fitting.

b.Packed Column Connection. The packed column connection is made to the mid-point restrictor (37) via a length of GLT (42). The existing sleeve of 1/16" O.D. x 0.8mm I.D. GLT (41) is removed.
The stainless steel union (43) is connected to the end of the packed column. Two unions are provided for this purpose. The SSU-4/16 is for 1/4" packed columns and the SSU-8/16 is for 1/8" packed columns. For sealing, either the GFF/4 or GFF/8 ferrules should be used.

9.The pneumatic cryogenic valve can then be connected to the cold trap tee (10) as detailed in Section 7.0.

5.2.4. Initial Setting Up.

With the mid point pressure regulator turned off (counter-clockwise rotation of the control knob), and the mid-point split partially open, the pre column pressure is slowly increased until the desired capillary or packed head pressure is read at the mid-point gauge.

The mid-point pressure is then gradually increased until the mid-point regulator just overwhelms the pressure influence of the pre-column. This will be indicated by rapid up or down movements of the mid-point gauge needle when corresponding changes are made with the mid-point pressure regulator.

The desired final mid-point split flow should then be set using the appropriate needle valve at the control module front panel. The split flow can be measured at either the M.P. SPLIT OUT or SPLIT OUT depending which valve is being used.

5.2.5. Optimizing the Mid-Point Restrictor.

The 2VSD/150 I.D. 320 O.D. or 2VSD/230 I.D. 320 O.D. tubing is attached to the fixed restrictor connection point at the mid-point restrictor utilizing either a GVF/004 ferrule or a GVF/005 ferrule. The length of this tube is then fixed to match the composite flow through the mid-point split and analytical column. This is completed via the same process which was described for the capillary to capillary installation in Section 4.1.4.

Once this length is set, the mid-point split flow should not be altered.

The fused silica restriction may now be connected to the MPPVT valve utilizing a MPPVT valve seat (35) and the male nut (36). For making this connection, follow the instructions given in Section 4.1.4 and Diagram 11.

6.0 OPERATION.

6.1. Capillary to Capillary System.

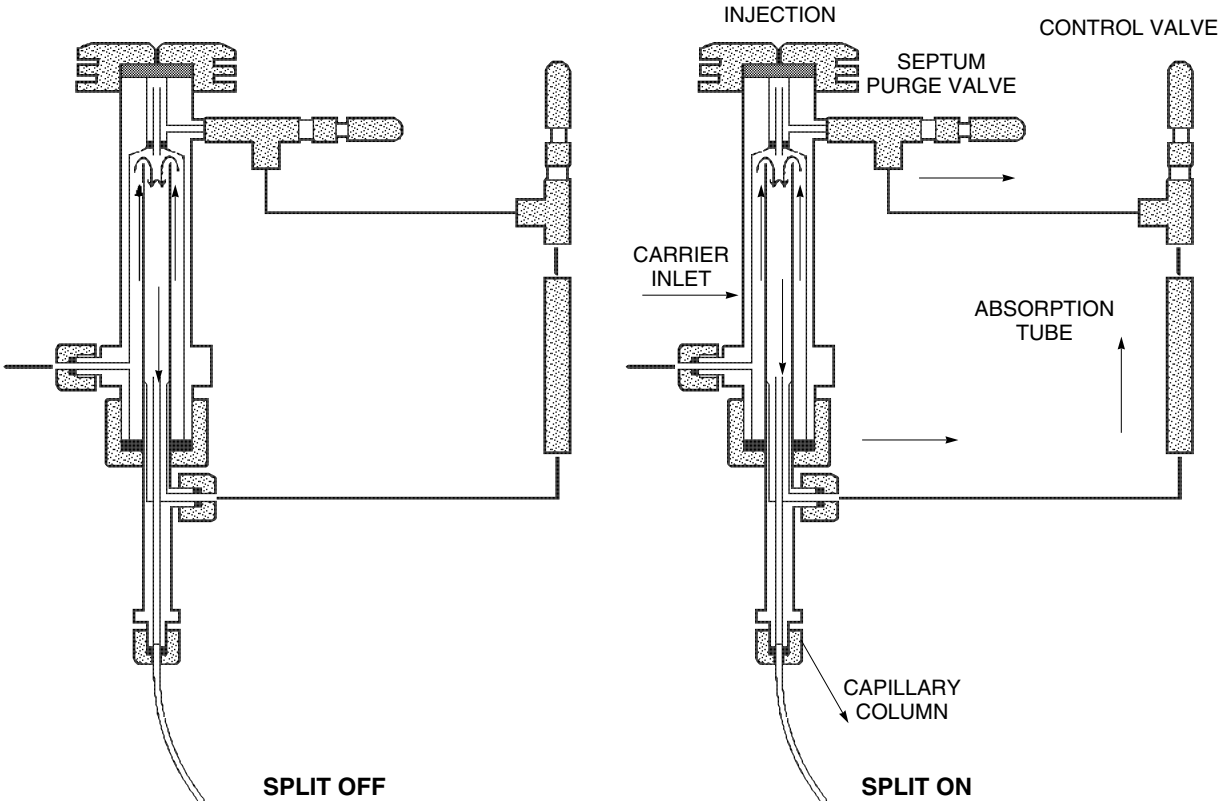
The following sections detail the basic operating priciples of the Capillary to Capillary System.

