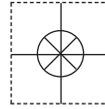


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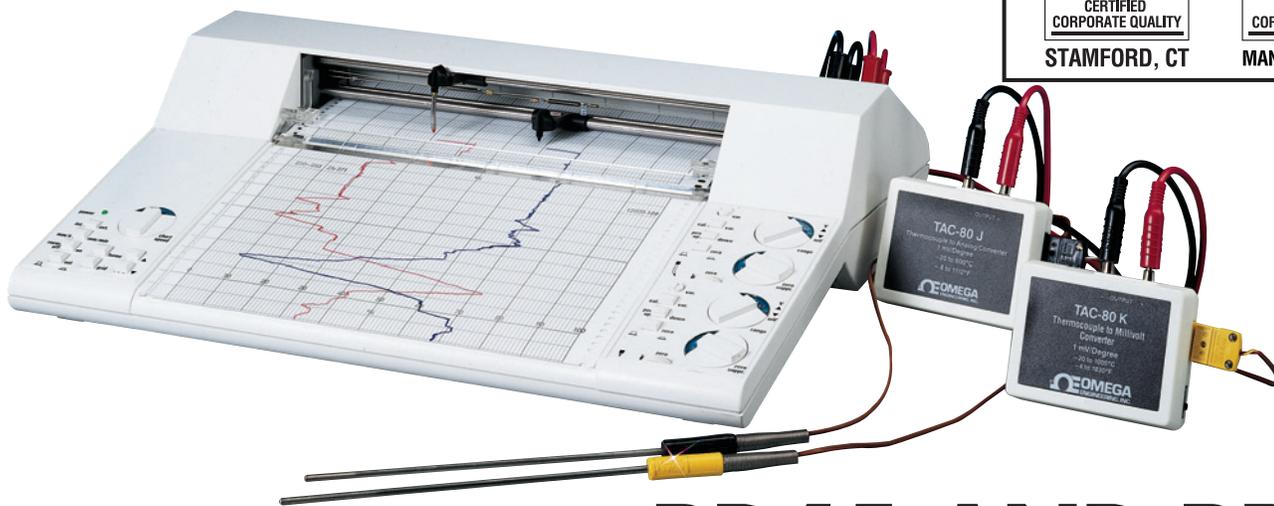
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WARNING: These products are not designed for use in, and should not be used for, human applications.

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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA® RD45 single channel and RD46 dual channel flatbed recorders are ideal instruments for use in research, development and production, as well as in service and education applications. Designed for ease of use, these recorders have an ergonomic shape, allowing the user to easily write comments on the chart, even next to the pen.

The wide, 200 mm (8") chart is capable of recording measurements from 1 mV full scale to 20 V. Chart speeds from 0.1 mm/min to 20 mm/sec are available. The standard electric pen lift function will automatically lift the pens if the chart has not been advanced for 30 seconds; this will lengthen pen life, as well as keep the chart paper clean and easy to read.

The RD45 and RD46 have built-in HOME and GRID functions. The Home function is useful for comparative measurements, where the chart is rewound automatically to the same starting point. The Grid function moves the pen to an exact grid line on the chart, which allows for easy repetitive measurements. As an option, pen offset compensation is available. This eliminates the record offset that is caused by the distance between the two pens.

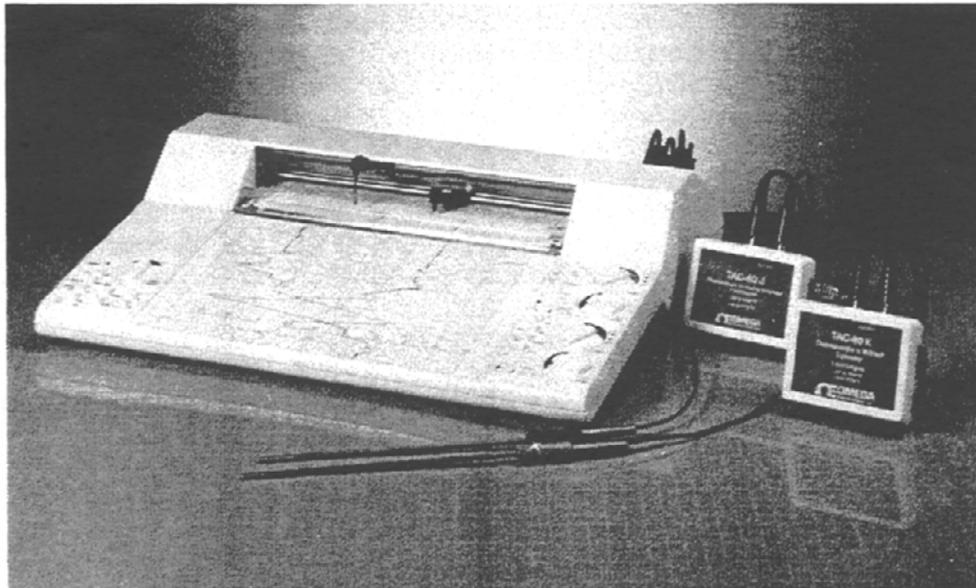


Figure 1-1. Model RD46 shown with optional TAC80J and TAC80K thermocouple converters and JMTTS-125G-6 and KMTTS-125G-6 thermocouple probes

1.2 PRINCIPLE OF OPERATION

The recorder transports the chart paper at a constant velocity which may range from 0.1 mm per minute to 20 mm per second. The positions of two independent pens represent the levels of the two corresponding inputs of which the time functions are drawn. The full scale input sensitivities range from 1 mV to 20 VDC. The recorder is equipped with one chart drive control panel and with two independent servosystem control panels, one for each channel.

A number of functions can also be controlled with external signals, as well as by the operator panel, including chart drive control and penlift for both channels. A complete description of these functions and the interface can be found in Section 4, EXTERNAL FUNCTIONS.

Due to the nature of the two-channel recorder, the pen of channel 1 is always 2.5 mm behind the pen of channel 2.

1.2.1 Pen Offset Compensation Module

In order to be able to compensate for the effect of the physical distance mentioned above, the user can install a pen offset compensation module (RDX40-POC). The pen offset compensation module allows a graphical representation of two input signals on the RD46 recorder without any trace offset. Normally when a multi-pen recorder is used for monitoring signal variations, the traces are shifted in the direction of paper transport with respect to each other, because the pens cannot write at the same time at the same spot. This effect has now been eliminated. The signal of the second pen is not immediately written on the chart, but is stored until the chart is advanced by 2.5 mm, which is the distance between the pens, measured in the paper feed direction. For more information, refer to Section 5, PEN OFFSET COMPENSATION.

1.3 AVAILABLE MODELS

MODEL NO.	DESCRIPTION
RD45	Single channel recorder
RD46	Dual channel recorder
RDX40-POC	Optional pen offset compensation/serial output module*

*One Pen Offset Compensation module required in RD46 for POC feature or one per channel for RS-232 data transmission.

SECTION 2 PREPARATIONS FOR USE

2.1 UNPACKING

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call OMEGA Customer Service Department.

Upon receipt of the shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

Each recorder comes with one pen for each channel, one 25m roll of paper, power cord, fuse, and input adapter connectors. See Section 7 for a list of optional accessories.

2.2 INSTALLATION

2.2.1 Power Connection

Adjust the recorder according to the available power supply. As the voltage selector suggests, the recorder may be operated at 230V or 115V. The switch is located at the rear side of the recorder, but can only be seen when the paper roll is removed. Removing the paper roll reveals a small square hole through which both the selected voltage and the switch can be seen. With the use of a pointed object, this switch can be moved to the left or to the right. The location of this switch is shown in Figure 2-1.

