PROGRAMMING INSTRUCTIONS

for the

ORTOFON P400 MEASURING COMPUTER

May 1986

INTRODUCTION

The P400 Measuring Computer has mainly been developed for production control purposes which means quality assessment of the acoustical performance of dynamic transducers.

The instrument can be applied to the measurement of relevant acoustical criteria of loudspeakers, microphones, headphones, telephone equipment etc.

Loudspeakers, individual drivers, HiFi speaker systems, TV and radio speaker units, car speakers, and miniature speakers can be tested in a matter of seconds - through incoming inspection, production tests or random AQL-testing.

The P400 is a computer-controlled signal generator and response analyser which can be programmed to perform exact and repeatable tests of the following parameters:

Frequency response
Efficiency/sensitivity
Rub & buzz/distortion
Polarity/electrical phase
Impedance (user defined)

Reference limit information can be individually programmed into the computer by the user and the measured data are compared to these limits. A GO/NO GO (APPROVED/REJECTED) condition is displayed on the colour CRT as a result of the measurement.

The instrument is provided with the necessary amount of basic software which enables the user to work out his own individual test programmes. This is necessary as each user may have different requirements to the quality assessment of his products.

Programming of the Measuring Computer P400 is simple, provided certain basic rules are followed. Therefore, a step by step description of the programming procedure is given on the following pages whereas the operation of the instrument is described in great detail in the separate Operational Manual.

PROGRAMMING THE P400 MEASURING COMPUTER
A STEP BY STEP INSTRUCTION

START-UP

Turn to the rear of the instrument and check whether the correct voltage has been set. If the setting is not correct, open the enclosure and set the voltage to the correct level. Check the fuse for safety reasons.

Connect the instrument to the mains and switch on. You will see that the P400 performs some selftests finishing with a listing of the software revision installed and the options built into this particular P400.

Now push START on the front keyboard of the instrument. The colour CRT displays a two channel voltmeter and it shows an identical setting for channel A and B of 10 V RMS logarithmic scale, manual operation.

PROGRAM

The instrument is menu-operated which means that you can display a great variety of menus from which you can choose between various alternative settings.

To initiate the operation of the instrument you have to follow the following steps: activate PROGRAM key. You see the main menu of the instrument consisting of 7 items:

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1: VOLTMETER
2: FREQUENCY COUNTER
3: TIME AND FREQUENCY RESPONSE ANALYSIS
4: PRINTER SETTING
5: PRODUCTION CONTROL (TEST PROCEDURES)
6: KEYBOARD SET-UP (MEMORY CASSETTE)
7: PROGRAMMING OPTIONS
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To address the various items of a menu, you have to activate the corresponding keys which means No. 1, 2, 3, 4, 5, 6, 7 etc.

OPERATION

At this point you have to make your first choice how you want to use the instrument. You can use it as a voltmeter only, to measure voltages in channel A or B, e.g. from a connected microphone. The alternative choice is to use the instrument as a frequency counter. Then you have to activate key No. 2. However, the most common procedure will be to activate key No. 3 which will let you choose between settings for time response or frequency response analysis. Therefore, it is suggested to start up the programming procedure by activating key No. 3.

TIME AND FREQUENCY RESPONSE

A new menu TIME AND FREQUENCY RESPONSE ANALYSIS is displayed. You can now choose whether you want to work in the time domain (menu item 1) or in the frequency domain (menu item 2 and 3).

TIME AND FREQUENCY RESPONSE

The most common procedure will be to work in the frequency domain by activating key No. 2. On the display is shown START FREQUENCY 20 Hz and STOP FREQUENCY 20 kHz (item 3). You can now individually choose start and stop frequency for your x-axis by using the left/right arrows in the upper right corner of the front panel.

Item 4 of this menu is automatically displaying ON which indicates that frequencies are automatically measured by the built-in system.

Item 5 and 6 are reserved for applications where external signal generators are used.

Push the PROGRAM key to exit the menu.

The CRT displays a coordinate system which displays "frequency response" to indicate that the x-axis is calibrated in terms of frequency (20 Hz - 20 kHz).

FUNCTION

As a next step you have to decide which parameter you want to measure. Activate FUNCTION A key and choose the appropriate parameter out of the 6 ones available. For frequency response analysis you have to use item 2 RMS.

Activate FUNCTION A key to exit the menu.

Repeat the same procedure for channel B if required.

