FLUKE ®

Fluke199XRAY
Medical ScopeMeter

Users Manual

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About this Manual

This manual provides information on the X-RAY kVp measurement function of the Fluke 199XRAY Medical ScopeMeter. It also describes user interface differences between the Fluke 190B/C and the Fluke 199XRAY.

For other information on the Fluke 199XRAY please consult the Fluke 190B/C Series Getting Started manual, the Fluke 190B/C Series Users Manual (on CD-ROM), and the Fluke 190B/C Medical Functions Users Manual Supplement (on CD-ROM) that are included in the shipment.

Safety Information

Read and comply with the safety instructions that you find in the ScopeMeter 190B/C Series Getting Started manual and in the Fluke 190B/C Users Manual .

Limited Warranty, Limitation of Liability

Read the Warranty and Limitation of Liability statements that you find in the ScopeMeter 190B/C Users Manual that is included in the test tool kit shipment (on CD ROM).

Shipment Contents

In addition to the shipment contents shown in the Fluke 192B-196B/C-199B/C Users Manual, the 199XRAY shipment includes the following parts:

Part	Ordering code
Power Adapter Plug UK	2726493
Power Adapter Plug EURO	2726507
Power Adapter Plug Australia	2726518
Power Adapter Plug USA	2726529
MA190 Accessory Set	See 190B/C Medical Functions Users Manual Supplement.

About the X-RAY kVp Function

The 199XRAY Medical Scopemeter, when used with Fluke Biomedical kVp Divider, automatically measure kVp average and kV peak. In the radiographic measurement mode, exposure time is also measured in milliseconds or pulses.

The Fluke Biomedical Non-Invasive kVp Divider (Model 35080/A/B/M) is an alternative to high-voltage divider tanks. It provides safe, non-invasive, fast measurement of kVp without endangering personnel and/or equipment. Its use is primarily intended for X-ray machine service and calibration. The kVp Divider provides an analog output voltage proportional to the instantaneous voltage applied to the X-ray tube.

The X-RAY kVp function provides oscilloscope setups for measurements using the kVp Divider and the following filter packs on Input A :

- Wide Range Filter Pack
- K-edge Mammo Filter Pack
- Linear Mammo Filter Pack
- CT Filter Pack
- Mobile Pack Plus Filter Pack
- Low Range Filter Pack

For details on the kVp Divider refer to the 35080/A/B/M Operators Manual.

190B/C vs. 199XRAY User Interface

The 190B/C and the 199XRAY operating instructions are equal, except for the following:

- The 199XRAY user interface text is available in English only, language selection is not possible. See 'USER Button Bar ' below.

- The 190B/C RECORDER functions can be selected by pressing the RECORDER key.
  The 199XRAY RECORDER functions can be selected by pressing the MEDICAL key.
  See '190B/C RECORDER Key' and '199XRAY MEDICAL Key' below.
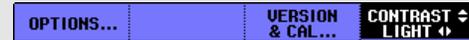
USER Button Bar

Pressing the 190B/C USER key will open the button bar:

Pressing the 199XRAY USER key will open the button bar without the LANGUAGE selection:

190B/C RECORDER Key

(RECORDER)	Pressing the RECORDER key will open the screen shown below.

```
Scope
  □ Trend Plot
    Plots a graph of selected Scope
    measurements over time.

  □ Scope Record
    Records scope waveforms in deep
    memory.
Meter
  ■ Trend Plot
    Plots a graph of selected Meter
    measurements over time.

                              ENTER
```
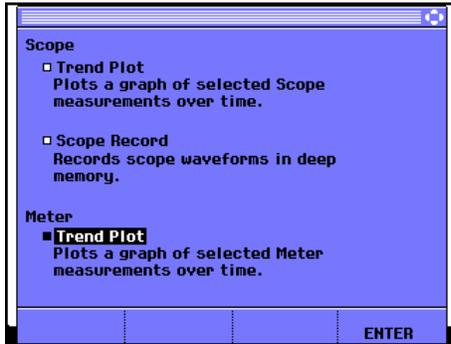
199XRAY MEDICAL Key