Before switching on the recorder, make sure that the required fuses are installed. Operating the recorder at 115V requires 250 mA fuses, while an operation voltage of 230V requires 125 mA fuses. The power on/off switch is located on the left-hand side of the recorder.

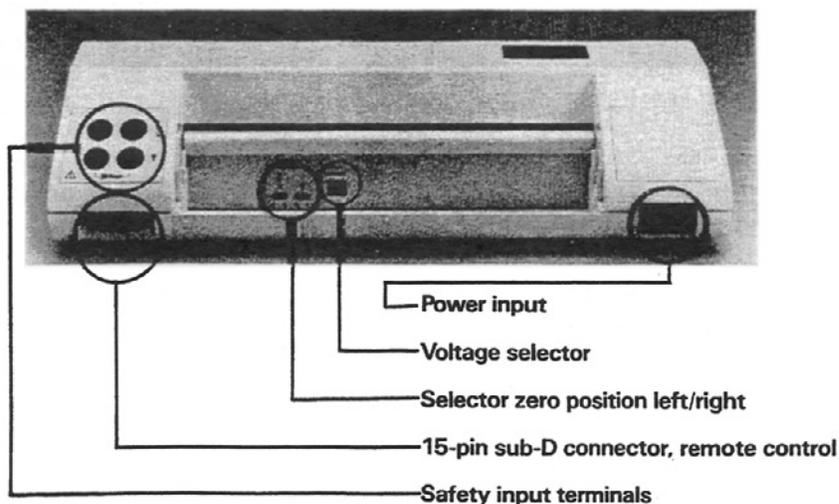


Figure 2-1. Rear Side of the Recorder

2.2.2 Changing Paper

First lift the plastic transparent ruler off the paper, turn it all the way to the top of the recorder and leave it in that position. In order to do so easily, place the fingers of both hands on top of the recorder housing and with both thumbs, apply a gentle force to the ends of the ruler pointing upward and backward, for which the ruler is equipped with small ridges.

Then push the edge of the paper (with a fingernail, for example) in order to loosen it from the sprocket wheels. The rest of the paper roll with the plastic shaft can now be taken out of the back of the recorder. The paper roll can be lifted easily through a hole in the bottom of the recorder housing. It may be necessary to apply a little force because the shaft is held in place by small extensions of the recorder housing.

Unpack a new roll of paper, insert the shaft in the roll and put back in place. When this has been done properly, the recorder could be turned upside down without the paper roll falling out. Make sure that the orientation of the paper roll has the printed grid on top during normal operation. Then take the edge of the paper and slide it through the horizontal slit. (The transparent ruler still remains in the upright position.) Pull the paper towards you far enough to make sure it is parallel to the recorder housing. Then, with your fingertips, position the holes in the edge of the paper on the sprocket wheels, first on the right side, then on the left side. This is because the holes in the right side guarantee exact paper positioning, while the oval holes at the left side only support vertical transport. When the paper is in the correct position, fitting both sprocket wheels, hold the paper in position and with the other hand, lower the ruler. Then with both hands, apply a gentle force both at the left and right side of the ruler. A double click indicates the proper lowering of the ruler.

2.2.3 Changing Pens

Before changing pens, switch off the recorder completely. The pen-holding mechanisms may then be moved freely into a position convenient for removing and replacing the used pens.

If it is not desirable to switch off the recorder (to retain the Home position, for example), use the following procedure. For both channels, lift the pens by putting the respective switches marked "Pen Up/Down" in the Up position. Zero the channel inputs by putting both "Zero" switches in the Down position. Both pens will then remain at the position which was chosen to correspond to zero of scale. Pen movement has stopped and they can be replaced.

After replacement, put both Zero switches back into the upright operating position. Finally, lower both pens to resume recording. Using this procedure will cause the least disruption to the recording process.

If you do not intend to use the recorder for some time, it is advisable to remove the pens and replace the caps to prevent the pens from drying out.

2.2.4 Inspection of the Main Functions

When all of the above procedures have been completed, the recorder is ready for a short test of the main functions, which are described in the next sections. No external signal source should be connected to the recorder yet. Before performing the test, each of the two-position switches which are on the control panel, must be put in the Up position.

A detailed description of all of the recorder functions can be found in Section 3, OPERATING PROCEDURES.

2.2.4.1 Chart Drive

Push the button marked with a Down arrow. After 0.5 seconds, the paper will start moving slowly, and after 2 seconds, the paper will start moving faster. Release this button and push the button marked "Home" once. This should bring the paper back to the position where it was before you operated the arrow key. Try the same test with the other arrow key.

Each time you press the "Grid" button, the paper should advance one unit (i.e. 10 mm). Press the "Record On/Off" button. The paper should start moving at a speed corresponding to the setting of the Chart Speed switch. The speed will be in mm per second, because that button is in the Up position.

2.2.4.2 Servosystem

The testing described below can be performed separately for each of the two channels.

First put the "Zero Suppr." switch into the position indicated as 0. By operating the "Zero" thumbwheel, the pen must then be positioned at the left-hand edge of the paper. When the "Zero Suppr." switch is turned counterclockwise one step, the pen should move to the right-hand side of the paper, after which you will probably want to return it to the original position.

The position of the "Range" switch is of no importance while performing these tests. The polarity switch should be in the left-hand side position.

The pen can be moved up and down by operating the corresponding button.

When all of this testing has been performed successfully, this means that the basic functions of your recorder are working properly.

2.3 CUSTOMIZING THE RD45/46

2.3.1 Polarity Selection

If desired, the polarity of each of the channel inputs can be inversed independently. The selection is performed by setting the switches located at the rear side of the recorder. The location of these switches is indicated in Figure 2-1. They can only be accessed after the paper roll has been removed, as described in Section 2.2.2, CHANGING THE PAPER.

The factory default setting of these switches is "Left". When looking at the recorder from the back side, this is the right-hand side, but still the left-hand side of the recorder. If one of these switches is set to "Right", the corresponding channel will have its zero position at the right-hand side.

Note: Inverting the input polarity does not result in a displacement of the zero position but in a mirrored channel performance.

2.3.2 Automatic Penlift

When the pen remains too long at the same position, ink stains will appear on the paper. To avoid this, the recorder automatically lifts the pen when there has been no paper movement for more than 30 seconds. This time interval is equal to the time between two chart speed pulses when the recorder is operating at the lowest possible speed (i.e. 0.1 mm per minute). This time-out is done by checking both the internal and external chart speed pulses, including checking the operation of the arrow keys on the operator panel.

Under certain circumstances, it may be desirable to inhibit the auto penlift function. This can be achieved by making a simple modification to the circuitry inside the recorder. Section 2.3.5 details how to perform this change.

2.3.3 50 - 60 Hz Synchronization

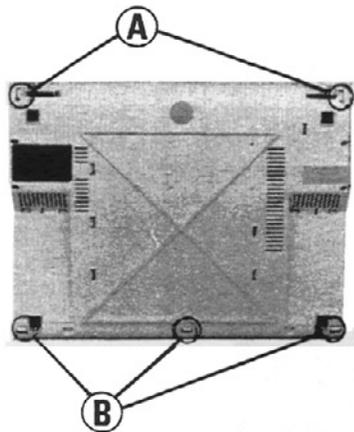
The recorder is shipped with no synchronization installed. It may be activated by means of an internal jumper. With this feature installed, the processor checks the power frequency to be 50 or 60 Hz and then synchronizes the X-tal controlled timebase of the chart drive. In this way, the recorder timebase will have the same accuracy as a power synchronized clock. Synchronization at 50 Hz takes place when the power frequency lies between 48.3 and 51.6 Hz; for the 60 Hz frequency, between 58.1 and 62.2 Hz.

