Operating Manual
Mössbauer Drive System 351
(MA-250 / MR-351)

Model MA-250
Mössbauer Velocity Transducer

DESCRIPTION

The Mössbauer Velocity Transducer MA-250 is equipped with Alnico high field magnets with have an excellent temperature stability. The high magnetic field and low mass of the moving parts make the MA-250 suited for operation at high velocities. For such applications the transducer can be optionally furnished with special springs. Due to the compact design of the MA-250, sources can be mounted at both ends of the driving tube for the simultaneous acquisition of two Mössbauer spectra. The MA-250 operates in any horizontal or vertical position. Seals are provided for operation in vacuum. The high precision used in our manufacturing process and the excellent stability of the springs allow the use of the MA-250 for a long time without the neccesity of recalibration. The factory suggested recalibration intervalls are 3 months.

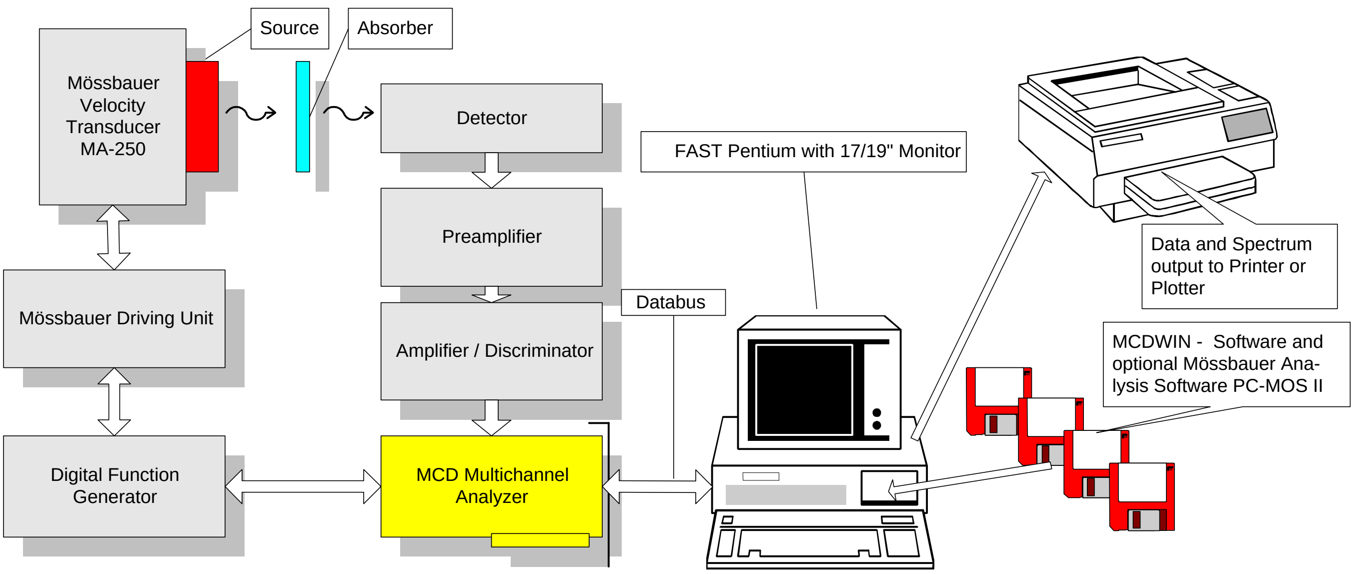
SPECIFICATIONS

Size: 178 mm long, 108 mm diam.
Weight: 5.2 kg
Housing: Brass, nickel plated
Guide Springs: fiberglass enforced epoxy

Option: Special guide springs for highvelocity range

POWER REQUIREMENTS:

Power is supplied by the Mössbauer Driving Units. Different models are available: MR-250, MR-350, and the combination Digital Function Generator/Mössbauer Driving Unit MR-351



