

**ATT-59/99, SMOOTHNESS OF PAVEMENTS**  
**Part II, CS 8200 Profilograph**

## **1.0 SCOPE**

This method describes the procedure for operating the CS 8200 Profilograph.

## **2.0 EQUIPMENT**

profilograph (model CS 8200)

calibration equipment: chain (or tape), keel, 3 pylons

DATA SHEET: Profilograph Index Report MAT 6-73.

## **3.0 PROCEDURE**

### **3.1 Calibration of Profilograph**

The accuracy of the profilograph should be checked when the profilogram results are in doubt.

#### **3.1.1 Odometer Calibration**

Before calibrating:

- a) Ensure the tire pressure is between 275 and 310 kPa (40-45 psi),
  - b) Check the profile wheel for roundness.
1. Choose a paved stretch of road (or parking lot), 100 m in length. Ensure the test section is relatively flat with good visibility for oncoming traffic from both directions.
  2. Ensure that the current safety regulations are followed.
  3. Use the keel to mark the starting point on the pavement. Place a pylon beside the mark as a reference while chaining.
  4. Use the chain (or tape) to measure a straight line distance of 100 m, marking on the pavement intermediate reference points every 10 m.
  5. Mark the end point with a keel and place a pylon beside the mark.
  6. Carefully unload the profilograph sections, wheels and microcomputer.

7. Assemble the profilograph.
8. Set the POWER SWITCH on the side of the controller to ON.
9. Enter the DIAGNOSTICS mode by holding down F1 while activating the RESET switch, "DIAGNOSTICS MODE" will show on the display.
10. Lower the recording wheel and slowly guide the profilograph so that the profile wheel is even with the starting point.

**NOTE:** The recording wheel must be in the up position when the assembled profilograph is manoeuvring (making a sharp turn).

11. Press the START button and the encoder count will go to zero, and RUN will be displayed on the top line.
12. Push the profilograph to the end of the measured distance.
13. Push the STOP button. The bottom line of the display will freeze, the cursor will flash and STOP will be displayed on the top line.
14. Press enter to update the ODOM FACTOR. A short report will be printed documenting the date and the old and new factors.

**NOTE:** The ENCODER COUNT should be  $9643 \pm 10\%$  for a 100 m distance. If the count is outside the limits, there is probably an equipment malfunction.

