

## Magnetic Resonance Output Conditioning (MROC)

The latest version of the IEC standard, published in the UK as (BS EN IEC-60601-2-33:2024 Edition 4.0) *Particular requirement for the basic safety and essential performance of magnetic resonance equipment for medical diagnosis* introduced the mandatory functionality of MR Equipment Output Conditioning (MROC). MROC only applies to proton imaging ( $^1\text{H}$ ) at 1.5 T and 3 T, but other field strength systems may implement MROC. Manufacturers typically have a regulatory grace period of three years from publication to fully implement these changes, although some manufacturers have already implemented similar capabilities to MROC.

The intended purpose of MROC is to enable the automatic control of MR scanner outputs, given the relevant MR Conditional label values and thus optimise potential workflow-induced errors. Hazards or hazardous situations associated with scanning patients with medical devices declared as MR Conditional, and to support the operator to perform the examination in accordance with the requirements specified on the medical device label.

Note that MROC is not an additional operating mode like normal and first level, but allows the specification of additional output limits. MROC should also include a means to remind the operator to consider other conditions relevant to safety, e.g., landmark restrictions, scan time limitations, etc.

MROC works alongside existing controls, i.e., SAR, and allows the operator to -

- Select the RF transmit (Tx) coil type and RF polarisation, e.g., circularly polarised or multi-channel (CP, MC-2 or MC-N). If an MR Conditional device does not specify RF polarisation type, then CP should be assumed.
- Select the maximum B1+RMS (this is the maximal value when averaged over any 10s period of the sequence) in  $\mu\text{T}$ .
- Select the maximum gradient slew rate  $|dB/dt|_{\text{PEAK}}$  per gradient axis in T/m/s.

MROC automatically ensures that the maximum B1+PEAK shall not exceed the following values:

RF Transmit Coil	1.5 T	3 T
Whole-body RF Tx coil	$\leq 30 \mu\text{T}$	$\leq 24 \mu\text{T}$
Other volume RF Tx coils, e.g. Head, Knee, Hand	$\leq 45 \mu\text{T}$	$\leq 35 \mu\text{T}$

When MROC is selected the user interface must continuously display the abbreviation “MROC” and display, upon request or continuously, the parameters described above together with any other additional parameters or selectable options that have been implemented.

Note that the MROC parameters displayed are conservative (to protect patient safety) and can therefore represent an overestimate of actual outputs.