MA-250 May 97

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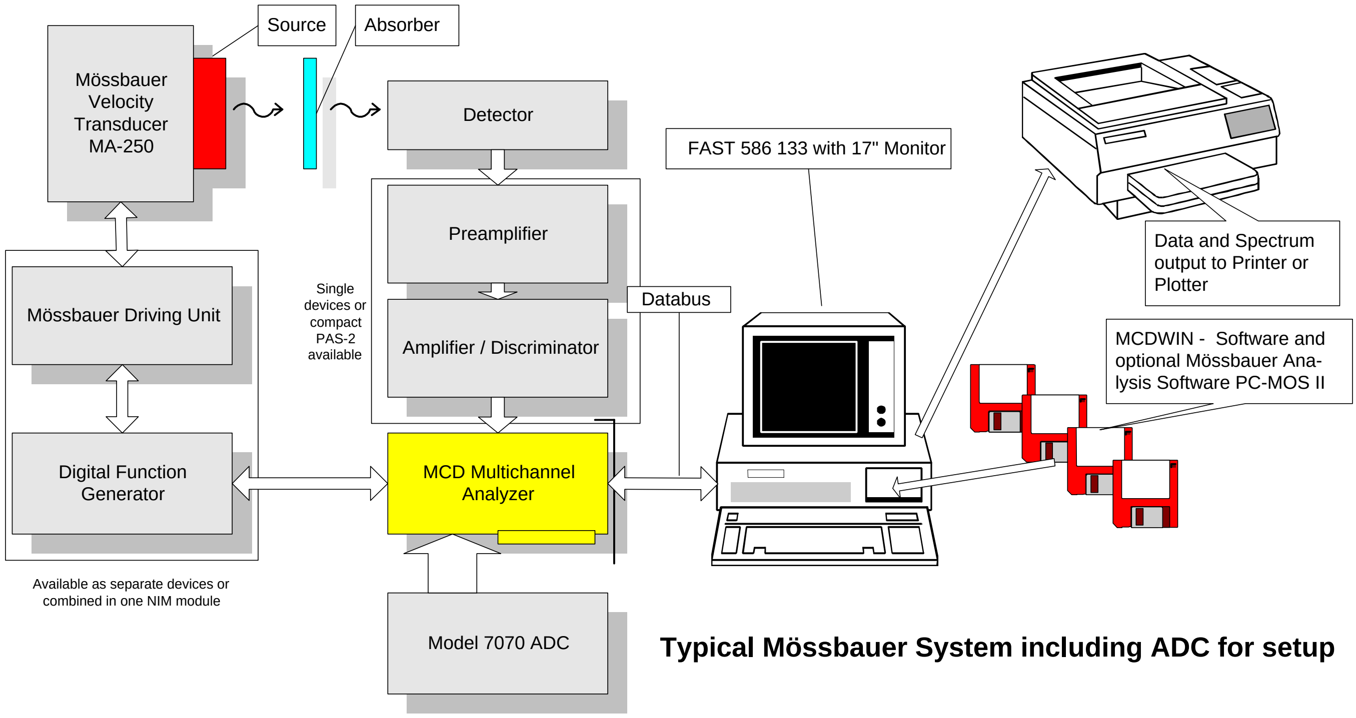


Typical Mössbauer System including ADC for setup

The Model 7070 Amplitude to Digital Converter is designed for the use in Mössbauer systems. The 7070 can be used for easy system setup. As the Mössbauer-Effect in iron 57 can only be obserbed at the 14.4 keV energy line (for other materials at other energies) it is very important that the amplifier, single channel discriminator used in the system is correctly set to this energy. The 7070 is not needed for the actual measurement.

Model MR-351
Mössbauer Driving Unit/Digital Function Generator

FEATURES

- **Digital Function Generator and Driving Unit in one 2/12 NIM module**
- **Sinusoidal and Triangular mode**
- **Digital display of:**
  Velocity with a resolution of 4 1/2 digits
  Error with a resolution of 3 1/2 digits

DESCRIPTION

The MR-351 is a compact Mössbauer driving system - it contains a digital function generator and the driving- and control electronics.

The MR-351 will operate with our two input multichannel scaler Model 7882, the line of Multichannel Data Processors MCD-2 and MCD-2E as well as with other models that provide connectors for the control signals required for the synchronization of the MCS sweeps.

A digital display can either indicate velocity or error and allows the user to constantly check the correct operation of the transducer.

Two modes are selectable: sinusoidal or constant velocity mode. The best accuracy is obtained in sinusoidal motion at the resonant frequency of the transducer approx. 23 Hz.

S P E C I F I C A T I 0 N S

Velocity Range: 0 - 200 mm/s

Resonance Frequency: 25 Hz

Frequency Range: 1 - 100 Hz

Calibration Constant (CC): 30 mm/s per 1 V

Accuracy (at a max. load of 400 g): +/- 0.5 %o in sinusoidal and triangular mode

Temperature Shift of the Velocity: smaller than $10^{-4}/^{0}C$

Outputs: VELOCITY (correct value of the velocity)

$U_{out} = V_{correct} /CC$
(30 mV per mm/s)

ERROR x 10 (difference between the correct and the actual value of the velocity; 10-fold enhanced error signal of the transducer):

$U_{err} = 10 \times (V_{actual} - V_{correct})/CC$
(300 mV per mm/s)

START,CHA: TTL signals to synchronize a multiscaler with a start of sweep pulse and channel advance pulses

Displays: MAX. VELOCITY: 4 1/2-digit display for the maximum value (199.99 mm/s) of the velocity ERROR: 3 1/2-digit display of the percentage error

Controls: VELOCITY: Front panel 10-turn potentiometer velocity for adjustment, front panel toggle switch for reducing the range of adjustment to one tenth

FREQUENCY: 1 to 100 Hz

CAL: Front panel 25-turn trim potentiometer for calibrating the display of the max. velocity

GAIN: Front panel 25-turn trim potentiometer for adjusting the amplification of the feedback loop

ERROR MINIMIZATION/ 1-2-3: Three front panel 25-turn trim potentiometers for error minimization, front panel toggle switch for switching control circuits 2 and 3 on or off

TRANSDUCER: Front panel toggle switch for switching the Velocity Transducer on or off

Internal Controls: Jumper plug to select the number of channels: 256, 512, 1024 or 2048 channels per sweep

switch to select sinus or linear mode

jumper plug to select high or low pulses for START and CHA signals

Mössbauer Velocity Transducer MA 250:

Size: 178 mm long, 108 mm in diameter

Weight: 5.2 kg

Housing: brass, nickel plated

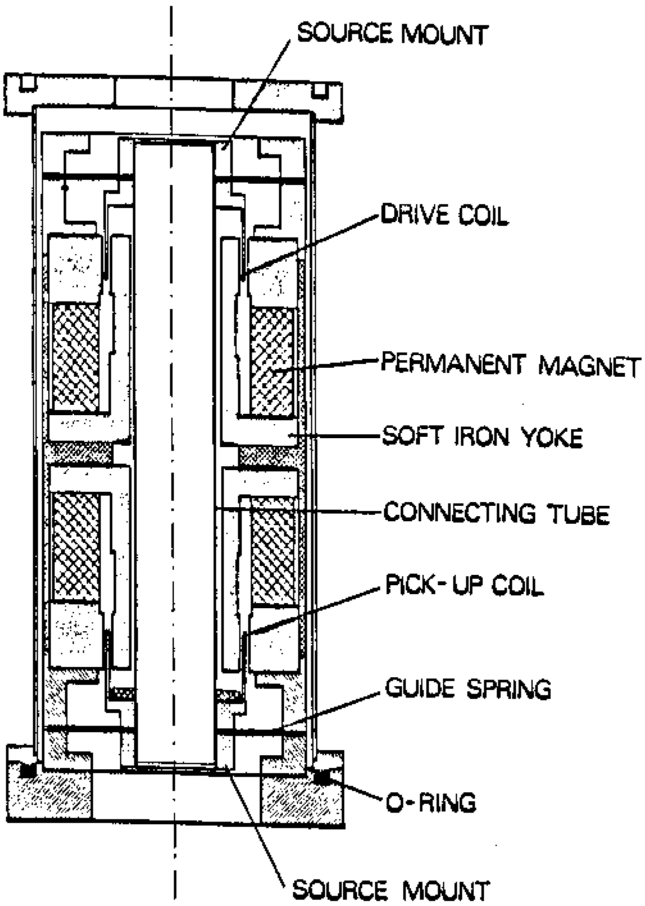
Guide springs: fiberglass enforced epoxy

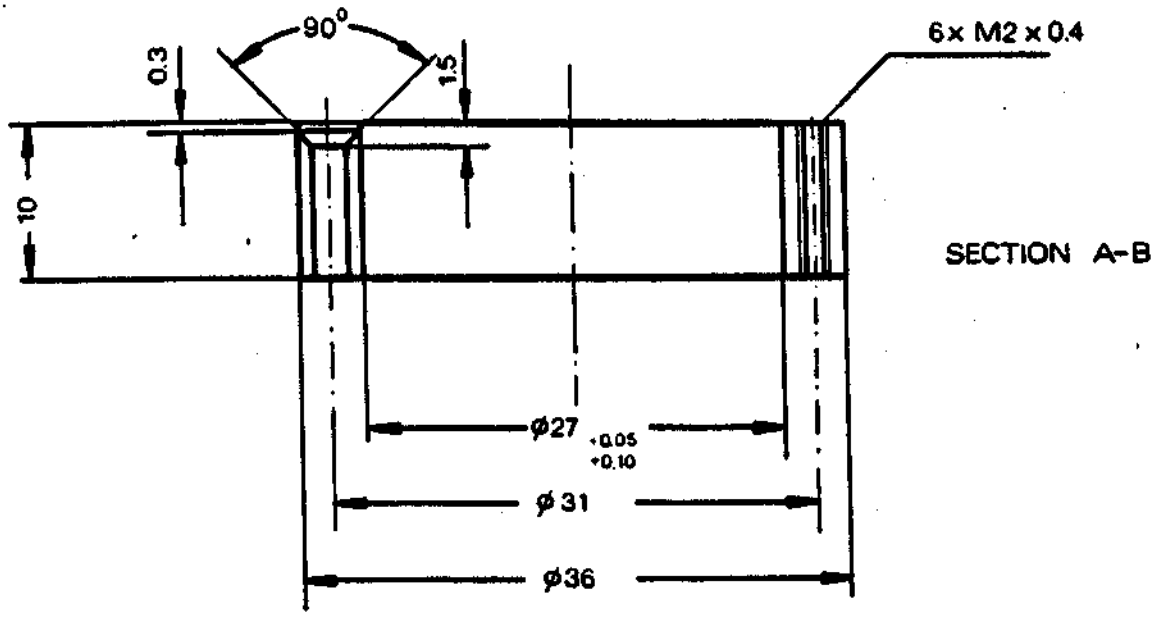
Mössbauer Driving Unit MR 351:

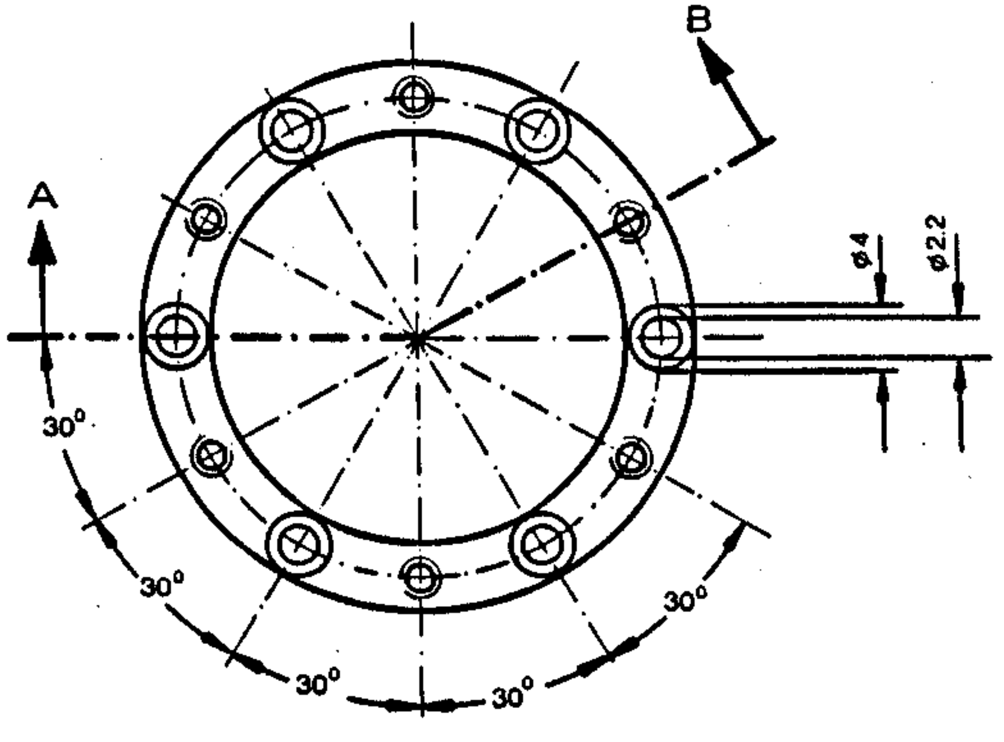
Size: Double width NIM-module

Weight: 1 kg

Power Requirements: +/-24 V, 50 mA
+/-12 V, 300 mA
+ 6 V, 300 mA




90°
0.3
1.5
6× M2 × 0.4
10
SECTION A-B
ø27 +0.05 +0.10
ø 31
ø36


B
A
ø4
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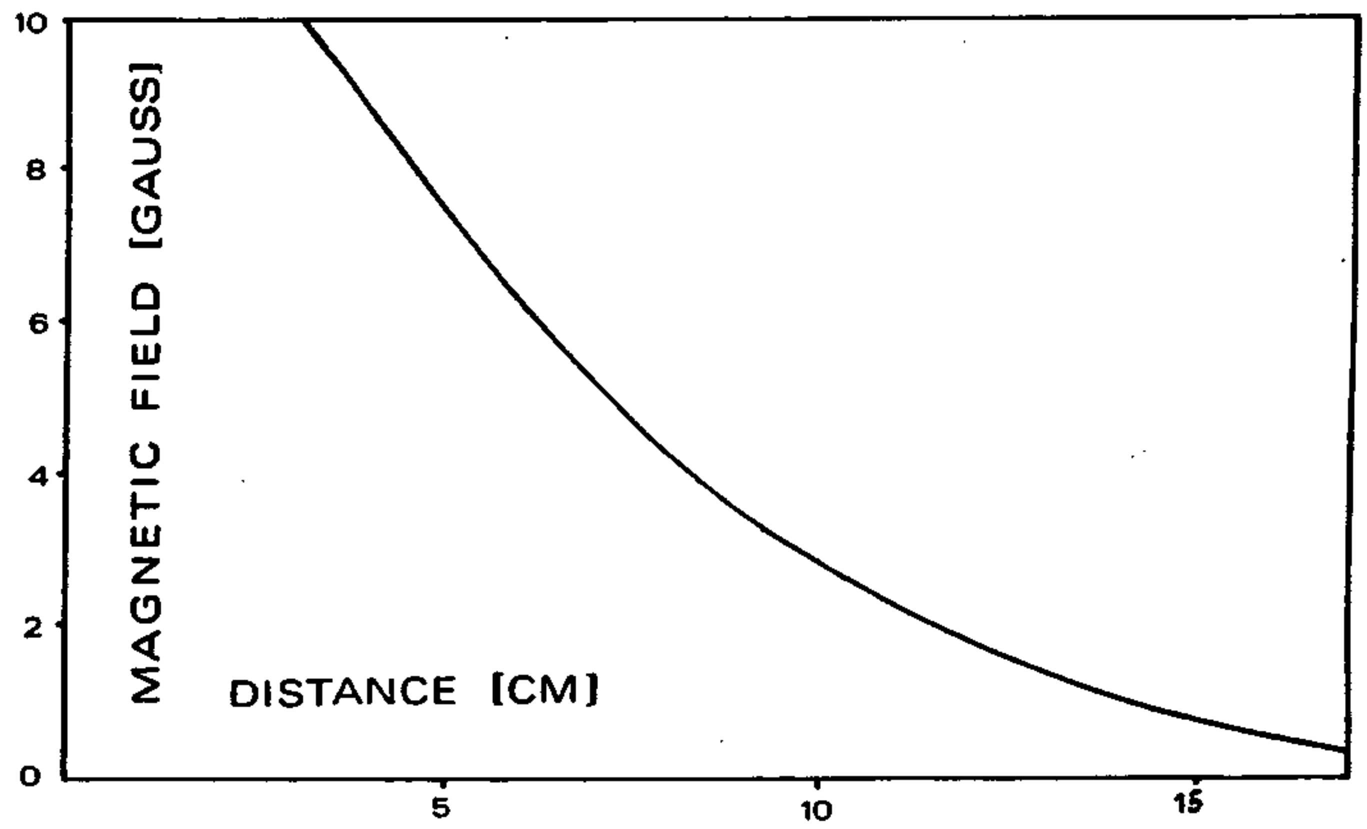
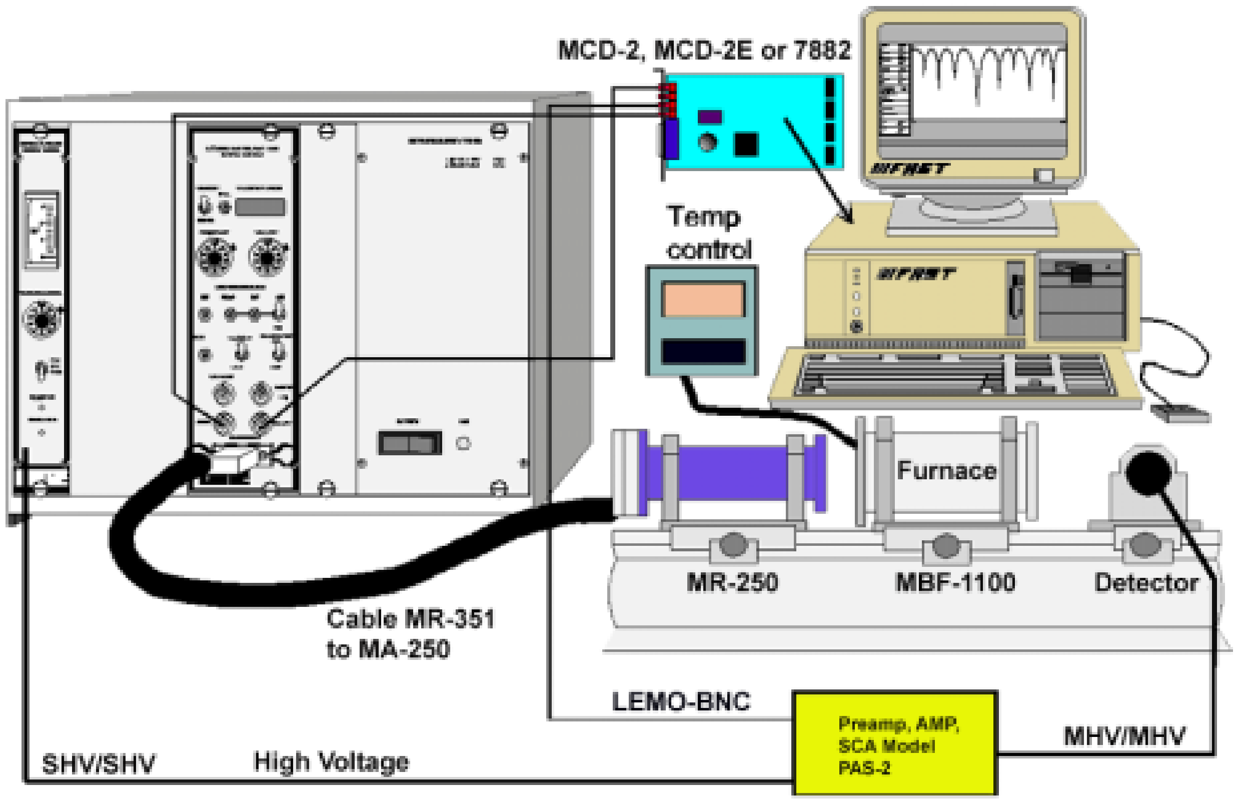
30°



DEPENDENCE OF THE MAGNETIC FIELD OF THE TRANSDUCER ON THE DISTANCE IN AXIAL DIRECTION

Typical Setup



typical setup of a Mossbauer system

Mössbauer Drive System Model 351

1) Introduction

The Mössbauer drive system consists of the electromagnetic Mössbauer velocity transducer-Drive-MA 250 and the MR 351 Mössbauer control unit with integrated digital function generator, which enables to select linear or sinusoidal reference signals. The Mössbauer Drive System 351 is capable to provide a precise velocity not only at the resonant frequency but also at other frequencies in the linear range.

2) Description

2.1 Mössbauer Drive MA 250

The MA 250 is based on the principle of two mechanically connected loudspeakers. one side provides the motion, the other is used as a velocity sensor, that feeds back actual velocity information to the control unit. A block diagram of the Drive is shown on page 10.

The resonant frequency is about 25 Hz. The large diameter of the hollow drive shaft and the special design of the springs provide a precise motion with a very low deviation.

The MA 250 is manufactured with great precision. The magnetic field in the direction of the motion is constant in the ppm range. The sensitivity is 30 mV/mm/S.

After installation of the Mössbauer Drive System 351 a calibration should be made with a 57 Co in Fe(Cu) source using an absorber of pure iron - a method far more accurate than for example a calibration with a laser interferometer (see calibration of Mössbauer spectra).

Recalibration is suggested about every six months. Strong vibrations could alter the calibration of the Drive and would make a recalibration necessary.