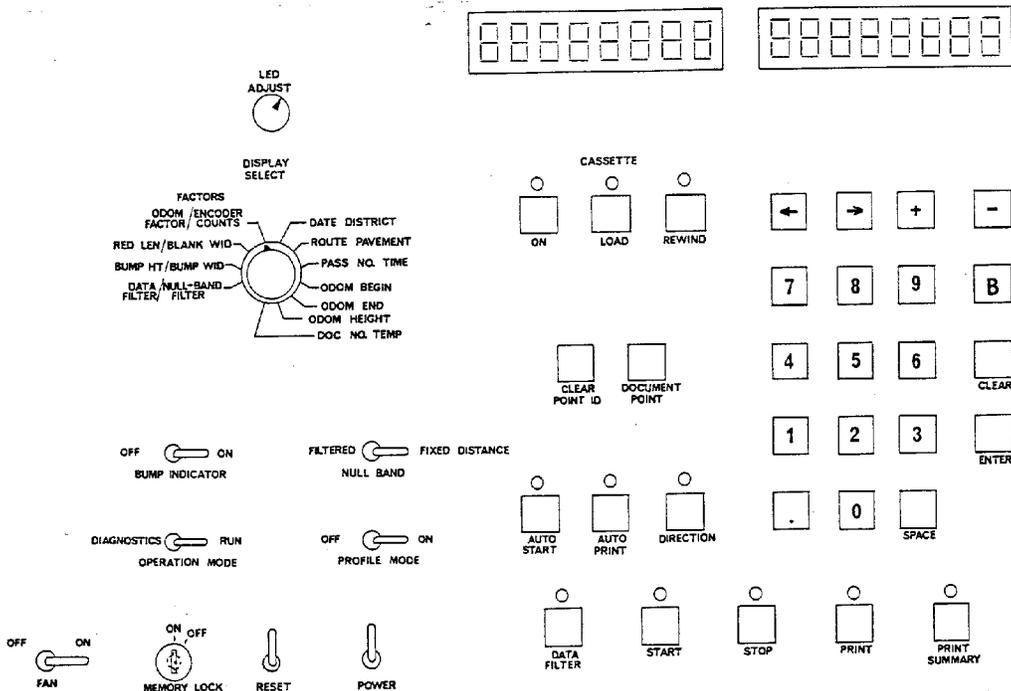


Figure 1

### 3.1.2 Horizontal Calibration

The horizontal calibration may be checked by comparing a 100 m section of profilogram to the length of a PrI template.

If the CS 8200 profilogram is shorter than the PrI template, then the ODOM FACTOR should be increased. An initial increase in the ODOM FACTOR of 20 is recommended. Compare the new profilogram length to the PrI template and adjust accordingly.

If the CS 8200 profilogram is longer than the PrI template, the ODOM FACTOR should be decreased.

These adjustments are performed by trial and error to increase the precision of the horizontal calibration.

### 3.1.3 Vertical Calibration

The vertical calibration has been programmed into the microcomputer at the factory, and should not change. When in doubt, repeat steps 1, 3 to 7, and 9 of Section 3.1.2 of ATT-59, SMOOTHNESS OF PAVEMENT, Profilograph Method, Part I. Compare each measured result on the profilogram to the corresponding board thickness. If they are not the same the profilograph will need repairs.

### 3.1.4 Front Panel Diagnostic Check

The front panel diagnostic check is performed once a month or whenever it is necessary to check the front panel buttons, switches, and displays.

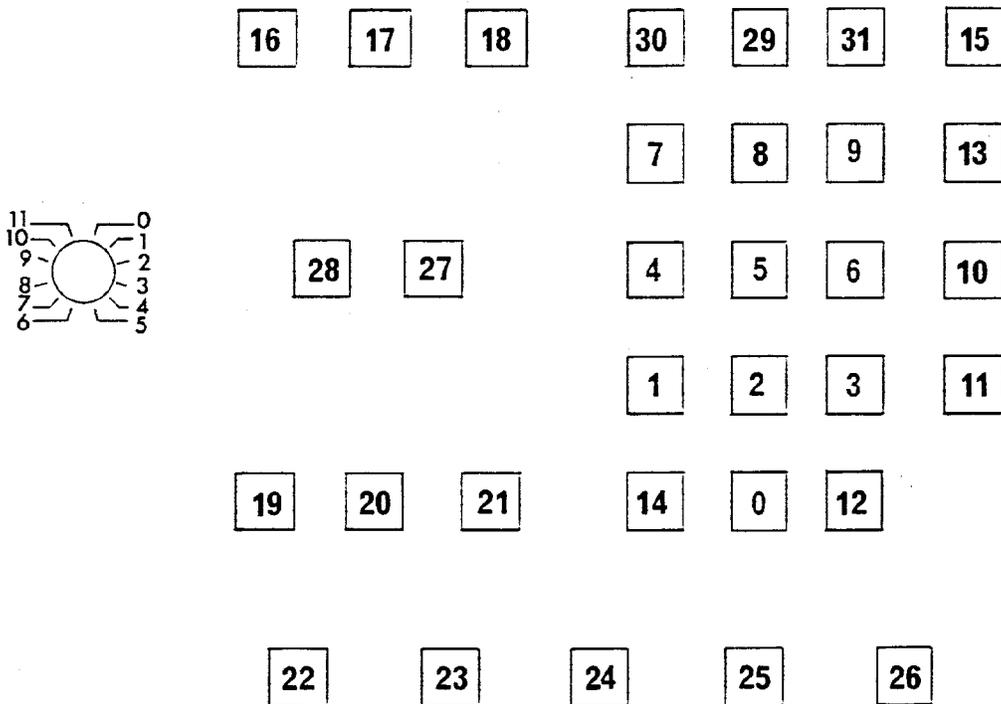
1. Enter the diagnostics mode by holding down the F1 button while activating the RESET switch.
2. Press any numeric key.

