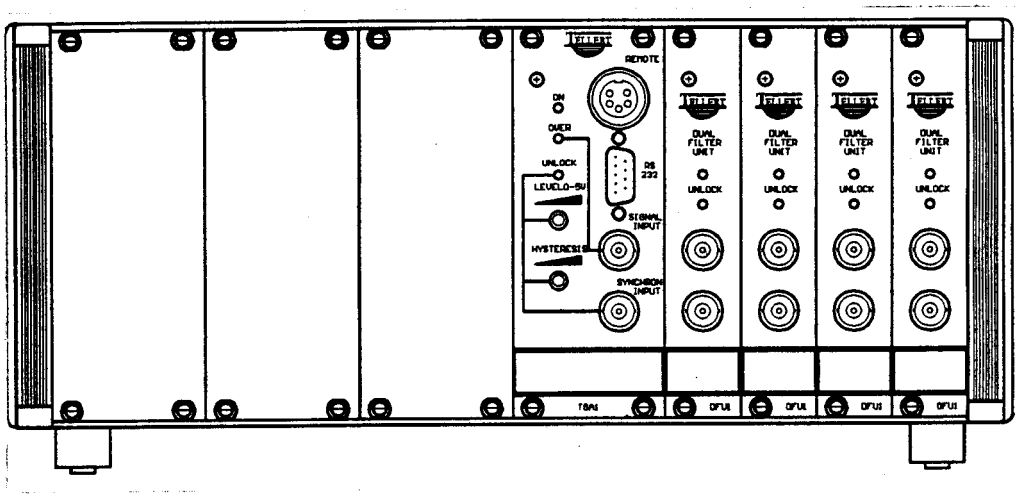
Harmonics Analysis

TSA

Tracking Spectrum Analyser



- Online (Real Time) measurement;
- Interface for standard PC without add-on board;
- Immediate hardcopy of results;
- Automotive applicable;
- Compact test set;
- Data reduction capability;

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Preface

In principal harmonics analysis means the measurement of frequency domains, which are related to a certain basic frequency, for example an engine rotational speed. Certain harmonics or even subharmonics can be extracted from the whole spectrum via tracking filters in order to record their specific amplitudes. The frequency response of each filter follows the basic frequency variation (tracking principle).

With the TSA test equipment eight individual channels can be recorded simultaneously. The interesting harmonics can be preselected on each channel in the range of 0.01 to 99.9. Choosing a value of 0 enables the bridging of the filter, in order to record the r.m.s. value of the original signal. With this option the ratio of specific harmonics to the total signal amplitude may be expressed.

The harmonics analysis is especially useful in conjunction with measurements of a variable basic signal (for example the acceleration of an engine speed). Hereby resonant peaks can easily be detected. The additional TSA-Software allows the real-time observation of the signal-amplitudes on each channel. The actual order of the harmonic, the filter frequency, and the amplitude level, converted to the desired physical unit, are displayed and recorded. Immediatelly after recording of a test cycle, a scaled graphical plot of the test progress can be displayed on screen and optional on a hardcopy device.

The TSA system concept makes intensive use of the added PC:

- Measurement control via PC;
- Recording of test samples via PC;
- Conversion of sample values via PC;