(MEDICAL)	Pressing the MEDICAL key will open the screen below. Press again or press [F1] to exit.

```
Medical measurements    kUp mode:
  ■ kUp
                        Automatically
                        measures kUp
Scope                   for various
  □ Trend Plot          filter packs,
  □ Scope Record        and offers
                        dedicated cursors
Meter                   for manual
  □ Trend Plot          measurements

MEDICAL
EXIT                              ENTER
```
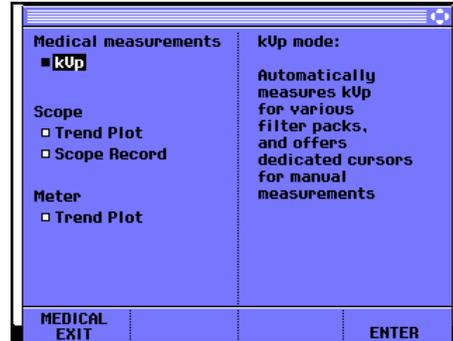
The Medical measurements kVp function is described in Chapter 2 of this manual.

Operating instructions for the Scope-Trend Plot, the Scope- Scope Record , and for the Meter-Trend Plot mode are described in the Fluke190B/C User Manual Chapter 3 Using the Recorder Functions.

Chapter 2
Using the X-RAY kVp Function

kVp Measurement Procedure

To perform kVp measurements, do the following:

1	Follow the operating instructions for the filter pack as described in the filter pack Operators Manual.
	Connect the kVp divider to Input A of the 199XRAY using a shielded 1:1 cable, for example the cable of the MA190 Accessory set.
2	Select the required filter pack, see 'Selecting a Filter Pack'.
3	Start the measurement. See kVp Scope Mode on page 2-7 for further instructions.

Selecting a Filter Pack

To select a filter pack, do the following:

1	(MEDICAL)	Display the MEDICAL/RECORDER screen.
2	F4	Select ■ **kVp** with the arrow keys, then accept with the F4 (ENTER) key. One of the Filter Pack Selection Screens will be shown.

Wide Range – Low Range Filter Pack

Similar screens are shown for Wide Range and Low Range.

Proceed as follows to select the filter pack:

1	▲ ▼ F4	Select ■ **Wide Range** or ■ **Low Range** with the arrow keys, then accept.
2	▲ ▼ F4	Select the wanted signal shape, then accept. The test tool will enter the kVp Scope Mode, see page 2-7.

CT & Mobile Pack Plus Filter Pack

Similar screens are shown for Wide Range and Low Range.

Proceed as follows to select the filter pack:

1	▲ ▼ F4	Select ■ **CT** or ■ **Mobile Pack Plus** with the arrow keys, then accept. The test tool will enter the kVp Scope Mode, see page 2-7.

Cadmium K-edge Mammo Filter Pack Calibration Overview

During Cadmium K-edge Mammo Filter Pack calibration, screen instructions will guide you through the calibration steps. This section provides an explanation of the calibration steps.

Read the mammographic filter pack sections of the Model 35080/A/B/M kVp Divider Instruction Manual to become familiar with the specifications, theory of operation, and application of corrections for these filter packs.

K-edge Measurement Setup:

Install the Cadmium K-edge Filter Pack in the kVp Divider. Place the kVp divider in the x-ray beam on the compression paddle or other suitable support with the long axis of the kVp divider perpendicular to the axis of the x-ray tube. Raise the kVp divider as close as possible to the x-ray tube. The x-ray beam should cover the entire filter pack. Select the k-Edge Mammo filter pack from the filter pack menu.

25 kVp Measurement Procedure:

Set the x-ray generator for 25 kVp, 100 mA, 80 ms. If not available, use a mAs setting that provides an exposure of 80 ms (+/- 10 ms). Select the molybdenum (Mo) filter on the generator. Make the first baseline measurement.