GENERATOR

Now, you have to programme the signal generator. The P400 Measuring Computer uses swept sine wave signals to excite the acoustical transducer. Activate GENERATOR key and choose the start frequency of the sweep on item 3, the stop frequency of the sweep on item 4, and the total sweep time on item 5. You will notice that 20 Hz to 20 kHz and 4.2 sec. are displayed. However, these values can be changed by using the left/right arrows in the upper right corner of the front panel.

When programming total sweep time you may see the warning "SWEEP TIME TOO LOW" displayed on the CRT. This means that although you can still use this sweep time, the measurement becomes doubtful. Since the sweep time is so low that there is less than one complete sinus signal for each of the frequencies used for frequency response measurement. Therefore, it is advisable to start with a longer sweep and then gradually go down by comparing frequency response curves on the screen. As soon as the curves start to change their appearance significantly, you should increase the sweep time again.

Item No. 6 "AUTOMATIC ON/OFF" should be left ON.

OUTPUT LEVEL

Thereafter you hit key No. 8 to adjust the OUTPUT AMPLIFIER. Item 1 lets you switch between low range (0 dB = 5 V RMS) and high range (0 dB = 20 V RMS).

Item 2 permits adjustment of the correct output power level between 0 dB and ÷ 84 dB. To the right of the word ATTENUATOR you see a display of two small left/right arrows and two up/down arrows. The up/down arrows permit a coarse adjustment of the output attenuation whereas the left/right arrows are used for fine adjustment. The arrows are located in the upper right corner of the front panel.

To secure a proper signal-to-noise-ratio it is advisable to adjust the OUTPUT ATTENUATOR as close to the 0 dB level as possible. In other words, use the highest possible output setting in the low or high range, but be careful not to overload your transducer.

Item 3 of this menu permits the choice between a constant output voltage (for frequency response and rub & buzz measurements) or constant current output (for impedance measurement), but maintain voltage setting for this measurement. Item 4 should be OFF. Item 5 should be OFF as well.

Activate the GENERATOR key to exit the menu.

TRIGGER

Now you activate the TRIGGER key which displays 4 menu items: No. 1 is used for frequency triggering when working with an external generator. No. 2 is ON indicating that you manually start a sweep by pushing START. No. 3 initially has a default value of 250 ms and No. 4 indicates that it is ON (i.e. in use). These default values can be changed as required. Using 250 ms delay means that the generator waits for 250 ms at its start frequency before going on with the sweep itself. That improves the transducer starting conditions and the accuracy of the RMS detector as well, especially at low frequencies.

Activate the TRIGGER key to exit the menu.

FIRST MEASUREMENT

Now, you are ready to make your first measurement. Check once more that the voltage level is at the appropriate level so that you avoid damage to your transducer. Then hit the key CHANNEL A and afterwards the START key in the lower right corner of the front panel.

INPUT SENSITIVIT

You will probably see a green curve which is on or close to the x-axis. This means that you have to increase the sensitivity of the instrument which is 10 V at the present time. This is displayed at the bottom of the CRT. By activating the GAIN UP key you increase the sensitivity accordingly and by repeating the CHANNEL A/START operation you will see the curves move up on the screen. Increase the sensitivity (by activating the GAIN UP key) until the green response curve almost reaches the upper limit of the display.

CURSOR

To check this, switch-on the cursor (activate CURSOR key). The cursor is a small white flashing dot whose position is displayed on the upper edge of the display. The standard position of the cursor after switch-on is 632 Hz positioned on the green A curve. By activating the left/right arrows in the upper right corner of the front panel you can move the cursor to the left and the right. Find the highest point of the curve and make sure that it is approx. 5 dB under the upper limit.

If you increase the sensitivity of the instrument too far, you run your signal into clipping which will produce distortion. This has to be avoided under any circumstances.

On the bottom of the display you will see Channel A, RMS, the sensitivity you have chosen, and LOG (an indication that the y-axis is programmed with a logarithmic scale).

READY

Now the instrument is set for running an appropriate frequency response curve. Activate the CHANNEL A and the START keys to initiate the measurement.

SWEEP TIME

Now you have to decide whether the sweep time chosen is appropriate. For that purpose convert the green curve into a reference by activating the REFERENCE key and thereafter item 3. Activate the REFERENCE key again and you will now notice that the green curve has been converted into a yellow curve indicating that this a reference. Now, you enter your GENERATOR menu, address item 5, and adjust the sweep time. In other words you run several sweeps with higher and lower sweep times and compare to the reference. The deviations you observe are an expression for the ability of the transducer and instrument to follow the sweep speed and sweep characteristic.

