# LUDLUM MODEL 43-10-10
# ALPHA-BETA SAMPLE COUNTER

## Addendum to Model 43-10-1 Manual

**February 2020**

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**February 2020**

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**DESIGNER AND MANUFACTURER OF**
*Scientific and Industrial Instruments*

# Addendum for the Model 43-10-10 Alpha/Beta Sample Counter with iCam Filter (to the Model 43-10-1 manual)

**February 2020**

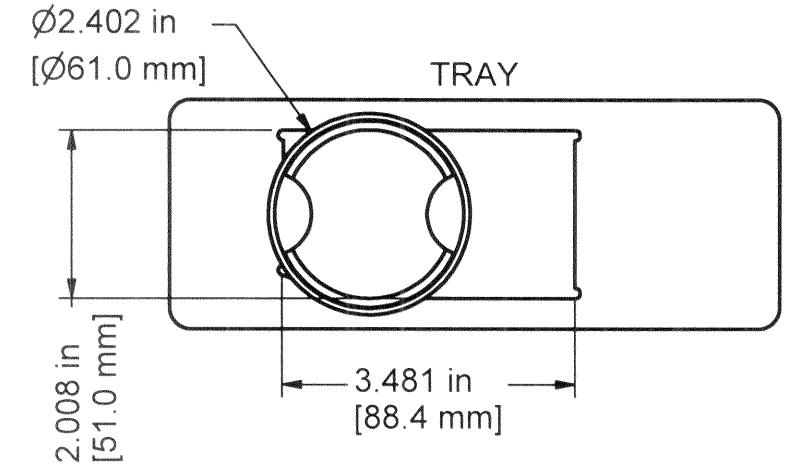
The Model 43-10-10 (part # 47-4114), which allows for counting of iCam air monitor filter cards, is very similar to the Model 43-10-1. Following are the differences:

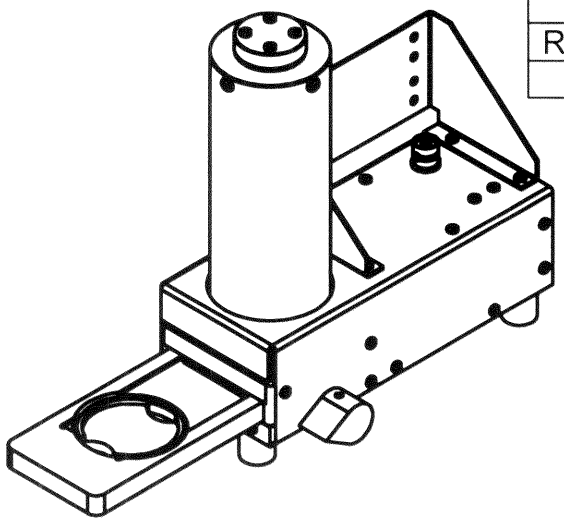
1. The sample drawer (or tray) has a cutout that fits the iCam filter card. The dimensions of the iCam filter card are 5.1 x 8.8 x 0.064 cm (2 x 3.5 x 0.025 in.) (H x W x D). It can also fit a 60 x 4.7 mm deep (2.36 x 0.187 in.) sample.

