LUDLUM MODEL 44-20
MODEL 44-20-1
AND MODEL 44-20-3
GAMMA SCINTILLATORS

June 2017

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AND MODEL 44-20-3
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LUDLUM MEASUREMENTS, INC
501 OAK STREET, P.O. BOX 810
SWEETWATER, TEXAS 79556
325-235-5494, FAX: 325-235-4672

STATEMENT OF WARRANTY

Ludlum Measurements, Inc. warrants the products covered in this manual to be free of defects due to workmanship, material, and design for a period of twelve months from the date of delivery. The calibration of a product is warranted to be within its specified accuracy limits at the time of shipment. In the event of instrument failure, notify Ludlum Measurements to determine if repair, recalibration, or replacement is required.

This warranty excludes the replacement of photomultiplier tubes, G-M and proportional tubes, and scintillation crystals which are broken due to excessive physical abuse or used for purposes other than intended.

There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face there of. If the product does not perform as warranted herein, purchaser's sole remedy shall be repair or replacement, at the option of Ludlum Measurements. In no event will Ludlum Measurements be liable for damages, lost revenue, lost wages, or any other incidental or consequential damages, arising from the purchase, use, or inability to use product.

RETURN OF GOODS TO MANUFACTURER

If equipment needs to be returned to Ludlum Measurements, Inc. for repair or calibration, please send to the address below. All shipments should include documentation containing return shipping address, customer name, telephone number, description of service requested, and all other necessary information. Your cooperation will expedite the return of your equipment.

LUDLUM MEASUREMENTS, INC.
ATTN: REPAIR DEPARTMENT
501 OAK STREET
SWEETWATER, TX 79556

800-622-0828 325-235-5494
FAX 325-235-4672

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Model 44-20, 44-20-1 and 44-20-3 Gamma Scintillators

1. GENERAL

The Ludlum Model 44-20, Model 44-20-1, and Model 44-20-3 utilize a Teledyne Integral Detector assembly containing a 3-inch diameter by 3-inch thick NaI (Tl) crystal optically coupled to a photomultiplier tube (PMT). The detectors are compatible with general purpose survey meters, ratemeters, and scalers for high-energy gamma detection (approximately 60 keV to 2 MeV range). The detectors provide high sensitivity for surveying and pulse height discrimination for single-channel or multi-channel applications.

The Model 44-20 is available with an optional signal splitter so that two different instruments may be used for high-voltage input and detector pulse signal output. For this option, the detector tube socket has two connectors - BNC for the signal output and MHV for high-voltage input. "SIG" and "H.V." are silk-screened onto the cover cap for identification of appropriate connections.

The Model 44-20-3 crystal has higher resolution for spectroscopy.

2. SPECIFICATIONS:

VOLTAGE: typically 500 volts to 1200 volts maximum

HIGH VOLTAGE (HV): Variances in HV are due to instrument input sensitivity, cable length, photomultiplier tubes (PMT) and applications.

SCINTILLATOR: 7.6 x 7.6 cm (3 x 3 in.) (Dia x thickness) NaI(Tl) crystal

SENSITIVITY: typically 2300 cpm/μR/hr (^{137}Cs gamma)

CURRENT DRAIN: 20 microamps at 1000 volts

PHOTOMULTIPLIER TUBE: 7.6 cm (3 in.) diameter, end window with 10-stage dynode chain at approximately 60 megohms

CONNECTORS: standard series "C" for normal mode; other types available upon request. For signal splitter option, BNC for signal output and MHV for high voltage input.

SIZE:
Model 44-20: 8.3 cm (3.3 in.) diameter by 28.4 cm (11.2 in.) long
Model 44-20-1: 8.6 cm (3.4 in.) diameter by 28.2 cm (11.1 in.) long
Model 44-20-3: 8.3 cm (3.3 in.) diameter by 28.4 cm (11.2 in.) long

CONSTRUCTION: aluminum cap with stainless steel body

HOUSING CONSTRUCTION: 0.05 cm (0.02 in.) aluminum

WEIGHT:
Model 44-20: 1.7 kg (3.7 lb)
Model 44-20-1: 2 kg (4.5 lb)
Model 44-20-3: 1.8 kg (4 lb)

3. CALIBRATION

Calibration of these Model 44-20 series scintillators consists of determination of (1) the resolution of the detector (also called a "probe peaking procedure") and (2) the operating voltage of the detector by "running a plateau." Both procedures are described in the following sections, using a Ludlum Model 2200 as the count rate instrument. A 1 μCi ^{137}Cs check source is used for the peaking procedure, and a calibrated ^{241}Am source is used for the plateau procedure.

