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Prepared For
U. S. Department of Transportation
Federal Highway Administration
Office of Research and Technology
Washington, D. C., 20590

WIM+RESPONSE TRAINING GUIDE

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March 1986

Fritz Engineering Laboratory Report No. 490.5
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1- Introduction

This Training Guide has been prepared for technicians who need an introductory guide on how to operate the WIM+RESPONSE system. It contains detailed descriptions including numerous pictures on the various phases of operation of the system. The phases include: set-up, data acquisition, field data processing, and take-down. The process of data reduction, performed after the completion of a field study, is discussed in the document "WIM+RESPONSE System User's Guide", FHWA/RD - 86/048, and the "WIM+RESPONSE Software Reference Manual", FHWA/RD - 86/050.

2- Phases of Operation

The operation of WIM+RESPONSE system is composed of five phases, set-up, data acquisition, field data processing, take-down, and data reduction.* The purpose of each phase is as follows: For various arrangements and connections of the equipment refer to the schematic diagrams in section 4 of this document.

The first stage, set-up, is preparation of the system for data acquisition, which includes:

- Placement of tape switches.
- The mounting of strain gages and transducers to the bridge.
- Connection of the gages and tapeswitches to the conditioners.
- Connections to the conditioners.
- Connection of the conditioners to the MINC.
- Booting the MINC computer.
- Examination of the system to ensure it works properly.

Each of these steps is covered in more detail in section 3 of this Manual.

In the second stage, Data Acquisition, two programs are executed to commence the collection of data. The necessary programs are SIMPLE, or BILIN8, and DP8. SIMPLE and BILIN8 are used to generate an influence line for simple spans or a continuous bridge, respectively. DP8 requests geometric information about the bridge and then proceeds with the collection of data.

In the third stage, Field Data Processing, the collected data are examined, through computer programs, to ensure their validity. The programs which are used in this phase are FIX8 and PLDAT8. FIX8 lists the collected data.

*Data Reduction is covered in the WIM+RESPONSE Software Reference Manual, FHWA/RD-86/050.
data, for each truck, on the CRT screen. PLDAT8 displays the plot of strain data. The complete description of all the programs involved in data acquisition and field processing are listed in the WIM+RESPONSE Software Reference Manual, FHWA/RD-86/050.

The fourth stage, Take-down, occurs after the completion of data collection. This phase involves the following steps: the removal of any temporary equipment such as tapeswitches, strain-gages and transducers; the disconnection of power supplies, signal conditioners, and other peripheral equipment; and any other clean-up procedures required.

3. Operation of Equipment and Sample Procedures

3.1 Set Up

The set up of the WIM+RESPONSE system may be grouped into the three inter-related categories as follows:

a) activities beneath the bridge deck;

b) activities on the bridge deck; and

c) activities inside the instruments van.

Many of these activities can take place concurrently as discussed later in this section.

The set up section of this document contains numerous pictures with brief descriptions on these activities as described next.

3.1.1 Activities Beneath the Bridge Deck

These activities generally take place first. They involve the placement of transducers, strain gages, and the connection of these sensors sources to the WIM+RESPONSE hardware located in the instruments van.

The two different kinds of gages used to acquire strain data are called transducers and strain gages. Transducers, more sensitive than strain gages, may not be conveniently placed on all members of a bridge cross-section because of their size and because of the installation techniques that are required.

Figures 1 through 3 show installed transducers on concrete as well as steel girders. As shown, clamps are used to attach the transducers to the girders.

Please note that identification numbers and calibration factors for these devices must be recorded to convert properly the deformation induced voltage change into the correct strains and hence stresses. The placement and installation of these gages should be done by an experienced technician.
Figure 1. A Typical Attachment of a Transducer to a Concrete Girder

Figure 2. Close-up of a Transducer Attached to a Concrete Girder
In addition to the transducers, strain gages may also be used for the acquisition of strain data. These gages are generally smaller than transducers, and do not require the use of large clamps.

Figures 4 and 5 show how a typical strain gage is pasted to a steel and a concrete member respectively.
The transducers and strain gages will be connected via cables to the WIM+RESPONSE hardware located in the van underneath the bridge. These connections are discussed in the section "activities inside the instruments van".

3.1.2 Activities on the Bridge Deck

After the transducers and strain gages have been attached (Section 3.1.1), and either during or after the connection of hardware inside the instruments van (Section 3.1.3), the tapeswitches are placed, secured, and connected to WIM+RESPONSE system.

The tapeswitches provide digital data to the MINC 11-23 on the number of axles and axle spacings. Then the vehicle speed can be determined. For each lane used for data collection, two tapeswitches are placed on as clean a surface as possible. The second tapeswitch is set to 6 feet (1.83m) from the first tapeswitch (set approximately 1 foot (.305 m) before the beginning of the weigh span). If the distance between tapeswitches is other than 6.0 feet, it can be entered as such into the system at the beginning of the data acquisition program.
Figure 6 shows the placement of tapeswitches on a road surface. As mentioned, it is important that the surface be as clean as possible prior to placement. This will help secure the tapeswitches during lengthy periods of data collection. Please note that on some of the newer bridge decks, the use of a propane burner may help remove the coating of linseed oil. It is also suggested that a heavy-duty, wide duct tape be used over the tapeswitches to protect them from both rain and heavy traffic conditions.

