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Instruction Manual for DISC MAS-5 Meter

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OPERATING MANUAL

THE NEW INTELLIGENT MAS-5 METER FROM DISC

**** For use by QUALIFIED SERVICE ENGINEERS ONLY!! ****

For many years service engineers have been asking for a meter that measures MAS, exposure time, and mA at the same time. DISC has produced this meter with extra features! Not only will the new MAS-5 provide MAS, exposure time, and mA, but the meter provides mA waveform information. The MAS-5 displays three 50 millisecond mA waveform samples so that radiographic and mammographic pre-heat circuits can be analyzed and adjusted without using an oscilloscope. Based on feedback from field service engineers, the MAS-5 also has a button that when pushed causes the meter to include/exclude the first 10 milliseconds of the mA waveform for mA sampling on Line 4.

The new MAS-5 intelligent meter uses a microcontroller to analyze the digital mA waveform and display accurate values essential for analyzing and calibrating radiographic and mammographic equipment.

Using MAS-5 to measure Single Exosures:

The four line LCD displays the following (single exposure):

Line 1: **MAS**

Line 2: **EXPOSURE TIME** (mA waveform exposure time in seconds)

Line 3: **MA (**average tube current (mA) over the entire mA waveform)

NOTE: MAS-5 will calculate mA as long as the exposure time is 50 mS or longer.

Line 4: **Three sample mA waveform values :** (with no delay)
*The 1st waveform value represents the average mA for the 1st 50 milliseconds of exposure.
*The 2nd waveform value represents the average mA for the 2nd 50 milliseconds of exposure.
*The 3rd waveform value represents the average mA for the 3rd 50 milliseconds of exposure.

NOTE 1: *If the 10 millisecond delay is enabled, the MAS-5 will wait 10 milliseconds before initiating it's mA sample routine (line 4).*

NOTE 2: *If the exposure terminates either before or during any particular mA sample, that mA sample value will show N/A.*

Using MAS-5 to measure AEC driven exposures with multiple exposure segments:

After the AEC driven segmented exposure terminates the MAS-5 will show that it detected multiple exposure segments. The four line LCD displays the following.

Line 1: **MAS** (Total accumulated mAs of all exposure segments).

Line 2: **EXPOSURE TIME** (Total accumulated radiation time of all exposure segments.

Line 3: **MA (**MAS-5 does not calculate mA and displays N/A)

Line 4: MAS-5 indicates the number of exposure segments detected.

NOTE 1: *As long as the elapsed(no radiation) time between exposure segments is less that 3.5 seconds, the MAS-5 meter will include them in the mAs and exposure time measurements.*

Features of the MAS-5 include: **A button that causes the meter to include/exclude the first 10 milliseconds of exposure**; a diagnostic power-up sequence to indicate operational status; auto LCD update; an automatic reset; automatic power-down when meter is not used for more than five minutes; displays blanks when an exposure is being made; and a low battery indication.

Background Information

The MAS-5 meter is designed to analyze any waveform signal from single phase (self half wave rectified) waveforms up to and including any of the high frequency (constant potential) waveforms.

The MAS-5 meter has two sets of mA input jacks on the bottom front of the meter face. The lower right hand jacks (both black) are for alternating current (AC) mA signals, and the lower left hand jacks (one red, one black) are for direct current (DC) mA signals.

The AC signals travel through a full wave bridge rectifier to invert any negative value portions of the mA waveform and then through an RC circuit to shape the signal. **The DC input jacks are provided for high frequency waveforms that may have negative wave components that if rectified could cause an error of 5% to 10% in the mA values.** It is recommended that the DC input be used whenever a high frequency waveform with negative waveform portions are encountered!

The trigger level detector triggers whenever the mA signal is greater than 7 milliamps. The internal trigger signal remains "on" for 14 milliseconds after the mA signal has dropped below 7 milliamps. (**NOTE: As long as the peak mA signal exceeds 7 milliamps at least once every 14 milliseconds, the meter continues to measure the mA signal; this is important for single phase exposures!)**

The internal exposure time signal is 14 milliseconds longer than the exposure time therefore it is possible to measure the exposure time by subtracting 14 milliseconds from the internal trigger signal.

The meter's MAS readout is determined by feeding the mA signal to the voltage-to-frequency converter input where the converter is scaled such that every pulse out is equal to 0.1 MAS.

The microprocessor counts and displays the pulses from the voltage-to-frequency converter (accumulated during the exposure), performs the math algorithms, and then displays the appropriate waveform values on the four lines of the LCD display.

mA Sampling for Single Exposures

Many radiographic and mammographic X-ray machines have relatively complicated X-ray tube filament drive circuits. The X-ray tube is similar to a vacuum tube rectifier that operates at saturation. During an exposure, the two main variables that determine the mA during the exposure are the filament heat and the kVp across the X-ray tube.

