

# Instruction Manual

## MODEL 820

**X-RAY kVp Meter / Exposure Time Meter  
mA / mAs Meter**

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**MODEL 820**  
**X-RAY kVp Meter**  
**Exposure Time Meter mA / mAs Meter**  
**INSTRUCTION MANUAL**

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## DESCRIPTION

The ECC Model 820 X-ray kVp Meter / Exposure Time Meter / mA Meter / mAs Meter combines all these functions in one instrument. When used as an mA meter, the 820 measures x-ray tube current. When used as a kVp meter, the 820 is used to measure the maximum or peak accelerating voltage output produced by tungsten X-ray generators. The ECC Model 820 is a solid-state, digital instrument designed specifically for service personnel in assessing the performance of radiation generators. This instrument not only samples the acceleration voltage of x-rays, but measures the length of an exposure in both kVp mode and mA mode. Having multiple functions in this instrument simplifies regular constancy checks. The instrument is used for dental x-ray units, radiographic and fluoroscopic x-rays. The operator switches from kVp to mA operation simply by plugging in the ECC supplied mA cable

The Model 820 is available with a low range option (Model 820L). See specifications section for actual range of both models.

### **mA / mAs Measurement Overview**

- Plug in the mA cable into the side of the 820
- Connect the leads in series with the ground side of the tube current
- Turn on the 820
- Set Range using "Mode Switch"
- Take an x-ray exposure
- 820 will display and hold mA reading
- Momentarily push "Mode Switch" to see mAs and Exposure Time
- 820 is ready for next reading, no reset is required

### **kVp Measurement Overview**

- Unplug the mA cable
- Place 820 in field of x-ray. Collimate beam to target on top of x-ray
- Turn on the 820
- Take an exposure of at least 0.04 sec
- 820 will display and hold kVp
- Momentarily push "Mode Switch" to see x-ray type and Exposure Time
- 820 is ready for next reading, no reset is required

In kVp mode, the Model 820 is used to measure the peak acceleration voltage produced by half-wave, full-wave rectified x-ray machines as well as DC or multiphase x-rays. It will accurately use ratios produced by two different differentially filtered x-ray detectors to observe kV levels. In order to measure mA, and mAs the operator simply plugs the mA cable into the side of the Model 820 and connect the leads in series with the tube current. This will measure x-ray tube current when an exposure is made.

When either kVp or mA measurement is being made, the Model 820 has the capability of automatically determining the type of x-ray that is being measured. It is not necessary for the user to program correction factors for different types of x-ray waveforms.

The Model 820 automatically resets at the beginning of each exposure, holding the reading until the next exposure. There is no need to reset the meter before each measurement. This also hold true when measuring mA and mAs.

This is a new state of the art instrument with many advanced features. For example, when taking ma / mAs readings, the mA reading is stored and displayed. It is not necessary to have exposure times long enough to display a reading. This minimizes unnecessary exposure to test personnel and minimizes heating as well as wear and tear on the x-ray tube. The Model 820 will display mA, mAs and exposure time for each x-ray exposure further minimizing the number of x-ray exposures.

The most convenient way of using the 820 for kVp measurements is to place it directly under the x-ray head. Step back, take the exposure and then observe the reading. This reading will give you kVp and exposure time. If you wish to obtain a mA or mAs reading plug cable into side of unit and attach the other end to the x-ray. Connect the red and black leads in the ground return line of the high voltage transformer, in the actual current path of the x-ray tube. Step back, take the exposure and then observe the reading. Refer to the section on Operation for information on how to obtain the most accurate measurements.

Note: With high energy (above 70 kVp) disregard first reading after power on.

**It is important that the user be thoroughly familiar with the contents of this manual before performing any tests on radiation generating equipment. It is also imperative that the user be thoroughly qualified, and familiar with safety precautions and other practices relating to radiation generators.**

## GENERAL INSTRUCTIONS

### SWITCH SETTINGS

In order to keep operation easy and straightforward there are only two switches on the front panel.