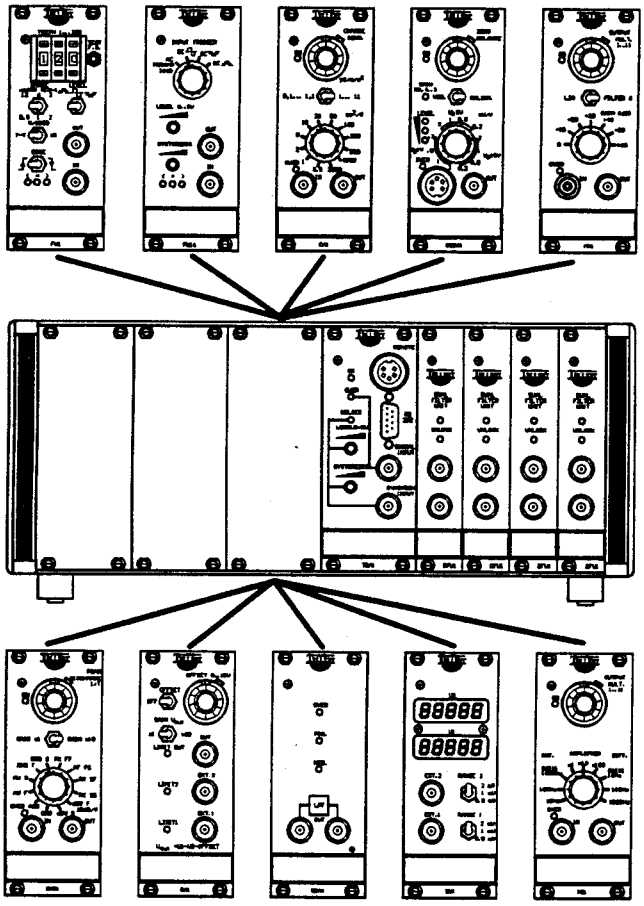
The data transfer via a serial RS232 Interface is easily established without an additional plugin-board to the PC. Even a small Lap-Top computer can be accomodated. In order to minimize data storage capacity processed data instead of rough data are saved. Therefore an typical engine test in the range of 500 .. 6000 rpm with 10 rpm intervals needs only 8 kB of storage capacity. This compact data volume helps to store more than 50 test cycles on a simple flexible disc.

Each MS/PC-DOS computer (version 2.xx or higher) with CGA or EGA/VGA graphics card may be applied.

A Complete Test System

The TSA is not only a standalone device. It may be extented by a number of different modular insertions, especially designed for various sensor signal processing tasks. Signal interfacing between the add-on boards is accomplished via a bus backplane of the test rack. The following add-ons can be supplied by us:

- Precision F/V converter;
- Charge amplifier;
- Microphone preamplifier;
- DC-bridge amplifier;
- Integrator / Differentiator;
- Subtracting amplifier;
- Multifunctional rectifier;
- Dual voltage meter;



For a complete solution of your measurement task, you additionally need only one ore more sensors and a standard PC.

Twin Filter Unit DFU1

The input signal first passes a low pass filter with butterworth characteristic (fg = 8kHz). The tracking filter which lets pass the selected harmonic is working with a bandwith of 6%. The filter can also be bridged, to use one of the channels as original reference signal. The output of the final averaging rectifier stage can be selected as linear or logarithmic and will be fed back to the control unit. Instead of the filtered output signal an external signal source can also be connected and selected.

One of these output signals can be jumpered to the BNC-output connector

The Software

Tasks

The MS-DOS compatible application software TSE.EXE performs several tasks: Online test visualisation, recording and evaluation of data together with a documentation of the actual test. Additionally all adjustments of the TSA system will be controlled by the PC.

Setup Structure

The setup menu manages the different adjustments in several files. Therfore parameters like system definitions, measurement titles, visualsation and plotting parameters are stored separately. Each defintion file may be altered in the main menu level. For that reason it is not necessary to redefine all settings for each measurement.

Online visualisation and data recording

On the PC screen the following data are displayed during measurement in real time:

- actual base frequency or rotational speed;
  and for each one of the eight channels;
- amplitude value (in predefined unit);
- amplitude value as bar graph;
- actual filter frequency and;
- related harmonics order.

Within this online display menu the data recording can be started, stopped, restarted and erased. Additionally an automatic push-pull measurement is possible. This means a test cycle recording is started if a determined minimum speed will be present. The recording will break with automatic data storage when a second determined maximum speed is reached. A new cycle will also be started, that ends when the minimum speed limit is reached again.

Data evaluation

The test results can be worked out in many kinds. The graphical presentation of the data in form of a line diagramm on screen can be