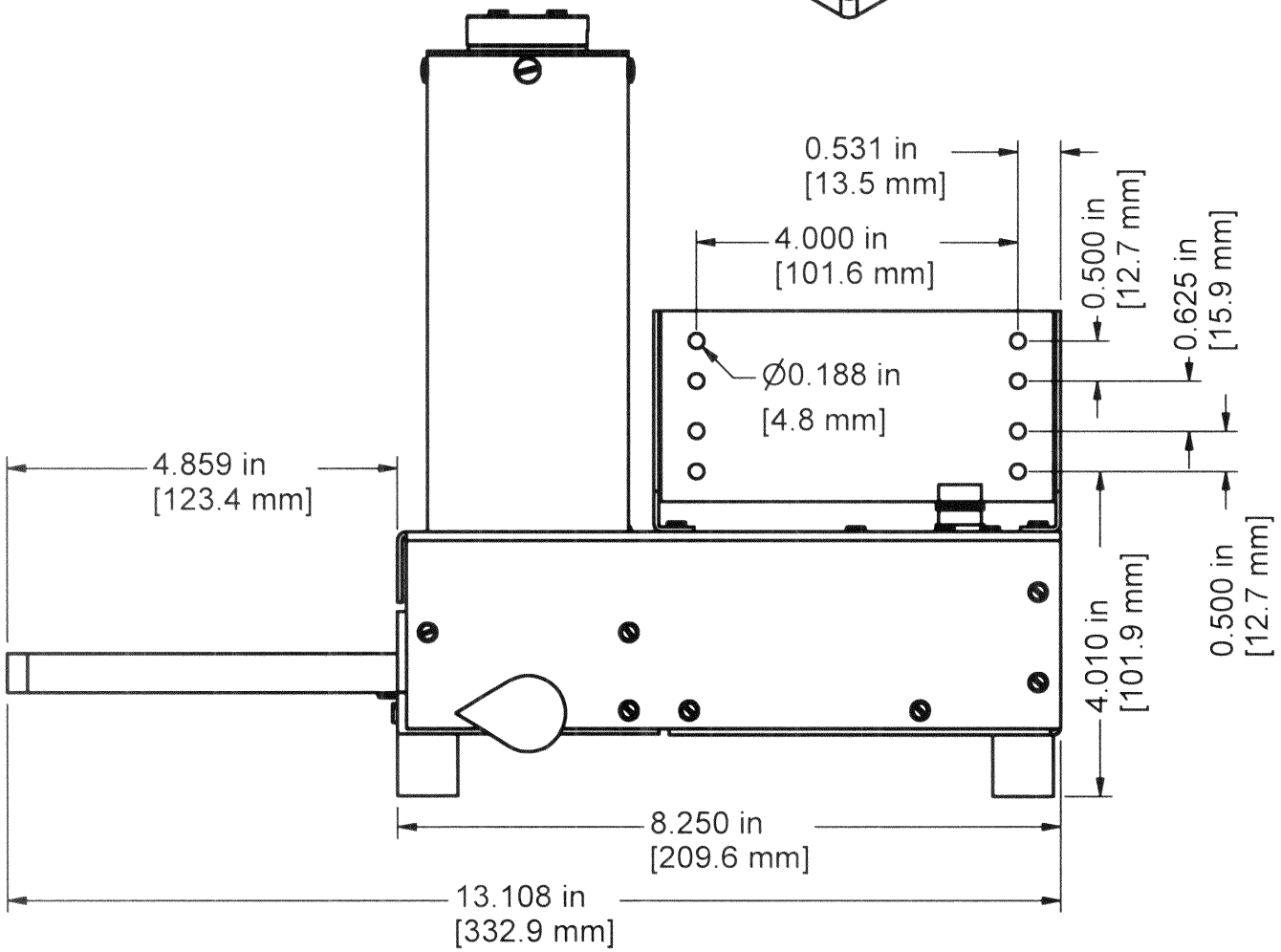
2. Other new part numbers include:
   - Tube holder/Base assembly – part # 2142-303
   - Tray – part # 7142-320
   - Base plate – 7142-305
   - 60 mm spacer – 7142-329