### ON/OFF SWITCH

The ON/OFF Switch is used to turn on the instrument. The switch is illuminated, and the green light will be **on** when the power is turned **on**. Remember to turn the instrument off when not in use to conserve the batteries. When switching between mA and kVp, turn the unit off.

### MODE SWITCH

The MODE SWITCH function is described below.

#### mA Mode

1. When initially turned on, use the Mode Switch to change from 200 mA range to 2 Amp range (and back).
2. After a mA reading is obtained, pushing the Mode Switch will display the mAs reading and exposure time.

#### kVp Mode

1. When initially turned on, use the Mode Switch to change from “High Speed” to the “High Resolution” mode (and back).
2. After a kVp reading is obtained, pushing the Mode Switch will display additional information i.e. x-ray type and exposure time.

When the Model 820 is first powered on as a kVp meter, it is in “Normal” or “High Speed Mode” which is used for most measurements. When used in Normal Mode the Model 820 inserts a delay of about 22 milliseconds before measuring the kVp. Pushing the button once will put the instrument into “High Resolution Mode”. In High Resolution Mode, the delay is approximately double.

**When using the instrument in High Speed Mode, the x-ray exposure time should be set to at least 40 ms (0.04 sec). When using the instrument in High Resolution Mode, the exposure must be at least 80 ms (0.08 sec).**

When the instrument is put into High Resolution Mode, it will stay in High Resolution Mode until it is turned off. To get the instrument into High Speed or Normal mode, turn the power off and then on. There is additional information about using High Resolution Mode in the Operation section.

When the instrument is first powered on as an mA / mAs meter, it is in the 200mA full scale range. Pushing the Mode Switch once will put the instrument into the 2 Amp range. Pushing the Mode Switch again will alternately put the instrument into the 200mA and 2 Amp ranges. After any reading is taken, the unit must be switched off to change the range.

## 2. Additional Information Display

After a measurement, the kVp value will be displayed. Additional information can be displayed by pushing the mode button momentarily. The instrument will then sequence through the following information:

After a measurement, the mA value will be displayed. Time exposure can be displayed by pushing the mode button momentarily.

### **mA Mode**

- mAs
  - Exposure Time in milliseconds
- And back to mA display.

### **kVp Mode**

- Exposure Time in milliseconds
  - Waveform type
- And back to kVp display

The additional information will each be displayed for about 1.5 seconds, and then the display will revert back to either kVp or mA. If the battery is low, a 'Batt Low' message will also appear for 1.5 seconds.

After the Additional Information is shown and the display returns to kVp or mA, the meter is ready for another reading.

## 3. mAs Cable

The mAs Cable provides a switch input to the 820. When the cable is unplugged the Model 820 functions as a kVp meter. When the cable is plugged in, the Model 820 functions as an mA / mAs meter.

**When changing the cable, turn the instrument off.**

## OPERATION

### **kVp Measurements:**

To use the Model 820 X-ray for a kVp measurement, in most instances it is only necessary to turn on the instrument, and then center the meter's target in the light field and make an exposure.

In order to ensure more accurate kVp readings, the following points should be kept in mind. Please see Appendix A for more information.

#### 1. Current (mA)

The Model 820 will operate down to approximately 7 mA if the x-ray is focused properly on the x-ray target. The best accuracy is obtained at 10 to 50 mA.

#### 2. Height

For half wave x-rays (Most dental x-rays) with 7 to 15 mA output, the cone should be ½ to 2 inches above the instrument.

For x-rays with 25 to 100 mA output, position the x-ray head 8 to 16 inches above the instrument. For x-rays with more than 100 mA, increase the distance from x-ray to instrument. There is a chart in Appendix A which shows maximum kV and mA for three different heights.

### 3. Collimation

Collimate the x-ray to approximately 2" by 2" centered on the target on top of the instrument.