Good care should be taken to properly mount the source specifically if an extension rod is used. Rubbing of the moving parts on guides or other surfaces could increase the velocity error and should therefore be avoided.

The MA 250 can be operated in vacuum.

Calibration of Mössbauer Spectra

FAST ComTec velocity transducers - designed, by Norbert Halder - are made from high quality materials, precisely mounted and severely tested prior to shipment. The magnets used are AL NICO-type which have an excellent temperature stability. The weight of 15 kg will make the MA250 less sensitive to ambient vibrations than lighter drive designs.

For the majority of Mössbauer experiments linearity errors, caused by the velocity transducer, are insignificant and to not influence the measurement accuracy.

I Calibration for sinusoidal velocity wave form

The linearity error of the MA 250 velocity transducer is approx. 0.1 %

This can be easily verified by a measurement using an iron absorber. The six iron-lines provide a sufficiently accurate assessment of the linearity.

II Calibration with triangular or sawtooth velocity wave forms

The linearity error with standard springs is in this mode 1 to 2% - with optimal soft springs 0.5%

For most applications a linearity error of 0.5% is acceptable.

Verification of the linearity Can be made with an iron absorber.

III Calibration with interferometric methods

For the majority of Mössbauer experiments velocity calibrations with interferometers does not bring an appreciable improvement in accuracy but adds to the complexity of the system.

Unlike the calibration with Iron absorbers, interferometric calibration can not take geometric errors into account that result from finite Gamma ray angles

One has to weight the slight conveniences of the linearity calibration with an interferometer at velocities above 100 mm/S against inherent accuracy of only 1% the finite livetime of the laser and the occasional but time consuming requirement to readjust the optical parts of the interferfometer.

2.2. Setup of the Mössbauer Control MR 351

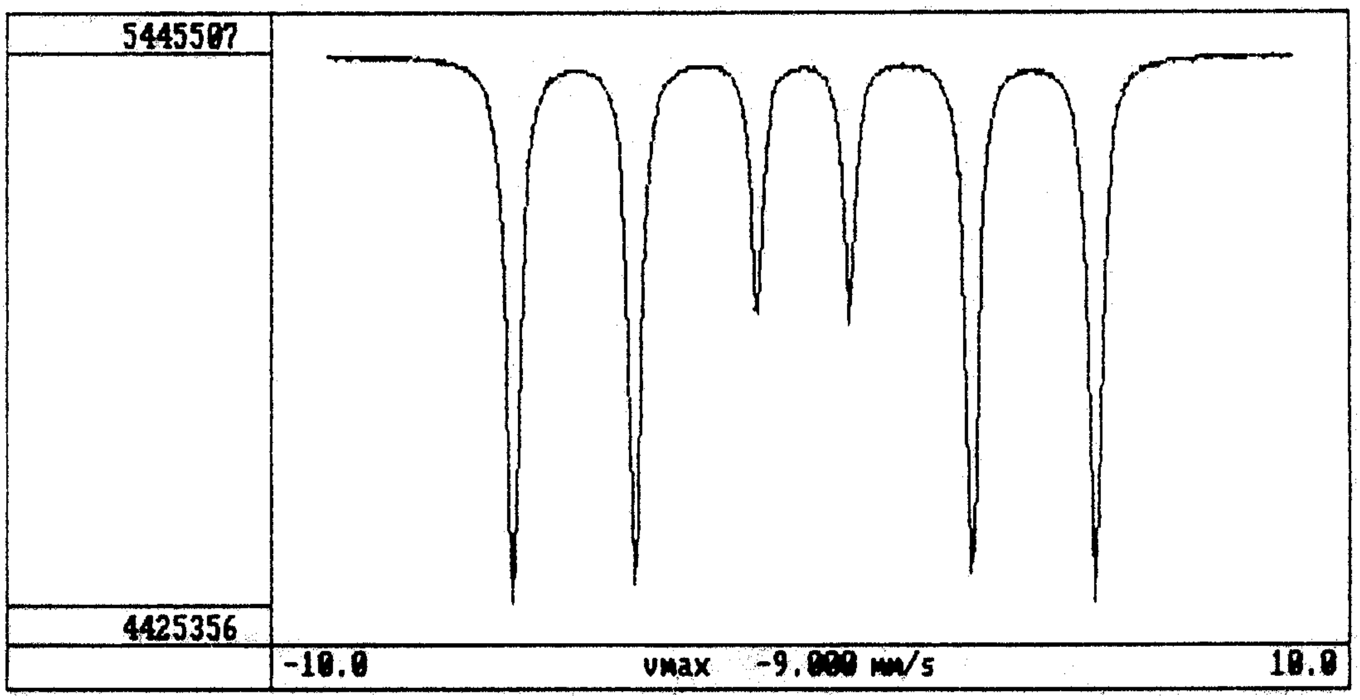
To minimise the deviation of the velocity from the nominal value the MR 351 compares the following signals:

1) The velocity sensor output, which is proportional to the actual velocity of the drive shaft

2) The reference signal of the integrated function generator, which is the nominal value of the velocity.

Note: Do not change the setting of the velocity potentiometer between calibration measurement and calibrating the instrument.