26 kVp Measurement Procedure:

Repeat the baseline measurement at a slightly higher kV setting that should still be below the k-edge (26.7 kV). Set the generator for 26 kVp,100 mA, 80 ms. If not available, use a mAs setting that provides an exposure of 80 ms (+/- 10 ms).

If the voltage difference between the first and second baseline measurements is within the limits (+/- 20mV), this is the baseline voltage. If the voltage difference is outside the limits, repeat the above measurements at 24 kVp and 25 kVp respectively.

29kVp Measurement Procedure:

Set the generator for 29 kVp,100 mA, 80 ms. If not available, use a mAs setting that provides an exposure of 80 ms (+/- 10 ms). Make the k-edge kV reference measurement.

If the exposure is within the range 27.5 to 29.5 kVp, the reading is accurate. If ---.kVp is displayed, set the generator for 28 kVp and repeat step 4. If 0.0 kVp is displayed, set the generator to 30 kVp and repeat step 4. The k-edge kVp is used to determine linear filter pack correction.

Once an accurate determination of kVp has been made do not disturb the x-ray generator settings. Proceed to linear mammo filter pack use.

Linear Measurement Setup:

Remove the k-edge filter pack and replace it with the linear mammo filter pack. Increase the target to filter pack distance to about 15 inches (38cm). If the Model 35080/A/B/M kVp Divider changes position in the x or y axis with respect to the x-ray generator during the linear kVp measurements, you must repeat the determination of the k-edge kVp and the correction value since this measurement is position sensitive.

Linear Correction Exposure:

Make an exposure using the same generator settings as those used to make the last k-edge exposure. After this measurement is complete, the kV correction for the linear filter pack will be displayed. If you do not want your linear kVp measurements automatically corrected, press F1 (LINEAR CHANGE…) and select No Correction. To recalibrate the k-edge correction, select Recalibrate…

k-Edge Mammo Filter Pack

The k-Edge Mammo filter pack is used to determine the correction factor (recalibrate) for the Linear Mammo filter pack.
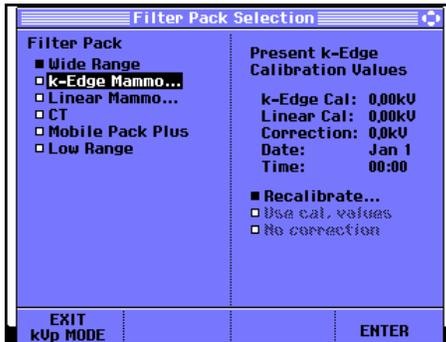
Proceed as follows to do the recalibration:

1 Select ■ **k-Edge Mammo…** with the arrow keys, then accept.

The screen will show the present k-Edge calibration values.

2 F4 Accept ■ **Recalibrate…** to start the calibration.

You will see the calibration startup screen as shown below.
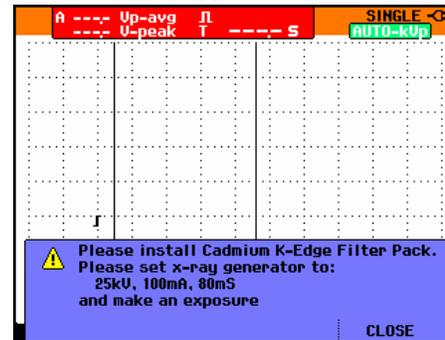
3 Follow the screen instructions.

4 F4 Close the instruction banner and start the calibration.

You will be guided through the calibration procedure by screen messages. See also 'Cadmium K-edge Mammo Filter Pack Calibration Overview' on page 2-3

Linear Mammo Filter Pack

```
┌─────────────────────────────────────┐
│ ═══════ Filter Pack Selection ══════ ⬙ │
│ Filter Pack          Present k-Edge   │
│  □ Wide Range         Calibration Values│
│  □ k-Edge Mammo...                    │
│  ■ Linear Mammo...    k-Edge Cal: 0,00kV│
│  □ CT                 Linear Cal: 0,00kV│
│  □ Mobile Pack Plus   Correction: 0,0kV │
│  □ Low Range          Date:      Jan 1 │
│                       Time:      00:00 │
│                                       │
│                       □ Recalibrate...│
│                       ■ Use cal. values│
│                       □ No correction  │
│                                       │
│   EXIT                                │
│   kVp MODE                    ENTER   │
└─────────────────────────────────────┘
```

Proceed as follows to select the filter pack:

1	Select ■ **Linear Mammo…** with the arrow keys, then accept.

| 2 | Select and accept:

■ **Recalibrate…** to determine the correction factor for the linear Mammo filter pack.
Continue as for the k-Edge Mammo filter pack step 3.

