

Determining Minimum Detectable Activity (MDA)

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In the interest of providing useful information to meet the needs of Ludlum customers, this column is featuring reprints of a popular series of articles addressing Minimum Detectable Activity (MDA) time constants. This three-part series, written by David Wyatt and published over 7 years ago, is updated to reflect changes in instrumentation and general thinking since then.

Note: This is part 3 of a 3-part series covering MDA time constants. Part 1 addresses linear ratemeters controlled by conventional resistor-capacitor (RC) integration components. Part 2 encompasses logarithmic ratemeters. Part 3 addresses microprocessor-controlled ratemeters. If you missed any of the articles, please call, and we will send you a copy of the series.

This article addresses response times for microprocessor (μ P) controlled ratemeters. A variable time constant is produced by the μ P to keep the ratemeter readout within a prescribed standard deviation based on the count interaction rate. LMI models which incorporate the μ P ratemeter response variables listed in the

table below, are the Models 2350, 306, 2240, and 2241. Models 2221 and 2224 follow the tables to an extent. The Models 2240 and 2241 also incorporate a selectable fixed response time mode. The Model 2221 uses the Fast or Slow fixed response when the X1 - X1k ratemeter multipliers are selected (analog meter only). The standard Model 375 Area Monitor has a fixed time constant of 1 second when in the monitoring mode. When in the calibration mode, a variable time constant applies. Please note that certain variations of the Model 375 have different firmware versions and therefore may have different response times.

Obviously, it is not possible to present one or two tables of time constants that apply to all (or even most) LMI ratemeters under all conditions. For response specifications for a particular model, consult the appropriate instrument instruction manual or call us.

The Time Constant variables listed in the table below are in seconds. Recall from Part 1 that "one time constant is the length of time required to reach 63% of the full charge or discharge"; therefore, it will take approximately 3 time constants for the ratemeter to reach its final value. Example: if the incoming counts are

between 0 and 1.20k counts per minute (cpm), then the ratemeter time constant will equal 10 seconds for the fast mode. The ratemeter will reach the count rate final value in approximately 30 seconds. The majority of LMI instruments with digital ratemeters update the digital display every two seconds. The display update time is independent of the ratemeter response time; therefore, a ratemeter time constant of 1 second may require 4-6 seconds (2-3 display updates) before the final count rate value is reached.

Since the ratemeter uses a variable time constant, the rise time from zero may take longer than the predicted approximate 3 time constants. This longer time is due to the time constant starting out high and continuing to the desired time constant.

For example, if the incoming counts are 3000 cpm and the ratemeter is zeroed, the Model 2350 will start out with a time constant of 10 (Fast Response). As the incoming counts continue to accumulate, the time constant will be adjusted down to a time constant of 4. After the ratemeter settles at 3000 cpm and the counts change within ± 300 , then the ratemeter will respond as predicted (within approximately 3 time constants).

Slow Time Constant	CPM	Slow Time Constant	CPM	Fast Time Constant	CPM
30	1.11k	15	2.22k	10	1.20k
29	1.15k	14	2.38k	9	1.33k
28	1.19k	13	2.56k	8	1.50k
27	1.23k	12	2.78k	7	1.71k
26	1.28k	11	3.03k	6	2.00k
25	1.33k	10	3.33k	5	2.40k
24	1.39k	9	3.70k	4	3.00k
23	1.45k	8	4.17k	3	4.00k
22	1.52k	7	4.76k	2	6.00k
21	1.59k	6	5.56k	1	-
20	1.67k	5	6.67k		
19	1.75k	4	8.33k		
18	1.85k	3	11.1k		
17	1.96k	2	16.7k		
16	2.08k	1	-		

Model 2241-3RK Response Kit

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INDICATED USE: Emergency Response

DETECTORS: Model 44-9, Model 44-2, Model 133-7

SCA/RATE: Toggle switch to select between the scaler and ratemeter display mode

ALERT/ALARM: Indicated by annunciator on display and audible tone

DISPLAY: 4 digit LCD display with 0.5"(1.3cm) high digits, separate annunciators for display units, alert, alarm, low battery, detector overload, counting overflow, and scaler counting