6.1.1. Split-Splitless Mode Injections.

This operation may be controlled manually by the SPLIT key or within a program through the SPLIT timing functions.

Split Mode Injection - SPLIT ON may be selected during an injection and the split ratio set by adjusting the Inlet Split control needle valve. The split flow may be measured at the SPLIT OUT on the rear of the module. After the injection, SPLIT OFF may be selected to conserve the carrier gas.

Splitless Mode - SPLIT OFF may be selected prior to an injection. After a suitable delay, (usually 15-60 seconds depending upon sample and column), SPLIT ON may be selected to remove any residual components.



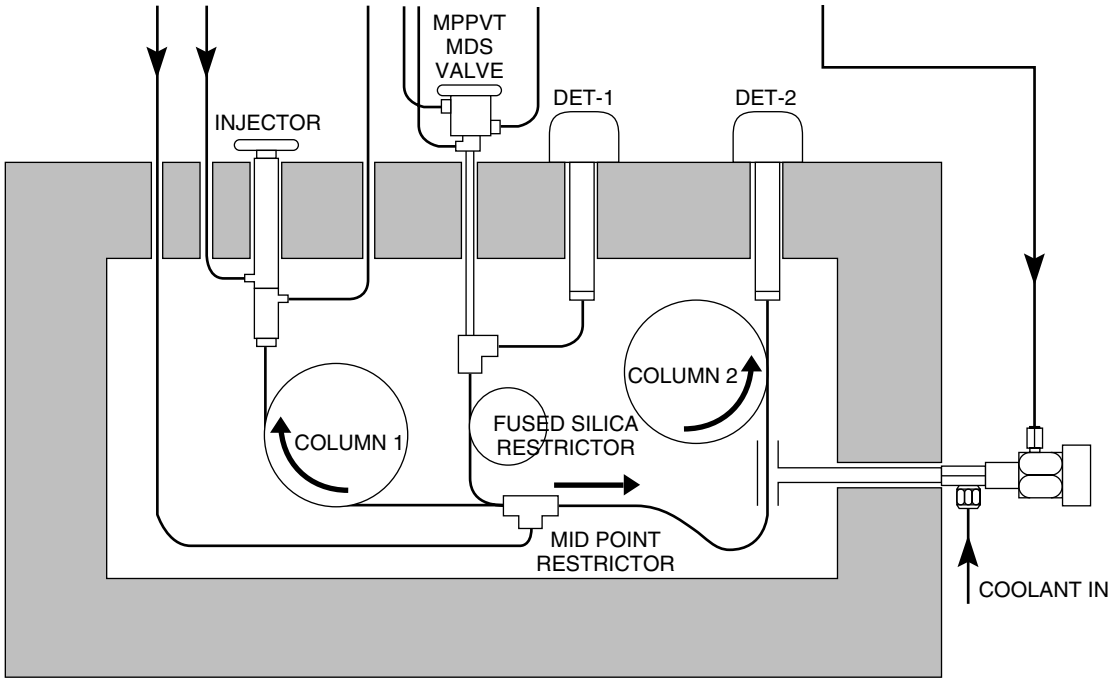
6.1.2. Backflush Operation.

The backflush operation may be used to shorten analysis time, protect the analytical column from non-volatile or damaging materials, as well as protecting either detector.

To initiate the Backflush Mode manually, the operator selects ***BACKFLUSH ON*** and ***SPLIT ON*** from the STANDBY display. Within a Program, these functions may be set to operate at specific ON and OFF times.

It is important that the Pre-Column be backflushed for at least as long a period of time as the sample components had been allowed to progress forward through the column.