SWEEP CHARAC-TERISTIC

The sweep characteristic is hyper-exponential below 156 Hz and exponential above. In addition to that the time constant in the RMS detector is automatically changed from 50 ms to 7 ms, or reverse if the sweep goes from top and down. Hyper-exponential means a sweep characteristic that uses most of its time in the lowest frequencies. This again means a more accurate measurement of a "slow" transducer and improved conditions for the rub & buzz checks (explained later).

A REFERENC

After you have made your decision regarding the appropriate sweep time you have done all the necessary settings for a frequency response measurement. Run a new frequency response curve (green) by activating the key's CHANNEL A and START. Convert this curve into your new reference by entering the REFERENCE menu. You will see 9 items and for changing the green A curve to a reference curve, you have to address item 3. The yellow reference curve is displayed immediately.

NOTE 1

NOTE 1: Alternative methods for generating references are described in "USER MANUAL" 9.7.1, 9.7.3 (or 9.6, 9.7.5) or see Appendix A of this programming instruction.

SENSITIVIT

You remain in the same menu and address item 5 MODIFY REFERENCE CURVES to adjust for the appropriate frequency for measurement of sensitivity/efficiency. Item 6 of this menu shows SAVE X-CURSOR FOR SENSITIVITY TEST.The instrument is automaticly programmed to measure sensitivity/ efficiency at 1 kHz. However, if you want to choose a different frequency, you have to proceed as follows: Activate STATUS key whereafter the display of the text will disappear from the CRT. Switch-on the cursor by activating the CURSOR key. After this the cursor position is displayed in the upper right corner of the CRT. Move the cursor to the desired frequency. If positioning of the cursor cannot be achieved with the necessary accuracy, you can zoom the area around the cursor by activating the ZOOM X key. Push the ZOOM X key once (2x), twice (4x) or three times (8x) for maximum zoom effect and adjust the cursor position as close as possible to the required frequency.

Activate STATUS key after which you get the display of the menu back on the screen. Now activate item 6 and you will notice that the frequency set by the cursor will be shown on the CRT. This frequency is now programmed into the internal memory for measurement of sensitivity/ efficiency.

Activate REFERENCE key to exit the menu and repeat frequency response curve by activating the keys CHANNEL A and START. The yellow reference and the green frequency response should now be almost identical and where this is the case, the colour of the curve appears to be red.

TOLERANCE BAND

Switch off the frequency response curve by activating the key CURVE A. The reference curve remains on the screen. Now you open this reference curve into the tolerance band by entering the REFERENCE menu again.

UPPER LIMIT

Activate REFERENCE key, address item 5 MODIFY REFERENCE CURVES, activate item 1, switch off the text by activating the STATUS key, and move the curve upwards by using the up/down arrow in the upper right corner of the keyboard. Each step corresponds to 0.25 dB which is displayed on the upper part of the CRT. The read out can only give the rounded values .2 dB (displayed) = 0.25 (actual) and .7 (displayed) = .75 dB (actual). Move the curve as far up as

UPPER LIMIT

you want and activate the STATUS key again. Now address item 2 of the menu after which you will observe that you can already see the upper part of a tolerance band. As the CRT has 250 display points, the upper part of the tolerance band consists of 125 points and the lower part of 125 points as well.

LOWER LIMIT

Switch off the text again by activating the STATUS key and use the other up/down key to move the curve in 0.25 dB steps downwards until you reach the appropriate width of the tolerance band. This width presents an upper and lower limit above and below the original reference curve.

You leave the REFERENCE menu by activating the STATUS key and the REFERENCE key.

CONNECT DOTS

You will now notice that the 125 display points of the upper limit and the 125 points of the lower limit are displayed individually. To connect them to a line you have to enter the CURVE menu. Activate the CURVE key and address item 3 CONNECT DOTS CHANNEL A. The display will change to ON and the display points of your tolerance band will be connected. Push the curve key again to leave the menu.

ZOOM

Run a frequency response curve (green) by activating the keys CHANNEL A and START and observe how the green response curve fits into the yellow tolerance band. In areas where the observation may be difficult you use the zoom function for better display resolution. For that purpose you move the cursor with the left/right arrows, in the upper right corner of the keyboard, to the appropriate spot and zoom in x and/or y direction. Zoom x can be activated 2, 4, and 8 times. Zoom y 2, 4, 8, and 16 times.

When using the cursor to address a certain area for zooming, you can let the cursor jump from one curve to the other by using the up/down arrows.

If you have convinced yourself that the tolerance band is appropriate, you cancel the zoom function by running a new response through activating the keys CHANNEL A and START.