### 4. Exposure Time

There are two modes requiring different exposure times.

*In the Normal or "High Speed Mode", the exposure time must be at least 0.04 sec (40 ms).* Longer exposure times than 50 or 100 ms are not necessary or desirable in order to minimize wear and tear on the head and exposure to the operator. When the instrument is used to measure exposure time, longer exposures may be tested.

*In "High Resolution Mode", the x-ray exposure time must be at least 0.08 sec (80 ms).*

### 5. Waveform

This instrument measures the maximum or peak accelerating voltage that occurs during any part of the x-ray exposure except for the first 22 ms which we use as a delay to make sure the x-ray waveform is stable. The instrument will read and display the maximum value of the accelerating voltage during the rest of the x-ray exposure.

### 6. Initial Reading

The x-ray detectors accumulate charge when the unit is not used. When initially powered on, the instrument will need one x-ray exposure to work correctly. Disregard the first reading, especially at higher energies i.e. above about 80 kVp.

### **Exposure Time Measurements:**

The Model 820 measures the Exposure Time each time a kVp measurement is made. To display the Exposure Time after an exposure, momentarily push the white Mode pushbutton switch. The exposure time will be displayed in milliseconds (ms). In normal or High Speed mode, exposure times less than 40 ms cannot be measured. The x-ray exposure time must be at least 40 ms. If it is necessary to measure exposure times less than 40 ms, please contact ECC to purchase our Model 8700 Digital X-ray Time Exposure Meter or Model 890 X-ray Dose Meter.

When the instrument is in High Resolution Mode, exposure times less than 80 ms cannot be measured. The x-ray exposure time must be at least 80 ms. we recommend using normal mode for all exposure time measurements.

More accurate reading of exposure times are obtained at lower kVp / mA settings. Many high-energy x-ray exposures have a noticeable decay at the trailing edge (end) that will be added to the exposure time. We recommend making exposure time readings at 50 to 80 kV and 25 to 50 mA.

## High Resolution

The Model 820 was specifically designed to accurately make measurements with a short exposure time in order to minimize wear on the x-ray head and exposure to service personnel. However, there are three conditions where more accurate readings can be obtained by sampling the x-ray waveform for a longer period of time.

Slow X-rays - Some x-rays, particularly older models take a relatively long time to reach peak exposure. In the normal or High Speed mode the instrument waits 22 ms before starting the x-ray measurement. The wait time is doubled in the High Resolution mode, and the actual measurement time is also doubled.

Some DC and multiphase units come on quickly but have a large overshoot. If the overshoot lasts more than 22 ms, High Resolution Mode will give a more accurate reading of the true maximum kVp.

## FILTRATION CORRECTION (kVp Measurement)

The Model 820 Meter is calibrated for tungsten tube x-rays with 1.5 mm of Al filtering. When the x-ray has different filtration, refer to the table below and make the appropriate correction to the kVp reading.

At 50 mA

Added Filtration	60 kVp	80 kVp	100 kVp	120 kVp
0.31 mm Al	-0.2	-0.5	-0.5	-0.5
1 mm Al	-1.1	-1.5	-2.6	-3.0

At 100 mA

Added Filtration	60 kVp	80 kVp	100 kVp	120 kVp
0.31 mm Al	-0.2	-0.6	-0.8	-1.7
1 mm Al	-0.9	-1.7	-1.7	-3.4

For example, if your x-ray has 2.5 mm Al, that is equivalent to 1.0 mm of added filtration. A reading at approximately 60 kVp, 50 mA will be 1.1 kV high. Subtract 1.1 kVp to get the correct reading.

The values can also be interpolated. For example, when taking a reading at 70 kVp, 100mA with 0.3 mm additional filtration (1.8 mm total), use a correction factor mid way between -0.2 and -0.6, which is -0.4. Therefore, when taking a measurement at about 70 kVp, 100 mA with 1.8 mm of Al filtration, subtract 0.4 kVp.