3.1 Probe Peaking Procedure

Energy resolution (probe peaking procedure) is performed to test the integrity of the crystal and tube socket.

Ensure that DISCR control is set so that 1.0 on THRESHOLD dial = 10 mV input sensitivity. (If it is not, use a Ludlum Model 500 or equivalent pulser to determine the threshold-versus-millivolt relationship.)

3.1.1. Set WINDOW at 0.40 with the WINDOW switched to the "ON" position.

3.1.2. Set the THRESHOLD dial at 6.42.

3.1.3. Set high voltage well below 500 V (about 1.10 on HV dial). This ensures that the peaking routine is started below the actual photopeak at 662 keV and thus does not find a false peak or the 32 keV X-ray peak.

3.1.4. Set three-position switch (RATE, HV, and BATT) to RATE.

3.1.5. Set range multiplier to X1 and expose the detector to the ^{137}Cs source.

3.1.6. Begin increasing high voltage by **slowly** rotating HV dial clockwise.

3.1.7. Once full-scale deflection is reached, switch range multiplier to X10. Press reset button and continue to increase HV until full-scale deflection is again achieved.

3.1.8. Repeat for X100 range and then 1K range by pressing reset button and increasing HV until maximum count rate is achieved.

NOTE: The X1K setting will likely be required for finding the photopeak, but occasionally the X100 range will suffice.

3.1.9. Once the peak is located, an increase or decrease in voltage should drop the count rate. If it does not, verify that WINDOW and THRESHOLD are properly set and repeat the above steps. If count rate does drop with an increase or decrease in HV, proceed to confirm peak.

3.1.10. To confirm probe is peaked, set WINDOW at 1.0 and THRESHOLD at 6.12 (corresponding to 612 keV). Note count rate, then switch window OFF. Count rate should stay approximately the same if probe is peaked. If it is not peaked, count rate will change dramatically.

3.1.11. Once the peak is confirmed, readjust THRESHOLD dial to 6.42 and WINDOW to 0.40 with WINDOW switched ON.

3.1.12. Initiate a 6-second count and record count rate (and peak HV if desired).

NOTE: If greater accuracy than a Model 2200 kV scale is needed to measure high voltage, disconnect detector and connect a high-impedance voltmeter to a Model 2200.

3.1.13. Rotate THRESHOLD dial counterclockwise below 6.42 until count rate is approximately half of previous 6-second count.

3.1.14. Record THRESHOLD dial setting.

3.1.15. Rotate THRESHOLD dial clockwise above 6.42, until count rate is again approximately half of peak count rate determined in step 3.1.12.

3.1.16. Record THRESHOLD dial setting.

3.1.17. Determine the resolution of the peaked probe for ^{137}Cs as follows:

$$\frac{\mathbf{FWHM}}{\mathbf{H_o}} = \mathbf{R}$$

where FWHM ≡ width of curve at half the peak height
H_0 ≡ location of the peak centroid (peak energy)
R ≡ resolution

Energy resolution is normally expressed as a percentage. This, in combination with the terminology used in this procedure, defines the peak resolution as:

$$\frac{\mathbf{U.\ T.\ S.\ -\ L.\ T.\ S.}}{\mathbf{Peak\ \ Energy}} \times \mathbf{100\% = R\%}$$

where U.T.S. ≡ upper threshold setting
L.T.S. ≡ lower threshold setting

EXAMPLE:

Threshold dial setting (U.T.S.) ≅ 6.82 = 5000 counts in 6-second period (from step 3.1.16)

Threshold dial setting ≅ 6.42 = 10,000 counts in 6-second period

Threshold dial setting (L.T.S.) ≅ 6.02 = 5000 counts in 6-second period (from step 3.1.14)

$$\frac{\mathbf{6.82\ -\ 6.02}}{\mathbf{6.62}} \times \mathbf{100\% = 12.08\%}$$

The resolution should be less than 13% to be considered an acceptable probe. The value of a new probe should be ≅ 8 to 9% and increase toward 13% or more as the probe ages. Any probe with resolution greater than 13% should be considered marginal and sent in for service.