Diagram 18 -Backflush



6.1.3.Variable Splitter Operation.

This operation allows the establishment of a variable split of the Pre-Column effluent between the Monitor detector and the analytical column.

When the mid-point pressure is dropped below the value which is required for the heartcut or backflush operation a portion of the pre-column effluent is permitted across the mid-point restrictor into the analytical column. The desired Split ratio may be controlled by incrementally lowering the mid-point or increasing the pre-column pressure.

Diagram 19 -Variable Splitting

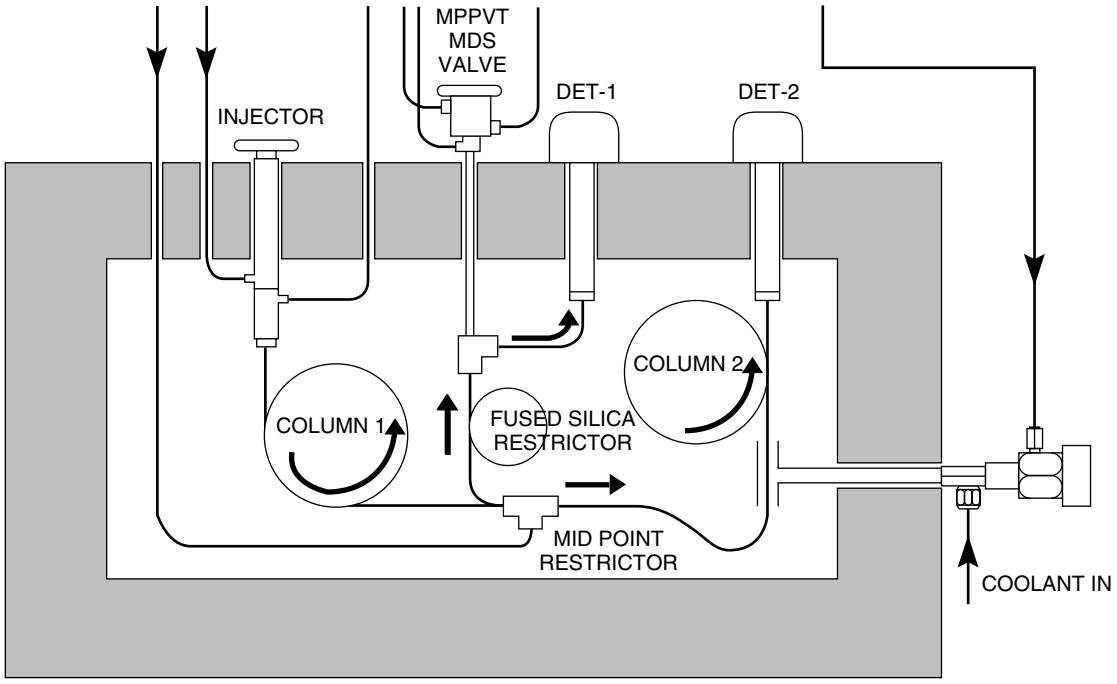


Diagram 19 -By Pass Operation

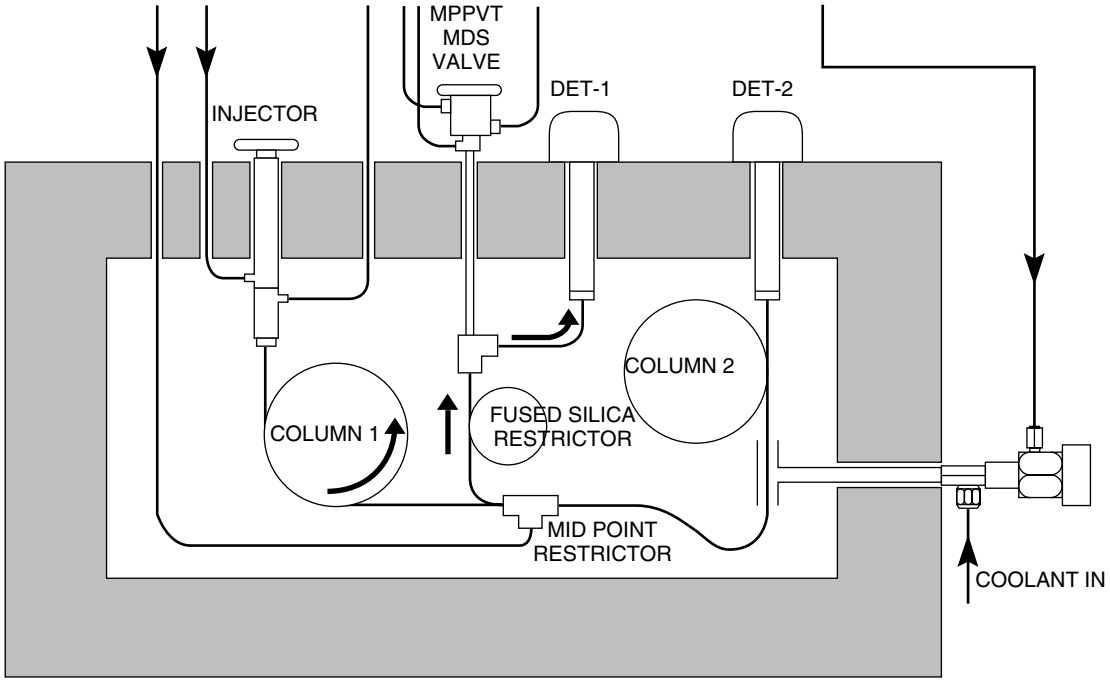
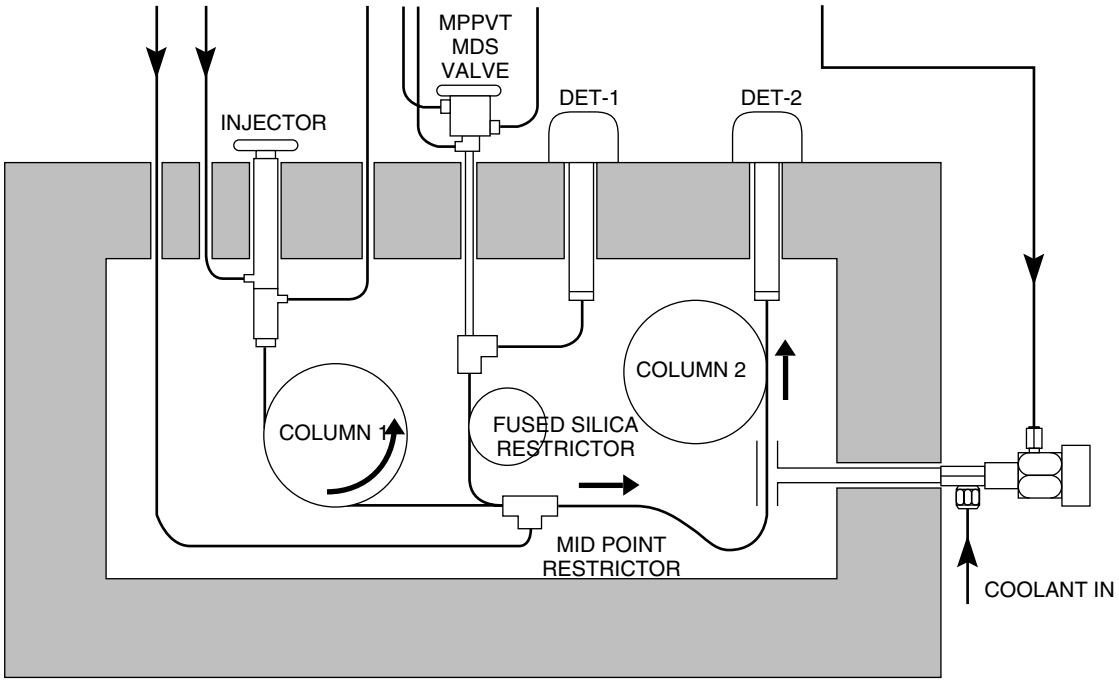


Diagram 20 -Heartcut



6.1.4. By-Pass and Heart-Cut Operation.

The heart-cut capability makes possible the selective transfer of sections of the chromatographed components from the pre-column onto a second analytical column (usually of different polarity).

The HEARTCUT key allows manual control of this function.

Within a Program, ON/OFF times may be set to provide automatic control.

6.2. Ultrabore/Packed to Capillary.

6.2.1. Partial Transfer.

In the partial transfer mode of operation, the mid-point split flow is maintained throughout the run. This results in a mid-point split of the pre column effluent being taken to the analytical column. It will be necessary to cold trap the transferred components to refocus them prior to analyzing on the analytical column. This can be carried out at the mid-point cold trap.

6.2.2. Total Transfer.

The only difference between partial and total transfer is the mid-point split flow is shut off during the time when total transfer is being made from the mid-pont cold trap onto the capillary column. The total transfer sequence would be as follows:

1.Injection is made with the MPPVT-MDS valve (HEARTCUT OFF) and mid-point split open (SPLIT ON).