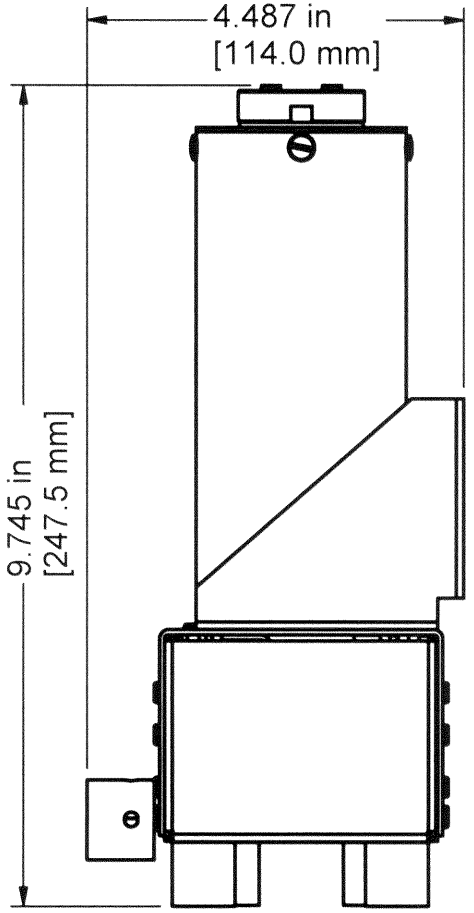
3. See Drawing 142 x 301 (following this page) for overall dimensions.

| REVISION HISTORY | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | BY |
| 1 | VALID | 12-16-14 | CMC |



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|---|---|---|---|---|---|
| DWN JGW | DATE 2-11-20 | CHK | DATE | APP GW | DATE 2-11-20 |

**DWG NUM:** 4142-301 SCALE: 7/16

**TITLE** M 43-10-10 OVERALL

LUDLUM MEASUREMENTS, INC.
501 OAK STREET
SWEETWATER, TEXAS 79556

SERIES 142 SHEET 301

**Model 43-10-1 Alpha/Beta Sample Counter**
**December 2019**

## TABLE OF CONTENTS

# Model 43-10-1 Alpha/Beta Sample Counter
# December 2019

## 1. GENERAL

The Model 43-10-1 is an Alpha-Beta Sample Counter capable of holding up to a 5.1 cm (2 in.) diameter filter or planchet. The sample drawer, when fully closed, strikes a microswitch to allow high voltage (HV) to be applied to the photomultiplier tube (PMT). The sample drawer is locked in the closed position by rotation of the slide lever mounted on the side of the instrument.

The detector is a 6.4 cm (2.5 in.) diameter "phoswich" with a 0.025 cm (0.010 in.) thick plastic scintillator coated with zinc sulfide (ZnS). ZnS(Ag) is used for alpha radiation detection, and the plastic scintillation material is used for detection of beta radiation. The scintillation material is covered by 0.4 mg/cm$^2$ metalized polyester to reduce light response (excessive background). If simultaneous alpha-beta discrimination is desired, the counting instrument must have separate power supplies or threshold controls for each channel. The Ludlum Model 2929 Scaler, Model 2223, or Model 2224 instruments provide the necessary circuitry for simultaneous alpha-beta discrimination.

## 2. SPECIFICATIONS

**SCINTILLATOR MATERIAL:** ZnS disc; plastic 0.025 cm (0.010 in.) thick

**DETECTOR OPERATING VOLTAGE:** 500-1200 Vdc

**WINDOW:** 0.4 mg/cm$^2$

**BACKGROUND**:
≤ 80 cpm beta-gamma, ≤ 3 cpm alpha
(in ambient background of 10μR/hr)

**CHANNEL CROSS TALK**: alpha in beta channel ≤ 10%; beta in alpha channel ≤ 1%

**EFFICIENCY (4π):** 37% for $^{239}$Pu, 5% for $^{14}$C, 27% for $^{99}$Tc, 32% for $^{230}$Th, 39% for $^{238}$U, 29% for $^{137}$Cs, 26% for $^{99}$Sr/$^{90}$Y

**HV SWITCH:** opening sample slide disables PMT high voltage

**PHOTOMULTIPLIER TUBE:** 5.1 cm (2 in.) diameter, 10 pin dynode structure

**SAMPLE SLIDE AND HOLDER**: sample cavity size is 56.9 mm (2.24 in.) diameter x 10.8 mm (0.428 in.) deep, with an insert cavity size of 50.8 mm (2.0 in.) diameter x 4.4 mm (0.175 in.) deep or 28.3 mm (1.115 in.) diameter x 4.4 mm (0.175 in.) deep.