3.2 Determining Operating Voltage

NOTE: Plateau HV should be considerably higher than peak voltage (by approximately 200 to 300 volts) if peak routine is performed correctly.

3.2.1. Connect the detector to the counting instrument.

3.2.2. Turn WINDOW to OFF.

3.2.3. Set input sensitivity to 10 mV.

3.2.4. Select the appropriate range or scale of the counting instrument.

3.2.5. Expose the detector to the calibration source. (LMI uses ^{241}Am, approximately 1.59 μCi in activity.)

3.2.6. Observing the meter needle deflection or digital readout, find the “knee” of the operating voltage plateau. For Model 44-20 without signal splitter and if using a Model 2200, both count rate and high voltage (KV scale) can be read on analog meter. For Model 44-20 with signal splitter, use two instruments: one for HV and one for pulse output. (LMI uses two Model 2200s, with HV disabled on one so as not to interfere with HV input on the other.)

3.2.7. Observe the voltage reading at the “knee.” Round down to nearest 50 volts. (Example: If knee is at 820 volts, round down to 800 volts. If knee is at 890 volts, round down to 850 volts.) Beginning at this voltage, take a 6-second count for background radiation. Record voltage and count rate. Repeat in 50-volt increments until background count rate exceeds 2000 counts in a 6-second period (assuming a 10

μR/hr background exposure rate).

3.2.8. Expose detector to calibration source. Perform and record 6-second source count rates for range of voltages used in step above for background count rates.

3.2.9. By examination or plotting the data, select an operating voltage that falls approximately in the middle of the plateau. There should be a 50-volt (or greater) buffer on either side of the selected operating voltage.

3.2.10. Adjust the instrument high voltage to the selected operating voltage.

PARTS LIST

Model 44-20 GAMMA SCINTILLATOR

Ref.	Description	Part No.
UNIT	Completely Assembled Model 44-20 Gamma Scintillator	47-1104
*	Tube Socket	47-1624
*	Teledyne Integral Detector Assembly	01-5184
*	Tube Socket Cap	2032-027
*	Voltage Divider Board	5002-233
*	HV Wire (White Teflon)	21-9362
*	Ground Wire	21-9432
*	Flanged Connector Series “C”	13-7752
*	4-40 x 5/16 BH Screws	17-8511
*	4-40 x 1/8 Soc Set Screws	17-8531

Voltage Divider Board, Drawing 2 x 179

Ref.	Description	Part No.
BOARD	Assembled Voltage Divider Board	5002-233
CAPACITORS		
C1	0.01:F, 2kV, C	04-5525
RESISTORS		
R1-R11	4.75 MEG, 1%	10-7100
R12	10 MEG, 1%	10-7102
MISCELLANEOUS		
13 EA.	CONTACT-003-1381-003	01-5245

Model 112-2 Tube Socket with Signal Splitter (Optional)

Ref.	Description	Part No.
UNIT	Completely Assembled Model 112-2 Tube Socket With Signal Splitter	47-1266

PARTS LIST

Model 44-20-1 GAMMA SCINTILLATOR

Ref.	Description	Part No.
UNIT	Completely Assembled Model 44-20-1 Gamma Scintillator	47-3129
*	Teledyne Integral Detector Assembly	01-5659
*	Voltage Divider Board	5002-571
*	HV Wire (White Teflon)	21-9362
*	Ground Wire	21-9432
*	Flanged Connector Series “C”	13-7752
*	4-40 x 5/16 BH Screws	17-8511

Voltage Divider Board, Drawing 2 x 359

Ref.	Description	Part No.
BOARD	Assembled Voltage Divider Board	5002-571
CAPACITORS		
C111	0.01μF, 2kV, C	04-5525
RESISTORS		
R5	4.75 MEG, 1%	12-7995
R001-R004	4.75 MEG, 1%	12-7995
R011-R013	4.75 MEG, 1%	12-7995
R101-R104	4.75 MEG, 1%	12-7995
R111	10 MEG, 1%	12-7996

