MEB-2c parameters setting guide

1. Introduction

This guide is a supplement to the MEB-2c meter user's manual. It provides practical information about MEB-2c parameters setting procedure, and shows how to set the gain of the Barkhausen effect (BE) signal amplifier and how to chose the threshold level of the BE pulse counter. This procedure is illustrated by results of measurements performed with MEB-2c for Polish low carbon steel type St3 (6 mm thick plate).

2. Amplifier gain setting

The BE voltage signal amplifier gain G is set with switches P1 and P2 (see Fig. 2 of manual). This gain level influences two parameter: the **v1** – effective intensity of BE voltage and the **counter –** number of BE pulses.

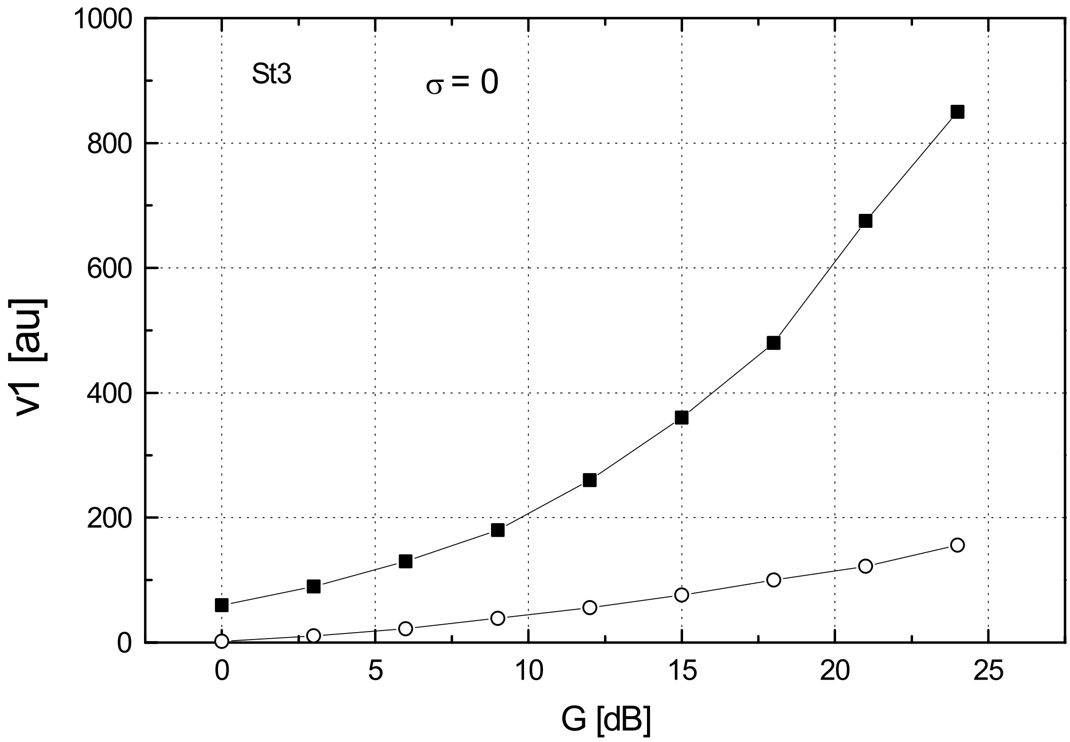


Fig.1. *Barkhausen effect intensity v1 in function of gain (G) for free probe (open circles) and for St3 (solid circles). Sample unloaded*

Fig. 1 shows how the v1 parameter varies in function of gain G. Bottom plot (open circles) reveals change of v1 parameter in function of gain when probe is without any contact with tested material. It is thus the intensity of the noise like signal which is induced in the pick-up coil inside the probe and which is provided by electronic circuits of the MEB-2c meter. Upper plot (solid circles) in Fig. 1 depicts the increase of v1 parameter as measured for the St3 steel without load ($\sigma = 0$). This plot depicts that the v1 parameter measured for St3 steel reaches its limit level (maximal reading scale v1 = 1023) for the gain higher than 26 dB. The recommended level of v1 parameter it is a level within the range between thirty and fifty percent of the total scale. This level should be not too high in order to not saturate the v1 parameter readings for the sample subjected to high level of tensile stress (external or residual) and also to reduce impact of noise component on the v1 parameter value. In the case of tested St3 steel, the gain G was set to G = 15 dB. This gain should be finely verified by means of analysis of stress dependence of v1 parameter.

