FLUKE®
Biomedical

Nuclear Associates 07-487

Dual-Range Digital mAs Meter

Operators Manual

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Section 1
General Information

1.1 Warnings

WARNING

When working with x-ray equipment, proper care must be taken to prevent injury. Please review x-ray machine manufacturer's suggested precautions when working with x-ray equipment circuitry.

CAUTION

Users of mAs meters must be aware of the potential damage to the x-ray generators in the case of improper connection or failure of any part of the metering circuit. The mAs meter is intended for use only by those skilled in the calibration and repair of x-ray machines. The most common cause of failure of the mAs meter is incorrect connection to the x-ray generator, usually to the tube filament circuit.

1.2 Introduction

The Model 07-487 is a digital mAs meter used to measure the product of tube current and exposure time of x-ray generators. It has two ranges of sensitivity, 199.9 and 1999 mAs. It is connected in series with the tube current ground return line of the high voltage transformer. A full-wave bridge feeds a five-ohm load resistor so that the polarity of the input signal is not important. It should be used only by those generators providing open and short circuit protection of the metering circuit and where the circuit operates near ground potential. The mAs meter will not read proper values when connected to mA calibration points used for amplifier or servo control of mA or any point other than the ground return of x-ray tube current.

1.3 Assembly Description

The single circuit board fits into the two-part case. The rear of the case has a battery cover over the 9 V battery. The rear of the case may be removed to access the two calibration potentiometers. Do not over tighten the screws or the case may be damaged.

1.4 Specifications

Range No. 1:	199.9 mAs max, over-range indication at 160.0 mAs
Range No. 2:	1999 mAs max, over-range indication at 1600 mAs
Input Current:	25 to 1250 mA
Accuracy:	± 2% (± 1 digit)
Load:	Full wave bridge feeding 5 ohm - 5W
Recalibration:	Annually
Battery:	9 V Alkaline
Display:	3 ½ digits, + sign, LO BAT
Input Connectors:	24" test leads with insulated alligator clip
Dimensions (H x W x D):	1.1 in. x 3.5 in. x 5.7 in. (2.8 cm x 8.9 cm x 13.7 cm)
Weight:	0.46 lbs. (0.21 kg)
Operating Conditions:	+10° to 40° C (+50° to 104° F) Maximum 90% relative humidity, non-condensing

CAUTION

Routine Cleaning: Do NOT immerse model 07-487 Dual Range Digital mAs Meter. The unit is not waterproof. Liquid could damage the circuits. The unit should be kept clean and free from dirt and contamination. The unit may be cleaned by wiping with a damp cloth using any commercially available cleaning or decontaminating agent.

1.5 Connection and Use of the mAs Meter

The mAs meter is designed to be connected in the ground return line of the high voltage transformer and must be in the actual current path of the x-ray tube. The meter can be connected in series with the rectified tube current (DC path), via the DC input jacks or it can be connected using the AC input jacks in series with the transformer down stream of the rectifier (AC path). However, all the tube current must go through the mAs meter to have an accurate reading. If an alternate or parallel current pathway of the x-ray generator is used, it could bypass the meter and invalidate the reading. Do not use resistors, varistors, bypass or distributed capacitors in parallel with the meter. This may affect the calibration. Before using the mAs meter, examine the circuit of the x-ray generator and be certain that the mAs meter is connected so that such components will not affect the readings. Varistors which have limiting voltages above 10 Volts will probably not disturb the reading.

1.6 Circuits That Do Not Permit the Use of the mAs Meter

Certain circuits will not permit the use of the mAs meter. Some dental tube heads do not provide access to the tube current and are adjusted by observing the primary AC current. Some systems use electronic control circuits with part of the control network inside the tube head and are adjusted by setting the control amplifier to specific reference voltages. Some high frequency generators require that the ground return

current be read as a voltage across an internal reference resistor. The mAs meter cannot be used with these types. It must read the actual tube current with no other parallel path.

1.7 User Hints

The most common cause of drift in calibration to an x-ray generator is the change of the x-ray tube filament emission. Because x-ray tubes and cables may arc on occasion, the high voltage transformer has a high impedance that keeps these short circuit currents within safe limits. The regulation of the transformer is often expressed as voltage drop per 100 mA of tube current. Large transformers regulate about 4 kVp/100 mA and small transformers about 12 kVp/100 mA. The design of the generator circuit compensates for the voltage drop: a large system exposing at 80 kVp at 500 mA would have an open circuit voltage of 100 kVp. The regulation of the transformer drops the voltage to the correct value. However, if the tube drifts to 350 mA, the regulation of the transformer will cause the tube voltage to rise to 86 kVp. It is interesting to observe that films should be lighter from the reduced mA and darker from the increased kVp. Actually, the real effect would be a change in the contrast scale of the radiograph and would reduce the visibility of iodine contrast agents. The first indication would be reduced image contrast. Whenever the kVp meter indicates poor calibration at high mA levels, it is probable that the tube filament settings require adjustment. The mAs meter is used to check the filament settings by monitoring actual mAs values of the exposures.