■ **Use cal. values…** to use the present calibration values.

The test tool will enter the kVp Scope Mode, see page 2-7. This choice is disabled if the calibration values are invalid. Select ■ **Recalibrate…** to get valid calibration values again.

■ **No correction…** to perform kVp measurements without applying the correction factors for the filter pack.

The test tool will enter the kVp Scope Mode, see page 2-7. |

kVp Scope Mode

When entering the kVp Scope mode predefined scope settings for the selected filter pack are provided. Some of these settings are fixed, some can be manually adjusted. See kVp Scope Mode Presets on page 2-12.

There are two different measurement modes in the kVp Scope Mode, the RADIO mode for measuring single radiographic exposures and the FLUORO mode for measuring continuous or pulsed fluoroscopic exposures.

Radiographic Mode (RADIO)

When used in the Radiographic mode, the 199XRAY waits for a trigger then stores the entire kV waveform. When the radiographic exposure is complete, kVp-avg, kV-peak, and exposure time in ms or pulses displayed (the kV waveform must also meet the Automatic kVp Mode requirements). The instrument is then ready for another exposure.

Note:

The most recent 100 screens are always stored in the replay buffer. To view stored screens, press the REPLAY button and use the F1, F2, and F3 keys. To start a new measurement, press F4, EXIT REPLAY. For more information, please see the 190B/C Users Manual.

Fluoro Mode (FLUORO)

When used in the Fluoro mode, the 199XRAY waits for a trigger then samples the kV waveform at one sample per second. For each sample, kVp-avg and kV-peak are measured (each sample must also meet the Automatic kVp Mode requirements). Each sample is stored in the instrument's replay buffer and up to 100 samples can be stored. When the fluoro exposure stops or if the replay buffer fills, the Replay Menu is displayed and each sample may be displayed using the F1, F2, and F3 keys. To start a new measurement, press F4, EXIT REPLAY.

kV Measurements

kVp average is the average value of the kV peaks within the measurement area and is indicated by the tick marks on the vertical cursors.

kV Peak is the highest kV value within the measurement area.

In radiographic (RADIO) mode, the kV measurement area is the central 80% of the kV waveform; the first and last 10% of the waveform are excluded from these measurements.

In fluoroscopic (FLUORO) mode, kV is measured over the complete waveform sample.

Note:

When measuring kV, the bottom of the trace (indicated by the A input zero icon "A-" at the left of the screen) is not zero. The value at the bottom of the trace is the zero value for the selected filter pack. Table 2-1, Default Filter Pack Settings, lists the zero values for all filter packs.

For example, when using the Wide Range Filter Pack the zero value is 40 kV. If the kV waveform is 3 divisions above zero and the vertical sensitivity is 20 kV/div (60 kV), the measured kV is 100 kV (40 kV + 60 kV = 100 kV). For more information, see the 35080/A/B/M User Manual. These adjustments are automatically performed for all kV measurements.

Exposure Time Measurements (RADIO only)

Exposure time in milliseconds is measured between the points corresponding to 75% of kVp-avg on the first rising edge and last falling edge of the kV waveform.

Exposure time in pulses is measured by counting the pulses that exceed 75% of kVp-avg during the exposure.

AUTO-kVp Mode, MANUAL Mode

In the AUTO-kVp mode, vertical cursor lines are automatically positioned to indicate the area used for the kVp measurement (10…90% area).

In the MANUAL mode you can select between horizontal and vertical cursors, and you can manually move the cursors. The cursors allow you to make precise digital measurements on the waveform manually.