2.The mid-point cold trap is switched on (COLD TRAP ON) approximately one minute prior to the heartcut operation.

3.The desired cut is made by switching off the MPPVT-MDS valve, i.e. HEARTCUT ON.

NOTE: Mid-point split flow is left on during this heartcutting period.

4.After the desired heartcut is made, the MPPVT-MDS valve is switched on, i.e. HEARTCUT OFF.

5.To make the total transfer onto the capillary column, the mid-point split flow is switched off followed by switching off the coolant to the cold trap.(COLD TRAP OFF).

6.After allowing sufficient time for transfer to be made, the mid-point split flow is switched on and the run completed.

NOTE: This process may be carried out within a Program by entering the correct times for the functions to action.

7.0 LIQUID CARBON DIOXIDE COLD TRAP.

7.1. Introduction.

The SGE Pressure switching system control module incorporates a solenoid pilot valve for cryogenic operation.
This solenoid supplies auxiliary gas to actuate the pneumatic valve mounted on top of the cold trap tee.
This pneumatic valve controls the flow of coolant to the cold trap tee.
The pressure switching system is supplied with liquid CO2 cryogenic systems as standard.

7.2. Installation.

The liquid CO2 trap is supplied connected to the mid-point restrictor bracket. If the cold trap is to be used, an additional 1/8" hole through the oven wall is required for the input leg of the trap when the bracket is installed.

The trap is held in place by
tightening the grub screw (11) on the bracket (38) or (13).

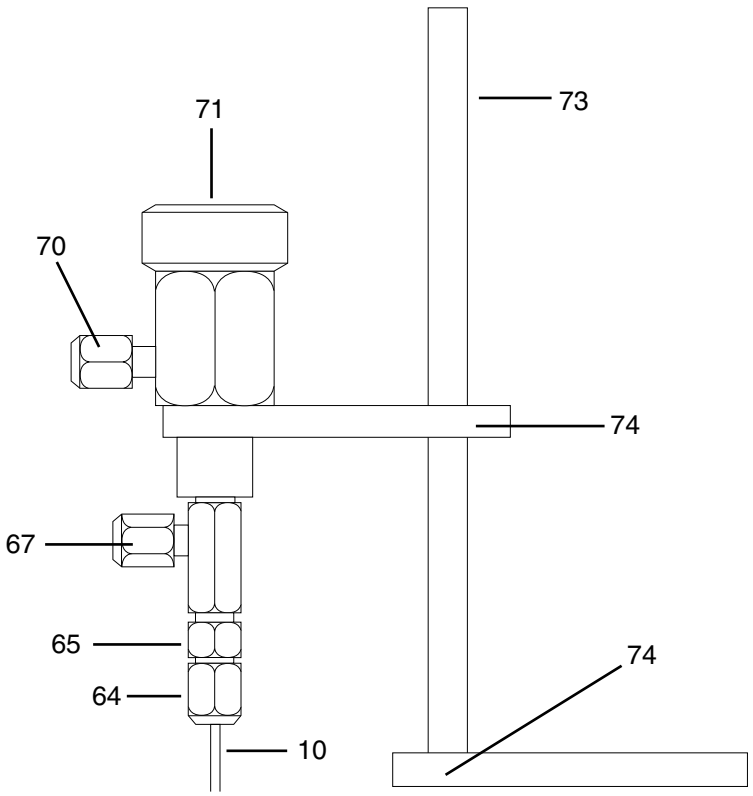
The cryogenic control valve can then be fitted onto the cold trap tee (10) using the nut (64) and a VSR/16 sealing ring.(See Diagram 21.)

It is recommended that the mounting bracket (73) is adjusted by loosening the grub screws (74) so that the bracket base (75) can be attached to a suitable location on the GC oven wall. Screws are provided for this purpose.

A 1/16" line (69) should be run between the pneumatic valve and the COOLANT VALVE bulkhead connection on the back panel of the MDU control module.

A 1/16" stainless steel transfer line should be run from the coolant source to the side connection on the cryogenic valve. This side connection has a 50 micron filter (not shown in Diagram 17.) fitted to prevent particulate matter from entering the restrictor tubing in the cold trap tee. If necessary, this can be removed for cleaning.

Diagram 21 -Cold Trap



The transfer line from the coolant source is connected to the filter on (67) using a VSR/16 sealing ring.