MAS-5 SPECIFICATIONS

RESET: Automatic reset & LCD update
DYNAMIC RANGE: 10 to 2000 mA
0.1 to 20000.0 MAS
1 mS to 20.000 sec

Operating Temp: 15 to 35º C
Power: One 9V battery
Typical Battery Life: > 40 hrs.
Size: 4" x 6.5" x 1/3"
Weight: 10 oz.

ACCURACY: MAS = ± 0.1 MAS or 1% (whichever is greater)
MA = ± 1mA or 0.5% (whichever is greater)
Time = 1mS or 1% whichever is greater

Preheat Circuits

Many X-ray machines have preheat circuits that heat up the filament prior to the main exposure. These preheat circuits control the filament heat of the X-ray tube according to the X-ray tube's emission characteristics, the "dialed-in" mA, and the "dial-in" kVp.

Feedback Filament Drive Circuit

The preheat circuitry adjusts the X-ray tubes filament heat such that when the exposure starts, the actual mA going through the X-ray tube matches the "dialed-in" mA (if calibrated properly). At this time the X-ray machine switches from its preheat circuitry to its feedback filament drive circuit. Since the exposure has started, the feedback circuit measures the actual mA flowing through the X-ray tube and compares the actual mA to the "dialed-in" mA. If the actual mA is different from the "dialed-in" mA, the feedback circuit changes the filament heat such that the actual mA matches the "dialed-in" mA. However, if the feedback circuit changes the filament heat in order to adjust the mA, the mA cannot change instantaneously.

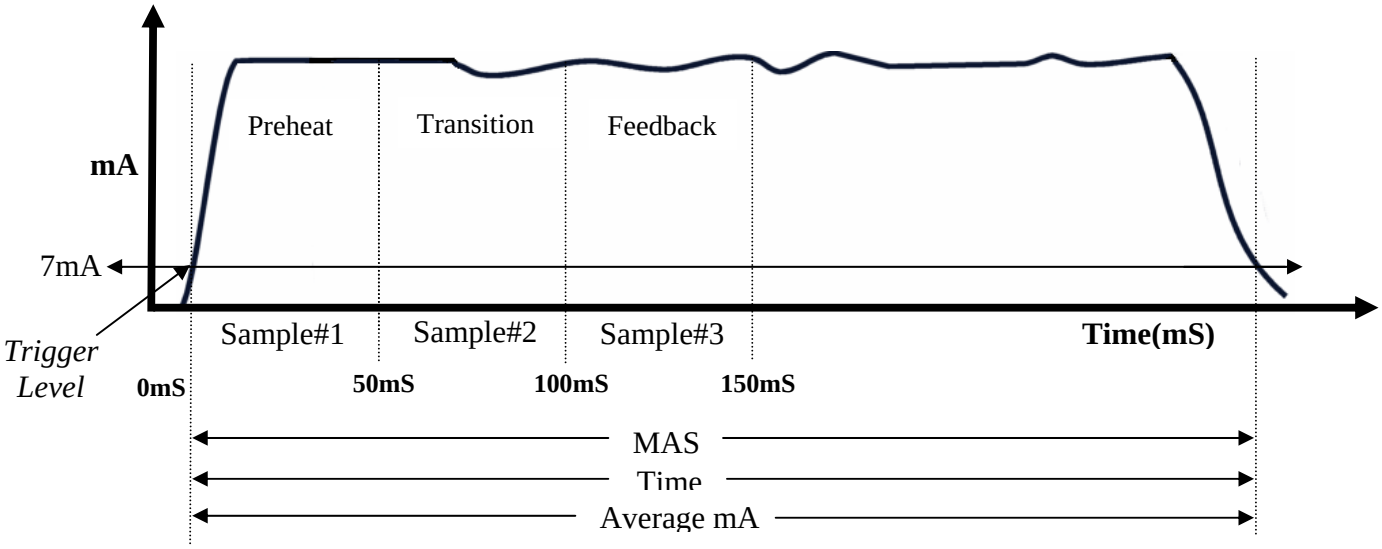
mA Waveform Characteristics for X-ray machines with Preheat and Feedback Circuits (see Figure 1)

The amplitude of the mA waveform at the start of the exposure is determined mainly by the calibration of the preheat circuitry. Sample number one of the MAS5 meter measures and displays the mA for the first 50 milliseconds of the exposure.

The amplitude of the mA waveform from 100milliseconds to 150 milliseconds after the exposure starts is controlled mainly by the calibration of the feedback circuit. Sample number three of the MAS5 meter measures and displays the mA during this time window.

Sample number two measures and displays the mA from 50 milliseconds to the 100-millisecond time window.