Model 44-20-3 GAMMA SCINTILLATOR

Ref.	Description	Part No.
UNIT	Completely Assembled Model 44-20-3 Gamma Scintillator	47-3952
*	Tube Socket	47-1624
*	Teledyne Integral Detector Assembly	01-5911
*	Tube Socket Cap	2032-027
*	Voltage Divider Board	5002-233
*	HV Wire (White Teflon)	21-9362
*	Ground Wire	21-9432
*	Flanged Connector Series “C”	13-7752
*	4-40 x 5/16 BH Screws	17-8511
*	4-40 x 1/8 Soc Set Screws	17-8531

The Model 44-20-3 uses the same voltage divider (Drawing 2 x 179) as the Model 44-20.

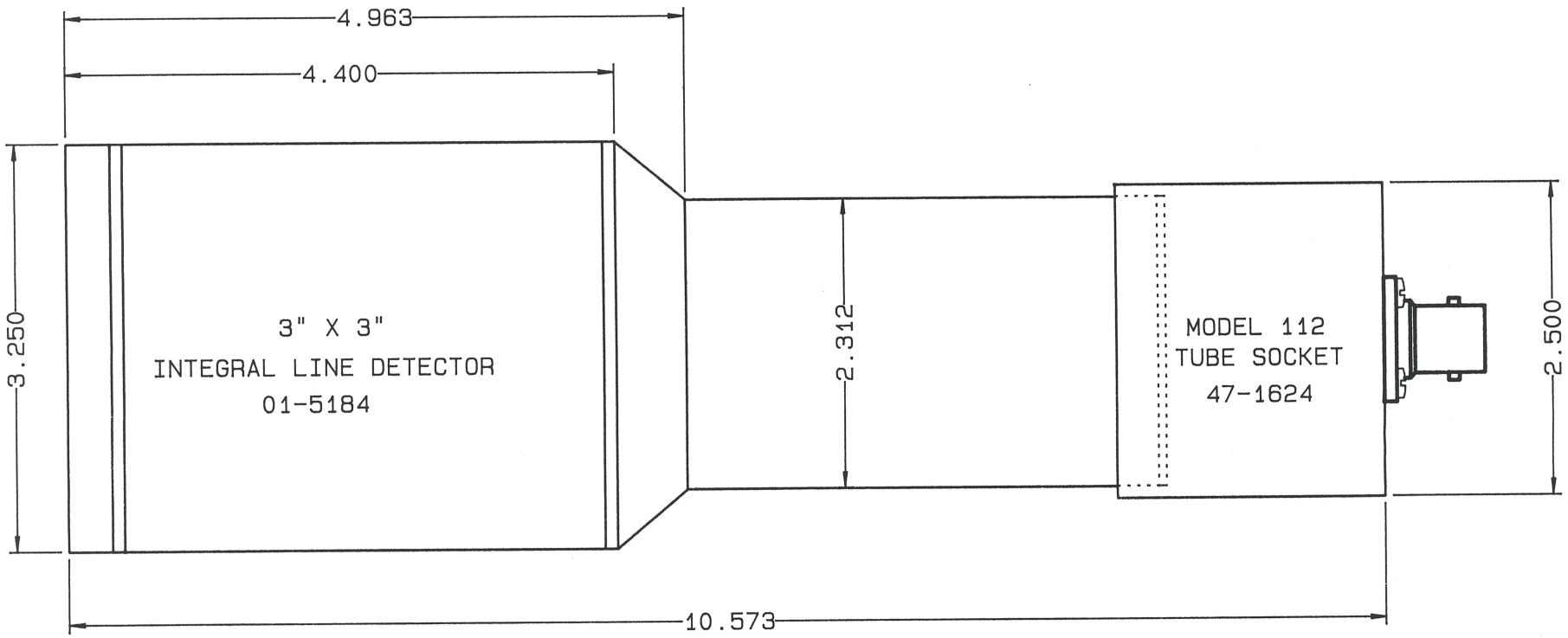