BACKLIGHT: Push-button to activate

RATEMETER: Can display in R/hr, Sv/h, cpm, or cps

DISPLAY RANGE: Auto ranging from 0.0 μ R/hr - 9999

R/hr; 0.000 μ Sv/hr - 9999 Sv/hr; 0 cpm - 999k cpm; or 0 cps - 100k cps

SCALER: Activated by push-button in handle (count time adjustable from 1 - 9999 seconds in 1 second intervals)

HIGH VOLTAGE: Four independent controls; each adjustable from 200 - 2500 volts

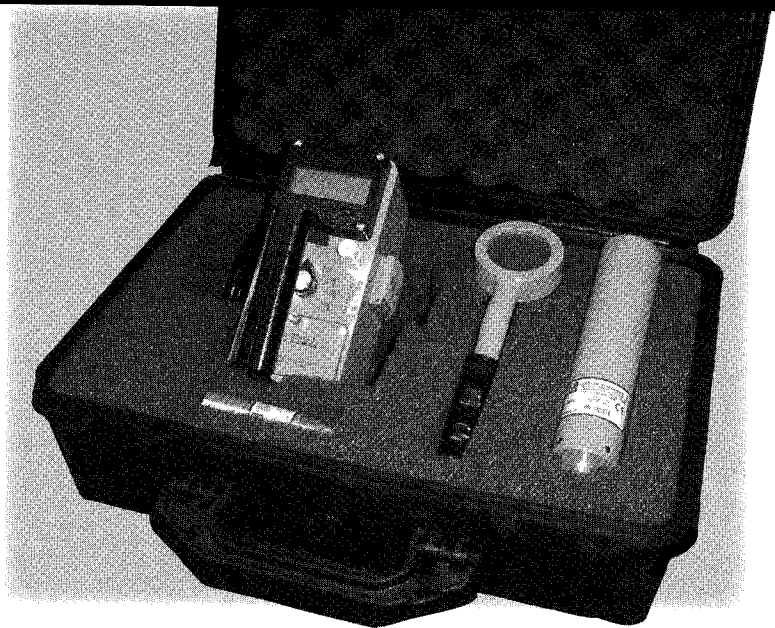
DISCRIMINATOR: Adjustable from 2 - 100 mV

OVERLOAD: Indicated by OVERLOAD on display (adjustable depending on detector selected)

BATTERY LIFE: Typically 200 hours with alkaline batteries (low battery indicated on display)

SIZE: 6.5"(16.5cm)H X 3.5"(8.9cm)W X 8.5"(21.6cm)L

WEIGHT: 3.5 lbs (1.6kg) including batteries



The following parameters are adjusted by a removable switchboard. Once initial setup and calibration have been completed, the switchboard can be removed without affecting normal operation of the instrument. (Model 2241-3 may be ordered without switchboard.)

BACKLIGHT "ON" TIME: 5, 30, 60, 90, 180, or 240 seconds for the backlight to stay "ON" .

SET MINIMUM DISPLAY: Allows lower limit of auto-ranging display to be fixed. For example, display can be set to not show values less than 1 μ R/hr.

RS-232 DATA DUMP MODE: Enables or disables dump mode to RS-232 port. When enabled, data will be dumped every 2 seconds.

RS-232 DETECTOR SETUP MODE: Allows for detector parameters to be input by RS-232 port

BAUD RATE: 150, 300, 600, 1200, 2400, 4800, 9600, or 19200 bps.

DEAD TIME: Adjustable from 0 - 9999 μ seconds

CALIBRATION CONSTANT: Adjustable from 0.001 - 280 X 10⁹ counts/display unit

DISPLAY UNITS: Can read in R/hr, Sv/h, cpm, or cps

TIME BASE: Can read in seconds or minutes

AUDIO DIVIDE: 1, 10, 100, or 1000 events-per-click

RESPONSE: FIXED: FAST response time adjustable from approximately 1 - 25 seconds. SLOW response is 5 times fast setting.

VARIABLE: Dependent on number of counts present. Typical times FAST - 4 - 25 seconds, SLOW - 4 - 60 seconds (All times stated from 10% to 90% of final reading.)

RATEMETER ALERT/ALARM: Set at any point corresponding to pre-selected ratemeter range

SCALER ALARM: Adjustable from 1 - 999999 counts

SCALER COUNT TIME: Adjustable from 1 - 9999 seconds

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