MODIFYING REFERENCE

However, if you want to change your tolerance band in certain areas, you have to re-enter the REFERENCE menu. Activate the REFERENCE key and address item 5 MODIFY REFERENCE CURVES. Address item 5 RELEASE CURSOR which cancels the dot connection introduced earlier (CURVE menu). Switch off the text by activating the STATUS key and move the cursor with the up/down arrows to the curve you want to change, and with the left/right arrows to the area (frequency) you want to change.

MODIFY PARTS OF CURVE

After that you activate the STATUS key again and can now choose between item 3 and 4 of this MODIFICATION menu. When addressing item 3 you can move parts of the curve in parallel to the original geometry. In other words, you can construct windows of certain widths and heights according to your individual requirements but still in parallel to the original reference curve.

To achieve this, address item 3, activate the STATUS key to switch off the text, move the cursor upwards or downwards in reference to the intended window dimensions (the y position of the cursor is displayed at the upper edge of the CRT). Move the cursor to the right or the left to construct the appropriate width of the window whereby the original display points of the limit curve are replaced with new ones in the chosen distance. You can read the width of the window by observing the x position of the cursor.

To return to the menu, activate the STATUS key, and address item 5 RELEASE CURSOR.

MODIFY CURVE

Now you can consider further modifications of your tolerance band. For that purpose switch off the text from the screen by activating the STATUS key and move the cursor to the appropriate curve (up/down arrows) and to the appropriate frequency range (left/right arrows), re-enter your menu by activating the STATUS key, and address item 4 MODIFY CURVE. Switch off the text from the CRT by activating the STATUS key and move the cursor with the up/down and left/right arrows in the upper right corner of the front panel so that the necessary changes of the curve occur. In this function you are completely independent from previous structures and geometries, in other words, you can freely draw changes, windows, and modifications according to your individual requirements.

After you have finished your modifications, activate the STATUS key to re-enter the menu, and afterwards the REFERENCE key to leave the menu.

To get a clear impression of the structure of the modified curve, enter the CURVE menu by activating the CURVE key, address item 3 and thereby connect the dots on the display.

Leave this menu by activating the CURVE key.

If you are still not satisfied with your tolerance band, re-enter the REFERENCE menu, address item 5, address item 5 again to release the cursor, move the cursor to the appropriate curve and frequency area, and then make the necessary changes by addressing item 3 MOVE PARTS OF CURVE (in parallel to the original geometry) or item 4 MODIFY CURVE (independent from previous structures).

To leave the REFERENCE menu, activate the REFERENCE key.

EEPROM

Now you have made all necessary modifications to your frequency response tolerance band. Run another frequency response by activating the keys CHANNEL A and START. If the result is satisfactory, you have to programme the tolerance band into the EEPROM cassette. Insert an EEPROM cassette (available in 2, 4, and 8 kBytes capacity) and re-enter the REFERENCE menu and address item 8 NON VOLATILE MEMORY STORAGE. Address item 6 to check the content of the cassette.

If there is sufficient space, address item 1 SAVE "A" REFERENCE. To judge whether there is sufficient space you have to know the following: Each cassette is divided into a certain amount of "units", each unit being 64 bytes. Each cassette uses 6 units for household leaving 26, 56, and 116 units respectively for the four sizes of EEPROMs. Storing a status takes 1 unit, storing an upper limit curve takes 5 units and storing a tolerance band (has both an upper and a lower limiting curve) takes 9 units if you need at least 9 free units.

TEST PROGRAM

Programming of references into the EEPROM cassette requires the use of certain names, otherwise the computer will not accept the test programme. When you are measuring loudspeakers, you have to use the letter L for a loudspeaker programme. In case of headphones you use H, and in case of microphones you use M.

DATA TRANSFER

The frequency response always has to be addressed by the number "1", which means that the first two characters for a frequency response of a loudspeaker are L1 (or correspondingly for a headphone H1 and a microphone M1). After that you give the tolerance band your individual name for which you have 4 characters available. This means that the complete name for a curve or tolerance band can consist of a maximum of 6 characters.

"CAPITALS" STATUS DATA TRANSFE

In case you make a writing error, move the flashing window to the left by using the left/right arrow and correct your spelling. Thereafter activate the key CAPITALS and the data transfer into the EEPROM cassette will start. This is indicated by a white letter "P" on a flashing red area in the lower left corner of the CRT display. This data transfer into the EEPROM cassette takes about 20 sec. While the P400 is programming the cassette - depending on your choice - you may start to operate the P400 again by pushing more keys. This is possible because the P400 has a multi-tasking operating system..