DRAWINGS AND DIAGRAMS

Model 44-20 and Model 44-20-1 Assembly View, Drawing 2 x 257

Model 44-20 Voltage Divider Board, Drawing 2 x 179

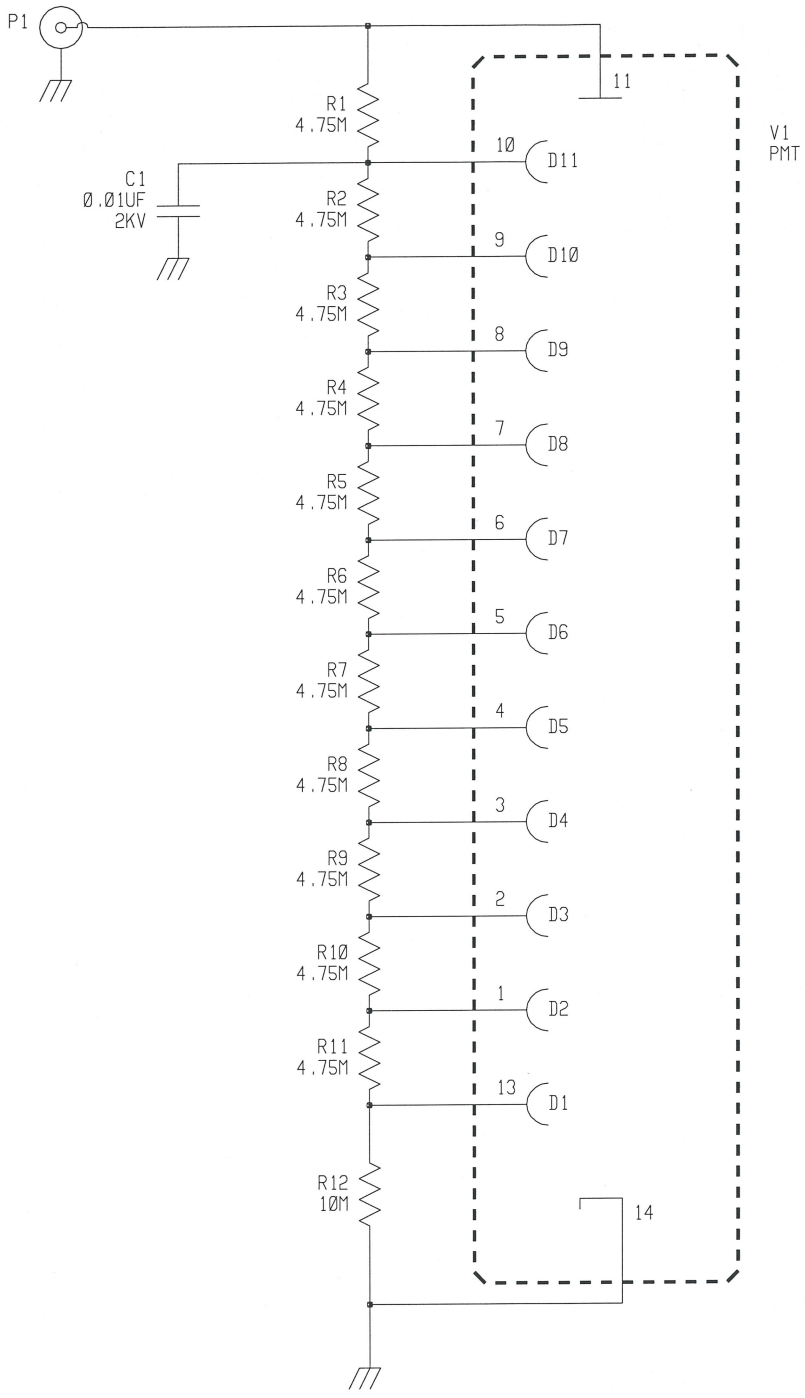
Model 44-20-1 Voltage Divider Board, Drawing 2 x 359

MODEL 44-20 3" X 3" INTEGRAL LINE SCINTILLATOR #47-1104



CHG	NO.		DWN	CHK	APP
DWN BQ	DATE 3-18-94	CHK DATE	APP JGW	DATE 3-1-02	
TOL: SHOP STD ☐ OTHER		SCALE: FULL ☐ OTHER	3/4		
TITLE MODEL 44-20					
LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556		SERIES 2	SHEET 257		