The following should occur:

- a) The bottom line of the display shows three fields.
  - b) The first field will display either FIX or FILT depending upon the position of the NULL BAND switch.
  - c) The second field will display either + or - depending upon the position of the DIRECTION switch.
3. The third field is blank until a key is pressed. Each key has a number. The numbers are shown in Figure 2.
  4. The program memory can be checked by pressing the PRINT SUMMARY button. A few seconds a number will appear on the bottom line of the

display. Record this number. If this number changes, it indicates a problem with the program memory. When this happens, contact the manufacturer.

**NUMERICAL CODES OF FRONT PANEL SWITCHES & BUTTONS**



Numerical Codes of Front Panel Switches & Buttons

**Figure 2**

**3.1.4.1 FRONT PANEL SWITCHES AND KEYS**

The front panel has a series of test control switches and keys. The following is a description of the keys:

The PAPER ADVANCE is a momentary switch at the top of the column of switches which advances the paper on the printer.

The RESET switch is also momentary and causes a hardware reset of the system. This performs essentially the same function as turning the system off and then turning it back on, but it causes much less stress on the system.

The NULL BAND switch is an alternate action switch that selects the method used to establish the null band. In the FIXED DISTANCE position, a mathematical best fit straight line is used as the centre of the null band. In the FILTERED position, a low pass filter is used to establish the centre of the null bank. The FILTERED position is used in sharp vertical curves and superelevation transitions.

The DIRECTION switch is an alternate action switch that determines whether the odometer will increment or decrement with the forward motion of the CS 8200. The positive position is used when increasing chainage and the negative direction is used for decreasing chainage.

The F1 pad has two functions. If it is held down as the system is powered up or reset, it will set the CS 8200 into diagnostic mode. If it is pressed after the system is stable, it will print the parameter report.

The up arrow and down arrow buttons are used to scroll through the 20 available parameters on the bottom line of the LCD display.

The LEFT ARROW and RIGHT ARROW buttons are used to access and move the cursor within the bottom line of the display.

The + and - buttons increment or decrement the pass number. The pass number may also be modified by keypad data entry.

The BRIDGE button is used to ignore a section.

The ENTER key in will update the appropriate value within the controller.

The CLEAR key in will cause the in-process key in to be discarded and allow the display to return to its normal mode.

### **3.1.5 KEYPAD DATA ENTRY**

The NUMERIC KEYPAD is used to modify the test control parameters and identification information on the fourth line of the display. The parameter to be modified is first selected with the UP ARROW or DOWN ARROW key. Characters to be modified are accessed with the RIGHT ARROW or LEFT ARROW buttons ( <- and -> ). An accessed character will flash showing the presence of the cursor. If no character is present, an underline will flash. The accessed character may then be modified by keypad entry. When a parameter is changed the ENTER button is pushed to store the value.

### **3.1.6 DOCUMENT POINTS**

The DOCUMENT POINT button is used to document roadway features. One major use is to mark recognizable features such as approaches, culverts, etc. When this key is pushed, a document number with a locating hash mark is then included on the profilogram. The operator can take written notes describing the document points.

### **3.1.7 RUN AND PRINT CONTROL KEYS**

The START, STOP, PRINT, and PRINT SUMMARY keys are described below under CONTROLLING THE RUN.

The START button is used when starting a test section. When it is pushed a listing of the run parameters is printed and the odometer goes to the beginning station.

The STOP button is used to stop a test run.

The PRINT button is used to print a section of the profilogram.