Now address item 6 and check whether the curve has been accepted by the EEPROM cassette. The identification displayed is L1, the name chosen, and a C which means curve. In other words, the shape of the tolerance band for the frequency response has now been programmed into the EEPROM cassette.

MEASURING CONDITIONS

Programming of measuring conditions always has to be carried out in 2 steps. The first step is programming of the tolerance band itself. This has just been done. Furthermore the keyboard set-up has to be programmed which means the input sensitivity, the logarithmic scale for the y-axis, the measuring parameter etc.

In case of loudspeakers this keyboard status (= keyboard set-up) programming is done jointly for channel A and B. However, when programming for headphones it has to be done for each curve separately. We will revert to this subject after programming of the B reference.

B REFERENCE

The REFERENCE menu is left by activating the REFERENCE key, and programming of the B reference for rub & buzz can be started. The FILTER key is activated and item 2 is addressed. The display now shows that no filter is inserted into channel A. However, the filter is switched on for channel B and the filter is centred on the 5th harmonic.

FILTER

The choice of the appropriate filter for a differentiation between good and bad units from a distortion point of view (distortion mainly caused by production problems) needs some experience because it is device and problem dependent. In other words, the tracking filter can be adjusted by addressing item 3 and centring the filter on the fundamental or to any harmonic between the 2nd and the 12th (use left/right arrows). The goal is a differentiation between good and bad units, and the achievement of this is a matter of experience and can therefore not be predicted in detail in advance. However, to start with filter tracking on the 5th harmonic is in most cases appropriate. Therefore it is suggested to start that way.

NOTE 1: Alternative methods for generating upper limit are described in "USER MANUAL" 9.7.2, 9.7.6 (or 9.6) or see Appendix A of this programming instruction. NOTE 1

Exit the FILTER menu and adjust sensitivity in B channel by increasing or decreasing gain setting to exactly the same level as channel A. Thereafter, activate the keys CHANNEL B and START and a red distortion curve is displayed on the CRT. To convert this into a reference, you enter the REFERENCE menu and address item 4 CHANGE B CURVE TO REFERENCE CURVE. The colour of the distortion curve changes to blue and you exit the REFERENCE menu for better visibility.

UPPER LIMIT

As a next step you want to establish an upper limit for your distortion curve (lower limit is hardly necessary). You move the cursor by the up/down arrows to the blue line and re-enter the REFERENCE menu. Address item 5 and on the menu and address item 1. Switch off the text by activating the STATUS key and use the up/down arrow to move the curve upwards in 0.25 dB steps to the required distance from the original curve. Activate the STATUS key and exit the REFERENCE menu, enter the CURVE menu, and address item 4 which connects the dots on the CRT display. Exit the CURVE menu and run a B curve by activating the CHANNEL B and the START keys.

Now, you may observe that on the right hand side of the display the red and the blue curve cover each other. In a measuring programme the computer will consider this situation as a reject. Therefore, the blue curve has to be opened somewhat to give more space for the up/down part of the red curve. To achieve this you move the cursor to the blue reference curve and re-enter the REFERENCE menu. Address item 5 and address item 5 again to release the cursor. Switch off the text of the menu by activating the STATUS key and move the cursor to the right with the left/right arrow. When you reach the right corner, you activate the STATUS key and address item 4 of the MODIFICATION menu. Thereafter, you pull the cursor further to the right so that you open this part of the reference curve. Exit the REFERENCE menu and enter the CURVE menu. Address item 4 and observe whether the opening of the blue curve area gives enough space for the up/down part of the red distortion curve. If it does, you have finished your upper limit for your rub & buzz measurement and you exit the CURVE menu.

CURVE SMOOTHING

The shape of the curves (frequency response, rub & buzz or any other curve) can be manipulated to a certain extent. For that purpose you have to enter the CURVE menu where item 1 and 2 will permit curve smoothing in channel A and B respectively. Curve smoothing means averaging a number of measuring points and bringing them back on the CRT display on the same amplitude level.

CURVE SMOOTHING

Address item 1 and use the left/right arrows to increase the number of data from 1 to 2 to 4 to 8 og 16 and so on, up to a maximum of 128. You will observe how the curves change their appearance.

Curve smoothing operates for all curves involved which means that you can smoothen your tolerance band for frequency response and/or your upper limit for the rub & buzz measurement according to your requirements. If you wish to do this, you have to carry out the curve smoothing before you programme the curves into the EEPROM cassette.