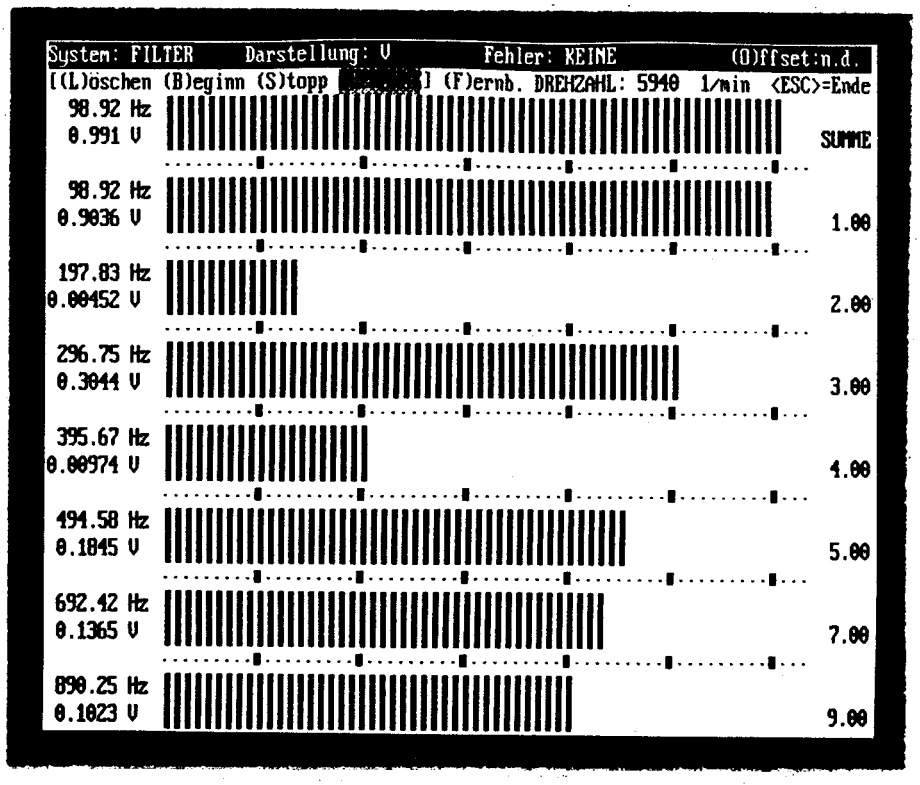
tailored to the individual requirements, like linear or logarithmic scaling (y-axis), scaling of the reference signal (x-axis) in the units rpm or Hz. The diagram basically shows the results of the 8 channels, each in one curve, which may be zoomed or moved for optimized data preparation. Additional functions allow a wide variety of data evaluation.

For example the data can be differentiated or integrated numerically. An interpolation of the curve data may be imposed and the curves of former test cycles may be entered for comparison purposes.