2.3.4 Active Level Selection

The logic of two of the signals that may be used for controlling the recorder externally can be inverted by means of internal jumpers. In the default situation, zero means active, which corresponds to a contact closure. Refer to Section 4.3, I/O CIRCUITRY SPECIFICATIONS for more information on this subject.

2.3.5 Performing the Customization

In order to be able to make the changes, you must first open the recorder. Switch off the recorder, remove the power cord, paper roll and inkpens, and turn the recorder upside down. The top cover of the recorder housing is fixed to the bottom cover by means of five small ridges. Figure 2-2 shows the position of the five ridges.



A: Ridges to be opened by screwdriver.

B: Ridges to be opened by hand.

Figure 2-2. Location of the cover ridges

An easy procedure for removing the top cover is as follows. With the recorder still upside down, put your fingernails against the bottom cover and at the same time, place your thumbnail against the top cover inside the groove, starting at one of the rear side corners. Apply a gentle force and at the same time use a screwdriver with the other hand to carefully bend the ridge away towards the side. This should allow you to separate the top from the bottom cover about half a centimeter. Repeat this with the other rear side corner. Figure 2-3 shows this approach.

NOTE: If a screwdriver is used to apply force between the top and bottom covers, it is possible to damage the recorder housing.

Repeat the same action for the three ridges at the front side. These three ridges can easily be bent forward by hand. When this has been done, turn the recorder upright.

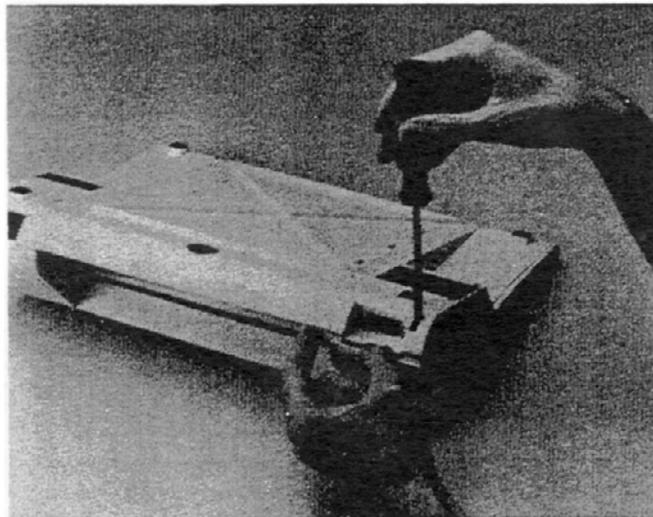


Figure 2-3. Opening the recorder housing

Once the recorder is upright again, you can easily remove the top cover. It remains connected to the inside of the recorder, however, because the top cover holds the input connectors. The connecting wires are just long enough to let the top cover rest at the table upside down behind the bottom part of the recorder housing.

Gain access to the Chart Drive PCB by removing the module cover.

Figure 2-4 shows the location of the jumper pads involved in customizing the recorder.

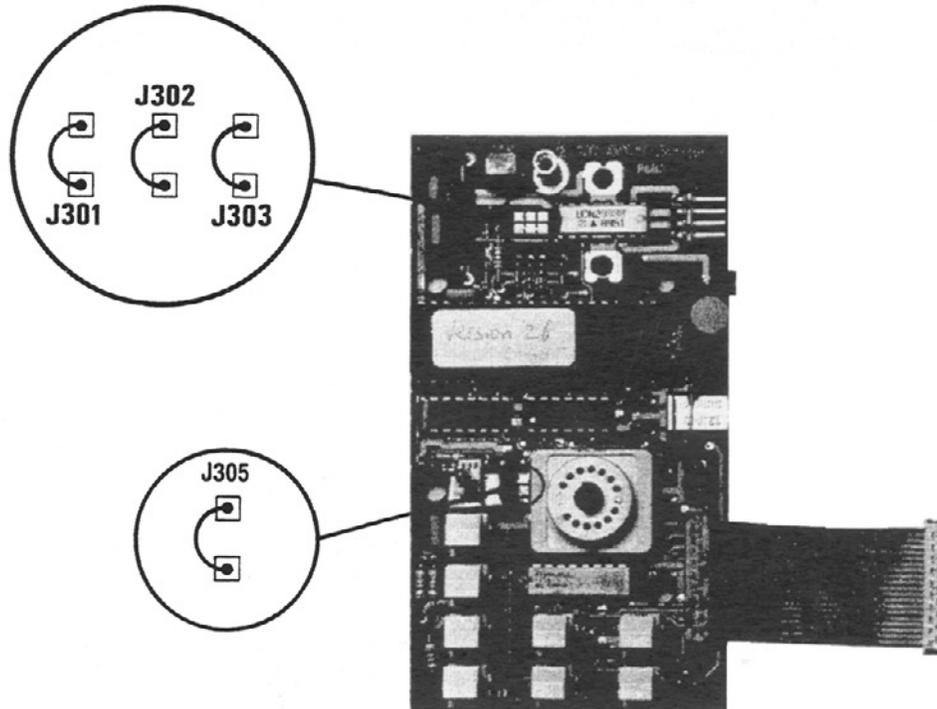


Figure 2-4. Location of the jumpers

Table 2-1 shows each of the jumper settings that you can select, and their effects.

**TABLE 2-1
EFFECT OF CLOSED JUMPERS**

J301	Invert external penlift logic level ("1" is pen down)
J302	Auto penlift off
J303	Invert start stop logic level ("1" is chart stop)
J305	Activate 50/60 Hz synchronization

When the changes have been made, you can replace the module cover and the top cover by placing it over the bottom part and bringing it precisely into position. When this is done properly, hardly any force is needed. As soon as the top cover is correctly in place, the housing can be closed by pinching the top and bottom parts of the cover together at each of the corners. Soft clicks will confirm the proper position.

SECTION 3 OPERATING PROCEDURES

3.1 GENERAL OPERATION

3.1.1 Switching On and Off

Switching on and off is done with the small black switch which is located at the left-hand side of the recorder. Once it is switched on, it immediately is ready for use. Upon power-up, the origin (Home position) is set at the location where the paper was at that moment.

With the "Set" button, the origin can be defined at any desired position.

3.1.2 Fuses

There are two fuses, which are located next to the power switch. They are easily removable with a screwdriver or a fingertip. Be sure to replace fuses with ones of the same type. When the recorder is operated at 230 V, 125 mA fuses are required. When operated at 115 V, 250 mA fuses are required.

3.2 OPERATOR PANEL DESCRIPTION

The location of each of the operator panel functions is indicated in Figure 3-1.