EEPROM CASSETTE

The B reference remains to be programmed into the EEPROM cassette. For that purpose the REFERENCE menu is entered and item 8 is addressed. As the B reference is established in channel B, you address item 2 SAVE B REFERENCE where you have to start with the same letter, namely L. However, the next character has to be the number "2" which indicates that this is a rub & buzz reference. The name for your rub & buzz reference is consequently L2. The remaining 4 characters (individual name for the test programme) have to be identical to those you have used for frequency response L1. After you have written the name of your B reference, you activate the key CAPITALS after which the programming of the curve into the EEPROM cassette starts up. Address item 6 after the programming is finished and check whether both curves are stored in the cassette. If they are, the tolerance band for frequency response and the upper limit for rub & buzz measurement have been correctly programmed into the EEPROM cassette.

To complete this part of the programme, the keyboard status has to be programmed into the EEPROM cassette. This takes place in a different menu. For that purpose exit the REFERENCE menu and enter the PROGRAM menu. Address item 6, address item 1 SAVE STATUS, write L1 and the name of the programme which you have used previously for your A and B reference curves. Activate CAPITALS to transfer the data. Address item 4 and check whether your programme is properly stored in the cassette. You will observe that the display shows L1, the name you have chosen, and an S which means status.

Now you have finished a loudspeaker test programme for frequency response and rub & buzz. The parameters are measured in parallel during one sweep. Additionally you can make test programmes for polarity and impedance which are described later on.

Individual headphone elements (earphones) are treated exactly like loudspeakers. A test programme identification will be L...

To check whether the test programme established so far is acceptable to the computer, you have to exit the PROGRAM menu, re-enter the PROGRAM menu, address item 5 PRODUCTION CONTROL (TEST PROCEDURES), address item 1 LOUDSPEAKERS, and write L1 and subsequently the name of the programme.

Activate the CAPITALS key and the computer will now display whether you have made an error.

If the references for frequency response and rub & buzz have been programmed correctly, the display will show the following information: FIRST ERROR DETECTED L3 S FILE NOT FOUND. L3 is the name of the programme for testing polarity/electrical phase which means that an automatic measurement cannot be carried out until the programme for this parameter has been established.

To prepare for a test programme you exit the PROGRAMME menu, enter the REFERENCE menu, address item 1 and 2 which switches off the A and B references from the display. After that you exit the REFERENCE menu and switch off the A and B curves from the display by activating the keys CURVE A and CURVE B.

Now you are ready to begin programming the instrument for polarity/electrical phase. **POLARITY**

Note that this measurement can be a little critical with some devices, especially tweeters, if you use the wrong measuring frequency, too little power, too long measuring distance and surroundings giving too many reflections. In these cases the microphone will not reproduce with any fidelity a copy of the electrical signal put into the loudspeaker. This signal is a full cycle of a sine starting going negative followed by a pause.

Enter the PROGRAM menu and address item 3 TIME AND FREQUENCY RESPONSE ANALYSIS. Address item 1 SELECT TIME BASE and adjust an appropriate time span for the x-axis with the left/right arrows in the upper right corner of the front panel keyboard. 0.1 or 0.2 secs. will be suitable for tweeters. 0.2 to 0.4 secs. for mid-range units and 0.4 up to 1 sec. will be appropriate for woofers. **POLARITY** **TIME BASE**

Leave the PROGRAM menu by activating the PROGRAM key.

Enter the FUNCTION menu by activating the FUNCTION A key. Address item 1 to choose DC as the measuring parameter. Exit this menu by activating the FUNCTION A key. **FUNCTION DC**

GENERATOR

Enter the GENERATOR menu by activating the GENERATOR key. Address item 1 FREQUENCY and set the frequency below the resonance frequency of the unit under test. Make sure that you do not go too far down in the frequency setting as this may result in a too low output from the device.

SINE PULSE

Activate item 2 REPEATED SINE PULSE MODE which has to be switched ON. Check that item 6 of this menu is as well set to ON.

OUTPUT

Address item 8 OUTPUT ATTENUATOR. Address item 1 and adjust for the highest possible power output that the unit under test can accept. Make sure that item 3 is set on V (constant voltage output) and that item 4 is set on OFF.

Leave the GENERATOR menu by activating the GENERATOR key.

Activate the LIN/LOG key and set the A channel on LIN.

The text at the bottom of the CRT should now read TIME RESPONSE CHANNEL A DC LINEAR MANUAL.

POLARITY TEST

To run a polarity test, activate the CHANNEL A and START keys and observe the apperance of a number of sinus pulses on the screen. The amplitude of the sinus signals on the screen should be between 1/3 and 2/3 of the up/down dimensions of the CRT, however without any kind of clipping. If this is not the case, the instrument sensitivity has to be adjusted (GAIN UP or GAIN DOWN keys).