Documentation

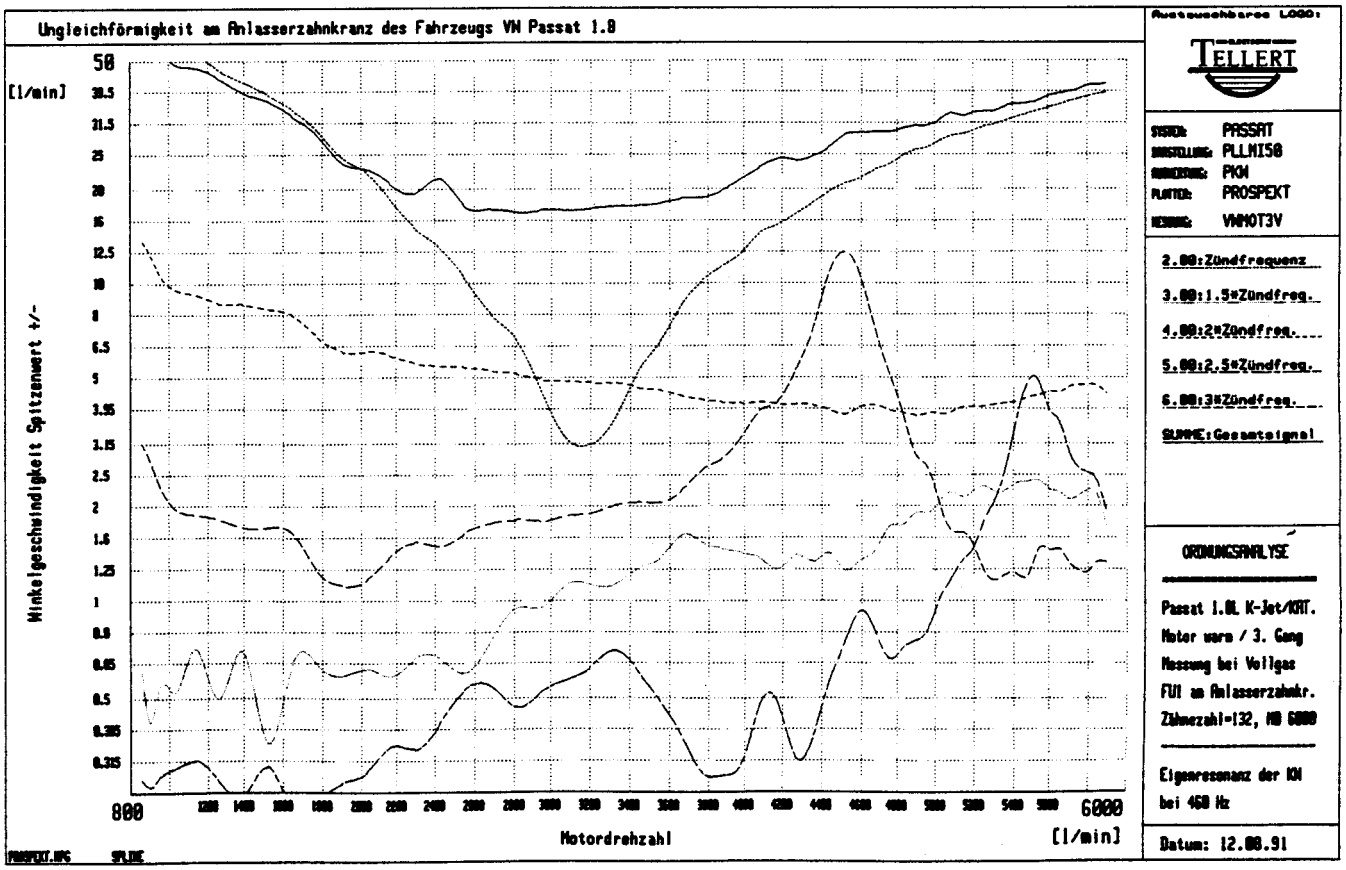
The final results of the on-screen optimized test evaluation can be archived as hardcopy. In order to produce a high resolution plot of the diagram, the software generates output data for HPGL-compatible plotting devices. If a plotter is currently not available, the HPGL data may be transformed by an additional software tool like: SERPLOT (TM), for almost any available printer (this tool is not included to the basic set).

The plot output disposes some options for optimized graphical presentation. The maximum 8 graphs may be plotted in different line types. Additional scaling lines and an individual company's logo may be included. One title line with 67 characters and an information field with 10 lines of 22 charactres each, allow an intensive data and test documentation. The German and American special character sets are supplied for HPGL output.



Picture: Screen display in Online Mode. As an example a square wave signal of 1 Vrms with 98.9 Hz has been analysed. The bar graph display works logarithmic and the harmonics amplitudes can be read directly in units of volt.

Picture below: Hardcopy of a test cycle. This example shows the result of an engine measurement, which exhibits the engine speed irregularities of a Volkswagen Passat. The graphs are interpolated from the recorded data. For a better readability of the chart two harmonics have been omitted. The company's logo (top right) is exchangable.



Fundamentals of application

The various test setups in conjunction with the TSA are extremly compact. This saves much time and space during a test performance. The internal bus backplane supplies most of the connections. Therefore only a minimum external wiring is necessary. The TSA is especially suited for automotive test applications, because it can be supplied by the battery voltage of the car without any additional voltage converter.

An additional enclosed software tool allows the transformation of the test data for further data evaluation and processing software like TurboLAB (TM of company STEMMER).

The data aquisition may be extended to further signal which are recorded without modifications.

If the input signals of your actual measurement task do not need a high dynamic range, an increased accuracy can be used by changing a jumper from logarithmic to linear data conversion. However our software is not yet prepared to transform these data to user defined units. This may be performed with an additional data processing software tool (like above).

One enclosed tool enables, with the following call-up parameters:

ADDTAB TAB_A TAB_B 14 26 38

the duplication of measurement TAB_A, graphs 1,2 and 3 to the graphs 4,6 and 8 of measurement TAB_B. Subsequently the measurement TAB_B can be evaluated, allowing an easy comparison of the first three graphs of both measurements.