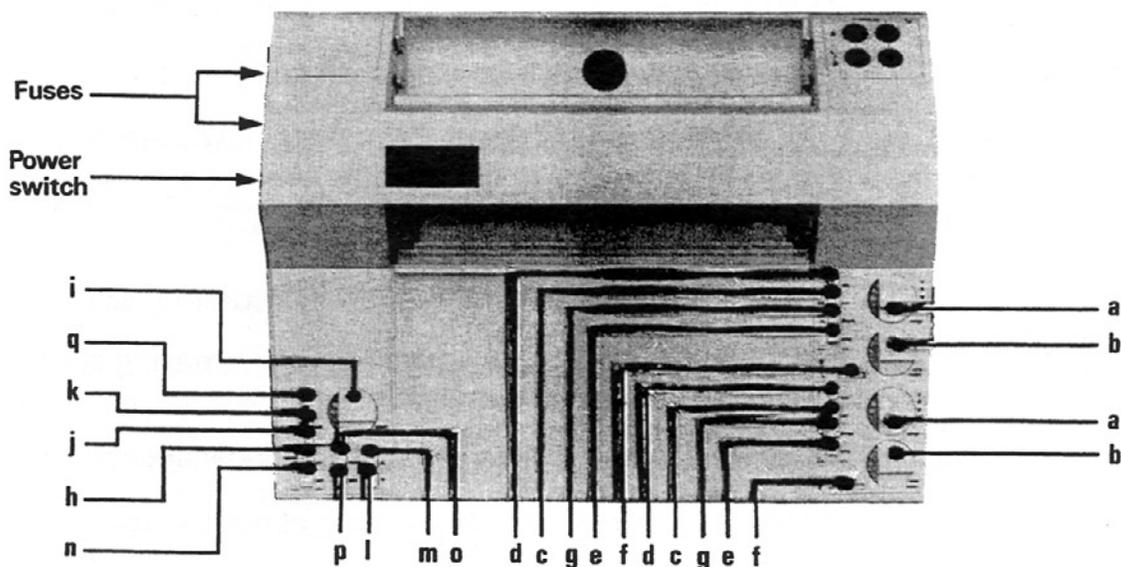


Figure 3-1. Location of Operator Panel Functions

SERVOSYSTEM (one for each channel)

- a) Range: Rotary switch with 14 positions selects span settings, ranging from 1 mV to 20 V FS
- b) Zero Suppression: Rotary switch with 7 positions suppresses -1 to +5 times selected span
- c) Cal/Var. Span: 2-position pushbutton selects between calibrated and user adjustable span
- d) Var. Span: Potentiometer to set span range from 40 to 100% FS
- e) Zero: 2-position pushbutton switches one channel amplifier input to zero, used for zero adjustment of the pen
- f) Zero Adjust: Potentiometer with thumbwheel, used to position the pen on the paper
- g) Pen Up/Down: 2-position pushbutton, used to activate the electrical penlift (pen 1 and pen 2 independently)

CHART DRIVE (left-hand side of recorder)

- h) Record On/Off: 2-position pushbutton, switches between:
Record On mode: internal chart speed settings or external pulse input and remote control functions
Record Off mode: keyboard control of chart drive; Forward, Reverse, Home, Zero Set and Go to major grid mark
- i) Chart Speed: 8-position rotary switch for fixed chart speed settings
- j) mm/sec or mm/min: Switches selected chart speed unit from mm/sec to mm/min
- k) Int/Ext.: 2-position pushbutton, switches between keyboard selected chart speed and external chart pulse input
- l) Forward: Pushbutton, moves paper forward with increasing speed
- m) Backward: Pushbutton, moves paper backward with increasing speed
- n) Start of plot/ Major grid mark setting: Pushbutton, sets start of plot and major grid mark position
- o) Home: Pushbutton, moves paper to start of plot position (pen up)
- p) Grid: Pushbutton, moves the paper (always forward) to the next major grid mark (lines with 10 mm distance). When on grid mark, the paper moves one grid mark further
- q) Power: Green LED to indicate power on

Note: The following functions are only available in Record Off mode:

- l) Forward
- m) Backward
- n) Start of plot and major grid mark setting
- o) Home
- p) Grid

3.3 CHART DRIVE FUNCTIONS

3.3.1 Record On/Off

The function of this switch is to start and stop paper transport. When "Record" is in the Off position, it interrupts both the internal chart speed pulses and the external pulses. This switch must be put in the Off position in order to be able to operate any of the following functions: Forward/Reverse (Arrows), Home, Grid and Set. When Record is in the On position, pressing any of the keys corresponding to the mentioned functions has no effect.

3.3.2 Chart Speed

The velocity at which the paper is moving is controlled by a combination of two selections: the position of the Chart Speed switch (eight possible positions, ranging from 0.1 to 20 units), and the position of the mm/sec or mm/min switch.

This combination gives you the lowest speed of 0.1 mm per minute, at which the paper roll has an expected lifetime of 4100 hours, and a highest speed of 20 mm per second, at which a new roll of paper is required after approximately 20 minutes.

3.3.3 Internal/External Switch

The position of this switch determines the source of the pulses which make the paper move. When it is in the "Internal" position, an internal clock, which can be adjusted as described in the previous section, is in effect. When the switch is in the "Ext" position, the chart drive must be fed with pulses from an external source. This is explained in more detail in Section 4.

3.3.4 Paper Transport

The buttons associated with this function are marked with two small black arrows. With these buttons, the paper can be positioned very precisely underneath the pens. Each time one of these buttons is pressed for less than one second, the paper is moved over a distance of 0.05 mm in the corresponding direction. If the key is held down, however, after one second the paper will start moving at a speed of 2 mm/s for the next five seconds, so it moves over a distance of 10 mm.

If the button is still being held at the end of six seconds, the paper will start moving at a speed of 20 mm/s. Using proper timing while operating, these paper transport keys make it possible to put the pens at any desired position very quickly. The paper can only be transported in this manner when the Record switch is in the "Off" position.

3.3.5 Home and Set Start of Plot

These buttons also can only be operated when the Record switch is in the "Off" position. Pressing the Home button will bring the paper back to the position where the origin is located. This is either the position of the pens during power-up or the position where the pens were at the moment that the Set button was last pressed. Set is used for defining a new origin at any position. Be careful not to operate the Home button if you are not certain about the location of the origin. If the origin lies within an area of the paper which already has been torn off, the recorder will lose control of the paper. Seeking Home takes place at a velocity of 20 mm/s.

3.3.6 Go to Next Grid Mark

This function is activated by pressing "Grid". Each time it is pressed, the paper advances to the next major grid mark. The major grid marks lines are the lines parallel to the paper ruler with 1 cm interval. When the origin has been set precisely on top of a grid mark, pressing Grid will always bring the pen on top of the next grid mark. This function also only operates when Record is "Off". Paper transport takes place at a velocity of 20 mm/s for this function.

3.4 SERVOSYSTEM FUNCTIONS

The RD45/46 is equipped with two fully independent servosystems. Each servosystem has an operator panel for controlling its functions. The following explanation of these functions applies to both channels.

The signals that are to be recorded must be connected to the corresponding input terminals at the rear side of the recorder. The black terminals are negative and the red terminals are positive.

The maximum input voltage which is allowed across the terminals for each of the channels is 30 VAC or 42 VDC for personal safety. If a higher input voltage is used, this will not damage your recorder, but the input terminals cannot be touched safely. The maximum allowable voltage difference across any two terminals of different channels is 500 V.

3.4.1 Span

The input span of each channel is selected with the rotating Range switch. This switch has 14 positions. Turned counterclockwise all the way, a span of 20 V is chosen. This means that an input voltage of 20 V will move the pen all the way from the left-hand edge to the right-hand edge of the paper (supposing, of course, that the zero-position was at the left side of the paper).