The PRINT SUMMARY button is used to print a summary of the test sections.

The CLEAR button is used to clear the parameter value displayed on the fourth line.

### 3.1.8 SETTING THE PARAMETERS

A list of the parameters are shown in Figure 3. Some are intentionally blank so that they can be changed when necessary.

Odometer	1.	ODOMETER FACTOR is the basic calibration factor in the CS 8200. Changing it will affect many other parameters. When a change is made to the ODOMETER FACTOR, check that all other factors are still correct.
Begin		
End		
Document No.	2.	NULL FILTER allows the null band to track the data. This is set at 80.
Pass No.		
Encoder	3.	DATA FILTER specifies the factor that is used to filter out local roughness such as dirt, rocks, and pavement texture. This is set at 8000.
Odom Factor		
Null Filter	4.	REDUCT LEN is the reduction length for automatic testing and is 100 m.
Data Filter		
Reduct Len	5.	BLANK WID specifies the width of the null bank. This is 0.58 cm.
Blank Wid		
Bump Ht	6.	BUMP HT is the height used for the maximum allowable bump. This is 0.80 cm.
Bump Wid		
Time	7.	BUMP WID is the length of the bump. This is 7.6 m.
Date		
Route		
Pavement		
District		
Bump Locator		
Bottom Bumps		
FIGURE 3		

Also on the list of factors are the following:

- a) ODOMETER which is the chainage on the road.
- b) BEGIN is the beginning station.
- c) END is the ending station.
- d) DOCUMENT # is the number that will be used to locate a point when the DOCUMENT POINT button is used.
- e) PASS # is the number of the pass that will be printed on the printout.
- f) TIME is the time of the day.
- g) DATE is the current date.
- h) ROUTE is the road that you are working on.

- i) PAVEMENT can be used for the control section.
- j) DISTRICT is the district where the project is located.
- k) BUMP LOCATOR identifies bumps on the profilogram.
- l) BOTTOM BUMPS identifies dips on the profilogram.

### 3.1.9 Front Panel Display

The front panel display has a four line by twenty character liquid crystal display, an example is shown below. The top line gives the vertical position of the measuring wheel, the current operating mode, and the odometer. The second line gives the beginning and ending station for automatic measurement. The third line gives the document number and pass number. The fourth line is selected with the up and down arrow buttons and can display any of the 20 parameters listed in Programming the Factors. The fourth line is also used to show the PRINT and PRINT SUMMARY keys are activated.

### 3.1.10 Programming Factors

There are a number of factors that can be modified to affect the operation of the CS 8200. These viewed on line 4 of the LCD display by stepping through them with the up and down arrow keys. They may also be printed by pressing the F1 key. These values must be corrected before the CS 8200 will function accurately. The values listed in Section 3.1.4 are the normal start up settings. They are given in the order that they appear on the printed report which is the same order that they appear as they are stepped through with the up and down arrow keys. Parameters such as date, time, job description, etc. can be changed when necessary.

### 3.2 Testing a Section

The profilograph is used to obtain the profilogram of the outer wheel path (OWP). If the OWP fails the profile index (PrI) specifications, the inner wheel path (IWP) must also be tested. In this case, the PrI is the average of the two wheel paths.

1. After a test section is identified, drive over the section and become familiar with the area. Note all curves, hills, and potentially unsafe areas.
2. Ensure that the current safety regulations are followed.
3. Repeat steps 6 to 8 of Section 3.1.1.
4. Enter the date, district, highway number and control section, pass number and the time. Also enter the beginning and end stations.

NOTE: The beginning station will always be the station with the lowest chainage.