3. Counter threshold setting

The BE pulses counter provides number of pulses with amplitudes higher than a given threshold level Uo. This threshold level is tuned with switch P3 (see Fig. 2 of the user's manual). Amplitude of pulse depends on the gain G and so, the counter reading depends on G level and on threshold Uo level. Increase of gain leads to increase of number of pulses counted by meter for a given threshold. This effect is shown in Fig. 2 where are plotted pulse numbers (counter parameter) against threshold level for various gains levels.

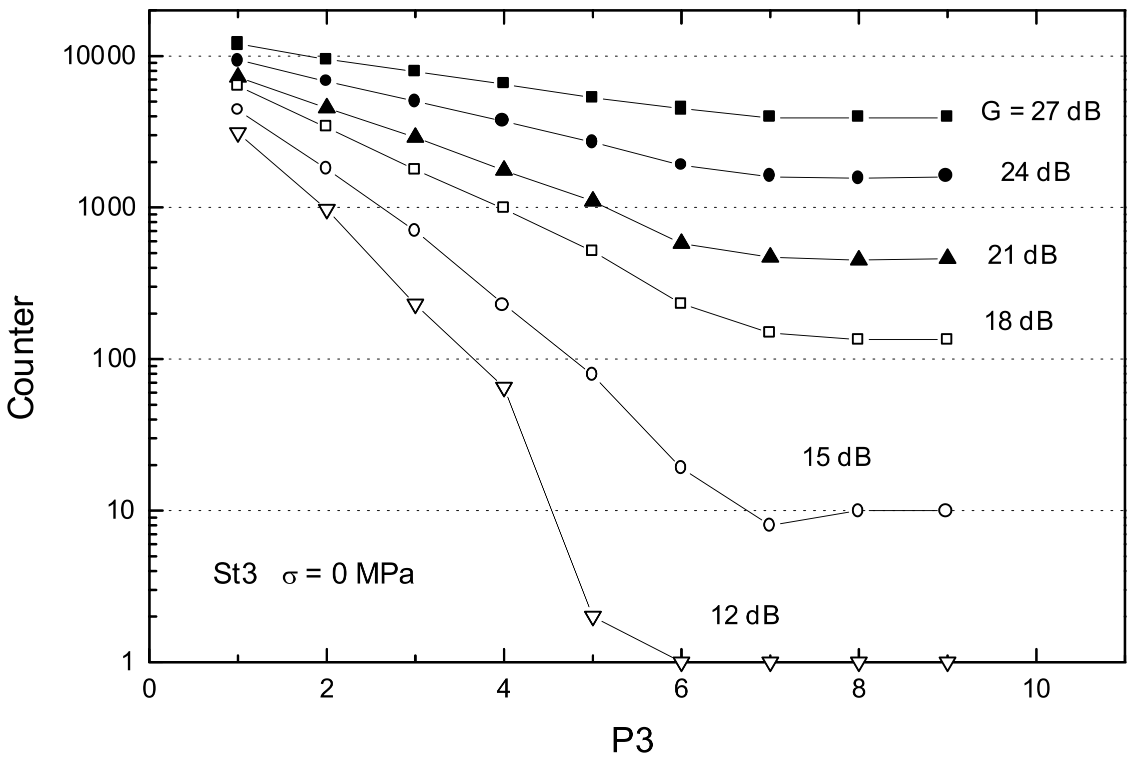


Fig. 2. Impact of threshold level on number of pulses for different gain levels

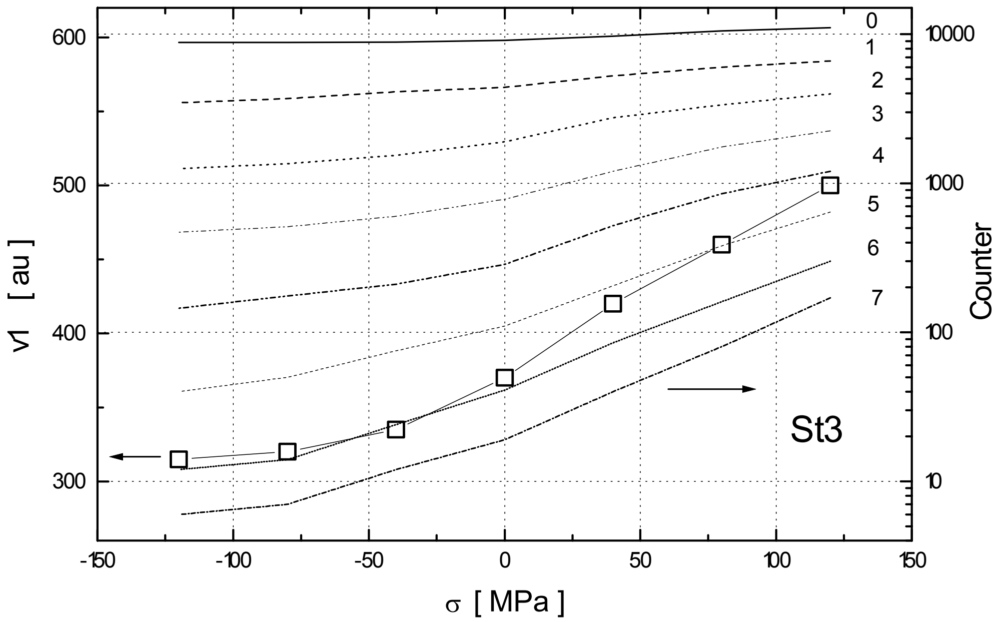
The number of pulses was presented in log scale. The counter parameter varies in function of threshold P3 within the range of 4 decades when low gain (G ≈ 12 dB) is used. However, for higher gain levels (G ≈ 27 dB) – this dependence is much less significant. It is because for high gain, the BE pulse amplitudes are mostly higher than the highest level of threshold (P3 = 9). The threshold level P3 from which this saturation of pulses number change appears shifts to the lower values when gain G is increased. There is also statistical scatter of counted pulses number (not shown in the Figures). Such scatter makes that relative change of counter parameter increases over the 10 % level for counter smaller than 100. It is evident that counter parameter lower values of than 100 ± 10 are not 'good' for application when 'high' accuracy of reading is needed. However, decrease of threshold level reduces the sensitivity of counter parameter to stress level or to structure variation. It is thus recommended to keep the counter level of order 1000.
In the case of the example which is here presented, one can find that 'the best' threshold level is close to the P3 = 3 when G = 15 dB or P3 = 4 for G = 18 dB. This choice of gain G and of the threshold can be now confirmed by means of analysis of stress dependence of BE intensity

4. Uniaxial load calibration procedure

The BE intensity stress dependence calibration made with uniaxial load mode is fully allowed when BE is used for evaluation of such type of stress states. For uniaxial load one can use MTS like loading machine and standard samples but it makes problems in compression. This the reason that bending and not traction or compression is used. There are shown typical results of calibration procedure where the cruciform sample of St3 steel (designed for biaxial load) was used The BE probe was positioned in central part of the sample. Load was applied by bending of the sample arms using "four points" method of load. Strain was measured with standard gauges on the opposite side of sample. The effective stress σ was evaluated from the strain ε measured in magnetization direction. Results of measurements of the v1 and counter parameters in function of stress σ are shown in Fig. 3 . The counter parameter was measured for different threshold P3 levels. The change of the counter level is presented in log scale. Calculated stress was varied within the range from –120 MPa (in compression) up to +120 MPa (in tension). The gain was G = 15 dB.

Both the v1 and counter parameters increase with tensile stress and decrease with compressive stress, but there is evident important difference between stress sensitivity of these parameters. The v1 parameter varies only from 320 at –120 MPa up to 500 at + 120 MPa. The relative increase of this parameter with stress is thus of order 2. Such dynamic is typical for the tested St3 steel.

The counter parameter varies much more then v1 parameter. However, dynamic of counter level variation with stress depends on P3 parameter.
This dynamic increases when threshold level is decreased. One can find, that counter does not decrease below limit of 100 at highest level of compression if P3 not grater than 4. This confirms that the choice of P3 = 4 is good for stress evaluation of St3 steel.



5. Final remarks

1. The as presented results shows how set the MEB-2c parameters gain and threshold. This is based on two simple conditions which are summarized in the **Table**.

	gain G (P1, P2)	threshold (P3)
unloaded state	v1 ≈ 40% of scale	counter ≈ 1000
maximal compressive stress		counter higher than 100

2. Stress calibration procedure for biaxial stress state needs measurements of BE intensity in function of two strain components which are parallel and perpendicular to the magnetization axe, respectively.