

# Quality Management of Welded Joints Based on the Analysis of Informative Frequency Ranges

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## Abstract

Modern welding equipment for realisation of various methods of arc welding with fusion electrode in shielding gases, manufactured by the world's leading manufacturers, is a complex technical device with digital microprocessor control. This equipment is capable of realising various cycles of electrode metal drop transfer with duration measured in milliseconds (CMT - Fronius, STT - Lincoln Electric, etc.). In the control circuit of welding systems a huge amount of digital data is processed. Thus, already nowadays modern welding equipment includes the possibility of online processing of signals from the welding zone. At the same time, as modern experience of application of special algorithms of Big Data and AI information processing shows, this data stream represents a promising opportunity for improvement of welding technologies. The application of Big Data and AI will enable a deeper assessment of joint quality and operational control of weld formation. For predictive control of welded joints quality the following approach is proposed - using oscillograms of current and voltage during welding, to identify in them separate frequency components of processes occurring in the circuit 'power source - arc - weld pool', taking into account their different inertia, to further determine the relationship of mode parameters with the quality indicators of joints. The first range (500 - 5000 Hz) - high-frequency, characterises the spatial stability of the arc, i.e. the movement of anode and cathode spots. On the spatial stability of the arc depends the transition of the drop from the electrode surface into the weld pool, which, in turn, affects the spattering of the electrode metal and weld pool metal. The second range (10 - 500 Hz) - medium frequency, characterises the drip transfer of electrode metal. The third range (0.1 - 10.0 Hz) is a low-frequency range, which represents jump-like deviations of current and arc voltage, characterises the frequency of weld pool oscillation and contains signals about the quality of weld formation (information about the geometrical dimensions of the weld, penetration depth, scalloping, etc.). The use of Big Data and AI in the processing of electrical signals during welding opens up new possibilities for defect prediction, and the introduction of additional informative frequency bands will enable predictive weld quality management at a deeper level.

## Keywords

Big Data, Artificial Intelligence (AI), Welding Zone, Predictive Quality Management, Inverter Power Sources, Arc Welding