In addition to the tapeswitches, an optional keypad or button box, shown in Figure 7, can provide digital signals to identify the type of vehicle (box, flat, auto carrier, etc.) and to identify if it is travelling in lane 2. As a vehicle approaches the weigh span, the appropriate vehicle category or lane number (2) may be input through this keypad.

The keypad, if used, will be connected to the WIM+RESPONSE hardware in the instruments van as discussed in section 3.1.3.
3.1.3 **Activities Inside the Instruments Van**

The central focus of activities throughout a field study will be the instruments van. In here will be the WIM+RESPONSE hardware, peripherals, connections to the data acquisition devices, and a connection to an external power supply.

The WIM+RESPONSE hardware and peripherals, shown in Figure 8, consists of the following units:

- a) MINC 11-23 Computer
- b) Keyboard and CRT
- c) Line Printer
- d) Two Vishay Conditioners

The system receives analog signals from the transducers and strain gages as well as digital signals from the tapeswitches (or button box). It then can record and store the truck weight and bridge response information for additional analyses.
Figure 8. The WIM+RESPONSE Hardware

The keyboard and CRT, shown to the left of the MINC in Figure 8, are used for data entries for program executions, and the display of results (either tabular or graphical).

The Line Printer, also shown in Figure 8, is simply used to obtain hardcopies of any results that appear on the screen.

The MINC computer shown in Figure 9 is used for three purposes. It converts analog signals, received from the gages via the conditioners, to digital signals. It also executes the software programs for data acquisition. The computer also stores all the vehicle data and strain data on the floppy disks.
The two Vishay Conditioners (WIM Conditioner and RESPONSE Conditioner), shown in Figure 10, have the capacity to receive analog signals from a total of 16 channels (0-15), and digital signals from 4 tapeswitches. These conditioners play the role of a "translator" between the data acquisition devices and the MINC computer.
Now that the WIM+RESPONSE hardware has been identified, the next task is to begin connecting the following to the MINC: the external power supply, the CRT, and the Line Printer.

First, the frequency of the main power should be checked to be sure it is near 60 Hz. This is done by reading the frequency meter as shown in Figure 11. This step is especially important if a generator is used as the external power source. A deviation of more than 5 Hz from 60 Hz may cause the data to be unreliable.
Next the CRT is connected to the MINC with two cables. Each cable is connected from the MINC to labeled designations on the back of the CRT. One cable provides the power for the CRT. The second cable is used for communications between the MINC and the CRT.

Then the printer and the keyboard should be connected to the back of the CRT as the labels indicate.

The next group of tasks involves connecting the conditioners to both all the data acquisition devices used and to the MINC. These tasks include the following:

a) Connecting the tapeswitch cables to the WIM Conditioner;
b) Connecting the button box (if used) to the WIM Conditioner;
c) Connecting up to 6 cables from the transducers to the WIM Conditioner;
d) Connecting up to 10 cables from other gages to the response Conditioner; and then
e) Connecting the conditioners to the MINC.
Once these connections have been successfully made, the system may be powered-up to begin the next phase-data acquisition.

In reference to task (a) above, the tapeswitches for each lane are attached to a T-box located inconspicuously near the bridge deck. This box is connected via cable to the TS1/2 or TS3/4 connectors. A typical tapeswitch and a connection (without the lengthy cable) is shown in Figure 12.

Figure 12. Connection of a Tapeswitch to the WIM Conditioner
(Shown here in the van)
Next, the keypad or K-box may be connected to the DIGITAL IN connector as shown in Figure 13. This connector is located below those for the tapeswitches.

![Image of Button Box Connected to DIGITAL IN]

*Figure 13. Button Box Connected to DIGITAL IN*

Next, the cables from the transducers must be connected to the WIM Conditioner. A large cable connects a S-box, which is a junction box for 4 strain transducers, to the ANALOG IN connector located on the left side of the WIM conditioner. The other two transducer cables are attached to the two connectors below the ANALOG IN.
Figures 14 and 15 show these connections. These channels are labelled 0 through 5 in the WIM+RESPONSE system.

![Connection of 4 Transducers to the WIM Conditioner](image)

**Figure 14.** Connection of 4 Transducers to the WIM Conditioner
Next, up to 10 cables from other gages may be connected to the RESPONSE conditioner. These channels are labelled 6 through 15 for the WIM+RESPONSE system. The locations of the connectors for all 10 channels are in the back of the RESPONSE Conditioner.

Figure 16 shows all the ten 10-pin quarter turn upper connectors that these cables will be connected into.

Figure 17 shows the front of the RESPONSE conditioner (10 Channels).

Figure 18 shows the back of the WIM conditioner and its connections.

Figure 19 shows the front of the WIM conditioner (6 Channels).
Figure 16. Location of the Strain Gage Connectors at the back of the RESPONSE Conditioner

Figure 17. Front of RESPONSE Conditioner
Figure 18. Back of WIM Conditioner

Figure 19. Front of WIM Conditioner
The next step is to connect all data acquisition channels to the MINC computer. Figure 20 shows the connection of the MINC conditioner to the MINC. Four of the 6 channels (0-3) are connected to the front of the MINC A/D module. The other two channels are attached to connectors in the back of the MINC.

![Figure 20. Connections of the WIM Conditioner to the MINC](image)

Then, the RESPONSE conditioner with 10 channels needs to be connected to the MINC. Figure 21 and 22 show the location of the connectors at the back of the MINC which are used for the wires from the RESPONSE Conditioner.

![Figure 21. Location of Connectors for RESPONSE Channels at the back of the MINC](image)
At this stage the WIM+RESPONSE system is ready to be connected to the main source of power, which is provided either through the electric company or by a portable generator. It is important that all the electrical devices, as well as the van are well grounded.

The system can be turned on then. The MINC has three red ON/OFF switches, two in the back and one in the front. Figure 23 shows the location of ON/OFF switches for conditioners.

The tapeswitches and keypad are connected to the DIGITAL INPUT module (refer back to Figure 7 of this document).
In the next step the conditioners must be checked and balanced to ensure there is proper AC and DC voltage as well as a proper excitation voltage. Check that there is no noise in the system that would effect the strain signals. In the power supply module for both conditioners, there is a channel selector, figure 24 and a volt meter.
The channel selector has positions marked as AC, DC, and 1-10 (1-6 for the conditioner with 6 channel capacity). The AC position monitors the peak-to-peak AC line input. A reading anywhere in the band from 9 to 11 on the Meter indicates that the input voltage is proper for the selected transformer tap. The DC position monitors a mixed output from +15, -15, and +17.5 V power supplies and should always read on the "DC" line at "10" on the Meter. If the Meter indicates zero volts the unit is not properly grounded. Position 1 to 10, or 6, select channel to display bridge excitation on the meter. More information with regard to the channel selector and its position is provided in "2100 System Strain Gage Conditioner and Amplifier System-Instructional Manual", Vishay Instruments, Raleigh, NC.

The following steps describes the procedure to balance one channel. For other channels the same procedure is identical and independent. Figure 25 shows a typical conditioner module, which features:

1) OUTPUT Lamps, which always monitoring amplifier output. It is primarily used to adjust AMP BALANCE and Bridge BALANCE.

2) BALANCE Control, a 10-turn potentiometer to adjust bridge balance.
3) GAIN Control, a 10-turn potentiometer to adjust amplifier gain. Gain is adjustable from 050 to 1050 on GAIN dial. For transducers it is set to 1050 and for strain gages it is set to 500. This is done so that the gains can be varied among the transducers so that the same calibration factor for the overall bridge can be maintained.

4) AMP BAL, a 22-turn trimmer to adjust the amplifier balance.

5) GAGE EXCIT, a 22 turn trimmer to adjust bridge excitation from 1 to 12 Vdc.

6) EXCIT Switch, a toggle switch controlling the excitation to the input bridge.

7) CAL Switch, a 2-position (with center off) toggle switch to shunt-calibrate the input bridge. Also switches in summing circuitry.

Figure 25. Conditioner Module
The EXCIT and CAL switches should be set to OFF position. At this time, if one of the LED indicators (OUTPUT lamps) is on, the AMP BALANCE trimmer must be turned to adjust for noise until both lamps are off. This procedure must be done when the strain gages or transducers are connected to the conditioner. When the LED indicator is off, that channel is balanced with regard to any distortion from the system or outside. The same procedure must be repeated for every channel that has a gage connected to itself. Turn the EXCIT switch to on adjust the EXCIT voltage and note the CAL voltage. At this time if any of the lamps is on, turn the BALANCE control dial until there is no lights on. If turning of the BALANCE control would not adjust that channel, set the CAL switch to the position A, if the negative lamp is on, or to the position B, if the positive lamp is on. Then turn the BALANCE control dial until there is no light on. The position A and B offsets the input bridge positively and negatively. The same procedure should be repeated for all of the channels. The end of this steps brings the system to a point which is ready for next stage, data acquisition.

3.2 Data Acquisition

After the end of first phase, set-up, all of the necessary equipment such as tapeswitches, transducers and strain gages, strain gage conditioners and MINC 11-23 have been installed and the user can proceed to the second stage which is data acquisition.

3.2.1 Purpose

The purpose of this stage, data acquisition, is to collect information with regard to trucks which cross over the instrumented bridge. Note that the data disks must be prepared prior to this stage. Such information includes truck weight, axle weight, axle spacing, and bridge response. This objective is accomplished through the use of two computer programs, SIMPLE (or BILIN8) and DP8. Program SIMPLE generates the influence line for a simple span bridge. If the bridge has continuous spans, program BILIN8 is used instead of SIMPLE. Program DP8 is used to collect and store the data.

The data acquisition phase is composed of three steps: booting the MINC-11 computer; generating the influence line for the bridge through program SIMPLE (or BILIN8 for a continuous bridge); and collecting data through program DP8. The following sections contain the description of the steps which must be taken for data collection along with a sample procedure for execution of programs SIMPLE and DP8.

3.2.2 Booting the MINC Computer

In order to execute the necessary programs for data collection, it is required that the MINC computer be brought up to the functioning level. This objective is accomplished by booting (i.e. starting) the system. After it is turned on. A system disk must be inserted into the left-hand drive (drive zero, DYO:) to boot the system. Figure 26 shows the procedure for inserting a diskette in drive 1 (DY1:). In this picture the system diskette has already
been inserted into drive zero. Please note the following precautionary procedures when handling disks:

1. Do not scratch or touch the disk itself (only hold the paper covering)
2. Do not bend the disk
3. When the disk is not in the drive, store it properly in a container.

Figure 26. Inserting a Disk

After the system disk is placed in the left hand drive, the user must type Y and press the NEW LINE key in response to the question "START"? which appears on the CRT after the system is turned on. When the prompt "." is shown, this means the computer is awaiting a command.