The analytical column front or tubing the sample is to be trapped on, is passed through the cold trap, and connected to the mid-point restrictor in the normal manner.

7.3. Operation.

The cold trap operation is initiated by simply selecting ***COLD TRAP ON*** in the manual mode, or setting specific times within a program. This should be initiated a short time (at least 60 seconds) prior to the arrival of the compounds to be trapped.

Switching from cold trap to run mode is accomplished by simply selecting ***COLD TRAP OFF*** , in either the manual mode, or setting a specific OFF time within a program mode. The column oven temperature takes over at this point and initiates the chromatography of the trapped components.

Note: The liquid CO_2 cryogenic valve and cold trap tee must not be used with liquid nitrogen.

8.0 LIQUID NITROGEN COLD TRAP (OPTIONAL ACCESSORY).

8.1. Introduction.

The column switching system control module may also be used for controlling liquid nitrogen cooling when the optional CTS-LN kit is employed. Additional instructions are supplied with CTS-LN kit.

8.2. Installation.

Ensure that the lower part of the MOVPT 8/8/16 valve is adequately tightened to the pneumatic head assembly as this is left loosely tightened for shipping.

Remove the piece of 1/16" stainless steel tubing from the valve base connector as this is only provided to locate the valve seat/ferrule.

The pneumatically operated valve should be mounted on the outside of the GC oven wall, but not in close proximity to high temperature regions such as detectors or injectors. The valve can be secured in position using the mounting bracket provided. This bracket may be held in place by drilling two holes with a 1/8" drill bit in the oven outer panel or suitable support, and using the sheet metal screws provided.

The valve should also be mounted so that the cold trap tee can be passed through the oven wall and connected directly to the 1/16" connector on the valve. Ensure that the cold trap is fully held in the vespel ferrule in the valve before tightening.

Connect the tee union containing the fixed vent to the inlet valve on the pneumatic head. A vespel ring in the female connector makes the seal. The nut on the sidearm of the tee should not be removed as it contains a restrictor designed to relieve the pressure in the pneumatic valve head when the source pressure is turned off.

Connect the supplied 1/8" stainless steel tubing from the high pressure liquid nitrogen source to either one of the 1/8" connectors on the pneumatic valve. Use the GFF/8 ferrules provided to seal the tubing into the valve.

Connect some more of the 1/8" stainless steel tubing from the remaining 1/8" connector on the valve to the modified Whitey valve, which should be mounted on a suitable panel in a convenient location. Connect the 1/8" tubing to the inlet of the valve as indicated by the arrow on the valve body showing direction of flow.

The 1/8" tubing for the liquid nitrogen source and the bottom part of the MOVPT 8/8/16 valve should be insulated to reduce the amount of liquid nitrogen required to lower the temperature to the desired level and keep it there.

Flexible foam hose or foam adhesive tape may be used as well as urethane foam which can be applied from aerosol containers. These insulating materials are available from suppliers of refrigeration equipment.

A 1/16" stainless steel line may be connected from the COOLANT OUT to the tee union with the fixed restrictor on the pneumatic head of the valve.

The "make-up" gas is used to activate the pneumatic head on the MOVPT 8/8/16 valve so a pressure of at least 55psi (370 kPa) is required.

Cooling of the cold trap can be commenced simply by selecting COLD TRAP ON on the module, or activating the system remotely at the desired time with the GC, integrator or data system external events.

8.3. Operation.

Prior to the commencement of cold trapping operations the system should be cooled down by opening the Whitey valve sufficiently to bring the system down to a temperature to observe liquid nitrogen (bluish haze) venting through the Whitey valve. The valve may then be closed to a position with reduced flow that is sufficient to maintain the system at a desired temperature. This position can then be held and returned to at a later time by setting the screw and lock nut in the base of the Whitey valve.

When the system has been brought down to temperature with the MOVPT valve fully open the cold trap will be cooled almost immediately. The temperature attained in the cold trap and therefore the components that can be trapped successfully depends on:

A: The purge flow set with the Whitey valve influences the temperature attained.
B: The oven temperature.