Special application examples

1. Irregularities

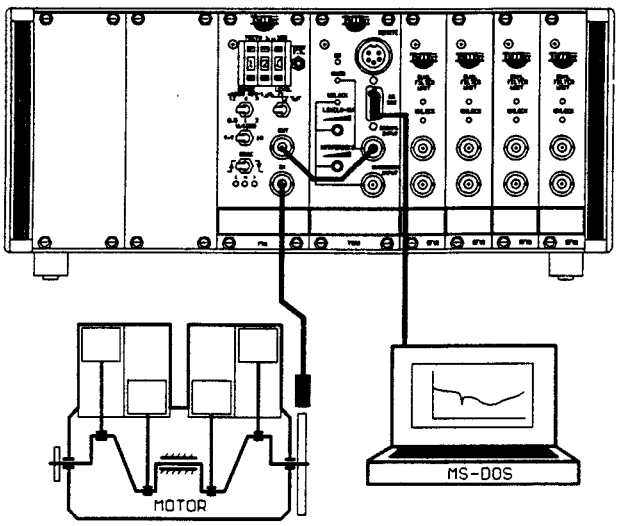
The irregularity of an combustion engine is the deviation of the cranc shaft speed within one engine revolution. Due to the fact, that this deviation is in reality less than one percent of the absolute engine speed, a precise F/V converter is necessary. Especially recommendable for such measurement tasks is our converter FU1 or FU10. For example it is possible with both converters to determine the ninth irregularity harmonics, detected on the starter gear crim of a 6-cylinder engine, with an accuracy of less than 1/1000 degree.

For measurements of this kind you need:

- TSA and PC (Personal computer)
- F/V Converter FU1 or FU10

- Inductive speed sensor.

Test setup:



First a suitable inductive sensor, adequately mounted, in order to scan the engine speed from the gear crim or similar tooth wheel, is connected to the F/V converter input. The number of teeth will be adjusted and a resolution of 1 mV/rpm will be selected. The converter output will be fed to the TSA signal input. The reference signal (synchronisation) is fed to the TSA internally by the bus.

The remaining adjustments can be established by the software. First the system file must be adopted to the actual test setup, whereupon a test can be initiated. Depending on the content of the visualisation file you may choose wether

... the rotational speed (rpm),

... the angle (degree) or

... the rotational acceleration (rad/s2)

may be displayed. After selection of a suitable intersection of the curve in the evaluation menu the result of a measurement may be documented in a clearly arranged form.

2. Torsion oscillations

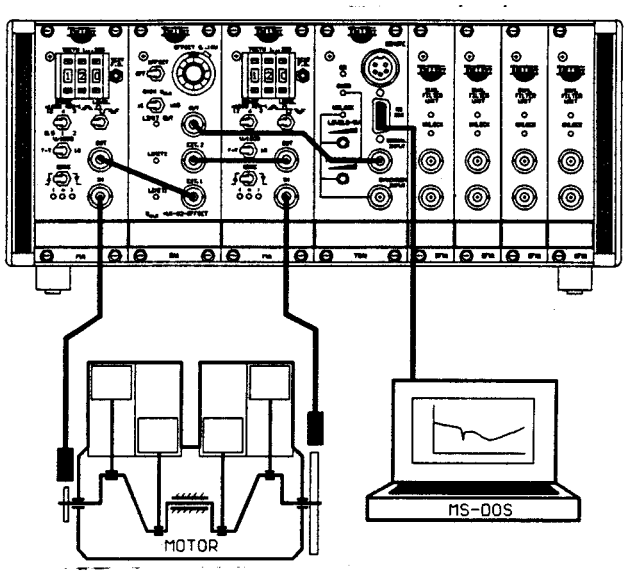
The measurement of torsion oscillations is usually used to detect the maximum angle of torsion on a cranc shaft. Especially dynamic measurements of that kind are necessary during the development and tuning of oscillation dampers.