1.8 Receiving Inspection

Upon receipt of the instrument:

1. Inspect the carton(s) and contents for damage. If damage is evident, file a claim with the carrier and contact Cardinal Health, Radiation Management Services at 440.248.9300.
2. Remove the contents from the packing material.
3. Verify that all items listed on the packing list have been received and are in good condition.

1.9 Storage

If the unit is to be stored prior to use, pack it in the original container, if possible, and store in an environment free of corrosive materials, fluctuations in temperature and humidity, or vibration and shock.

1.10 Procedures, Warnings, and Cautions

The equipment described in this manual is intended to be used for QUALITY ASSURANCE testing of diagnostic x-ray machines. It should be used only by persons who have been trained in the proper interpretation of its readings and the appropriate safety procedures to be followed in the presence of radiation and the high voltages associated with x-ray machines.

Although the equipment described in this manual is designed and manufactured in compliance with all applicable safety standards, certain hazards are inherent in the use of this equipment.

WARNINGS and **CAUTIONS** are presented throughout this document, when applicable, to alert the user to potentially hazardous situations. A **WARNING** is a precautionary message preceding an operation which has the potential to cause personal injury or death. A **CAUTION** is a precautionary message preceding an operation which has the potential to cause permanent damage to the equipment and/or loss of data. Failure to comply with **WARNINGS** and **CAUTIONS** is at the user's own risk and is sufficient cause to terminate the warranty agreement between Cardinal Health, Radiation Management Services and the customer.

Adequate warnings are included in this manual and on the product itself to cover hazards that may be encountered in normal use and servicing of this equipment. No other procedures are warranted by Cardinal Health. It shall be the owner's or user's responsibility to see to it that the procedures described here are meticulously followed, and especially that WARNINGS and CAUTIONS are heeded. Failure on the part of the owner or user in any way to follow the prescribed procedures shall absolve Cardinal Health and its agents from any resulting liability.

Section 2
Calibration

2.1 Bias Adjustment

With no input signal, connect the oscilloscope probe to pin 7 of the CA3160E Operational Amplifier, U1, which feeds the 555 relaxation oscillator. Set the scope for 1 v/cm and 100 usec/cm. Adjust the bias potentiometer, R12, until a complex sawtooth pulse waveform is seen on the scope. Rotate the potentiometer CCW so that the oscillation stops and the indicated voltage just returns to 0 and then about 5 degrees farther. This will be adjusted again during the final calibration phase.

2.2 Use of Precision Calibrator

The special calibration tool uses a crystal controlled gate circuit feeding a constant current generator. Gate times are 0.50 and 1.00 sec and currents are 75, 300, 450, and 750 mA (approx.). The calibrator provides precise gate times, but the mA values must be measured and listed with a precision of 0.1% before use. The mA measurement can be made with a precision milliampere meter with the gate circuit bypassed. The calibration values and limits given below assume that the measured mA values are exactly as above. In practice, the calibration limits will depend on the measured mA values. When a decimal point is shown in the calibration value, the range switch of the mAs meter should be set to the high sensitivity range.

Use the calibrator to inject a 75 mA signal for 1.00 sec. Set the calibration potentiometer, R14, for 74.3 ± 0.2 mAs (0.7 mAs less than the measured value) displayed and reset the bias potentiometer, R12, for a return to zero time of the signal at U1-7 of 0.5 to 1.0 sec. Reset the meter after each test.

Inject signals of 75, 300, 450, & 750 mA for 0.500 and 1.00 sec and record the readings. Adjust the calibration potentiometer, R14, if necessary to keep the precision within the required range. Record the final values on the calibration sheet for the meter. The most common causes of failure to meet the calibration standards are: defective input CA3160E, defective C6, or improper bias adjustment.

2.3 Alternative Calibration Method

A calibrator can be built out of common laboratory instruments and can be used when the recommended calibrator is not available. The alternative calibrator can be assembled using a medium voltage power supply, some resistors, a relay, a precision milliammeter, an interval counter, and a few common parts. A pushbutton switch is used to cause the electrolytic capacitor to discharge through the relay which closes for a period of between 0.30 and 1.1 sec. The value of the capacitor, relay load resistor, and the relay must be selected to set that interval. The interval counter must read the period in increments of less than 0.001 sec. Resistors are chosen for current values close to those defined above. The calibration proceeds in the same way as described previously.

2.4 Over-Range Indication

Following the calibration process, repeat the injection of mAs signals without resetting. Note that the "+" sign should appear at 1600 (160.0) mAs and above and should remain on when total mAs value exceeds 2000 (200.0) mAs, 3000 (300.0) mAs.

2.5 LO BAT Indication

A quick test demonstrates the action of the LO BAT circuit: short circuit R8 (also U6 pin 2 to U6 pin 4) and note that the "LO BAT" display appears. A more precise test uses an adjustable power supply in place of the 9 V battery. Slowly reduce the voltage and observe when "LO BAT" appears. It should first appear when the external power supply is between 7.7 and 7.3 volts and must remain displayed as the voltage is decreased to less than 5.0 Volts. In general, the "LO BAT" will remain displayed until the entire display fades out. Note: mAs readings taken when the "LO BAT" appears may not be valid.

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