**MAXIMUM SAMPLE SIZE:** 56.9 mm (2.24 in.) diameter x 10.8 mm (0.428 in.) deep

**CONSTRUCTION**: aluminum housing with beige powder coating

**SIZE:** 23.6 x 11.4 x 23.6 cm (9.3 x 4.5 x 9.3 in.) (H x W x L)

## 3. OPERATING PROCEDURES

Connect the Model 43-10-1 to the scaler counting instrument. The coax cable with "C" connectors carries both the signal and HV.

HV is applied to the PMT when the sample slide is pushed completely in, tripping the microswitch. Rotate the sample slide lever to the locked position, securing sample slide in the "ON" position.

Alpha background count is approximately less than or equal to 3 cpm.

Beta background count is approximately 60-100 cpm.

To check a radioactive sample, place sample on the appropriate side of the sample holder for the 2.5 or 5.1-centimeter (1 or 2 in.) filters. Do not allow the sample to extend above the top of the sample slide.

A background count should be taken after each source count to check for contamination on the sample holder or area within the O-ring.

## 4. CALIBRATION

**CAUTION:** Do not tip sample counter over with sample holder in sample slide. The sample holder will tear the thin metalized polyester window, allowing light to scintillate the ZnS and cause excessive count in the beta channel.

For instruments with separate power supplies (fixed threshold), the alpha channel will operate at a lower voltage than the beta channel.

### 4.1 Counting Instrument

Calibrated scaler instrument
HV range, nominally 800 ±200 volts
Nominal input sensitivity:
alpha channel = 175 mV
beta channel = 4 mV (with upper discriminator set at 50 mV)

### 4.2 Operating Voltage

1. Connect Model 43-10-1 to the counting instrument with proper cable.

2. Place a calibrated $^{14}C$ source in the sample holder. Close and lock the sample drawer.

3. Adjust the counting instrument HV until it receives at least 5% ($4\pi$) efficiency.

4. Decrease HV by 25 volts.

5. Record the HV.

6. Record the $^{14}C$ source count and beta crosstalk in the alpha channel.

7. Remove the $^{14}C$ source and record the background count in the alpha and beta channels.

8. Place a calibrated $^{239}Pu$ source in the sample holder. Close and lock the sample drawer.

9. Record the $^{239}Pu$ source count and the alpha crosstalk in the beta channel.

10. Increase the HV by 25 volts.

11. Repeat steps 5-10 until one or more of the following conditions is met (assuming a 10 μR/hr background exposure):
   (a) beta background exceeds 80 cpm

(b) alpha background exceeds 3 cpm
(c) alpha crosstalk in the beta channel exceeds 10%
(d) beta crosstalk in the alpha channel exceeds 1%

12. The operating voltage should be selected as a point where:
(a) $^{14}C$ efficiency $(4\pi) \geq 5\%$
(b) $^{239}Pu$ efficiency $(4\pi) \geq 37\%$
(c) alpha crosstalk in beta channel less than or equal to 10%
(d) beta crosstalk in alpha channel less than or equal to 1%

### 4.3 Calculating Efficiency

1. NIST-traceable sources required.
2. Set HV as determined above.
3. Record a one-minute background and one-minute source count. Subtract the background count from the source count. Divide the net source count by the dpm value of the source, times 100 for $4\pi$ efficiency.

**If the source value is listed in microcuries (activity):**

4. Convert the microcurie value to a dpm value by multiplying the microcurie value by $2.22 \times 10^6$. Calculate the $4\pi$ efficiency as in the previous steps.