DISPLAY

The shape of the sinus pulses can be further modified by using the curve smoothing function found in the CURVE menu.

ZOOM

In the automatic mode the built-in software will make an evaluation of the received curve. Since the sine pulse generator and the time response is not synchronized, make sure that you receive 2 full cycles of the sine pulse signal. If this is not the case, you can extend the time base or increase the frequency.

A polarity measurement is not a comparison to a reference but an indication of a correct direction of the sinus pulse produced by the movement of the membrane. The shape of the curve should be a minor negative-going pulse followed by a major positive-going pulse repeated a few times over the CRT.

PROGRAMMING

The determination of the correct polarity of an acoustical transducer is carried out by built-in software. Therefore, a reference has NOT TO BE ESTABLISHED as was the case for frequency response and rub & buzz. The polarity test programme is consequently a keyboard status only which has to be programmed as follows: enter the PROGRAM menu by activating the PROGRAM key. Address item 6 KEYBOARD SET UP and subsequently address item 1 SAVE STATUS. Key in the identification L3 and the same up to 4 characters for the name of the programme. Activate the CAPITALS key and wait until the flashing key sign in the bottom left corner of the CRT disappears.

POLARITY TEST

Connect the external keybox to the input connector of the Measuring Computer P400, use the PROGRAM STEP key and find the L3 programme for the polarity test. Text in the lower left corner of the CRT will show the individual programme names L1..., L2..., L3...Activate the EXECUTION key of the external keybox. Run a polarity test and observe the curve display on the CRT. Repeat this test several times to make sure that the measuring result is sufficiently repeatable and reliable.

CORRECTION

If you should observe a flashing red light for the polarity measurements, you have to choose a different frequency of your generator setting or reverse the connections to your speaker. In case the CRT display shows a yellow TEST ERROR indication, you have to adjust your output level, your measuring frequency, and maybe even your time base.

USER DEFINED 5th PARAMETER

The instrument is now programmed for frequency response, sensitivity, rub & buzz, and polarity, and can be operated automatically with the external keybox. However, the built-in software allows a fifth parameter to be measured. This could be a second frequency response or rub & buzz measurement - but you llows a fifth parameter to be measured which could be a second frequency response, rub & buzz or polarity measurement - but you can also use this freely programmable parameter for an impedance measurement as the instrument can be provided with constant current output.

IMPEDANCE

To programme the instrument for the impedance measurement you have to place the P400 in a frequency response mode. The easiest way to achieve this is to run a frequency response/ rub & buzz test controlled and initiated by the external keybox. Thereafter you disconnect the external keybox and enter the GENERATOR menu by activating the GENERATOR key. Address item 8 and after that item 3 and change the display from constant voltage (V) to constant current (C). Address item 1 to operate in low or high range where 0 dB in the low range equals 20 mAmps and 0 dB in the high range equals 2.0 Amps. Make the correct current output setting depending on the device under test and leave the GENERATOR menu by activating the GENERATOR key.

GENERATOR

Select FILTER menu and select 1st filter channel A ON and 3rd filter tracking "1" to eliminate influence from electrical noise.

Run an impedance measurement by activating the CHANNEL A or CHANNEL B key and subsequently the START key. Observe the curve display on the CRT and adjust the input gain of the instrument if necessary (GAIN UP or GAIN DOWN).

DISPLAY

GAIN

Establish your reference, your tolerance band and programme it as L4... into the EEPROM cassette by entering the REFERENCE menu item 8 and item 1. Thereafter programme the keyboard set up by entering the PROGRAM menu item 6 and item 1 and use the same identification L4....

PROGRAMMIN

Re-connect the external keybox and run the impedance measurement and observe the display.

Now the basic programming of the P400 Measuring Computer has been completed and you can choose to run complete test programmes (AUTOMATIC) or part of the programme (FREQUENCY RESPONSE/RUB & BUZZ/POLARITY/IMPEDANCE, User Defined). The choice can be made by the external keybox and it displayed on the bottom of the CRT display.

In excess of the basic programme, the instruments provides a number of additional features:

- addition and subtraction of curves
- curve registers
- compensation curve
- alternative methods to establish references

9.6. GENERATE CURVES WITH CURSOR

This sub-menu is for programming reference curve with the cursor. The curves are programmed by entering key points which will automatically be connected by the P400.

```
┌──────────────────────────────────────┐
│                                      │
│          CURSOR REFERENCES           │
│                                      │
│      1: A REFERENCE                  │
│      2: B REFERENCE                  │
│      3: UPPER OR LOWER LIMIT         │
│      4: ENTER KEYPOINT               │
│                                      │
│      Push REFERENCE to exit MENU     │
└──────────────────────────────────────┘
```

During programming of the curves, the menu text can be switched on and off by activating the STATUS key so that the cursor value can be shown.