When the Range switch is turned fully clockwise, the span is 1 mV full scale. The whole range in between these spans is covered in 14 steps according to the sequence 1, 2, 5, 10. The input spans have these calibrated values only when the Cal/Var switch is in the "Cal" position.

3.4.2 Zero Suppression

Zero suppression can be controlled with the seven-position rotating switch marked "Zero Suppr". With this switch, the zero position of the input signal can be elevated one to five times the selected span.

Example: A span setting of 10 VDC and a zero suppression setting of +2 results in an input range of 20 to 30 VDC.

3.4.3 Calibrated/Variable Span

When this switch is in the "Cal" position, an input signal equal to the selected range will result in a full scale deflection. It may, however, sometimes be desirable to have an input span, which lies in-between the values that can be chosen with the range switch. In such a case, the Cal/Var switch must be put in the "Var" position, after which the variable span can be set by turning the Var potentiometer with a small screwdriver.

Example: A signal varying between 0 and 25 mV is to be recorded using the full scale width.

1. Select the 50 mV range.
2. Put the Cal/Var switch in the "Var" position.
3. Adjust the potentiometer until the amplitude reaches 100% of scale.

Since the variable span allows for 40% to 100% span adjustment, any desired (non-calibrated) span between 0.4 mV and 20 V can be obtained.

3.4.4 Zero Adjust

When the Zero switch is in the Down position, the pen will remain at its zero location. This is the location of the pen in the absence of an input voltage. The location of this point can be shifted to the left or right by turning the small wheel "Zero". This function allows relocation of the zero point anywhere between the left and right edge of the paper. After the zero location has been chosen, the recorder must be put back into operation by pressing Zero once again, which brings the switch back to the upward position.

If desired, the signal axis together with the location of its zero point can be mirrored with respect to the center of the recorder. Refer to Section 2.3.1, POLARITY SELECTION for more information.

3.4.5 Pen Up/Down

This switch is used for controlling vertical movement of the pen. When there has been no chart drive pulse for a period of 30 seconds, the pen will be lifted off the paper automatically to avoid ink stains on the paper.

This situation will occur whenever the Record switch is put in the "Off" position and Pen in the "Down" position. It will also happen when the paper transport is being controlled externally and the chart drive pulses have stopped.

The auto penlift function may be inhibited by making a small modification to the recorder. Refer to Section 2.3, PERFORMING THE CUSTOMIZATION for more information on this subject.

SECTION 4 EXTERNAL FUNCTIONS AND OPTIONS

4.1 GENERAL

A number of functions of the RD45/46 can be remotely controlled. Some of these functions are standard RD45/46 functions; others are only available when the respective options have been installed. The RD45/46 recorder is equipped with a D-15 type connector, which is located at the rear side of the recorder. The location of this connector is shown in Figure 2-1.

The connector pins carry the signals for the corresponding functions. Each of these signals is described in Section 4.4, SIGNAL EXPLANATION.

4.2 OPTIONS

For special applications, the following options are available:

1. Pen Offset Compensation/RS-232
2. Retransmitting potentiometer

These options must be purchased separately. Each of these options is described below. For a complete description which covers installation and user information of the POC/RS-232 option, refer to Section 5.

Note: When one POC/RS-232 module and BOTH retransmitting potentiometers have been installed, the following functions are disabled at the D-15 connector:

- POC On/Off
- Serial out
- Go to major grid mark

These three pins are used to access the three potentiometer terminals instead. The two corresponding keyboard functions remain unchanged and can still be used.

4.2.1 Pen Offset Compensation

Because of the nature of the RD45/46 recorder, the two pens have a different position with respect to the time axis of the recorder. The pen of channel 1 is always 2.5 mm behind the pen of Channel 2. This could cause interpretation problems. If this is the case, or if this is just not desired, the POC should be installed. The circuitry in this option delays the values of Channel 1. The delay comprises 50 steps of 0.05 mm, which compensates for the 2.5 mm difference.

4.2.2 RS-232C

With these options installed, input information for both channels is available in digitized form. This information can be directly read by any computer with an RS-232C interface. Data is sent in a time-multiplexed form. After each step of the paper transport mechanism, a digitized value for Channel 1 and Channel 2 is transmitted.

4.2.3 Retransmitting Potentiometers

If it is necessary to have precise information about the position of each (or one) of the pens, this option should be installed. If it is installed, the servosystem potentiometer shaft controls a secondary potentiometer. Its exact position can be derived from the resistance value available at the potentiometer contacts. This additional potentiometer has a resistance value of 5 kOhm 10%, nonlin. 0.25% and has a maximum current rating of 14 mA. The contacts may never be connected directly to a power supply, for at the two ends of scale, there is a resistance value of zero ohm between two of the three contacts. For each of the two channels, one retransmitting potentiometer may be installed.

4.3 I/O CIRCUITRY SPECIFICATIONS

All incoming signals are received by input logic as shown in Figure 4-1.

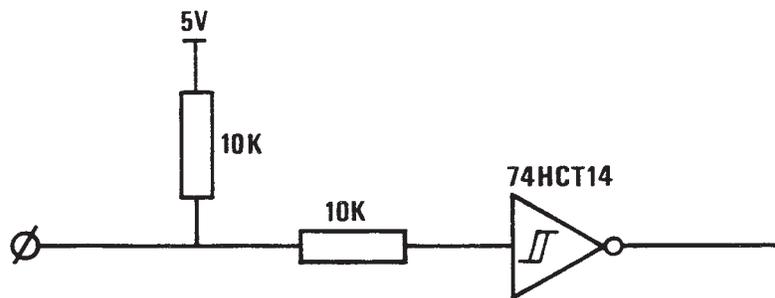


Figure 4-1. Input Logic

When no signal is applied (open input), the 10K ohm pull-up resistor keeps the Schmitt-trigger input at a logical 1. This corresponds to a non-active situation for the respective function. This is true for all functions in the default situation (i.e. the way your RD45/46 was factory set and shipped). If the function has to be activated, a logical 0 (zero) must be applied. This can be done by either short-circuiting the input to ground or by applying an active zero (TTL spec.).

For three functions (Chart On/Off and Penlift Channel 1 and 2) it is possible to invert the logic of the external control. These modifications can be made by changing the respective straps inside the RD45/46 recorder. This process is described in Section 2.3, Customizing the RD45/46. When these inputs have been modified to accept logical 1's in order to activate the involved functions, the inputs cannot be left open without activating them.

Note: Making the modifications mentioned above does not change the actual input circuitry in any way. It just changes the internal interpretation of the input logic.

4.4 SIGNAL EXPLANATION

Figure 4-2 shows the connector layout of the 15-pin sub-D connector. The following functions are available when no options are installed.

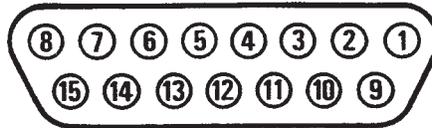


Figure 4-2. 15-pin sub-D Connector Layout

1	- Penlift Channel 1	x * +
2	- Penlift Channel 2	x * +
3	- Start of plot/major grid mark	x o
4	- Goto major grid mark	x o
6	- Servomarker Channel 1	o
7	- Servomarker Channel 2	o
8	- Home	x o
10	- Ground	
12	- Chart on/off	x *
14	- External chartdrive pulse input	x
15	- Ground	

x = Only available in record on mode

* = Default "O" active or contact closure

"1" active selectable by internal strap

o = "O" active or contact closure

+ = Only available when internal penlift is not active

When the POC (Pen Offset Compensation) option is installed, the following additional functions are available:

5	- POC on/off
13	- Serial out Ch.1/2 (9600 Bd)

When one retransmitting potentiometer is installed, the following additional functions are available:

9	- W1
10	- CCW1 (See note below)
11	- CW1

Note: When the first retransmitting potentiometer is installed, the GROUND function of pin 10 is replaced with CCW1.