## 5. TROUBLESHOOTING

### 5.1 Zero or Very Low Counts

- Large light leak
- PMT malfunction
- Broken wire in tube socket
- Inoperative HV switch on sample counter or broken wire
- Counting instrument malfunction
- Source too far from scintillation material
- Cable malfunction

### 5.2 No Source Plateau

- Light leak, slide not sealed properly against true base
- Noisy PMT
- Noisy HV switch
- Poor PMT to scintillation, light pipe interface

### 5.3 Excessive Background Count

- Light leak
- PMT malfunction
- Cable malfunction
- Noisy HV switch
- Instrument contaminated

## PARTS LIST

| Ref. No. | Description | Part No. |
|---|---|---|
| **Model 43-10-1 Alpha/Beta Sample Counter** | | |
| UNIT | Completely Assembled 43-10-1 Detector | 47-1305 |
| **Assembly View, Drawing 142 x 39B** | | |
| * | PM TUBE ASSY | 01-5919 |
| * | EJ444L-2.20 x .010 ZnS | 01-5698 |
| * | METALIZED MYLAR | 01-5143 |
| * | TUBE HOLDER/BASE | 2142-002-02 |
| * | CONNECTOR CAP | 7142-014 |
| * | SAMPLE DRAWER Model 43-10 | 7142-001-06 |
| * | O-RING-2-229 | 16-8286 |
| * | ACRYLIC DISC | 7142-002-01 |
| 2 EA. | SPACER STRIP .015 | 7142-002-03 |
| * | ADAPTER PLATE | 7142-003-01 |
| * | CASE TOP | 7142-004-03 |
| * | CASE BOTTOM | 7142-004-04 |
| * | CAP GASKET | 7142-017 |
| * | BASE PLATE | 7142-018 |
| * | SHAFT | 7142-019 |
| * | LIFTER | 7142-020 |
| * | PIN | 7142-021 |
| * | O-RING-2-226 | 16-8270 |
| 2 EA. | SPACER STRIP .010 | 7142-232 |
| 5 EA. | 5.1 cm (2 in.) X-TAL FOAM PAD | 7260-001-05 |
| 10 EA. | PLANCHETTE-2/X1/8 IN. | 7525-371A |
| * | PLANCHET HOLDER | 7142-001-07 |
| * | BRACKET | 7142-004-01 |
| * | CAP | 7142-004-02 |
| 1 EA. | SWITCH-BZ-2RD-A2 | 08-6538 |
| 1 EA. | KNOB-90 4 2G POINTER | 08-6608 |
| 1 EA. | RECPT-UG706/U “C” LMI | 4478-011 |
| 4 EA. | BUMPER PADS | 21-9376 |
| 2 EA. | SPACERS | 18-9043 |

| Ref. No. | Description | Part No. |
|---|---|---|
| **Switch Filter Board, Drawing 142 X 58** | | |
| BOARD | Assembled Switch Filter | 5412-103 |
| ▪ | **CAPACITORS** | |
| C1-C2 | CAP-0.0047µF, 3kV, NPO | 04-5547 |
| C3 | CAP-0.0015µF, 3kV, C | 04-5518 |
| ▪ | **RESISTORS** | |
| R1-R2 | RES-1MEG, 1/4W, 5% | 10-7028 |
| **Voltage Divider Board, Drawing 435 X 964** | | |
| BOARD | Assembled Voltage Divider | 5435-401 |
| ▪ | **CAPACITORS** | |
| C1 | 0.01µF, 2kV, C | 04-5722 |
| ▪ | **RESISTORS** | |
| R1-R12 | 4.75 MEG, 1/8W, 1% | 12-7995 |