5. Place the BUMP INDICATOR in the ON position; the OPERATION MODE to RUN; the NULL BAND to FIXED DISTANCE; and the PROFILE MODE to the ON position.
6. Ensure that the fan is ON during warm weather.
7. MEMORY LOCK should be ON so that none of the factors entered into memory are tampered with.
8. Select whether the odometer will increase or decrease using the DIRECTION button. When the DIRECTION button LED is lit, the odometer will start to count down from the end station listed in the ODOM END position.
9. Press the AUTO PRINT button and the LED above the bottom will go on.
10. Press the DATA FILTER button and the LED above it will go on indicating that the data filter is on. The DATA FILTER should be on at all times except when checking the vertical calibration.
11. Press the START button at the station where you want to begin. A header with the description of the road being tested and the calibration factors will be printed, as shown in Figure 4.

NOTE: The computer will generate profilograms at the interval specified by the reduction length (100 m). There will be no output until the first length is completed. The report will then be printed. The report printing does not interfere with the accumulation of data for the next report.

12. Push the profilograph over the section that is to be tested.

<b>HEADER WITH ROAD DESCRIPTION AND CALIBRATION FACTORS</b>			
	E.B.L.	O.W.P.	
	8/22/95	12:39	
DISTRICT	ROUTE	PAVEMENT	PASS
7	66	2	4
ODOMETER (COUNTS/100 m)			9873
BLANKING BAND WIDTH (cm)			0.58
BUMP HEIGHT (cm)			0.80
BUMP WIDTH (m)			7.6
DATA FILTER			8000

FIGURE 4

13. When a section to be tested does not begin or end on a 100 m station, there will be an overlap in the testing.

EXAMPLE: The section to be tested is 0+140 to 2+100. The first run would be from 0+140 to 0+240; the ODOM BEGIN number would be 140.0; and the ODOM END number would be 240.0.

The second run would be from 0+200 to 2+100; the ODOM BEGIN number would be changed to 200.0; and the ODOM END number would be 2100.0.

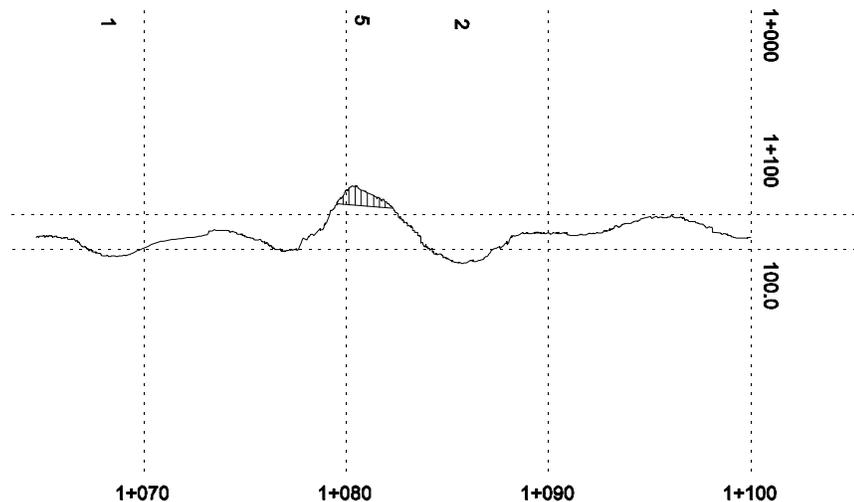
14. Press the DOCUMENT POINT button whenever it is necessary to locate a reference point such as joints, culverts, approaches, kilometre markers and curves, a number will appear on the printout which locates the reference point. Be sure to write on the output what you want to reference. The document point number automatically increases by one after each use and can not be changed during a run. The CLEAR POINT ID button will clear the document point from your display and return it to the normal display.