When the second retransmitting potentiometer is installed as well, the following additional functions are available:

- 4 - CCW2
- 5 - CW2
- 13 - W2

Because these pins get reassigned after installation of this option, the following functions are now disabled at the D-15 connector:

- Go to major grid mark
- POC on/off
- Serial out

In order to suppress unwanted interference from external sources, all signal inputs except ECP and servomarker, are filtered. Any pulse that is shorter than 40 ms is rejected. As a result, these signals are always delayed for 40 ms.

When an External Chart Drive Pulse is used for moving the paper under the pens, a dividend is applicable. This is a number between 1 and 12000, by which the number of received pulses is divided before one step (i.e. 0.05 mm) is made. The value of this dividend depends on the position of the "mm/min" or "mm/s" buttons and the Chart Speed switch. Switching from "mm/s" to "mm/min" increases the dividend with a factor 60 and turning "Chart Speed" from 20 towards 0.1 accounts for a factor of 200. The combination of these two results in a maximum dividend of 60×200 which equals 12000.

The maximum frequency at which External Chart Pulses may be sent to the RD45/46 is 8 kHz. (Pulse duration is at least 1 ms). Since the maximum stepping rate, corresponding to a maximum chart speed of 20 mm/s and a step size of 0.05 mm, equals 400 Hz, this maximum ECP frequency can only be handled properly by the recorder if a dividend value of at least 25 is applicable. The user is responsible for maintaining this lowest value. If the stepper motor of the chart drive receives stepping pulses at a frequency greater than 400 Hz, it will stop turning regularly.

This special property of the RD45/46 has been built in to meet the requirements needed for unusual laboratory applications. Under normal circumstances, External Chart Pulses do not need to have such a high frequency.

There is no maximum for the ECP pulse duration, but it is recommended to use pulses of at least 1 ms. As soon as the positive edge is received, the chart drive will make one step. This is only true when the dividend equals 1. When the dividend has a value of N, that step will not be made until the Nth positive edge has appeared.

When one of the servomarker functions is activated, the corresponding pen moves 10 mm to the left, with respect to the position it had. It then continues drawing the applied signal, only the drawn curve is shifted 10 mm to the left. As soon as the function is deactivated, the pen moves back to the position that represents the channel input value. This is true if the "Zero" position is at the left-hand side of the paper. If it is at the right-hand side of the paper, the pen moves to the right when the servomarker function is activated.

SECTION 5 PEN OFFSET COMPENSATION MODULE (RDX40-POC)

5.1 GENERAL

The Pen Offset Compensation module allows a graphical representation of two signals on a RD46 recorder without any trace offset. Normally, when a multi-pen recorder is used for monitoring signal variations, the traces are shifted with respect to each other, because the pens cannot write at the same time on the same spot. This effect has now been eliminated. The signal value of the second pen is not immediately written on the chart, but is stored until the chart has been advanced by 2.5 mm (the distance between the two pens).

5.2 SPECIFICATIONS

MODULAR DESIGN:	Both channels can be retrofitted with a Pen Offset Compensation unit without any calibration. (Channel 1 for RS-232C output)
PEN OFFSET COMPENSATION DISTANCE:	0, 2.5 mm switch selectable
INPUT SAMPLING:	Continuous tracking; 1 digitized value for each chart step
RESOLUTION TIME AXIS:	0.05 mm
RESOLUTION X-AXIS:	0.07 mm; 12 bit
INACCURACY X-AXIS:	0.04% FS max.
DIGITAL OUTPUT FILTER:	Two successive digitized values are averaged
SERIAL OUTPUT: RS-232C	Each unit transmits optically isolated serial data, the real time digitized input voltage is transmitted, transmission starts after each chartstep
MAX. CHARTSPEED FOR DATA TRANSFER:	0.5 mm/s
DATA TRANSMISSION FORMAT:	Space/channel code/4 data bytes Space/channel code/4 databytes/CR/LF
DATA BYTE VALUE:	0000 to 4095 (3685 \pm 3% for a full scale deflection)
WORD LENGTH:	8 bit/character 7 bit ASCII and the 8th bit zero One start bit One stop bit No parity
TRANSMISSION RATE:	9600 baud fixed
DIMENSIONS:	1.97" x 2.36" x 0.39" (50 x 60 x 10 mm)

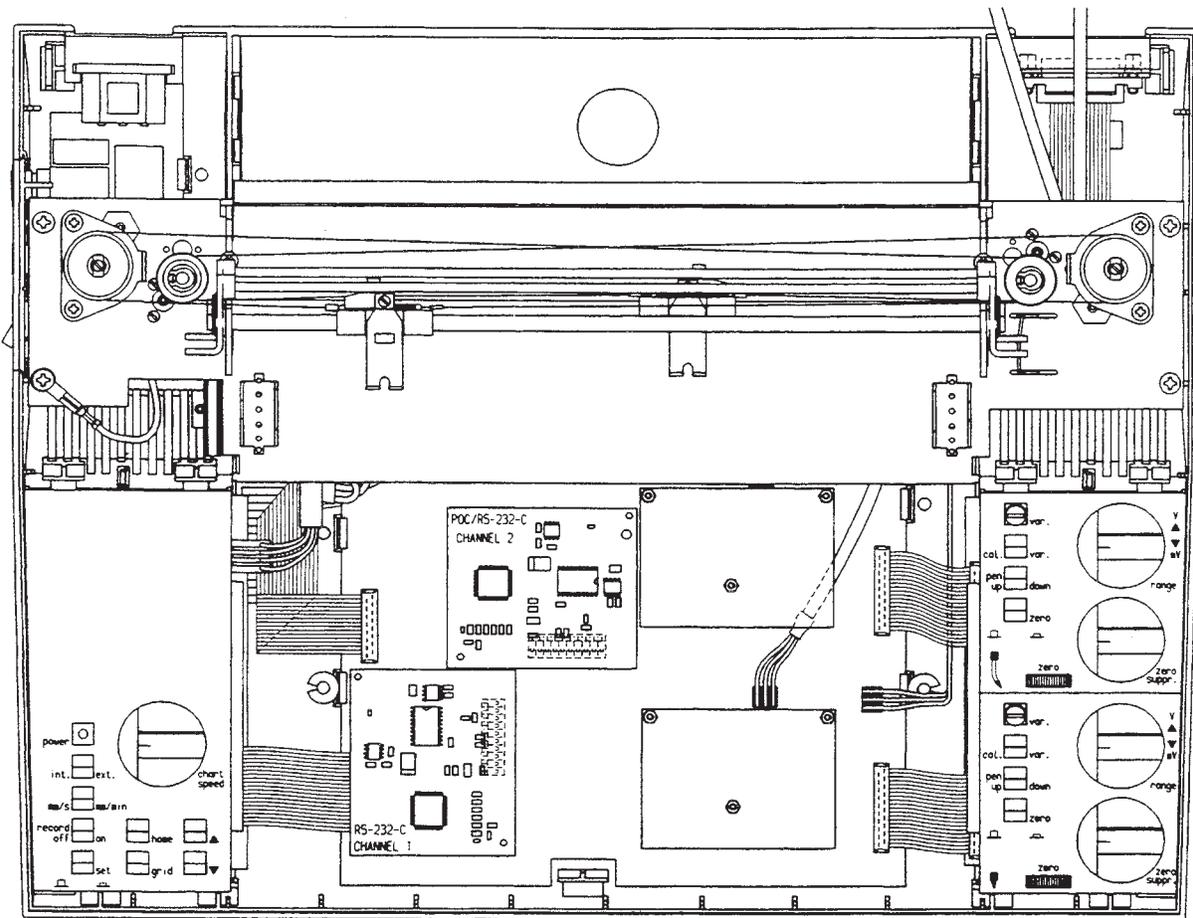


Figure 5-1. Mainboard Layout

5.3 INSTALLATION

A POC/RS-232C module can be placed on each channel. When a pen offset compensation module is not mounted yet, proceed as follows:

- 1) Switch off the recorder.
- 2) Refer to Section 2.3.5 for opening the case and remove the jumper from the female socket on the mainboard.
- 3) Set the switch on the module for channel 1 to "0" or "8" and the switch for Channel 2 to "1" or "9". See Figure 5-2.
- 4) Attach the POC module(s) onto the socket. See Figure 5-1. (Figure 5-1 also shows the locations of the modules on the board).
- 5) Close the case.

*For removal of the POC, this procedure can be done in reverse order.

RS232-C data block transmitted

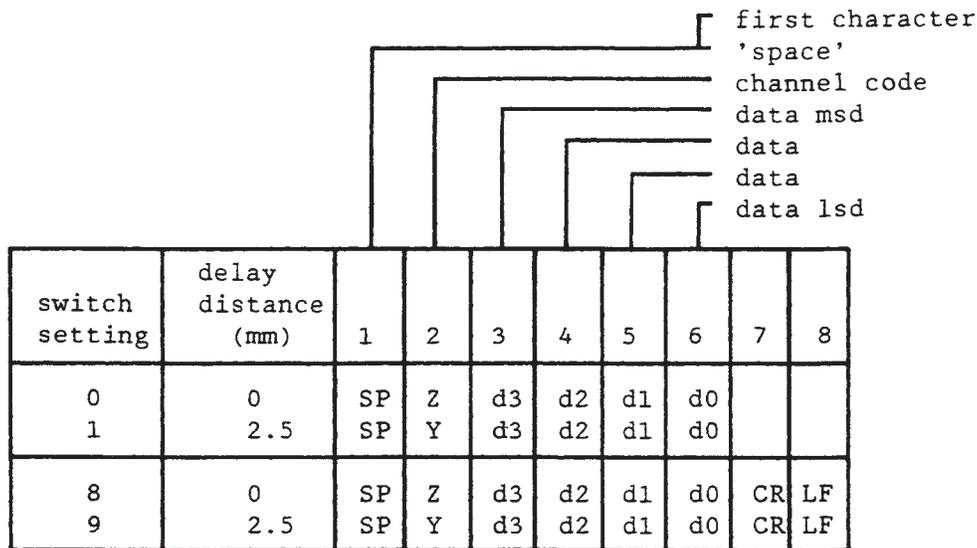


Figure 5-2. Switch setting and data format

Note: To synchronize both channels, the signal of Channel 2 must be delayed. The POC module must therefore be mounted on Channel 2. The non-delayed pen need no POC module. When a POC module is mounted, it must be set to 0 mm.

When interchanging two modules or mounting a new one, adjust the correct settings of the pen offset compensation switch.

5.4 OPERATION

When the modules are installed into the recorder, close the case and switch the power on. To facilitate Zero adjustment for each pen, the pen offset compensation is automatically switched off when the zero switch of the input module is set to zero. When turning the switch from zero, the pen of Channel 2 will start tracking this input signal after a delay that is needed to compensate for the distance between the pens.

Switching off the Pen Offset Compensation of Channel 2 is accomplished by pulling pin 5 of the 15 pin-sub D low (connecting pin 5 and 15).

5.4.1 RS-232C Output

A fully floating serial RS-232C output is available on the rear connector of the recorder. The optional POC modules permit RS-232C cables to be connected according to the EIA standard. The recorder can be connected directly to other equipment configured as DCE (Data Communication Equipment) with a special interface cable with 25-pin connector). See Figure 5-3.

When the status of the device (printer, computer, RXD) is DTE (Data Terminal Equipment), change it to DCE. See the manual of the device in question. If this reconfiguration is not possible, the change can be made in the 25-pin connector: loosen the wire on pin 2 (TXD) and reconnect it to pin 3 (RXD).

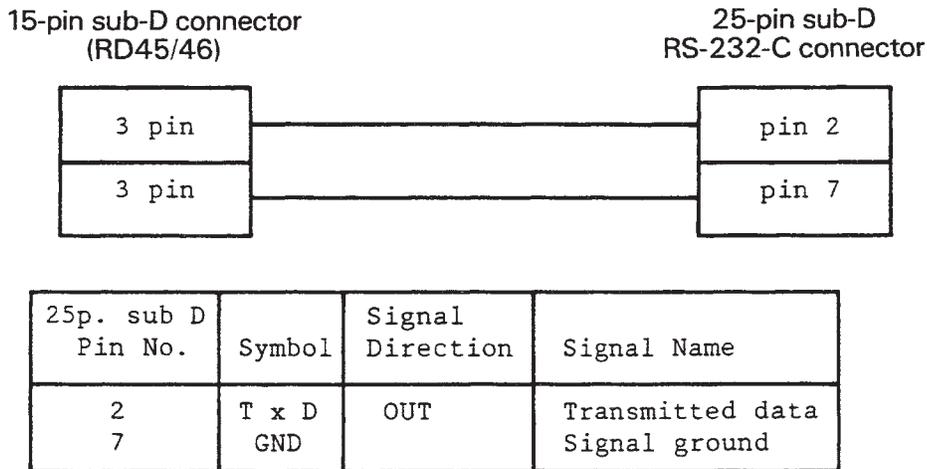


Figure 5-3. Cable Layout

5.4.1.1 RS-232C Serial Interface

The serial data outputs of more than one channel are clamped together, so that information of both channels can be transmitted over the same two wires (see Figure 5-1) so a computer or printer can be used easily for further adaptation of the data, related to the pen deflection, while a full mutual isolation is maintained.

Transmission of data occurs after each step of the chart drive. A block containing the data of all channels is sent in ascending sequence, starting at the POC module with a switch that is set to 0. See the previous section.

The value of the data transmitted is proportional to the deflection of the pen. This value is 3685 +/- 3% for a full scale deflection. The maximum of 4095 and the minimum of 0000 are out of scale. The resolution is about 0.07 mm or 15 points/mm.

An example of a RS-232C input routine written for an Epson PX-4 computer handling two channels (X and Y) of the RD46 is given in Section 5-5.

5.4.1.2 Maximum Permissible Chart Speed For RS-232C Operation

Note that the maximum permissible chart speed when the recorder is connected to another device (e.g. printer, computer) is 30 mm/min.

5.4.1.3 RS-232C Data Format

Data is transmitted in blocks of 6 or 8 ASCII bytes. Each block contains the information for one channel. The channels are transmitted sequentially, the data coming from the POC module with the lowest setting first. A data block is built as shown in Figure 5-4.