# DRAWINGS AND DIAGRAMS

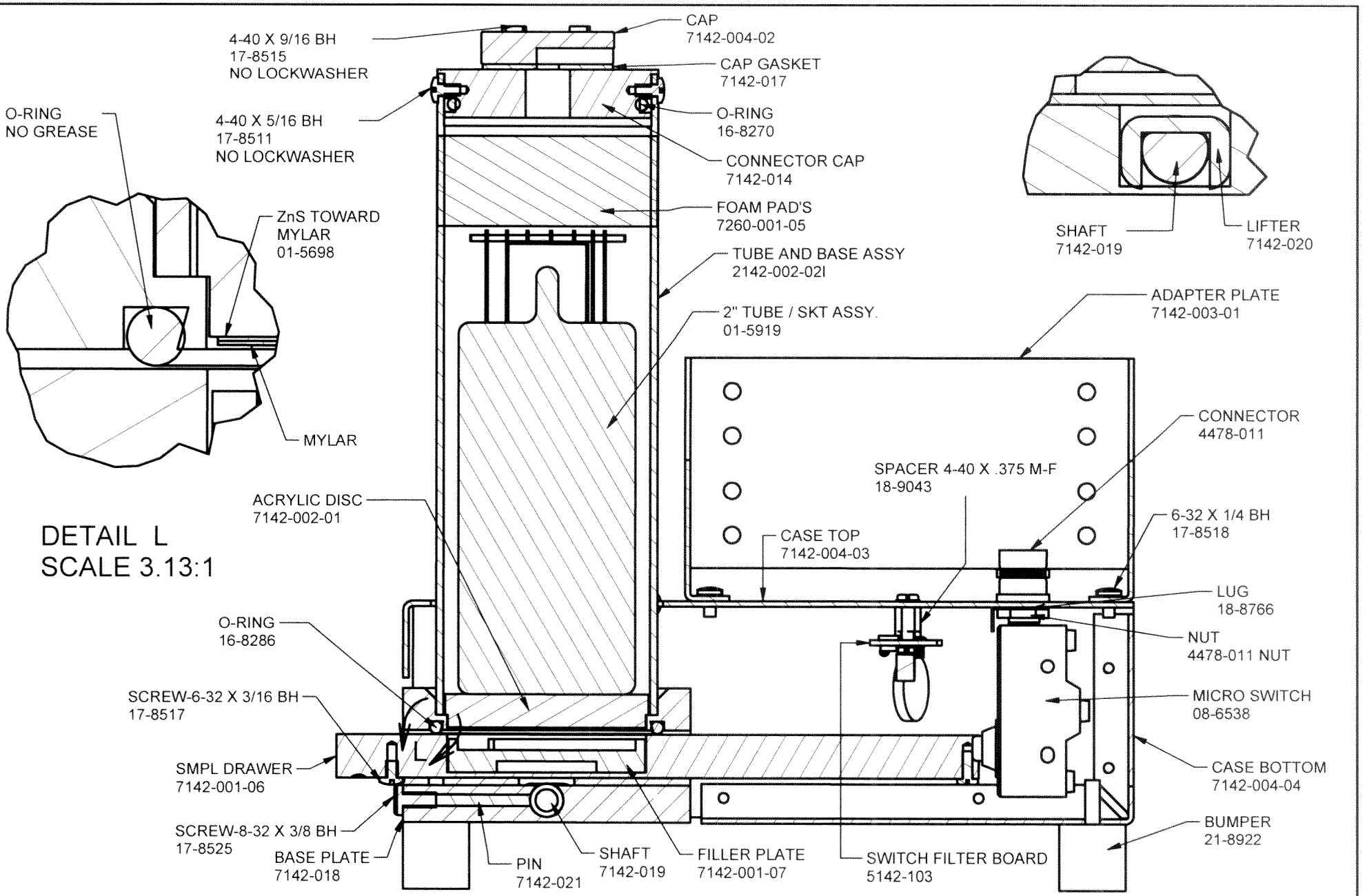
Model 43-10-1 Assembly View, Drawing 142 x 39B

Switch Filter Board, Drawing 142 x 58

Switch Filter Board Layout, Drawing 142 x 59

5.1 cm (2 in.) Voltage Divider Board, Drawing 435 x 964

5.1 cm (2 in.) Voltage Divider Board Layout, Drawing 435 x 965




DETAIL L
SCALE 3.13:1

| REVISION HISTORY | | | |
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| 3 | ECF # 1072 | 10/31/01 | DSW |
| 4 | REDRAWN ON COMPUTER | 05/23/2012 | ADG |
| 5 | PLACED LOCKWASHERS | 1/2/18 | ZSZ |
| 6 | 17-8518 WAS 17-8511 | 11/19/19 | DLJ |

| DWN | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|
| ABM | 11/27/19 | | | JGW | 11-27-19 |