For values below about 50 kVp, the correction factor is minimal and can be ignored.



## **OPERATION - mA / mAs Measurements:**

1. Before making any connections to the x-ray generator, MAKE CERTAIN THAT THE GENERATOR POWER IS TURNED OFF.
2. Connect the Model 820 mA cable to the x-ray generator under test (see below).
3. Plug cable into side of Model 820.
4. Push in Green Button on front display to turn 820 on.
5. Set the range (200 mA or 2 Amp) by pressing the white Mode Switch.
5. Step back from x-ray and take exposure.
6. Observe the reading.
7. To see mAs and exposure time, momentarily push the white Mode Switch after observing initial reading.

**CAUTION: Do Not Plug Or Unplug mA Cable While Unit is ON. Line up the pins in the cable and chassis connector before inserting.**

When taking mA or mAs measurements, it is not necessary to set the exposure time to any particular value. The advanced circuit in the Model 820 will determine the average current for the entire x-ray exposure and display the result. Short exposures can be used because the mA value is calculated and then stored.

The ECC Model 820 performs a true RMS measurement of the x-ray current, and then converts that value to average current to conform to industry standards.

If the instrument is set for 200mA range and any portion of the current reaches 200 mA, the unit will indicate that the reading is Overscale. Turn the unit off and on and set the range for 2 Amp to get the proper reading. This can happen with AC x-rays measuring between 150 and 200 mA as well as DC and multiphase x-rays that have an overshoot.

## **mA Cable Connection**

The mAs meter was 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 jack in series with the transformer downstream of the rectifier (AC Path). However, all 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 present, it could bypass the meter and invalidate the reading. Do not use resistors, varistors, bypass, or distributed capacitors in parallel with the meter. This will affect 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 voltage above 10V, will probably not affect the reading.

## BLUETOOTH REMOTE MONITOR

This instrument is equipped with a feature that can be used to show output data on an Android smartphone or tablet using the Bluetooth module in every instrument. When not using the Bluetooth feature, the unit is used in normal fashion. In order to use the Remote Monitor, an application (app) must be installed on your Android phone or tablet.

This feature is installed on Model 815 kVp Meters serial number 646 and up and Model 820 kVp/mA Meters serial number 329 and above.

This feature is provided as a convenience so that it is not necessary to go into the x- ray room to observe the meter after each reading. There is also a file save capability which can assist in recording data.

### How to download the app:

- 1: Open the Google Play Store
- 2: Search for ECC Remote Monitor
- 3: Download the App
- 4: The app will install automatically

### Running the App:

When the ECC Remote Monitor app is started, it asks for your permission to use the Bluetooth capabilities of your Android device, if you deny this request, the application will close.

### Connecting to a device:

The home screen should now be shown, and you may choose to connect to a device via Bluetooth in the action bar at the top or bottom of the screen (depending on your device screen size).

You may choose devices by using the menu button in any Android systems below version 3.0 (Honeycomb). If the ECC device does not appear in the connection menu, select the scan button and it will appear in the menu if it is within range.

The device name will either be shown as **null**, or **ECC\_XXX** where “XXX” is the serial number of the device. Select the ECC device to connect with it.

The first time you attempt to connect with this device, you will be asked for a pairing code, which will be ‘1234’. A confirmation message will be displayed if the device has been successfully connected. You may now take an x-ray or mA measurement.

### Data

The data will be displayed on the screen with each reading numbered sequentially, along with the time each measurement is taken. If an x-ray is taken, kVp, ms, and a

time stamp will be shown.

If you are using a model 820 meter, mA and mAs will also be shown.

Note: when using a model 815 meter, mAs will display as N/A (not applicable). If the data extends beyond the size of the screen, you may swipe vertically or horizontally to scroll through it.