NF



UPDATED	-	
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DSGN		
APPD	RSS	1/2nn 02
NEXT HIGHER ASSY.	-	
13:49:43		16-Nov-99

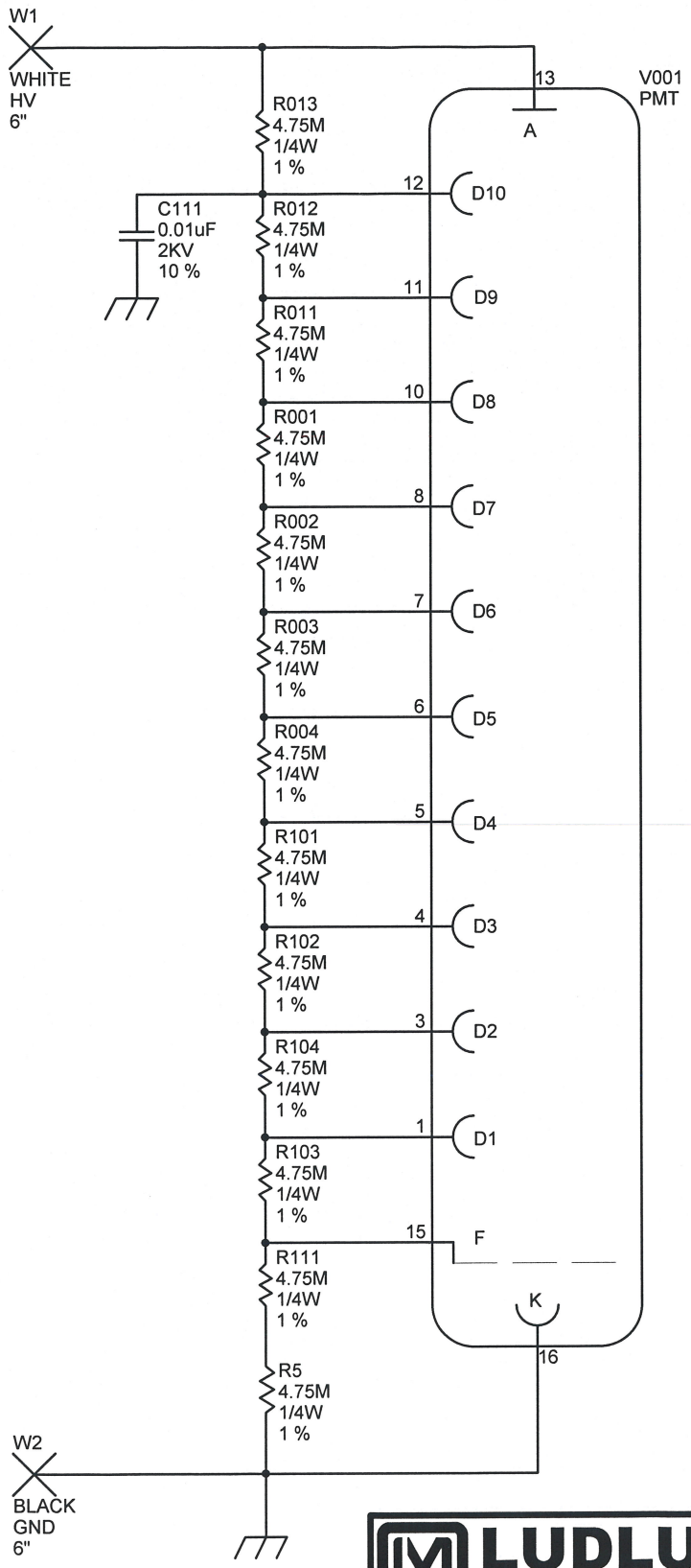
LUDLUM MEASUREMENTS INC.

TITLE: VOLTAGE DIVIDER

BOARD# 5002-233

SIZE	MODEL	SERIES	SHEET
C	VARIOUS	2	179

SB002233 SHEET 1 OF 1



LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: SA	07/06/06	Title: VOLTAGE DIVIDER	
Design: RSS	07/06/06	Model: VARIOUS	
Check:		Board#: 5002-571	
Approve: BS	17Feb11	Sheet: 1 of 1	Series 2 / Sheet 359
19:03:56	14-Feb-2011	Rev: 2.0	
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