Before starting execution of the programs it is necessary to input the date and time of the day of operation to initialize the clock in the computer. The date is entered in the following format:

```
.DATE dd-mmm-yy <RETURN>
```

where dd is the day (in numbers), mmm is the first three letters of the month and YY is the last two digits of the year.
The current time is entered in the following format:

```
.TMIIE hh:mm:ss <RETURN>
```

where hh, mm and ss correspond to the hour, minutes and seconds, respectively (in military or 24 hour format).

The collected data will be recorded onto the disk in drive 1. The disks which are used for this purpose must have been formatted through the programs FICRE8 and CREAT8 (called automatically by FICREA8). These programs locate any bad blocks on each disk, which is being formatted, and create two files, FTN14.DAT and FTN15.DAT, on each disk.

Next, the user should insert a blank disk in drive 1 and assign files 14 and 15 to drive 1. The assigning of files to the drive 1 is performed as follows:

```
.ASSIGN DY1: 14 <RETURN>
.ASSIGN DY1: 15 <RETURN>
```

Complete descriptions of these programs and the procedure of formatting disks are provided in the "WIM+RESPONSE Software Reference Manual", FHWA/RD-86/050.

### 3.2.3 Execution of the Program SIMPLE

In order to calculate the weight of a truck crossing the bridge it is first necessary to generate the influence line for the bending moment at the location of transducers which are used for weighing. This is accomplished by the program SIMPLE, if the bridge is simply supported. Program BILINE is used for continuous bridges up to five spans or nine sections with a maximum of three sections per span. These two programs are discussed in detail in the WIM+RESPONSE Software Reference Manual. The program SIMPLE is discussed briefly next, and a sample procedure for the execution of this program is provided.

The program SIMPLE, in order to generate the influence line for a bridge, requires the length of the weigh span and the distance to the transducers measured from the first bearing in the direction of traffic. The influence line, then, will be stored in a file whose name is assigned by the user. This file can be stored on either the disk in drive 0 or drive 1 (usually in drive 1). This file will be used later in the program DP8 to process the weights. The use of the influence line file in the program DP8 will be discussed later in section 3.2.4.

To execute the program SIMPLE, the following command should be given by the user:

```
.R SIMPLE <RETURN>
```

The system then responds with:

```
INPUT NAME OF INFLUENCE LINE FILE
```
The user should enter a filename in the following format:

```
DY0:RT22019.084 <RETURN>
```

where DYO: indicates the disk drive that contains the disk on which the influence line will be written. If, however, the file is on the disk in drive 1, then DY1: must be typed instead of DYO: but the user must make sure that there is enough space available in addition to File 14 and 15. R22019 is a sample name of the file, and can be used to identify the site of the bridge, in this case Route 22 over 19th street. The file extension, which is three alpha-numeric characters in length, comes after the filename and a period. It can be used to indicate the length of the influence line to the nearest foot, in this case 84 feet.

Next, the system responds with:

```
INPUT LENGTH OF BRIDGE AND DIST. TO TRANSDUCERS
```

Then the user enters these data as real numbers:

```
84.83,42.333 <RETURN>
```

The first input is the span length of the bridge and the second input is the distance to the transducers from the first bearing of the span in the direction of traffic. This distance must be recorded during the installation of the transducers in the first phase, set-up.

The program will then calculate the influence line for the specified transducer location. The influence line will be written to the specified file on the specified device, DYO: in this case. The appearance of the period on the CRT shows the completion of the program SIMPLE. The user can now proceed to the next step to actually start the process of data acquisition.

### 3.2.4 Execution of the Program DP8

At this stage, the user can begin the data acquisition by executing the program DP8. This program requests information to analyze the signals from the tapeswitches and the strain gages, and to convert them into digital data. This information is as follows: the distance between tapeswitches; the distance between the first tapeswitch, in each lane, to the first bearing of the bridge in the direction of traffic; the span length of the bridge; the number of lanes; the number of transducers and strain gages; etc. This program has several options with regard to the change of the default parameters, use of keypad, and the process of the truck weight. The complete description of these options and the required information are provided in the "WIM+RESPONSE Software Reference Manual". It is suggested that the user become familiar with the parameters used in this program before using this program in the field. A brief description of the program DP8 is provided next.

The program DP8 interactively requests the necessary information. This information will be explained in the sample procedure herein. When the input
is complete, the system will wait for a signal from the keypad and/or the tapeswitches to start the collection of data and store it in the file 14. The keypad, as was mentioned in section 3.1 is used by the operator to trigger the system for a specific truck. If the data is being collected from two lanes the use of the keypad is mandatory to separate the trucks in lane one from the trucks in lane two. After the system is triggered by the keypad signal, it waits for a signal from the tapeswitches, when the truck axle hits them. The program will then start the collection of data. If the keypad is not used, the system will start collection of data when a signal is received from the tapeswitches. The optional use of keypad will be discussed later in the sample procedure (Section 3.2.5).

At the time that data is being collected, the DATA button should be set in the OUT position. The purpose of this switch is to interrupt the collection of data when it is necessary to change some parameters or options of the program. By setting the switch in the IN position the data collection will be stopped. The program will provide the I.D. number of the next truck and the options of, START OVER, STOP, or MINOR CHANGES. Figure 27 shows the location of this button on the front panel of MINC-11.