### **Saving Data:**

The data collected will be displayed on screen and you may choose to save it on your SD card or Google drive account. To save the file to your SD card, type the desired filename in the text box at the top of the screen and press the 'save' button. If you have a Google account, you may choose to upload the data to your Google Drive™ cloud storage. Select the 'Google Drive' button to choose an account to upload to. To send the file to Google Drive, press the 'Upload' button, which will appear after selecting an account.

**Changing Accounts:** To select a different account, long press (Hold) the 'Upload' button until the account selection menu appears.

If you choose to upload the data, a text file with all the information collected will be stored in your Google Drive cloud storage.

If you saved your file to the SD card, use a file explorer program (search "file explorer" in Google Play) and navigate to your SD folder. Your file will be there named as "the text you chose".txt.

To clear the data at any time, press the "Clear" button.

### **Troubleshooting:**

If at first, the ECC Remote Monitor application does not function properly, try exiting and reopening the app. If a Bluetooth connection cannot be made between your Android and the ECC device, try turning the ECC device off and on, and then try to connect again with the application.

**If the app does not display readout when taking x-ray measurements**, it is possible that your payment method is still pending. Once the payment is cleared, your application will be licensed and allow measurement readouts.

If for some reason, the app will not work with your android device, the instrument can still be used for measurements. You may contact us to report bugs in the application. If we fail to correct an issue regarding the compatibility of the app with your device in a timely manner, we may issue you a refund for the purchase price of the application.

## **STATUS MESSAGES**

### **Applies to kVp and mA Measurements**

The alphanumeric display on the Model 820 is capable of displaying messages along with the output readings that give the user additional information. Each message is described below:

Rdy Fast - Unit is ready for a reading in Fast mode

Rdy mA- Unit is ready for a reading in mA mode

RdyHiRes - Unit is ready for a reading in Hi Resolution mode

AlignErr - Alignment Error. Position the Model 820 in the center of the x-ray beam.

Over Rng - Over Range. The x-ray output is too high. Use a lower mA setting or increase the distance from the x-ray head to the Model 820.

OvrScale - Over Scale. The output of the x-ray exceeds the measurable range of the Model 820.

Low Batt - Battery is low. The unit may still be operated for several hours, but accuracy may suffer. Replace the batteries as soon as possible.

Low Time – The exposure time is too low. Make sure that the x-ray exposure time is at least 0.04sec (40 ms). When this error occurs, pressing the white button will not give the user any information about the exposure time or waveform type.

## **BATTERY REPLACEMENT**

The Model 820 is supplied with 4 AA batteries. Replace the battery when the "Low Batt" indication shows in the display. Any standard AA batteries can be used in the 820. To prolong battery life, turn the instrument off when not in use.

To replace the battery, open the battery compartment on the bottom of the case using a small screwdriver or thumbnail. Remove the old batteries, and install the new batteries. Observe the correct polarity of the batteries as shown on the bottom of the battery compartment.

## **WARRANTY**

Electronic Control Concepts warrants the Model 820 X-ray kVp Meter / Exposure Time Meter/mA/mAs from defects in materials and workmanship for a period of 2 years. There is no warranty on the battery. ECC will replace or repair any Model 820 during the first year after shipment that does not show obvious signs of abuse. Contact the factory as described below.

## **SERVICE INFORMATION**

If a unit should need calibration or service, please contact the factory by phone, fax or Email.

(800)VIP-XRAY or (800)847-9729 Phone  
513-248-2402 Fax  
[sales@eccxray.com](mailto:sales@eccxray.com)

Ship the unit to:  
**Electronic Control Concepts**  
1160 US Highway 50  
Milford, OH 45150 USA

## SPECIFICATIONS

### SPECIFICATIONS FOR 820/820L mA

- **RANGE**
  - ✓ 200 mA Full Scale  
mA Resolution (mA or mAs)  
10 Ohms Input impedance
  - ✓ 2A Full Scale  
1 mA Resolution (mA or mAs)  
1 Ohm Input impedance
  - ✓ Meter automatically selects AC/DC  
Select range via pushbutton
  - ✓ mA / mAs ACCURACY  
2% +/- 1 mA on all ranges
- **CONNECTION**  
Via 5 meter cable with two alligator clips or banana clips