Selecting AUTO-kVp mode – Manual Mode

Do the following to select AUTO-kVp or Manual mode:

AUTO MAN	Select AUTO-kVp or MANUAL mode.
	The right top corner of the screen shows **AUTO-kVp** or **MANUAL**.

To operate the cursors you can turn the cursor menu on:

CURSOR	Turn cursor menu OFF or ON.

F1…F4 key labels for cursor menu OFF:

WIDE RANGE CHANGE…	RADIO FLUORO	TIME PULSE◊	EXIT kVp MODE

F1…F4 key labels for cursor menu ON:

CURSOR kVp ▯▯ = I	MOVE	TIME PULSE◊	CURSOR MENU OFF

Auto kVp Mode Waveform Requirements

For automatic measurement of kV in the Fluoroscopic measurement mode, the waveform must be onscreen and must meet the following criteria:

- The kV being measured must be within the range of the chosen filter pack and must be above the trigger level for the filter pack and sensitivity setting (See Tables 2-1 and 2-2).

- The vertical height of the entire waveform must be greater than 2.5 divisions above the zero level

- No portion of the waveform may be off the top of the screen

For automatic measurement of kV and exposure time in the radiographic measurement mode, the entire waveform must be onscreen and must meet the following criteria:

- The kV being measured must be within the range of the chosen filter pack and must be above the trigger level for the filter pack and sensitivity setting (See Tables 2-1 and 2-2).

- The vertical height of the entire waveform must be greater than 2.5 divisions above the zero level

- No portions of the waveform may be offscreen

- The last falling edge of the waveform must be greater than 3.5 divisions horizontally from the rising edge (trigger position).

- The last falling edge of the waveform must be less than 9 divisions from the rising edge (trigger position). This leaves the last horizontal division with a signal at zero level, which verifies that the current acquisition contains the complete signal.

kVp Scope Mode Screen, Readings, F1-F4 Keys

An example of the kVp scope mode screen is shown in the figure below. Numerical readings and the softkey button bar differ from the normal Scope mode.
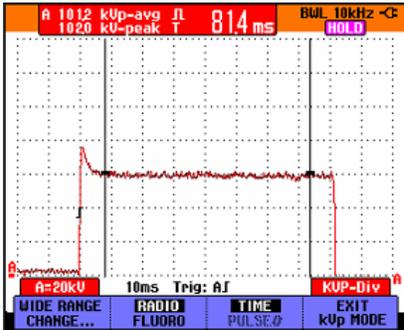
kVp Mode Readings

Voltage readings:

xxx.x kVp - avg average kVp value between cursors, indicated by the tick marks on the vertical cursors

xxx.x kV - peak kV peak value between cursors

In the MANUAL mode other readings may be shown depending on the selected cursors. See 'F1…F4 softkey functions for cursor menu ON' on the next page.

TIME/PULSE# Readings:

You can select Time or Pulse readings, if applicable, using the F3 key.

XX.XX ms time of pulse (AUTO)

XX.XX ms time of multiple pulses (AUTO)

XXX pls number of pulses (AUTO)

XX.XX ms time between cursors (MANUAL)

XXX pls number of pulses between cursors (MANUAL)

Note: If the kV or exposure time values cannot be calculated because of the signal shape, or because the kV is not within the range of the chosen filter pack, dashes will be displayed. Use the Manual mode to read the voltage at each cursor position or adjust the vertical and/or horizontal sensitivity to obtain a signal that meets the Auto kVp Mode Waveform Requirements.

F1…F4 Softkey Functions

F1…F4 softkey functions for cursor menu OFF:

F1	The key label shows the current filter pack name. Press to return to the Filter pack selection screen if you want to select another filter pack.
F2	Select optimal scope settings for RADIO or FLUORO mode measurements (if applicable).
F3	Select between **TIME** (in ms) or **PULSE#** reading in the RADIO mode. PULSE# is not available when HF/Three Phase signal shape is selected.
F4	Exit the kVp mode and return to the MEDICAL/RECORDER screen.