Figure 27. IN/OUT DATA Button
3.2.5 Sample Procedures for DP8 Program

The following illustrates a sample procedure to execute the program DP8 (the program's requests for input are underlined).

.R DP8 <RETURN>

DP8 OF JUNE 1985

IF YOU HAVE NOT ENTERED THE TIME STOP THIS PROGRAM WITH A CTRL C.

DATE MMDDY

06225

where MM and DD corresponds to the number of the month and the day, respectively. Y is the last digit of the number of the year. For example, June 22, 1985, is input as 06225.

ICHANGE, SPACING, TS1-BRIDGE, MIN STRAIN, TRUCK, SPAN

1, 4., 5., 0.15, 1, 84.83

where ICHANGE is the index for the user's option to change the default parameters such as: max axle spacing, max car length, max truck length and number of lanes for collecting data (INTEGER).

ICHANGE = 0 use the default values for collection of data in one lane.

ICHANGE = 1 use the default values. The number of lanes will be determined by the user later in the program.

ICHANGE = -1 all the parameters will be entered by the user interactively.

SPACING (REAL) is the distance between the two tapeswitches in lane one. This value must have been recorded in the set-up phase.

TS1-BRIDGE (REAL) is the distance between the first tapeswitch to the first bearing of the bridge, in the direction of the traffic. This value must have been recorded in the set-up phase.

MIN STRAIN (REAL) is the value which the strain on any channel, for weighing, must be greater than so that the vehicle being weighed is considered to be a truck. Enter the value in volts; typical range is 0.15 to 0.50 volts, as a threshold value.

TRUCK (INTEGER) is an identification number for a truck. The program starts collecting data for this truck record on event number and those following.
SPAN (REAL) is the distance (devided by the velocity of the truck to obtain the time period for collecting data), over which strain data is required.

**PROCESS, KEYPAD, SAMPLING RATE.**

1, 1, 45

where PROCESS (INTEGER) is the index to determine if the truck weight should be processed

- PROCESS = 0  Do not process the truck weight.
- PROCESS = 1  Process the truck weight.

KEYPAD (INTEGER) is the index to determine if the keypad to be used for vehicle selection

- KEYPAD = 0  Keypad input will be accepted but it is not mandatory.
- KEYPAD = 1  Keypad input is mandatory.

Note: If two lanes are being studied the keypad must be used. That is enter 1.

SAMPLING RATE (INTEGER) is the number of strain samples per second, per channel for strain data acquisition. The Range is between 40 to 60 Hz.

**LANES, NCHAN**

2, 16

where LANES (INTEGER) is the number of lanes that are instrumented and data is being collected from.

NCHAN is the number of channels of strain data.

**NO OF TRANSDUCERS AND STRAIN GAGES**

3, 13

where NO OF TRANSDUCERS (INTEGER) is the number of channels (1-6) used for weighing. The second number entered here (INTEGER) is the number of strain gages that are used for response.

**LANE 2 TS SPACING, TS3 - BRIDGE**

4, 5.

Note: This information is requested by the program only if two lanes were being studied.
where, TS SPACING (REAL) is the distance between two tapeswitches in lane 2. This value must have been recorded in the set-up phase.

TS3-BRIDGE (REALT) is the distance between the first tapeswitch, in lane 2, to the first bearing of the bridge, in the direction of traffic. This value must have been recorded in the set-up phase.

**NAME OF FILE WITH INFLUENCE LINE.**

DYO:RT22019.84

where, the name of the file with the influence line is the file created by the program SIMPLE (or BILIN8).

**LENGTH OF INFLUENCE LINE, CALIBRATION, SAMPLES**

85, 1., 0

LENGTH OF INFLUENCE LINE (INTEGER) is the length of influence line, to the nearest foot.

CALIBRATION (REAL) is the factor obtained from the calibration vehicle to calculate the actual weight of the truck. Assume 1, if unknow.

SAMPLES (INTEGER) the number of data points to be ignored at the beginning of the strain record when processing truck weights. (Typically 0,1,2)

Note: This information is required when requesting the processing of truck weights.

Input is now complete. The computer system is awaiting data from the sensors. The program starts data acquisition when a signal is received from the tapeswitches, and stores the data for each truck in File 14. File 14 is formatted for a specific number of trucks. The data acquisition continues until the disk is full. Then the system will request a new, formatted disk to be inserted into drive 1. The system will then continue to collect more data on the new disk.

If there is any change to be made in the parameters or the options, push the DATA button on the MINC to the IN position. the program will stop the collection of data and display the following:

**NEXT TRUCK NUMBER IS 43**

CHANGES? -1 START OVER 0 STOP 1 MINOR CHANGES

The program will show the I.D. number for the next truck that the data will be collected for, and the options that the user has to stop the program (0), to make minor changes (1); or to start over (-1). the user can now push the
DATA button to the OUT position. If the user chooses MINOR CHANGES, -1, the computer will respond as follows:

```
PROCESS, KEYPAD, #SAMPLES, CALIBRATION
```

0, 0, 50, 1.

These are the options that the user can change at this level. If any other parameters or options need to be changed, the user must choose START OVER option (-1) and follow the exact steps which were discussed earlier in this section.