### GENERAL SPECIFICATIONS

- **DISPLAY**
  - ✓ 0.4" (10.2mm) Liquid Crystal  
8-Character Alphanumeric
- **CONTROLS/INDICATORS**
  - ✓ ON/OFF Switch – Illuminated push- button  
with green power-on indication
  - ✓ MODE Switch - momentary push-button
  - ✓ 8 Character Liquid Crystal Display
  - ✓ No connections needed for kVp measurement
- **POWER**
  - ✓ 4 AA batteries accessible from bottom of case
  - ✓ Low battery indicator
- **BATTERY LIFE**
  - ✓ 48 hours continuous
  - ✓ Typically 9 months of normal use
- **WARRANTY**  
2 years from ship date
- **PHYSICAL SIZE**  
150 X 120 X 58.5 mm  
5.9 X 4.7 X 2.3 inches

- **WEIGHT**  
0.7 kg, (1.5 lb)

### SPECIFICATIONS FOR 820/820L kVp

- **RANGE**  
**820:** 45 to 125kV  
**820L:** 40 to 115kV
- **KVP ACCURACY**  
2% +/- 1 kV, at 25 to 100 mA (820)  
or 10 to 50 mA (820L)  
both 18 to 47 cm from head, for Tungsten target x-ray tube with 1.5 mm Aluminum equivalent filtration.
- **EXPOSURE TIME ACCURACY**  
1% +/- 2 millisecond (min time to 2 sec)
- **MINIMUM EXPOSURE TIME**
  - ✓ 40 millsec -High Speed Mode
  - ✓ 80 millsec -High Resolution Mode
- **MINIMUM CURRENT (mA)**  
7 mA (820) or 5 mA (820L) at 50 kV,  
10cm from x-ray, depending on focus

### ORDERING INFORMATION

- **Model 820** X-ray kVp /mAs / Exposure Time Meter
- **Model 820L** Low Range X-ray kVp / mAs / Exposure Time Meter

Please note that the **Model 815** X-ray kVp/Exposure Time Meter is also available from ECC.