	FROM	TO	DIST	COUNTS
	16+000	16+100	100.0	0.10
	16+100	16+200	100.0	0.06
	16+200	16+300	100.0	0.08
	16+300	16+400	100.0	0.10
	16+400	16+500	100.0	0.09
	16+500	16+600	100.0	0.08
	16+600	16+700	100.0	0.03
	16+700	16+800	100.0	0.06
	16+800	16+900	100.0	0.08
	16+900	17+000	100.0	0.07
	17+000	17+100	100.0	0.17
	17+100	17+200	100.0	0.20
	17+200	17+300	100.0	0.21
	17+300	17+400	100.0	0.18
	17+400	17+500	100.0	0.09
	17+500	17+600	100.0	0.21
	17+600	17+700	<u>100.0</u>	<u>0.08</u>
PI = 1.1	1700.0	1.89		

Figure 5

15. At the completion of the section, press STOP and then PRINT SUMMARY buttons and a summary of the PrI per 0.1 km will be printed, as shown in Figure 5.
16. Remove the profilograms of that section from the machine and properly describe and label the roll.

17. From the PRINT SUMMARY the PrI for a 100 m section is determined by multiplying the counts for that section by 100.0.
18. All bumps and dips on the profilograph should be checked with the bump template. An example of how the BUMP LOCATOR will indicate a bump is shown in Figure 6.
19. Turn the profilograph off.
20. Disassemble and load the profilograph.



Typical Located Bump  
Figure 6

### 3.2.1 Manual Operation

The older manual profilograph is better suited for testing short sections because the profilogram is being continuously displayed.

The CS 8200 profilograph can also be used in the manual or automatic mode to locate bumps or check areas where the contractor has been cross-rolling to eliminate roughness, but, the profilogram will only be displayed after the section has been completed, or the PRINT button has been pressed.

1. Turn off the AUTO PRINT by pushing that button and make sure that the LED is off.
2. Key the beginning station into ODOM BEGIN when moving in the direction of increasing chainage and a station into the ODOM END that will allow the complete coverage of the section being tested.

3. Key the end station into ODOM END when moving in the direction of decreasing chainage and a station into ODOM BEGIN that will allow the complete coverage of the section being tested.
4. Select, using the DIRECTION button, whether it is increasing or decreasing chainage.
5. Press the START button at the beginning station.
6. Push the profilograph over the distance that is to be tested.
7. Press the PRINT button whenever a printout is needed.
8. Disassemble the profilograph and place it in the van.

### 3.2.2 Bump Locations

Due to the profilograph design the profilograph trace may show a bump as a dip/bump/dip (dips will produce the opposite effect). The height and length of the bump or dip will determine the degree of amplification that they will display on the trace. Figure 7 only requires a repair of the bump at 10+084. Figure 8 shows a bump/dip/bump/dip when only a dip (11+077) and bump (11+083) exist. The bump at 11+073 does not register as a bump because it is too small. In both these cases the leading/trailing bump or dip was caused by the front of the profilograph following the actual profile while the trace records the centre sensing wheel position in relation to the frame. Therefore, to ensure proper identification of bumps or dips the profilograph traces must be manually reviewed.