**DWG NUM:** 4142-076 SCALE: 1:1.5

**TITLE** M 43-10-1

LUDLUM MEASUREMENTS, INC
501 OAK STREET
SWEETWATER, TEXAS 79556

SERIES 142 SHEET 39B

| REVISIONS | | | | | | |
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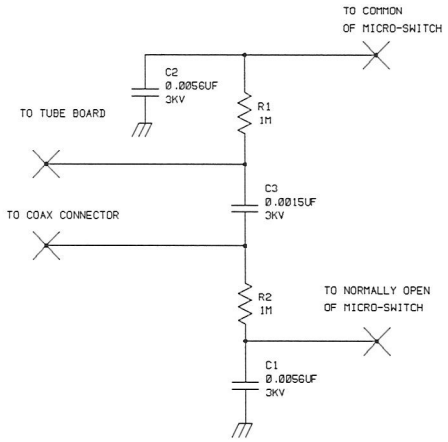



| | |
|---|---|
| UPDATED | - |
| DR PW | 10/20/92 |
| CHK | CKB 27-JAN-99 |
| DSGN PW | 10/20/92 |
| APPD | 11-6-91 |
| NEXT HIGHER ASSY. | - |
| 08:36:53 | 27-Jan-99 |

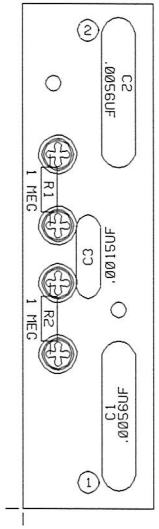
LUDLUM MEASUREMENTS INC.