F1…F4 softkey functions for cursor menu ON:

F1 **kUp**	Select the cursor mode: AUTO-kVp mode
▐▐	MANUAL mode: Two vertical cursors. Use ◁▷ to move the cursors. Use F2 to select cursor to be moved. kVp measurements apply to the area between the cursors.
▬	MANUAL mode: two horizontal cursors. Use △ ▽ to move the cursors. Use F2 to select cursor to be moved. Readings are: - voltage difference between cursors (**A** ↕) - voltage at the upper (**HIGH**) and lower (**LOW**) cursor position
▐▐	MANUAL MODE: One vertical cursor. Use ◁▷ to move the cursor. Readings are: - the average, minimum, and maximum voltage at the cursor position
F2	Select the cursor to be moved.
F3	Select between **TIME** or **PULSE#** reading.
F4	Exit the MANUAL mode and return to the AUTO kVp mode.

kVp Scope Mode Presets

When entering the kVp mode some Scope functions are preset. Some of these function setting are fixed, some can be changed. See Table 2-1 and Table 2-2 for details.

Trigger settings can not be changed.

Vertical defection can be changed using the RANGE key.

Time base can be changed using the TIME key. The highest time base speed is 500 µs/div.

Sensitivity, **Probe Factor**, and **Bandwidth filter** are fixed.

Note:

In kVp mode Input B can be used , but will show no readings. A trace will only be shown if triggering via Input A occurs.

Table 2-1. Default Filter Pack Settings

Filter Pack	Vertical Sensitivity	Zero Value	Horizontal Deflection	Trigger Level
Wide Range	20 kV/div	40 kV	10 ms/div	80 kV
K-Edge Mammo	500 mV/div	0 V	10 ms/div	1 V
Linear Mammo	5 kV/div	0 kV	10 ms/div	10 kV
CT	20 kV/div	60 kV	10 ms/div	100 kV
Mobile Pack Plus	20 kV/div	40 kV	10 ms/div	80 kV
Low Range	20 kV/div	26 kV	10 ms/div	46 kV

Table 2-2. kV Range and Trigger Level vs. Filter Pack and Vertical Sensitivity

Filter Pack	Vertical Sensitivity	kV Range	Trigger Level
Wide Range	20 kV/div *	80 -150 kV	80 kV
	10 kV/div	60 – 100 kV	60 kV
	5 kV/div	50 – 70 kV	50 kV
K-Edge Mammo	500 mV/div*	N/A	1 V
Linear Mammo	5 kV/div *	10 – 30 kV	10 kV
	10 kV/div	20 – 40 kV	20 kV
CT	20 kV/div*	100 – 140 kV	100 kV
	10 kV/div	80 -120 kV	80 kV
	5 kV/div	70 – 90 kV	70 kV
Mobile Pack Plus	20 kV/div*	80 – 135 kV	80 kV
	10 kV/div	60 – 100 kV	60 kV
	5 kV/div	50 – 70 kV	50 kV
Low Range	10 kV/div*	46 – 90 kV	46 kV
	5 kV/div	36 – 60 kV	36 kV
	2 kV/div	30 – 40 kV	30 kV

* Default settings.

Specifications

The 199XRAY kVp Measurement Accuracy Specifications
are shown in table 2-3.

Table 2-3. 199XRAY kVp Measurement Accurcy Specifications

Filter Pack	kVp-Avg Accuracy		kV Peak Accuracy*	Exposure Time Accuracy
	Large Signal	**Small Signal**		
Wide-Range	1%	1.5%	2%	0.5%
K-Edge Mammo	1%	N/A	N/A	0.5%
Linear Mammo	1%	1.5%	2%	0.5%
CT	1%	1.5%	2%	0.5%
Mobile Pack Plus**	1%	2%	2%	0.5%
Low Range	1%	1.5%	2%	0.5%

* The kV peak measurement accuracy may be affected by measurement system noise and waveform artifacts.

**Maximum error with 100% ripple