The error display is only a quick indication if the drive is working correctly. For a more accurate measurement of the error signal or for setting the error signal to the minimum an oscilloscope should be used.



The difference o"Error X10" BNC connector. In voltage the Error is calculated:

Δ V = U x CC/10 CC= Calibration Constant

The relative error is indicated on the frontpanel display in % (percent). The "Velocity/Error" switch must be in position "Error".

The difference signal is added to two signals - one proportional to the reference signal, the other to the integral of the reference signal. This compensates for friction and the characteristics of the springs. The summed signal is the actual drive voltage. The amplification of the difference signal is limited by harmonic resonances - with much higher frequencies - of the Drive, which could lead to oscillations. The amplification factor can be set by the "Gain" potentiometer.

In order to minimize the error in a correctly working Drive the "Gain" potentiometer should be set to the maximum (fully clockwise).

Make sure, that all mechanical connections are tightly fastened, no rubbing of the moving parts occur and that there is no external vibration. A lose source holder will seriously distort your spectrum !!!

For error minimisation three fontpanel potentiometers are provided

BW = Bandwidth

PROP = Proportional

INT = Integral

Bandwidth adjusts the frequency range of the feedback loop. Set the integrated function generator to "Linear" and select a high velocity. The "Error Minimisation" must be in the OFF position. View the error signal with an oscilloscope on the "Error x10" output. Set the BW potentiometer in a position, where the peaks of the error signal disappear rapidly. If oscillations appear, turn far enough to the other direction. In sinusoidal velocity mode operating at resonant frequency no further adjustments are required.

For other velocities switch "Error Minimisation" to ON and adjust "PROP" and "INT" successively until the error signal is at a minimum. The adjustment of one parameter influences the other therefore make the adjustment iteratively until you see, that the error signal cannot be decreased further.

The MR 351 displays the max. velocity and the error signal. The calibration of the velocity display can be made with the "CAL" potentiometer.

Turn the potentiometer until the display indicates the maximum velocity identical to the velocity obtained by the velocity calibration.

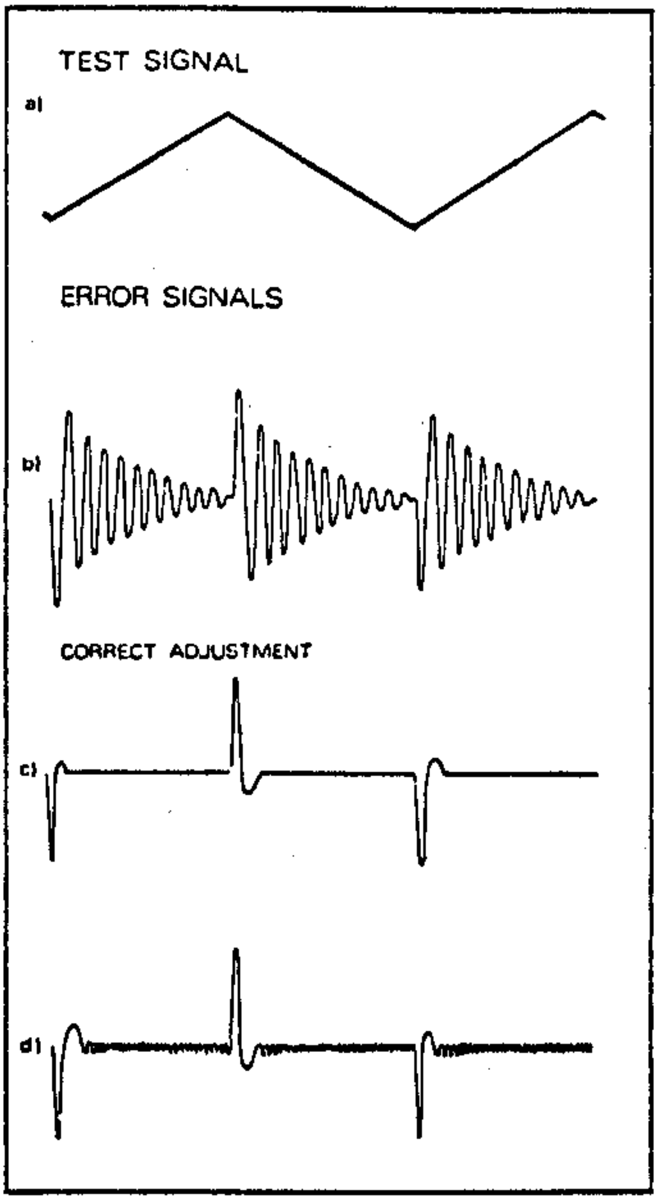


Fig. 1: ADJUSTING OF THE FREQUENCY RESPONSE

Fig. 1 b-d show the error signal due to triangular waveform of the reference signal (fig. la) at various adjustments of the screw -adjustable potentiometer marked BW

The figures 1b-d correspond to a clockwise turning of the potentiometer. In fig.lb the damping of the oscillation is too weak. Fig.1c shows optimal adjustment.

In fig.1d the system oscillates on higher frequencies. Both axes are not given in correct scale.

FAQ's

Question:
We replaced our Iron source by a new one - we now get an inverted Mössbauer spectrum that will not fold and seems to contain meaningless data.
What have we done wrong?