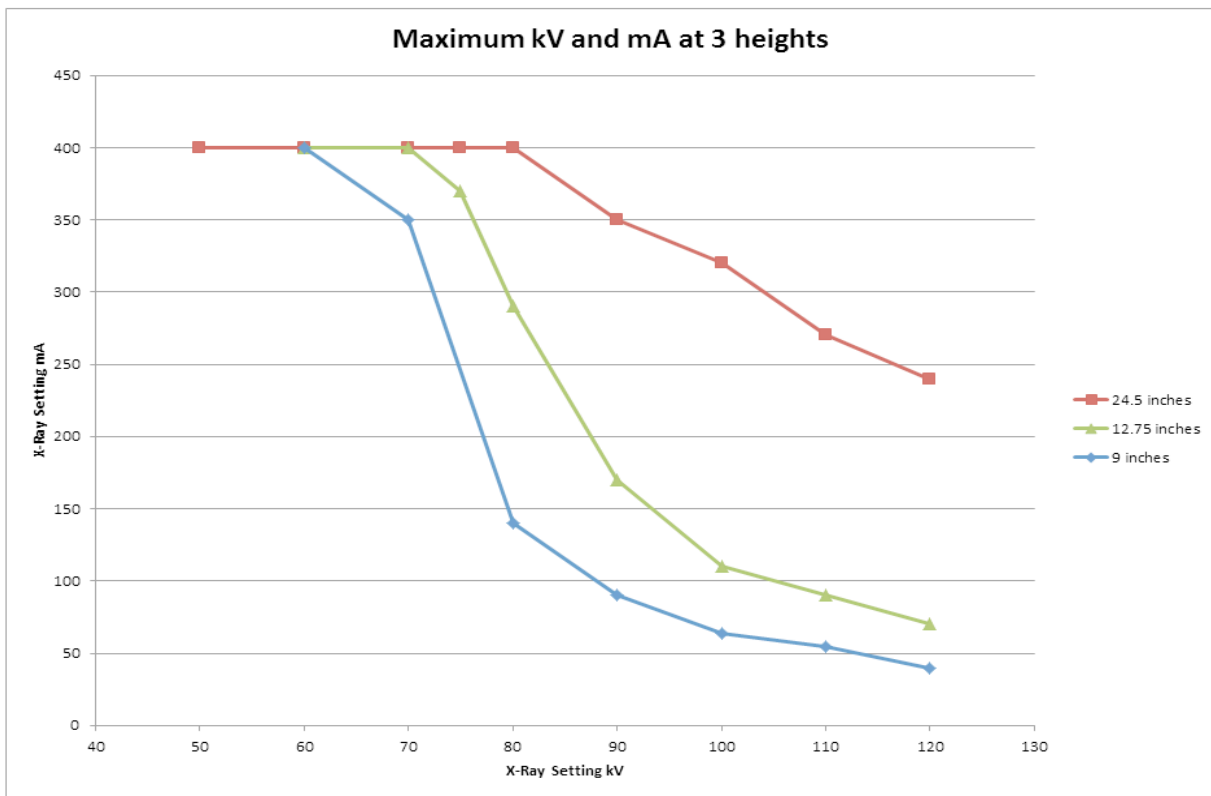
## APPENDIX A

Additional information for accurate kVp Measurement.

### Height (distance from instrument to x-ray head)

This instrument can measure kVp accurately over the specified range and is relatively independent of the height of the x-ray tube above the instrument. However, there are limitations that must be taken into account. Please note, that when we refer to height, we are discussing the height above the instrument to the actual x-ray head, not the collimator. The intensity of any x-ray is proportional to kV, to x-ray tube current (mA) and distance (height), so all three parameters are important. To simplify this discussion, please refer to the chart below:

The chart below shows the maximum kV and mA. This instrument can accurately measure at kV / mA combinations below the three curves at the particular height.



Two examples will clarify the use of the chart. If the user anticipates measuring a kV of 100 at a tube current of 200 or 250 mA, the height should be 24 or 25 inches (about 64 cm). If the user tries to make the measurement at a height of 12 or 13 inches (31 cm) the unit will read overscale. As another example, at 60 kV, the instrument can measure up to 400 mA at a height of at least 9 inches (23 cm). Keep in mind that for low mA, and low kV there is also a sensitivity issue, and that lower heights will be helpful in getting readings at low kV / mA settings.

Here are some more guidelines:

For dental x-rays with an output from 7 to 15 mA, place the instrument ½ to 2 inches (2 to 5 cm) under the cone.

For kV of 40 to 50 kV, 15 to 50 mA a height of about 6 inches (15 cm) will work well. Additional height will allow measurements at high kV and mA.

### **Measurements with plastic wrap**

Many dental offices use a thin, transparent plastic cover over the x-ray head to help with infection control. The plastic can induce measurement errors because of the static charge that gets built up on the plastic. For best results remove the plastic cover.

### **Pre-Heat**

Many x-rays, particularly dental units with a single winding head excite the x-ray at a lower voltage before the actual exposure in order to allow the filament to warm up. Some of these x-rays emit radiation during this “pre-heat” time. This presents a measurement problem. If the kVp reading appears to be inaccurate, check the exposure time. If the measured exposure time is longer than the expected time, the meter is picking up the pre-heat radiation. Increase the distance from the x-ray head to the instrument. If the pre-heat radiation is significant, you may need to experiment to find the right height.

### **Electronic Control Concepts**

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