TITLE: SWITCH
FILTER BOARD

BOARD# 5142-103

| SIZE | MODEL | SERIES | SHEET |
|---|---|---|---|
| C | 43-10 | 142 | 58 |

SB142103 SHEET 1 OF 1




| | | | | | |
|---|---|---|---|---|---|
| LUDLUM MEASUREMENTS INC. SWEETWATER, TX. | | | | | |
| DR PW | 10/20/92 | TITLE: SWITCH FILTER BOARD | | | |
| CHK CKB | 27-JAN-99 | | | | |
| DSGN PW | 10/20/92 | BOARD# 5142-103 | | | BS142103 |
| APP RSE | 1-27-99 | MODEL 43-10 | SERIES 142 | SHEET 59 | |
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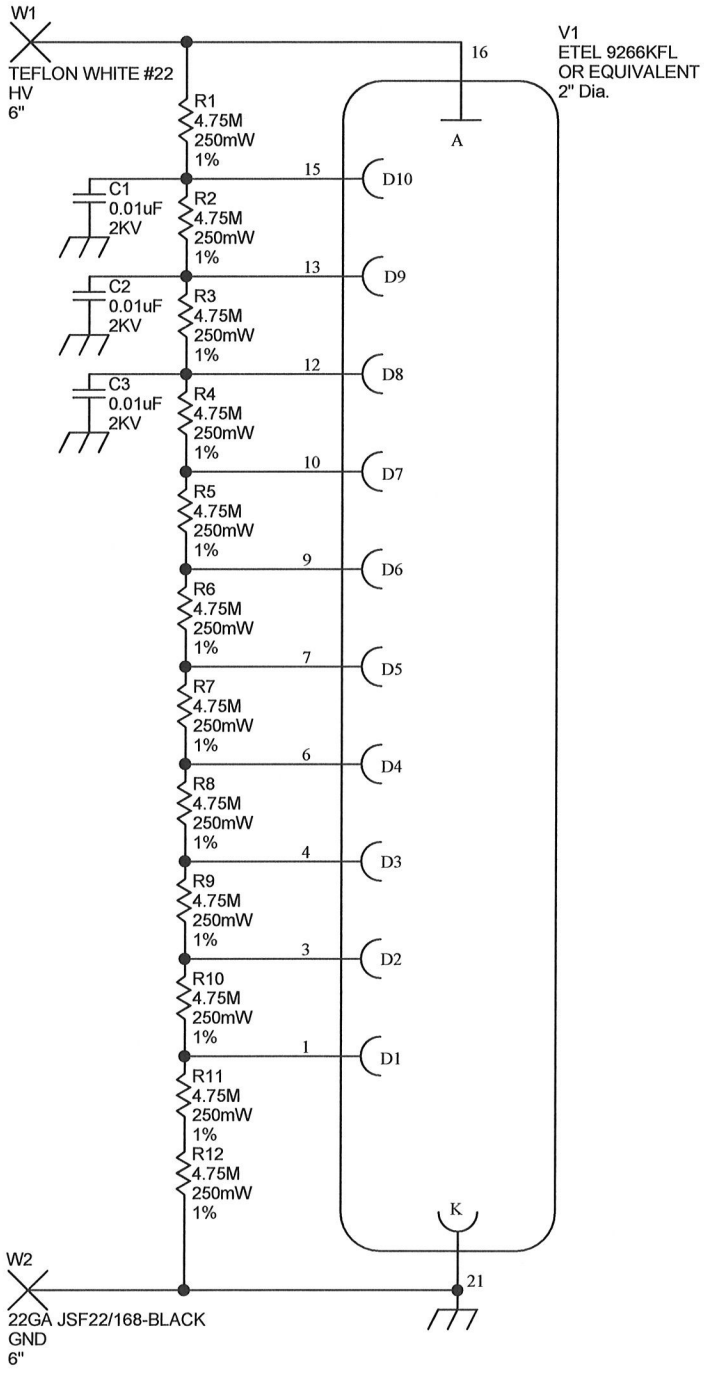
| COMP PASTE ☐ | COMP MASK ☐ | SLDR PASTE ☐ | SLDR MASK ☐ | | |

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|---|---|---|---|
| **LUDLUM MEASUREMENTS, INC.** | | **PO Box 810, 501 Oak Street, Sweetwater, Texas 79556 U.S.A. 1-800-622-0828** | |
| **Drawn:** AC | 05/07/2012 | **Title:** VOLTAGE DIVIDER | |
| **Design:** RSS | 05/07/2012 | **Model:** VARIOUS | |
| | | **Board#:** 5435-401 | |
| **Approve:** JOV | 10-22-12 | **Sheet:** 1 of 1 | **Series** 435 / **Sheet** 964 |
| **Print Date:** 10/10/2012 9:37:50 AM | | **Rev:** 2 | |
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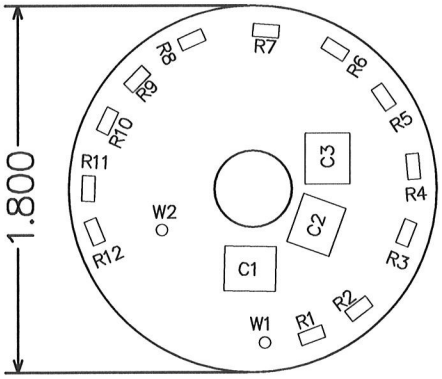


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|---|---|---|---|
| **LUDLUM MEASUREMENTS, INC.** | | PO Box 810<br>501 Oak Street<br>Sweetwater, TX 79556<br>U.S.A. 1-800-622-0828 | |
| **Title:** VOLTAGE DIVIDER | | | |
| **Drawn:** AC | 05/07/2012 | **Model:** VARIOUS | |
| **Design:** RSS | 05/07/2012 | **Board#:** 5435-401 | |
| **Approve:** JGW | 10-22-12 | **Rev:** 2 | |
| ***Print Date:*** 10/10/2012 9:37:52 AM | | **SCALE: 1.00** Top Overlay | **Series** 435 / **Sheet** 965 |
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