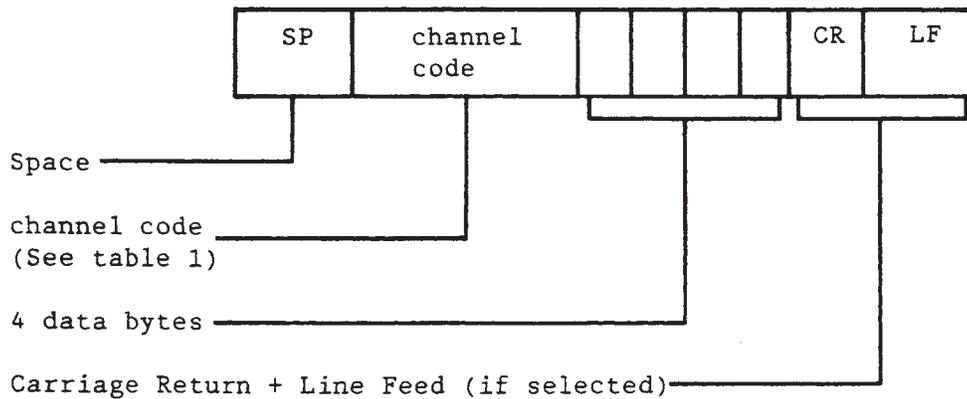


Figure 5-4. RS-232C Data Format

The channel code can be used by the computer for identification, and the optional CR LF for acknowledgment of the data block received.

5.5 DEMONSTRATION PROGRAMS

The printed demonstration programs were written on a PX4 Epson hand held computer to give the user more information on how to handle the serial data output.

5.5.1 DEMO 1

```
10 REM    demo 1
20 :
30 :
40 :
50 REM demo RD45/46 RS-232 data transmission
60 REM receive data from Channels 1 and 2
70 REM display value and draw curves
80 :
90 :
100 :
110 REM enable input,set baudrate and clear screen
120 OPEN "i",#1,"com0:(e)":DEFINT P,G,V,X,Y
125 PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:YV=200:XV=200:GOTO 340
130 :
140 REM    wait for code "Y"
150 IF INPUT$(1,#1)<>"Y" THEN 150
160 RETURN
170 :
180 REM    wait for code "Z"
190 IF INPUT$(1,#1)<>"Z" THEN 190
200 RETURN
210 :
220 REM    get pen position value
230 G=VAL(INPUT$(4,#1)):RETURN
240 :
250 REM    scaling
260 P=-G*.037+235.5:RETURN
270 :
280 REM    draw line
290 PSET(VP,Y-1):LINE-(P,Y):VP=P:RETURN
300 :
310 :
320 :
330 REM    main program
340 GOSUB 190:GOSUB 230:GY=G:GOSUB 260:GOSUB190:Y=Y+1:VP=YV:GOSUB
    290:YV=P
350 GOSUB 150:GOSUB 230:GX=G:GOSUB 260:GOSUB 150:VP=XV:GOSUB
    290:XV=P
360 GOSUB 190:IF Y=63 THEN Y=55:PRINT"Y";GX;TAB(8);"Z";GY:PSET(83,Y)
370 GOSUB 150:PSET(84,Y):GOTO 340
```

5.5.2 DEMO 2

```
10 REM    demo 2
20 :
30 :
40 REM    print all characters received
50 :
60 OPEN "i",#1,"com0:(e)":PRINT:PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
70 PRINT INPUT$(6,#1);:GOTO 70
```

5.5.3 DEMO 3

```
10 REM    demo 3
20 :
30 :
40 :
50 REM
60 REM
70 REM
80 OPEN "i",#1,"com0:(e)":GOTO 210
90 B$=INPUT$(6,#1)
100 IF B$="" THEN 90
105 RETURN
110 A$=LEFT$(B$,2)
140 IF A$=" Z" THEN CH=6:RETURN
150 IF A$=" Y" THEN CH=5:RETURN
160 IF A$=" X" THEN CH=4:RETURN
170 IF A$=" W" THEN CH=3:RETURN
180 IF A$=" V" THEN CH=2:RETURN
190 IF A$=" U" THEN CH=1:RETURN
200 G$(CH)=B$:RETURN
210 FOR I=1 TO 6 :G$(I)="----":NEXT:CLS
220 GOSUB 90:GOSUB 110:GOSUB 200
230 LOCATE 1,1
240 PRINT " u";G$(1);" v";G$(2);" w";G$(3);" x";G$(4);" y";G$(5);" z";G$(6)
250 GOTO 220
```

SECTION 6 SPECIFICATIONS

INPUT RANGES:	1, 2, 5, 10, 20, 50, 100, 200, 500 mV; 1, 2, 5, 10, 20 VDC
VARIABLE RANGE:	From 40 to 100% FS
SPAN ACCURACY:	0.3% FS
NON-LINEARITY:	0.3% FS
DEADBAND:	0.2% FS
RESPONSE TIME:	0.2 sec. for 5-95% FS
INPUT IMPEDANCE:	1 Mohm DC; 10k ohm in series with 1.5 μ F for AC
INPUT:	Floating, non-symmetric
INPUT BIAS CURRENT:	5 nA, max.
ISOLATION:	>50 Mohm between channels, and between channel and power supply
MAX. INPUT VOLTAGE:	42 VDC/30VAC max. at input terminals; 500 VDC max. between channels.
CMRR:	130 dB
ZERO ADJUSTMENT:	-50 to 150% FS
ZERO POSITION:	User selectable, left or right side
ZERO SUPPRESSION:	-100, 0, 100, 200, 300, 400, 500% FS
ZERO DRIFT:	1 μ V/ $^{\circ}$ C max.
CHART SPEEDS:	0.1, 0.2, 0.5, 1, 2, 5, 10, 20 mm/min. or mm/sec.
CHART PAPER:	200 mm wide (7.87"); 25 m length
EXTERNAL INPUT:	TTL signal chart advance -0.05 mm per pulse. A pulse divider may be set between 1 and 12000 via the chart speed and mm/s or mm/m switches - the number of received pulses is divided by this before one step is made.
PEN LIFT:	Electronic; automatic pen lift after 30 seconds if chart is not advanced

SPECIFICATIONS (Cont'd)

OPERATING AMBIENT TEMP.:	14 to 104°F (-10 to 40°C); 35 to 85% RH, non-condensing
STORAGE TEMP. RANGE:	-40 to 167°F; (-40 to 75°C)
POWER:	115/230 VAC, switchable; -15/+20%; 50/60 Hz
POWER CONSUMPTION:	30 VA single channel; 50 VA dual channel
DIMENSIONS:	3.6"H x 15"W x 11.5"D (90 x 380 x 290 mm)
WEIGHT:	7.7 lbs. (3.5 kg)

SECTION 7 ACCESSORIES AND SPARE PARTS

DESCRIPTION	PART NO.
Power cord USA	2570-042
Power cord Europe	2570-041
Input cable	0302-801
Set of 3 fuses, 125 mA for 230 V	2655-099
Set of 3 fuses, 250 mA for 115 V	2655-088
10 rolls of chart paper, 25 meters each	RDX40-RP
10 rolls of chart paper, low particulate paper, 11 meters each	RDX40-RPLP
Fiber pens (short) for the RD45 recorder and Channel 1 of the RD46 recorder:	
6 fiber pens, black	RDX40-BK
6 fiber pens, red	RDX40-RD1
6 fiber pens, green	RDX40-GR
6 fiber pens, blue	RDX40-BL
Fiber pens (long) for Channel 2 of RD46 recorder:	
6 fiber pens, red	RDX40-BD2
6 fiber pens, black	RDX40-BK2



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OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

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Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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