Both upper and lower limit for reference bands can be programmed individually, or a tolerance band can be made.

The reference curves drawn can be modified by using the sub-menu described in chapter 9.5.

9.6.1 A REFERENCE

This function is a selection of the reference curve to be drawn. Reference curves drawn after having selected this sub-menu point will be A reference. If an upper or a lower limit, or both as a tolerance band, has to be drawn, this can be selected as described in 9.6.3.

The reference curve is drawn by moving the cursor with the up/down and left/right arrows. Whenever a keypoint is wanted, the ENTER KEYPOINT function is activated. The keypoints are immediately connected by the P400.

9.6.2 B REFERENCE

This function is a selection of the reference curve to be drawn. Reference curves drawn after having selected this sub-menu point will be B reference. If an upper or a lower limit, or both as a tolerance band, has to be drawn, this can be selected as described in 9.6.3.

The reference curve is drawn by moving the cursor with the up/down and left/right arrows. Whenever a keypoint is wanted, the ENTER KEYPOINT function is activated. The keypoints are immediately connected by the P400.

9.6.3 UPPER OR LOWER LIMIT

This function will select the limit (upper or lower) which is to be drawn. If both limits are drawn, the function will shift the cursor between upper and lower limit. After the first limit has been drawn, this function will release the cursor for drawing the other part of a tolerance band.

WARNING: A lower limit will not be used in AUTOMATIC programmes for RUB & BUZZ in channel B.

9.6.4 ENTER KEYPOINT

This function is for entering keypoint for reference curves drawn with the cursor. When a keypoint is entered, the point will automatically be connected with the neighbouring points.

9.7 REFERENCE CURVE ACQUISITION

This function is for generating referance bands or upper limits out of a number of tests. This is done automatically by selecting one or two of these functions (one for channel A and one for channel B) and run 1,2,4,8 or 16 tests.

9.7.1 USE NEXT ... A CURVES AS REF. (average)

This function is for averaging measurements for the reference curve.

With the left/right arrows a number of responses (0, 1, 2, 4, 8, and 16) can be selected for making an average of the reference curve.

The selected number of curves for the averaging will be indicated on the CRT (lower left corner) and this number will be decreased by each measurement.

The average of the curves will be shown as the A reference curve and the last measurement will be shown as A curve.

9.7.2 USE NEXT ... B CURVES AS REF. (average)

This function is for averaging measurements for the reference curve.

With the left/right arrows a number of responses (0, 1, 2, 4, 8, and 16) can be selected for making an average of the reference curve.

The selected number of curves for the averaging will be indicated on the CRT (lower left corner) and this number will be decreased by each measurement.

The average of the curves will be shown as the B reference curve and the last measurement will be shown as B curve.

9.7.3 USE NEXT ... A CURVES AS REF. BAND

This function will generate a reference band (envelope) out of the selected number of tests. The upper limit is generated of the highest values found for each point out of the total number of tests. The lower limit band is made in the same way except for the lowest values used. The resulting reference band will accept all the curves used for generating the reference band.

Select with the left/right arrows any number between 0 and 250 of responses for making the A reference band. The selected number of curves for generating the reference band will be indicated on the CRT in the lower left corner and this number will be counted down by each measurement.

The resulting curves will be shown as the A reference band and the last measurement will be shown as the A curve.

9.7.4 USE NEXT ... B CURVES AS REF. BAND

This function will generate a reference band (envelope) out of the selected number of tests. The upper limit is generated of the highest values found for each point out of the total number of tests. The lower limit band is made in the same way except for the lowest values used. The resulting reference band will accept all the curves used for generating the reference band.

Select with the left/right arrows any number between 0 and 250 of responses for making the B reference band. The selected number of curves for generating the reference band will be indicated on the CRT in the lower left corner and this number will be counted down by each measurement.

The resulting curves will be shown as the B reference band and the last measurement will be shown as the B curve.

WARNING: A lower limit will not be used in AUTOMATIC programmes for RUB & BUZZ in channel B.

9.7.5 USE NEXT ... A CURVES AS UPPER LIM

This function is equal to 9.7.3 except for the fact that only the upper limit will be generated.

9.7.6 USE NEXT ... B CURVES AS UPPER LIM

This function is similar to 9.7.4 except for the fact that only the upper limit will be generated.