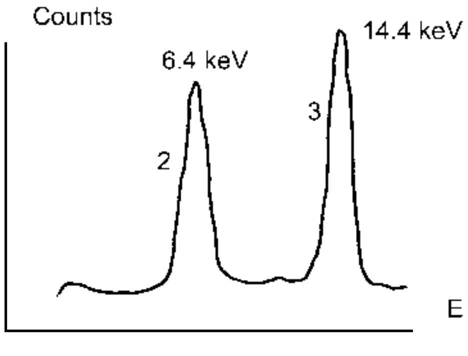
Answer:
The much higher count rate you see with the new source has possibly caused a shift in the energy lines in your detector and/or electronics. Since only the 14.4 keV line is responsible for causing the Mössbauer-Effect you will have to readjust and recalibrate your Mössbauer System. If your energy window setting has sufficiently shifted away from the 14.4 keV line or you have set the window to the wrong energy peak you will get an inverted Mössbauer spectrum.

There is a quick check: move the new source so far away from the detector until you get roughly the countrate the old source provided. If you now get proper results, put the new source back in the correct position and use a multichannel analyzer to readjust the energy window in your SCA.
Check the correct adjustment every three to six months.

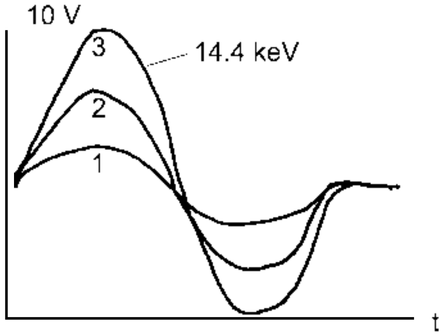
Question:
How can I calibrate a Mossbauer System without using an ADC. We have just a PAS-2.

Answer:
Setup of a Mossbauer system with a PAS-2 using an oscilloscope

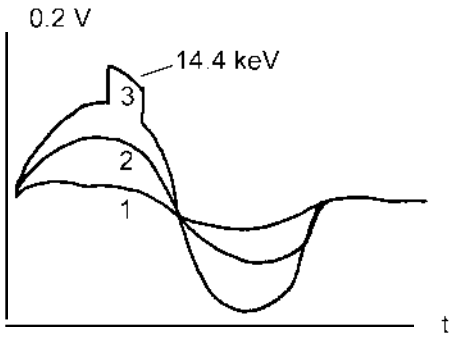
A typical pulse-height spectrum 57Co looks like this:
a) with a detector filled with Xenon gas, b) with a Krypton gas

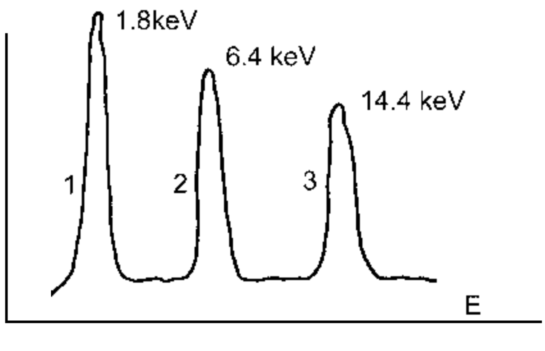


The output of the Amplifier looks like this - the example is for a detectoer filled with Krypton gas

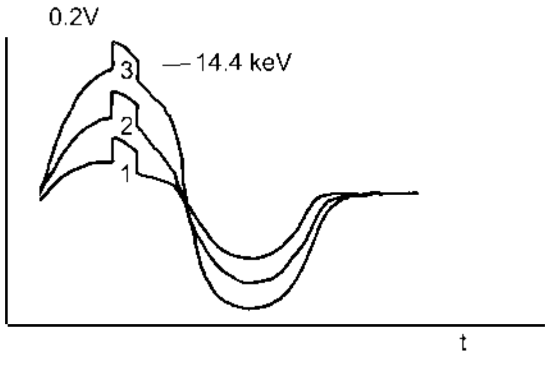


A typical monitor output signal after setting the lower- and upper level to the 14.4 keV line which is significanr for Mossbauer work





The monitor output with lower level setting at minimum and upper level setting at maximum



An oscilloscope must be used for proper setup.The **monitor** output shows three (two with a Xenon gas filled detector) clearly separated energy lines. By adjusting the lower level and upper level potentiometers the 14.4 keV energy line can be clearly set. Setting the potentiometers to the 6.4 keV line will not produce the desired Mossbauer effect.
Some hints: The monitor output should be set to 5 to 7 Volts for the 14.4 keV line. Use the HV potentiometer to make this adjustment.
Make sure the trigger level of the oscilloscope is set just slightly above the zero level as you otherwise do not see the rising edge of the pulses correctly.

An alternative is to connect the OUT pulse to input 1 of a scope, the SCA pulse to input 2 and set the scope to "add". You will see the same kind of displays as above but because of the higher output level you will find it easier to trigger the oscilloscope.

If a MCA is available the setup can also be made in pulse height analysis using the Amplifier output of the PAS-2 as the input to the ADC and the SCA output as a gate signal of the ADC.

The internal switch should be in pos. 1 for setup as otherwise the output pulses of the amplifier will be inverted and therefore difficult to setup.