When a truck crosses over the bridge and the computer has stored the data on the disk, information such as the truck number, axle spacing, speed and number of times that the tape switches have been contacted by the truck axle will be displayed on the CRT. It is possible that the number of contacts for the first tapeswitch in one lane will not be equal to the number of contacts for the second tapeswitch in the same lane. Common problems include: bouncing of vehicles, weak or failing signals and a pulse width that is too short. This problem can be solved by adjusting the pulse widths using the dials on the WIM conditioner. Figure 28 shows these two dials for tapeswitches 1 and 3, and tapeswitches 2 and 4. Also there is a LED lamp and audio alarm for each tapeswitch that will be lighted, when contact is made to check for proper functioning of the tapeswitches.

Figure 28. Tapeswitches Pulse Width Module
During the data acquisition it is necessary to keep the Vishay signal conditioners balanced. The balancing should be done when there are no vehicles on the bridge. The user can predict, by checking the tapeswitches' LED, that there is no vehicle on the bridge.

At this point, the data acquisition phase continues as long as desired. During this phase, however, some field processing of data may be undertaken. This is discussed in the next phase - Field Processing of Data.

3.3 Field Data Processing

During data collection, there might be some occasional faulty performance due to improper set-up. For example, the bad connection of a strain gage to a girder may cause faulty signals that are not detectable without the review of the record data. As part of the field processing stage, some of the data can be examined and corrected wherever possible. Signals should be examined using a voltmeter or oscilloscope.

3.3.1 Purpose

Field data inspection has the objective of reviewing the collected raw data in FILE 14. This function is accomplished through two computer programs, FIX8 and PLDAT8. FIX8 will numerically display the collected information with regard to truck geometry and weight as well as strain data on the CRT. PLDAT8 plots the strain data versus time on the CRT.

There are two kinds of data corrections that can be made. One kind is the correction of the problem to improve future data collection. For example, mounting a new strain gage, or resetting the value of a parameter in the data acquisition program, DP8. The second kind is to correct the already collected raw data on FILE 14 through program FIX8, perhaps to fix a header value that was incorrectly entered during set-up. The programs FIX8 and PLDAT8 will be explained briefly along with a sample procedure. A more complete description of these programs is contained in the WIM+RESPONSE Software Reference Manual, FHWA/RD-86/050.

3.3.2 Execution of the Program FIX8

When the disks are being formatted, the user decides how many trucks will be stored on each disk, and how many data entries for each truck will be recorded on File 14. The decision on these numbers is based on the number of strain samples that needs to be collected, the number of trucks, and the capacity of each disk. The creation of File 14 is explained thoroughly in the WIM+RESPONSE Software Reference Manual. The program FIX8 has the capability to display, on the CRT, the entries for each truck on File 14. The first 60 entries for each truck, comprise the header block. The remaining entries are the digitized strain samples. The program FIX8 also is capable of changing any of the 60 entries either for a single truck or a group of trucks. A summary of the contents of the header block is shown below.
The contents of FTN14.DAT Header Block are as follows:

1. Truck ID No.
2. Accelerometer Flag
   1=Accelerometer used  0=No Accelerometer
3. No. of Strain Channels Recorded
4. Tapeswitch 1 to Tapeswitch 2 in 1/100's of feet
5. Tapeswitch 1 to Bridge in 1/100's of feet
6. Length of Buffer for Strain Records
7. No. of Axles on TS-1 or TS-3
8. No. of Axles on TS-2 or TS-4
9. Keypad Input (8192 if none)
10. Velocity in ft/sec *100
11. Strain Sampling Rate in Hz (samples per second)
12-21 TS-1 or TS-3 Axle Arrival Time in milliseconds
23-31 TS-2 or TS-4 Axle Arrival Times in milliseconds
32-33 Time of Day (in internal format)
34. Date: MMDDY
35-42 Axle Weights (if processed at time of acquisition with
   standard FORTRAN writing routines)
43. Correct Span Length of Bridge
44. Span used in Acquisition of Data
45. Blank
46. Tapeswitch 3 to Tapeswitch 4 in 1/100's of feet
47. Tapeswitch 3 to bridge in 1/100's of feet
48. No. of Lanes used for Acquisition
49. ID of lane truck is in
50. (blank)

The following is a sample procedure to execute the program FIX8 (the
system responses are underlined.

RUN FIX8 <RETURN>

NO. OF TRUCKS ON A DISK, NO. OF DATA PER TRUCK

110,2060

These values are assigned when the blank disks are being formatted as
part of the standard set-up.

INSPECT WHICH TRUCK? -1 TO PROCEED

15
if -1 is input instead, the program attempts to correct one of the first 60 numbers; an example will be shown later in this section. A typical print out of this execution is shown as:

| 15 | 0 | 16 | 600 | 750 | 250 | 3  | 5  | 8192 | 8333 |
| 45 | 0 | 160 | 479 | 622 | 926 | 1507 | 0  | 0  | 0  |
| 0  | 72 | 180 | 228 | 547 | 593 | 937  | 0  | 0  | 0  |
| 0  | 81 | -12824 | 6275 | 0  | 0  | 0  | 0  | 0  | 0  |
| 0  | 0  | 12500 | 0  | 0  | 0  | 600 | 750 | 2  | 1  | 0  |
| 2045 | 2051 | 2035 | 2044 | 2030 | 2048 | 2047 | 2048 | 2045 | 2045 |
| 2046 | 2047 | 2047 | 2051 | 2048 | 1975 | 2046 | 2055 | 2031 | 2040 |
| 2027 | 2048 | 2045 | 2047 | 2047 | 2047 | 2047 | 2045 | 2047 | 2045 |
| 2049 | 1990 | 2046 | 2052 | 2026 | 2037 | 2025 | 2048 | 2045 | 2047 |
| 2045 | 2047 | 2045 | 2046 | 2050 | 2051 | 2048 | 1993 | 2040 | 2056 |
| 2027 | 2038 | 2025 | 2048 | 2047 | 2047 | 2044 | 2044 | 2047 | 2045 |
| 2047 | 2049 | 2047 | 1995 | 2043 | 2057 | 2032 | 2038 | 2029 | 2048 |
| 2045 | 2046 | 2047 | 2047 | 2046 | 2045 | 2047 | 2050 | 2048 | 1996 |
| 2045 | 2061 | 2038 | 2044 | 2033 | 2048 | 2046 | 2047 | 2045 | 2046 |
| 2048 | 2045 | 2047 | 2053 | 2049 | 1996 | 2050 | 2062 | 2045 | 2050 |
| 2038 | 2048 | 2047 | 2049 | 2047 | 2047 | 2046 | 2046 | 2046 | 2051 |
| 2048 | 1995 | 2055 | 2068 | 2055 | 2059 | 2044 | 2048 | 2051 | 2050 |
| 2045 | 2047 | 2044 | 2047 | 2047 | 2048 | 2047 | 1993 | 2062 | 2072 |
| 2063 | 2072 | 2050 | 2048 | 2049 | 2050 | 2045 | 2046 | 2046 | 2045 |
| 2047 | 2051 | 2048 | 1993 | 2055 | 2074 | 2066 | 2070 | 2050 | 2048 |
| 2048 | 2051 | 2048 | 2048 | 2045 | 2046 | 2048 | 2050 | 1992 | 2050 |
| 2056 | 2071 | 2061 | 2067 | 2047 | 2048 | 2048 | 2052 | 2048 | 2048 |
| 2048 | 2047 | 2047 | 2051 | 2049 | 1993 | 2051 | 2070 | 2057 | 2063 |
| 2046 | 2048 | 2050 | 2049 | 2046 | 2046 | 2047 | 2046 | 2046 | 2047 |
| 2049 | 1995 | 2053 | 2066 | 2053 | 2059 | 2042 | 2048 | 2047 | 2051 |
| 2046 | 2047 | 2047 | 2047 | 2048 | 2050 | 1997 | 2048 | 2062 | 2062 |
| 2047 | 2052 | 2038 | 2048 | 2047 | 2048 | 2050 | 2048 | 2046 | 2046 |
| 2046 | 2047 | 2048 | 1997 | 2058 | 2070 | 2055 | 2059 | 2045 | 2048 |
| 2047 | 2049 | 2051 | 2047 | 2045 | 2047 | 2049 | 2054 | 2050 | 1992 |
| 2065 | 2071 | 2053 | 2059 | 2047 | 2048 | 2049 | 2048 | 2050 | 2047 |
| 2045 | 2047 | 2047 | 2052 | 2051 | 1993 | 2079 | 2079 | 2064 | 2066 |

The screen will scroll to display the remaining data.

The first number shown above is the truck I.D. Entries 2 through 60 are information such as: axle spacing, speed, gross weight, axle weight, the distance between tapeswitches, etc. Entries 61 through 2060 are the recorded strain data. The system next responds with

```plaintext
INSPECT WHICH TRUCK? -1 TO PROCEED

-1
```

```plaintext
CHANGE WHICH HEADER ENTRY?

4
```

(change the distance between Tsl and TS2, in 1/100's of a foot)
CORRECT VALUE?

610
(the actual distance is 6.10 feet)

CHANGE HEADER TRUCKS _____ TO _____
-START TO CHANGE ANOTHER, 0 START TO STOP

1,110

The program will proceed to change the value of the header number 4 to 610 for trucks 1 through 110. Then the program asks the same questions. If another header needs to be changed, two negative values must be entered. Entry of two zeros will bring the program to halt.

3.3.3 Execution of the Program PLDAT8

Program PLDAT8, provides a plot of strain data versus time, to readily inspect these data for errors, incorrect zero shifts, the influence of possible other vehicles on the bridge, or to assess what lane weighing factors should be assigned. The program plots one channel per truck for each execution.

The following is a sample procedure to execute the program PLDAT8 (The system responses are underlined.)

.R PLDAT

THIS PROGRAM DISPLAYS ON THIS SCREEN THE DIGITAL STRAIN RECORDS FOR ANY CHANNEL FOR A TRUCK CROSSING

YOU MUST HAVE GIVEN...ASS D1: 14...COMMAND

DATA DISK SHOULD BE IN RIGHT DRIVE - D1:
DO YOU WANT TO GET HARD COPY OF PLOT? 1-YES,0-NO

1

WHICH CHANNEL (0-15)

3

TRUCK NUMBER

15

The strain data on channel 3 will be plotted versus time for truck number
15 on the CRT and then transferred to the line printer. Figure 29 shows this type of display.

**Figure 29. The Plot of Recorded Strain Data vs. Time**

- **TO CONTINUE:** (1), **STOP:** (0)

The same procedure can be applied to other channels or trucks as desired.

Next, the user can make the necessary changes to remedy the errors. As mentioned, these changes might be in reconnection of gages or tapeswitches, change of a cable, or change of the parameters in the data acquisition program, DP8. The acquisition of data can then resume until enough data has been collected. At that point, the next phase, take-down, would commence.

### 3.4 Take-Down

After data collection is complete, the take-down phase begins. The data acquisition process will stop and disassembling of the system will start.

#### 3.4.1 Purpose

In the take-down stage, the tasks are centered around an orderly disconnection of the WIM+RESPONSE equipment and a removal of all temporary instrumentation from the bridge site. This phase can be divided into three major steps.
Step 1: The disconnection of the instruments inside the van
Step 2: Disconnection of the gages beneath the bridge deck
Step 3: The removal of all the temporary devices on the bridge deck

These steps are explained in more detail in the following sections.

3.4.2 Disconnection of the WIM+RESPONSE System

This step starts with removal of the disks from the two disk drives on MINC-11. No programs should be running at this time. All system disks and data disks must be stored in a secure location. It is important that the system is disconnected from the main power supply before the initiation of take-down. Follow these steps:

1. power down the signal conditioner
2. power down the MINC
3. disconnect the power supply

The next task is separation of the conditioners from the MINC. That is, to disconnect all cables that connect each channel of the conditioners to the MINC. Please note that the cables connecting Channels 6-15 to the MINC are not separable from the conditioner. The cables which connect the keypad, tapeswitches, transducers and strain gages to the conditioners must also be disconnected from the conditioners at this stage.

After disconnecting the printer and the keyboard from the CRT, and the CRT from the MINC, the crew should secure and "tie-down" the sensitive instruments inside the van.

3.4.3 Take Down of Transducers and Strain Gages

In this step, all the cables will be disconnected from the transducers and strain gages. Because of the long length of the wires, it is easy to get them entangled. Therefore, the cables should be coiled carefully bound and stored for use in other tests.

Transducers will then be removed from the bridge by carefully taking off the clamps. Transducers are very sensitive devices and as soon as they have been removed, they should be enclosed in their special protective casings.

The strain gages are removed from a steel bridge by grinding off the steel surface after the protective cover is removed. In concrete bridges, strain gages are stripped from the bridge. In steel bridges, repainting of the ground surfaces is necessary to protect against corrosion.

At this time, the "disassembly" of the system is almost complete except for the temporary devices on the bridge deck.
3.4.4 Removal of Tapeswitches from the Pavement

As it was mentioned in Phase 1, Set-Up, the tapeswitches were placed on the deck using heavy duty duct tape to prolong the life of the tapeswitches against traffic and weather conditions. They can be removed by tearing them off the bridge deck. The cables that connect the tapeswitches to the conditioner as well as tapeswitches must be disconnected from the T-Box. All cables should be collected carefully and stored with the rest of the instruments.

It is important to realize that removal of tapeswitches and perhaps strain gages and transducers may be done under heavy traffic conditions. Therefore, it is advisable to use traffic control to reduce the chance of an accident. The transducers must not be bent while removing them. Tapeswitches may be reused if they are in good condition.

At this stage, all the equipment should be packed into the van for transfer to a more permanent location.

4. SCHEMATIC DIAGRAMS OF EQUIPMENT ARRANGEMENT

While all the strain gages are directly connected to the RESPONSE signal conditioner (RES. S.C.) through white cables, the strain transducers can be connected to WIM signal conditioner through various combination of connection boxes. Figures 30-34 show the five possible ways of system set up. For further information regarding the functions of the individual connection boxes, refer to Chapter 3 of this guide or the "WIM+RESPONSE HARDWARE MANUAL", FHWA/RD-86/049.
- + TRANSUCERS FOR WIM
- + TRANSUCERS FOR RESPONSE
- STRAIN GAGES FOR RESPONSE

BRIDGE

TRAFFIC FLOW

T BOX

TAPESWITCHES

ONLY ONE SET OF TAPESWITCHES REQUIRED

SET UP CONFIGURATION A
+O+ TRANSDUCERS FOR WIM
+O+ TRANSDUCERS FOR RESPONSE
- STRAIN GAGES FOR RESPONSE

ONLY ONE SET OF TAPESWITCHES REQUIRED

K BOX CAN BE SET UP ON EITHER SIDE OF HIGHWAY

SET UP CONFIGURATION B
+O+ TRANSDUCERS FOR WIM
+O+ TRANSDUCERS FOR RESPONSE
- STRAIN GAGES FOR RESPONSE

SET UP CONFIGURATION C
+O+ TRANSDUCERS FOR WIM
+O+ TRANSDUCERS FOR RESPONSE
- STRAIN GAGES FOR RESPONSE

BRIDGE

TRAFFIC FLOW

TAPESWITCHES

ONLY ONE SET OF TAPESWITCHES REQUIRED

K BOX CAN BE SET UP ON EITHER SIDE OF HIGHWAY

S BOX

D BOX

RES. S.C.

WIM S.C.

MINC

VAN

SET UP CONFIGURATION D
TRANSDUCERS FOR WIM
TRANSDUCERS FOR RESPONSE
STRAIN GAGES FOR RESPONSE

- BRIDGE
  - TRAFFIC FLOW

- S BOX
- D BOX
- T BOX
- K BOX
- TAPESWITCHES

ONLY ONE SET OF TAPESWITCHES REQUIRED
K BOX CAN BE SET UP ON EITHER SIDE OF HIGHWAY

SET UP CONFIGURATION E