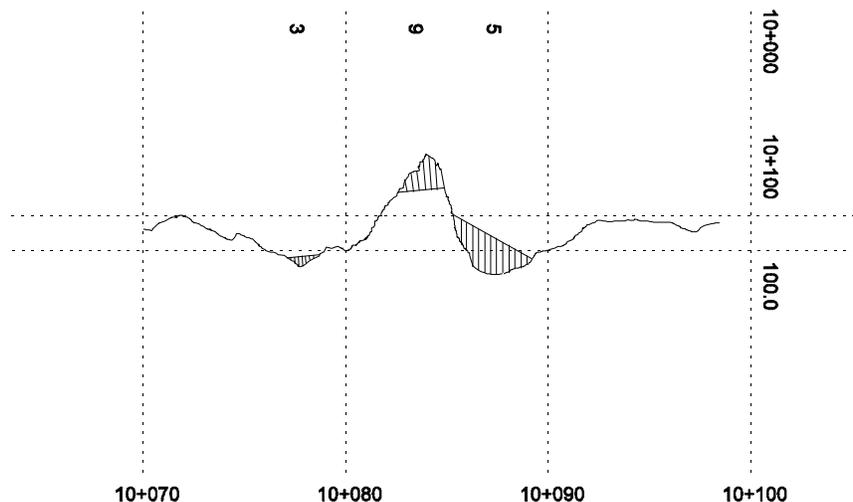


Figure 7

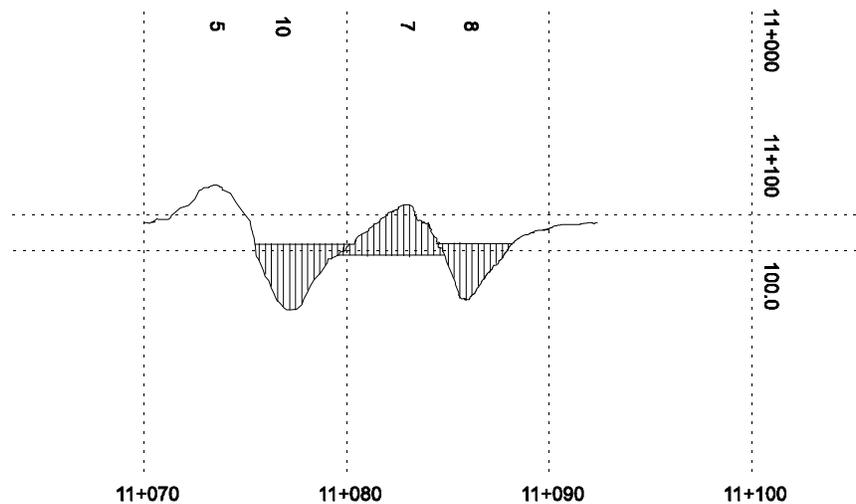


Figure 8

Figure 7 would count as one bump (one repair) and Figure 8 as one dip and one bump (two repairs).

Once a list of bumps and dips is compiled and repairs completed the sublots must be retested to determine final subplot PrI and the number of repaired bumps or dips.

### 3.2.3 Strip Chart Mode

This profilograph can produce a printout similar to the mechanically linked profilograph. It generates a profilogram without a null band, bump shading, or stationing. It does not reduce scallops or report "roughness". This mode can be used to exactly locate pavement features. In this mode the profilograph can be backed up and this will cause the profilogram to be pulled back into the printer, but, there is no printout in the reverse direction. It will print a new profilogram when pushed forward.

1. Repeat steps 6 to 8 and 11 of Section 3.1.1.
2. Set the OPERATION MODE switch to DIAGNOSTICS.
3. Press the AUTO PRINT button.
4. Push the profilograph and a profilogram will be printed as the profilograph is moved forward.
5. When the test section is complete, the strip chart mode is terminated by switching to Run mode or by pressing one of the front panel keys.

### 3.2.4 Omitted Bridges

This feature can be used to omit recording of the profilogram of a bridge or other non-measurement section when running in the AUTO PRINT mode.

1. Allow the printer to stop printing if there is a report in progress. The bridge feature will not function until the report is finished.
2. Push the B button at the beginning of the section to be omitted. This will cause the STOP and PRINT LED's to be illuminated; a report will be printed. Do not pick up the measurement wheel.
3. Push the profilograph across the section that is to be omitted.
4. Stop at the end of the section.
5. Allow the printer to stop printing if there is a report in progress.
6. Push the START button. The START LED will be illuminated and measuring will continue. No header report will be written.

The bridge feature results in a profilogram without the omitted section. Reports will start and end at normal 100 m intervals. There will be an additional report for the first part of the section that was interrupted and another for the section in which the bridge ended. The odometer will have the same reading as if the B button had not been pushed.

### 4.0 HINTS AND PRECAUTIONS

1. Ensure that the beginning and end stations have been properly entered or you will get unusual and incoherent output.
2. The microcomputer unit has to be protected from moisture so that the electronics are not damaged.
3. Ensure that the microcomputer and generator are placed into their storage boxes after use. This will protect the equipment from damage during transport.