9.0 OPERATIONAL MODE TABLE.

Basic Functions

OPERATIONAL MODE	HEARTCUT	SPLIT	BACKFLUSH	COLD TRAP
Split Mode				
- Split Initial	---	ON	OFF	---
- Run	---	OFF	OFF	---
Splitless Mode				
- Splitless Initial	---	OFF	OFF	---
- Delay	---	ON	OFF	---
- Run	---	OFF	OFF	---
Backflush				
- Initial Injection	---	---	OFF	---
- Delay	---	---	OFF	---
- Backflush	---	ON	ON	---
Monitor Detector Mode	OFF	---	OFF	---
Heartcut	ON	---	OFF	---
Cold Trap				
- Trap	---	---	OFF	ON
- Run	---	---	----	OFF

10.0 REMOTE OPERATION.

10.1. General.

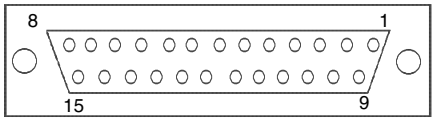
The MDS unit has can be remotely controlled by external devices, or remotely control up to four external devices through the External Events Mode.

10.2. Output Port.

As a program begins executing a 50 millisecond High to Low going pulse is generated on the START output of the Remote Output Port, and when the program terminates a second 50 millisecond High to Low going pulse is generated on the STOP output of the Remote Output Port. These pulses are generated whenever a program is executed regardless of whether External Events have been programmed.

The External Event Program allows timed control of the external device. The ON/OFF times relate to High to Low transitions of four TTL Output Port lines of which the default state is equal to all lines high. As program execution progresses the state of individual lines will change according to their ON/OFF times. The ON time is equal to the time a line will spend in the Low state. Diagram 22 ilustrates the Pin Out Configuration. Diagram 23 illustrates the Pin Out Configuration.

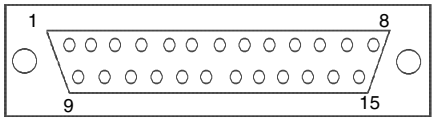
Diagram 22 - TLL OUTPUT



PIN	DESIGNATION	COLOUR
1	START	GREEN
2	STOP	AQUA
3	NOT USED	
4	EXT 1.	GREY
5	EXT 2.	BLUE
6	EXT 3.	PURPLE
7	EXT 4.	YELLOW
8	NOT USED	
9	+5V	RED
10	+5V	PINK
11	OV	BLACK
12	OV	BROWN
13	OV	WHITE
14	OV	ORANGE

MALE

Diagram 23 - TLL INPUT



PIN	DESIGNATION	COLOUR
1	TRIG 1	ORANGE
2	TRIG 2	PURPLE
3	TRIG 3	AQUA
4	TRIG 4	GREY
5	TRIG 5	GREEN
6	TRIG 6	YELLOW
7	TRIG 7	WHITE
8	TRIG 8	BLUE
9	+5V	RED
10	+5V	PINK
11	OV	BLACK
12	OV	BROWN
13	OV	
14	OV	
15	OV	

FEMALE

10.3. Input Port.

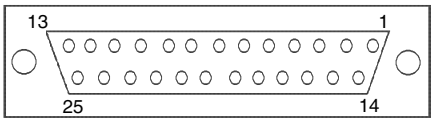
The Remote Input Port allows up to eight devices to cause a selected Program to begin execution. A High to Low going signal applied to any of the eight inputs will cause the current program to be executed. The input signal source can be either a relay contact closure shorting the input to Ground, or a Low going TTL voltage level.

NOTE:For the external input signal to cause immeadiate program execution, the MDU must be in the STANDBY MODE. If it is not, program execution will be delayed until STANDBY MODE is re-selected.

10.4. RS232 Port.

The RS232 Port is available for interface with a computer. Diagram 24 illustrates the Pin Out configuration.

Diagram 24 - RS232



PIN	
1	GND
2	TX
3	RX
4	NOT USED
5	CTS
6	NOT USDE
7	OV
8-19	NOT USED
20	DTR
21-25	NOT USED

11.6. PACKING LIST.

Capillary to Capillary System (Part No. 0933406)