The following test equipment will be required:

- TSA and PC;
- 2 F/V converters FU1 or FU10;
- Differential amplifier DA1;

- 2 inductive speed sensors;

Test setup:



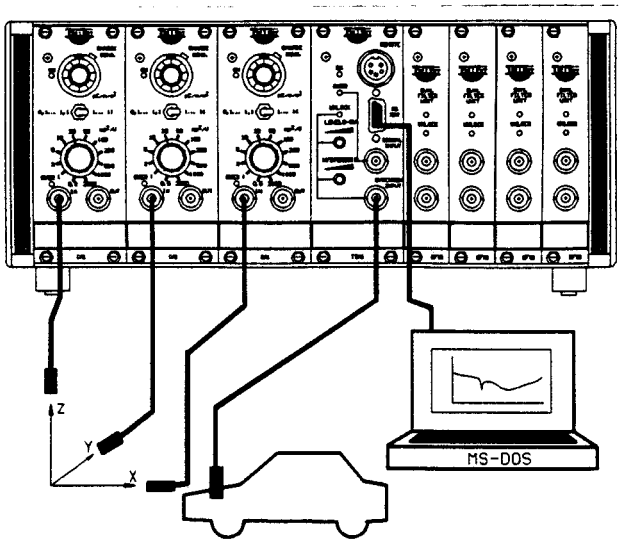
3. Accelerations

A tracking spectrum analysis is essentially useful in conjunction with resonance or vibration measurements, for example of car bodies, exhaust pipe systems, etc. It is especially helpful for tests of that kind to detect the accelerations in all 3 space axis. Otherwise the whole vibration amplitude may not be detected.

Requirements for three axis acceleration tests:

- TSA and PC;
- 3 coloumb amplifier;
- 3 acceleration sensors;
- Trigger pincers or similar tool for synchronisation;

Test setup:



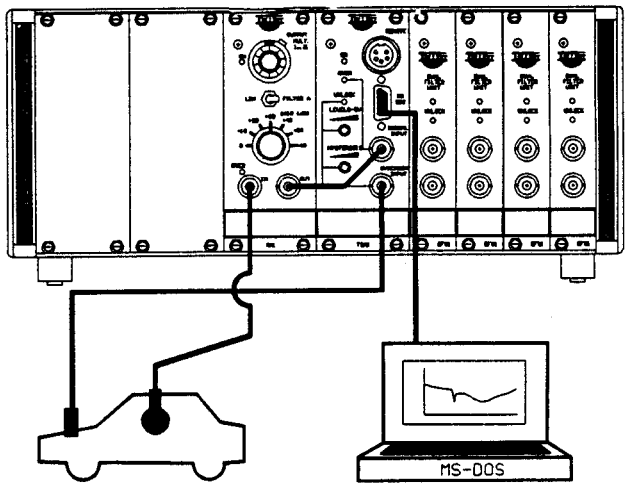
4. Acoustic Noise

Noise measurements inside the passenger compartment of vehicles can be significantly improved with the TSA. The selective filtering of the whole noise spectrum to its harmonic additives, helps to separate the noise portions from engine, tooth wheels, rolling wheels and even from the fan.

Requirements:

- TSA and PC
- Microphone preamplifier MA1
- Condenser microphone (i.e. Bruel & Kjaer)
- Trigger pincers or similar tool for synchronisation

Test setup:



Technical data

Filter characteristics

One filter plugin board is equipped with two individual filter modules. The bandwidth is adjusted to 6 % of the filter frequency. Other bandwidths, if required, can be ordered on inquiry. The tracking frequency can be set within the range 6 Hz ... 6 kHz. The dynamic range covers 60 dB with an amplitude accuracy of ñ 0,5 dB. The orders of harmonics are selctable in the range 0,01 ...9,99 or from 10,0 ... 99,9. For the sychronisation signal a frequency division factor in the range of 1 ... 999 % and a multipliing factor of 1 ...999% (the default value is 100 % for both) can be adjusted. The speed recognition established within the TSA-processor works crystal based with a resolution of 5 rpm.

Trigger Level

Via the BNC connection alternating voltage signal above 50 mV can be supplied as synchronisation signal. The positive trigger level can be adjusted in the range 0 ... 12V. For special sensor types also an negative trigger level may be adjusted. A F/V converter (FU1,FU10 or FU16), plugged to the insertion place directly left beneath the TSA, uses the internal sync connection of the bus backplane.

Data interface

The communication link between TSA and the corresponding personal computer works via a serial interface in accordance to the RS232 standard with the following configuration: 9600 Baud, 8 data, 1 stopbit, no parity.