FIGURE 1 - mA Wave form(*No Sample Delay*)

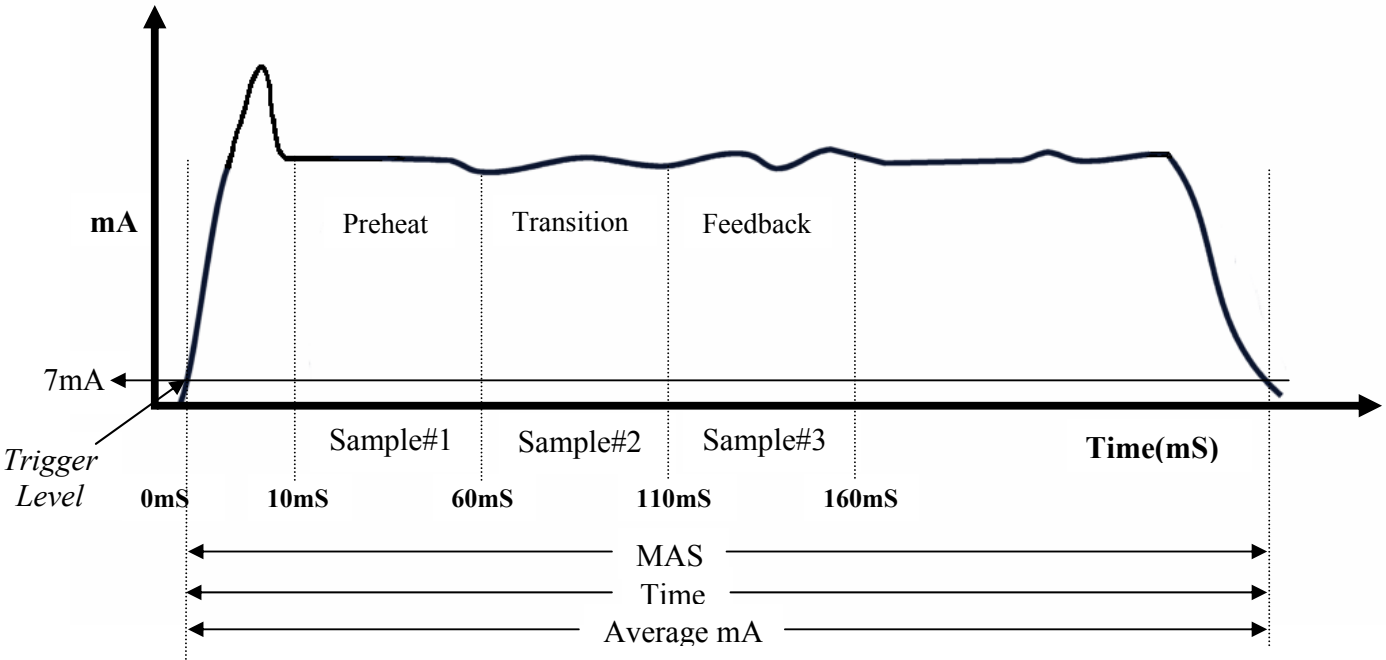


The 10 millisecond Delay (see Figure 2)

In order to calibrate the preheat as well as the feedback circuitry, many OEM's recommend ignoring the first 10 milliseconds of the mA waveform when there is an influx of current needed to charge the high tension cables as the voltage builds up across the X-ray tube. Due to this phenomenon, a "spike" is produced at the beginning of the mA waveform.

In order to avoid measuring the influx of current (current spike) at the beginning of the exposure in sample number one, the MAS5 meter can be adjusted so that all three-sample time windows can be delayed by 10 milliseconds.

FIGURE 2 – mA Waveform (10 mS Delay)



LIMITED WARRANTY

DISC MAS-5 Meter

This product, except the use, is warranted by Diagnostic Imaging Specialists Corporation (DISC), to the original purchaser to be free from defects in material and workmanship under normal use for a period of one (1) year from the date of purchase. During the warranty period, and upon proof of purchase, the product will be repaired or replaced (with the same or similar model) at our option, without charge for either parts or labor at the DISC factory. The purchaser shall bear all shipping, packing, and insurance costs to the DISC factory. The warranty will not apply to this product if the product has been misused, abused, or altered. Without limiting the foregoing, bending or dropping of unit, broken electrical wires, visible cracking of the product components and/or enclosures are presumed to be defects resulting from misuse or abuse.

NEITHER THIS WARRANTY NOR ANY OTHER WARRANTY EXPRESS OR IMPLIED, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY, SHALL EXTEND BEYOND THE WARRANTY PERIOD. NO RESPONSIBILITY IS ASSUMED FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITING THE SAME TO MATHEMATICAL ACCURACY OR PRECISION OF THE PRODUCT. SOME PROVINCES AND OR STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS AND SOME PROVINCES AND OR STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THAT THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY.

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