Description	Quantity
MDS2000 Control Unit	1
MPPVT-MDS Valve	1
MOVP-CO2 Valve	1
CTS-LCO2 Cold Trap (fitted to bracket)	1
MRC/0.2 Restrictor (fitted to bracket)	1
MPPVT Valve Seat (pkt of 5)	1
PTFE Seal, MOVPT Valve (pkt of 2)	1
BS001 "O" Ring	1
AT-PCS Adsorption Tube	2
VSR/16 Sealing Ring (pkt of 10)	2
2VSD/420 I.D. Fused Silica Tubing	1
1/4" x 5/16" AF Spanner	1
1/16" Allen Key	1
Self Tap Screws 8 x 1/2"	6
Mounting Bracket	1
GFF/8 Graphite Ferrules (pkt of 5)	1
6BA Allen Key	1
Power Lead (no plug)	1
Remote Input Lead	1
Remote Output Lead	1
Fuse, 110V, 1.25 Amp (T)	1
240V, 630m Amp (T)	1
MRC/0.3 Restrictor	1
2VSD - 150 I.D., 320 O.D.	1
2VSD - 110 I.D., 320 O.D.	1
GVF/004 Vespel Ferrule (pkt of 5)	1
GVF2/004 Ferrule (pkt of 5)	1
GVF2/004/005 Ferrule (pkt of 5)	1
GVF/005 (pkt of 5)	1
GVF/008 (pkt of 5)	1
1/16" x 0.8mm I.D. x 10 metre Stainless Tubing	1
Instructions	1

Ultrabore/Packed to Capillary System (P/N 0933407)

Description	Quantity
MS 2000 Control unit	1
MPPVT-MDS Valve	1
MOVP-CO2 Valve	1
LTS-CO2 Cold Trap (fitted to bracket)	1
0.8 PA-15 Special Tee (fitted to bracket)	1
MPPVT Valve Seat (pkt of 5)	1
PTFE Seal, MOVPT Valve (pkt of 2)	1
BS001 "O" Ring Seal	1
AT-PCS Adsorption Tube	2
VSR/16 Sealing Ring (pkt of 10)	2
2VSD/420 I.D. Fused Silica Tubing	1
1/4" x 5/16" AF Spanner	1
1/16" Allen Key	1
Self Tap Screws 8 x 1/2"	6
Mounting Bracket	1
GFF/8 Graphite Ferrules (pkt of 5)	1
6BA Allen Key	1
Power Lead (no plug)	1
Remote Input Lead	1
Remote Output Lead	1
Fuse, 2 Amp.	1
MRC-0.5/MRP Restrictor (fitted to bracket)	1
2VSD - 150 I.D., 320 O.D.	1
2VSD - 220 I.D., 320 O.D.	1
BP1-CAP-PCS (tube of fused silica)	1
GVF/004 Vespel Ferrule (pkt of 5)	1
GVF2/004 Ferrule (pkt of 5)	1
GVF2/004/005 Ferrule (pkt of 5)	1
GVF/005 (pkt of 5)	1
VF/008 (pkt of 5)	1
GFF/4 Ferrules (pkt of 5)	1
OGF/008 Ferrules (pkt of 5)	1
1/16"x 0.8mm I.D.x 10 metre Stainless Tubing	1
SSU-4/16 Union	1
SSU-8/16 Union	1
PCS-GLT 1/16"O.D. x 0.5mm I.D. GLT x 250mm	1
Instructions	1

11.7. REORDER LIST.

Part Number	Description	Quantity
0933432	MRC-0.5/MRP Restrictor Kit	1
0933430	MRC/0.2 Restrictor Kit	1
0933431	MRC/0.3 Restrictor Kit	1
093346	CTS-LCO2 Cold Trap	1
0933438	Mounting Bracket Cap to Cap	1
0933437	Mounting Bracket Pack to Cap	1
0624459	2VSD 110 I.D. 320 O.D.	1
0624465	2VSD 150 I.D. 320 O.D.	1
0624469	2VSD 220 I.D. 320 O.D.	1
0624477	2VSD 420 I.D. 600 O.D.	1
0933420	0.53 mm I.D. 0.1 micron film BP1 fused silica (pkt of 10)	1
0932163	Skirt Seal, MOVPT Valve	1
040103	BS001 "O" Ring Seal	1
123687	PTFE Seal, MPPVT Valve	1
0933435	MPPVT Valve Seat	1
0933424	40 micron filter, Cold trap	1
072654	GVF/005 Ferrule (pkt of 10)	1
072663	GVF/004 Ferrule (pkt of 10)	1
072662	GVF2/004 Ferrule (pkt of 10)	1
0726642	GVF2/004/005 Ferrule (pkt of 10)	1
072655	GVF/008 Ferrule (pk of 10)	1
072626	OGF/008 Ferrule (pkt of 10)	1
072601	GFF/4 Ferrule (pkt of 10)	1
072602	GFF/8 Ferrule (pkt of 10)	1
072653	VSR/16 Sealing Ring (pkt of 10)	1
101230	SSU-4/16 Union	1
103414	SSU-8/16 Union	1
18000005	RS232 Interface Lead	1
18000007	Remote Input Lead	1
18000009	Remote Output Lead	1