Signal Input

If the common signal source of the TSA is used, the folowing voltage ranges can be used:

10 mV	...	10 V
3,16 mV	...	3,16 V
1 mV	...	1 V
316 uV	...	316 mV
100 uV	...	100 mV

31,6 uV ... 31,6 mV
10 uV ... 10 mV
3,16 uV ... 3,16 mV
1 uV ... 1 mV

The range selection will be set under software control and the signal distribution uses the bus backplane. Yet it is possible to feed different signals to each filter board. In that case only one voltage range of 1mV ... 1V may be used and an overload cannot be detected. The signal path switching must be performed on the back of the cabinet.

Power supply

The TSA test system may be supplied alternativly with AC 220V, 50/60Hz (about 15 W) or with a DC voltage in the range of 9 ... 32 V (about 6 W). The internal supply voltage is wired via the bus backplane too.

Test cabinet

The plug-in boards of the TSA system are fixed in a stable test cabinet, made of anodized aluminium with small grap handles, manufactured by Schaffner TM. You can choose between three standardized cabinet sizes, depending to your additional plugin board requirements. The 40 TE-housing offers one, the 60 TE- housing offers three and the 80 TE-housing offers four free insertion places beside the already used 5 boards of the TSA system. The free insertion places may be used for additional signal conditioning boards of our system module set. The 80 TE- housing can optionally be shipped with flanges for installation into a 19-inch rack housing.

Housing dimensions

The TSA system in 40 TE cabinet measures about 230 mm * 145 mm * 280 mm (length * height * depth). The 60 TE housing is about 380 mm , the 80 TE housing is about 480 mm long.

Personal Computer

The TSA system works in conjunction with a standard IBM(TM)-compatible PC or Lap-Top computer, equipped with MS/PC-DOS of version 2.xx or higher. The software supports CGA, EGA and VGA

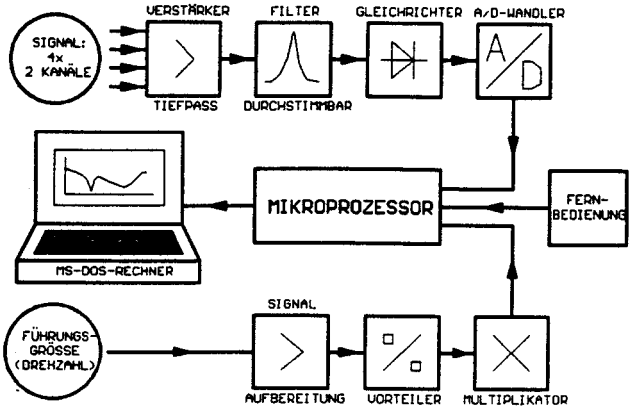
compatible display graphics boards. The PC must not supply excessive processing power, because all timing-relevant tasks are performed by the TSA-hardware. Due to the utilized standard serial link no additional plugin boards are necessary within the PC, only one RS232 serial link will be occupied.

Extent of delivery

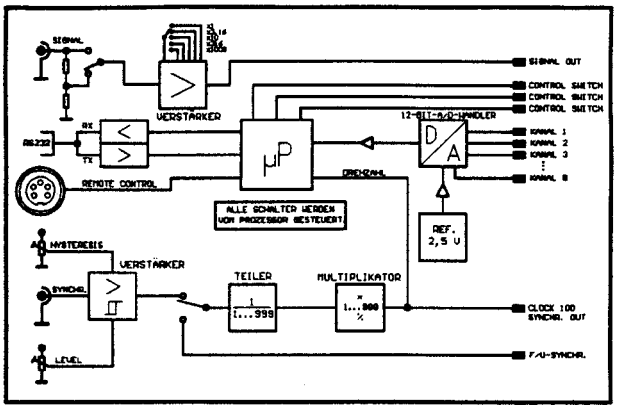
- Control unit TSA1;
- Four Twin filter units DFU1;
- Test cabinet with 1,3 or 4 spare insertion places;
- TSA software package;
- User Manual;
- Interface cable.

Appendix

Mode of Operation:



TSA1 Circuit schematic:



Twin Filter Unit DFU1 Circuit schematic: