
**LUDLUM MODEL 215 AND MODEL 215-20
ALPHA FRISKER AND
CHARGING/CALIBRATION STAND**

May 2010

**Serial Number PR270687 and Succeeding
Serial Numbers**

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Section

1

Introduction

The Ludlum Model 215 Alpha Frisker is an air proportional detector designed to be used in detecting low-activity alpha radiation. The detector requires a charging/calibration stand (Ludlum Model 215-20), a 15-volt wall transformer, and an RS-232 communications cable for calibration. The Model 215 operating voltage is altitude sensitive. The detector can be used as a hand monitor while placed in position on the charging/calibration stand. A blinking red LED and clicking audio sound indicate activity, and a steady-tone alarm audio warns of contamination. The detector can also be removed from the stand and used as a frisker for up to 30 minutes before recharging is necessary. The maximum recharge time is 20 minutes to full charge. The Model 215 consists of a conductive plastic body with internal electronics. The window consists of 0.4 mg/cm² aluminized Mylar with an aluminum screen (79% open). The window can be easily replaced by removing four screws to open the back of the probe.

*Model 215**Model 215-20
Charging/Calibration Stand**Model 215 in the
Charging/Calibration Stand*

A graphic for Section 2 Specifications. It features a grey square on the left containing the word "Section" in a small font above a large white number "2". To the right of the square, the word "Specifications" is written in a large, grey, sans-serif font. A horizontal line is positioned below the word "Specifications".

Section 2 Specifications

Indicated Use: alpha frisking, hand monitor with alarm

Detector Type: alpha air proportional probe with integrated electronics

Operation: While sitting on the calibration/charging stand, the probe may be used as a hand monitor. A blinking red LED and click audio indicate activity, and a steady-tone alarm audio warns of contamination. The probe may also be removed from the stand and used as a frisker for up to 30 minutes before recharge. Maximum recharge time is 20 minutes to full charge, while the maximum time to operation from a fully discharged state is 5 minutes.

Display: Red LED – blinking (alpha pulse) or continuous (alarm)

Amber LED – trouble

Green LED – ok

Window: 0.4 mg/cm² aluminized Mylar with aluminum screen (79% open). Can be easily replaced by removal of six screws on back of probe.

Window Area: Active – 139cm²

Open – 110cm²

Efficiency (4pi geometry): typically 10% - ²³⁹Pu

Audio: 85dB at 30.5 cm (12 in.); programmable to other sound levels

Operating Voltage: altitude sensitive

Sea Level - 1950 volts

610 m (2000 ft) – 1900 volts

1524 m (5000 ft) – 1825 volts

2134 m (7000 ft) – 1775 volts

Counter Threshold Setting: -4 mV

Calibration Due Date: when exceeded, amber trouble light will illuminate (real time clock located in calibration/charging stand).

Construction: conductive plastic body with internal sealed electronics

Temperature Range: -20 to 50 °C (-4 to 122 °F)

May be certified to operate at -40 to 65 °C (-40 to 150 °F)

Probe Size: 24.1 x 11.4 x 3.8 cm (9.5 x 4.5 x 1.5 in.) (H x W x D)

In stand: 26.7 x 14.7 x 7.6 cm (10.5 x 5.8 x 3.0 in.) (H x W x D)

Weight: 0.54 kg (1.2 lb)

Power: The Model 215's internal capacitors provide power for a minimum of 30 minutes in a non-alarming condition. The capacitors will not be damaged by a complete discharge.

Accessories:

Model 215-20Charging/Calibration Stand: Input power is +15 V (+12 V minimum to +20 V maximum) at 100 mA maximum. Four charging stands can be interconnected to run from a single 500 mA wall-mounted power supply. The stand interfaces with a personal computer or any other device with an RS-232 port and uses infrared communications to set parameters and run automatic plateau routines.

Stand Size: 13.5 x 14.7 x .58 cm (5.3 x 5.8 x 2.3 in.) (H x W x L)

Weight: 0.50 kg (1.1 lb)

Section

3

Safety Considerations

Environmental Conditions for Normal Use

Indoor use only

Operating voltage is altitude sensitive

Temperature range of -20 to 50 °C (-4 to 122 °F)

Maximum relative humidity of less than 95% (non-condensing)

Pollution Degree 2 (as defined by IEC 664). (Normally only nonconductive pollution occurs. Temporary conductivity caused by condensation is to be expected.)

Cleaning Instructions

The Model 215 Alpha Frisker may be cleaned externally with a damp cloth, using only water as the wetting agent. Do not immerse the instrument in any liquid.

Section

4

Getting Started

Unpacking and Repacking

Remove the calibration certificate and place it in a secure location. Remove the instrument and stand, and ensure that all of the items listed on the packing list are in the carton. Check individual item serial numbers and ensure calibration certificates match. The Model 215 Alpha Frisker serial number is located on the label on the base or the body of the detector for model and serial number identification.

To return an instrument for repair or calibration, provide sufficient packing material to prevent damage during shipment. Also, provide appropriate warning labels to ensure careful handling. Include brief information as to the reason for return, as well as return shipping instructions:

- **Return shipping address**
- **Customer name or contact**
- **Telephone number**
- **Description of service requested and all other necessary information**

Setting Up the Model 215

After unpacking the Model 215, the calibration/charging stand (Model 215-20), and the 15-volt wall transformer, the detector will need to be charged. The maximum charge time is 20 minutes to full charge. Plug the 15-volt wall transformer into the charging stand and place the Model 215 on the stand.

The Green LED should light up and stay on. If any other LED is lit, there is a problem with the detector, or a parameter may not be set correctly. The Green LED will blink in low power conditions and when charging.

Expose the Model 215 to a low-activity alpha source. Ensure that the source is detected and that the alarm is set off once the counts exceed the alarm points.

To change factory settings, the detector will need to be placed in the calibration/charging stand. The stand will need to be connected to a computer via the RS-232 communications cable. New parameters can then be set up using the software provided with the Model 215. The Model 215 software section in this manual should be used as a reference for parameter changes. Once the parameters are established and stored in the instruments internal EEPROM, the Model 215 is ready for use.

In the likely event that an error occurs when restoring data from the Model 215's internal EEPROM on power-up, the Model 215 will generate a visual and audible alarm. The audible alarm will be a single tone once per second while all LEDs on the Model 215 will be lit. In this case, place the Model 215 in the calibration/charging stand and issue the "uP Load Default Setup" command from the Model 215 software. As a result, a new device that has never been initialized should always report a system setup error. In either case, the Model 215 will require calibration once default settings have been restored.

Section
5

Calibration Software

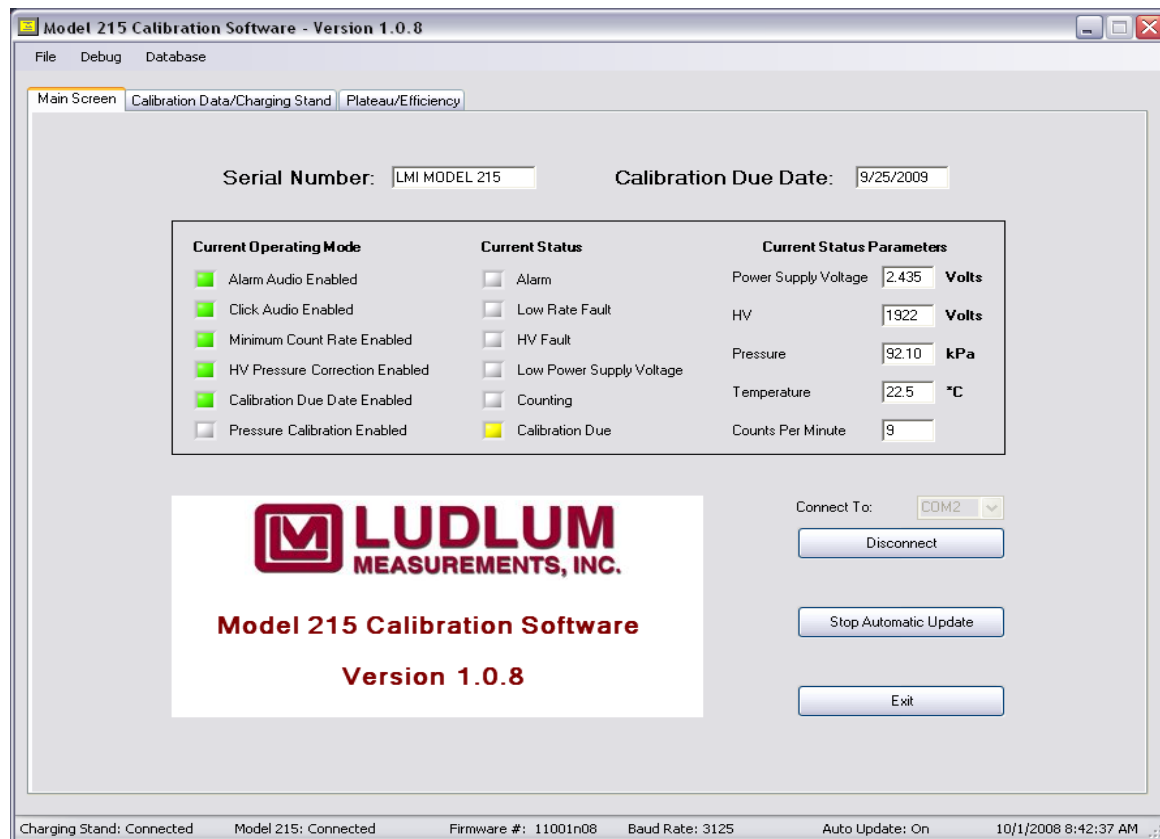
The Model 215 Calibration Software package allows the user to calibrate a Model 215 instrument and provides user-friendly access to the Model 215 features, including a general status check, as well as the ability to view and change calibration parameters, run a plateau, and calculate the efficiency of a Model 215 instrument.

The software interfaces with the instrument using an RS-232 serial connection. Instrument status parameters are updated every two seconds, allowing for continuous monitoring of an instrument, as well as the connection between the instrument and the charging stand. The auto-update feature can be started and stopped at the discretion of the user. The software also contains the Model 215 Debugger program, which can be accessed through the Debug menu on the main screen.

The software contains three tabs: the Main Screen tab, the Calibration Data/Charging Stand tab, and the Plateau/Efficiency tab.

Main Screen Tab

The following image shows an example of the main screen after a successful serial connection with the charging stand, as well as a successful connection with a Model 215 instrument.



To establish a serial connection to the instrument, simply click on the “Connect” button. Once a successful connection is established, the status bar on the lower left-hand corner of the screen will show both the charging stand and Model 215 are connected. The status bar also displays the firmware number of the instrument, the baud rate of the serial connection, whether or not auto-updating is on or off, and the current system date/time.

At the top of the main screen, the serial number of the instrument and calibration due date are displayed. The charging/calibration stand contains a real-time clock, which is used to update the time in the Model 215 every minute. The 215 checks this time to determine whether or not the calibration due date has passed. If the calibration due date has passed (as in this example), the “Calibration Due” indicator will turn yellow.

Below the serial number and calibration due date is another panel, which is divided into three sections: Current Operating Mode, Current Status, and Current Status Parameters.

Current Operating Mode

The Current Operating Mode section of the middle panel contains indicators that allow the user to toggle on or off for the following parameters:

- **Alarm Audio**
- **Click Audio**
- **Minimum Count Rate**
- **HV Pressure Correction**
- **Calibration Due Date On/Off**
- **Pressure Calibration Enabled**

Simply click on a gray button located to the left of the preferred feature to turn that feature on or click on a green button to turn the associated feature off. A command will be sent to the instrument, and after a short delay, the requested change is made.

Current Status

The Current Status section of the middle panel contains indicators that inform the user of any of the following situations:

- **Instrument Alarm** – Indicator will turn red.
- **Low Rate Fault** – Indicator will turn yellow.
- **HV Fault** – Indicator will turn yellow.
- **Low Power Supply Voltage** – Indicator will turn yellow when the power supply voltage is low. This means that the instrument needs to be charged.
- **Counting** – Indicator will turn green when the instrument is counting.
- **Calibration Due** – Indicator will turn yellow when the calibration due date has passed, and the instrument needs to be recalibrated.

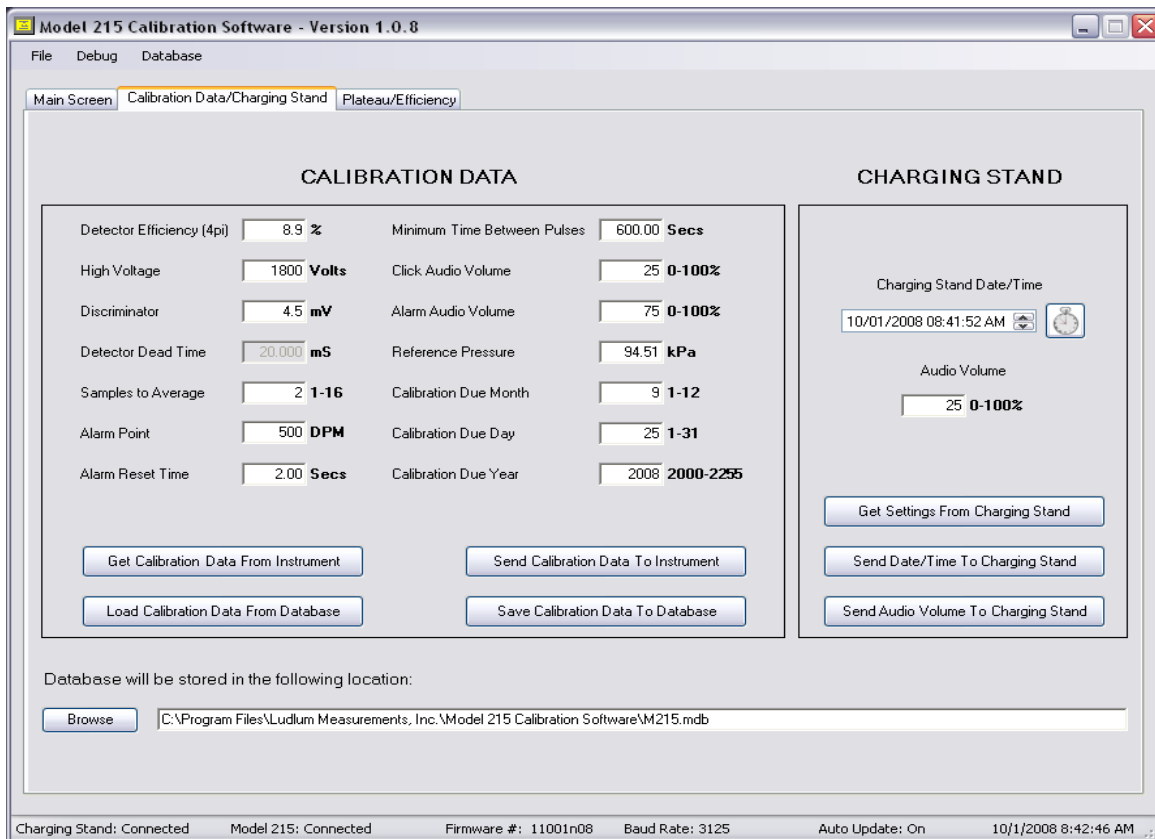
Current Status Parameters

The Current Status Parameters section provides the user with a current reading for each of the following instrument parameters:

- **Power Supply Voltage** (volts)
- **High Voltage** (volts)
- **Pressure** (kPa)
- **Temperature** (Celsius)
- **Counts Per Minute**

Calibration Data/Charging Stand Tab

The following image shows an example of the Calibration Data/Charging Stand tab that has been populated with data.



Calibration Data

Calibration data is saved in two locations: the instrument itself and in a Microsoft Access database, which is located in the program installation folder. The default installation folder is C:/Program Files/Ludlum Measurements, Inc/M215 Calibration Software.

There are four buttons in the Calibration Data section. The top two buttons allow the user to get/send calibration data from/to the instrument itself. The bottom two buttons allow the user to load/save calibration data from/to the database. The database allows the user to roll back to the previously saved calibration settings if necessary. If the database is located in a folder other than the one specified in the bottom text box, click the Browse button to choose the correct folder.

Charging Stand

There are four buttons in the Charging Stand section. The first button allows the user to get the charging stand settings from the charging stand. The second button sends the current date and time displayed in the Charging Stand Date/Time field to set the real-time clock (RTC) in the charging stand. The third button allows the user to set the audio volume for the charging stand. The fourth button is a small clock icon, which may be clicked to automatically load the Charging Stand Date/Time field with the current date and time as displayed in the lower right corner of the software.

Below is a list of the parameters that may be viewed and/or changed under the *Calibration Data/Charging Stand* tab (units for each parameter are in parentheses):

NOTE: Value ranges are what the software will accept without error.

Calibration Data Parameters:

- **Detector Efficiency** (% steps, 0.1-100%)
- **High Voltage** (volts, 0-2500)
- **Discriminator** (mV steps, 0.3-11.5 mV)
- **Detector Dead Time** (mSec, 20.0 mSec)
- **Samples To Average** (1-16)
- **Alarm Point** (DPM, 0-10,000 DPM)
- **Alarm Reset Time** (secs, 1-65.5 secs)
- **Minimum Time Between Pulses** (secs, 1-655 secs)
- **Click Audio Volume** (0-100%)
- **Alarm Audio Volume** (0-100%)

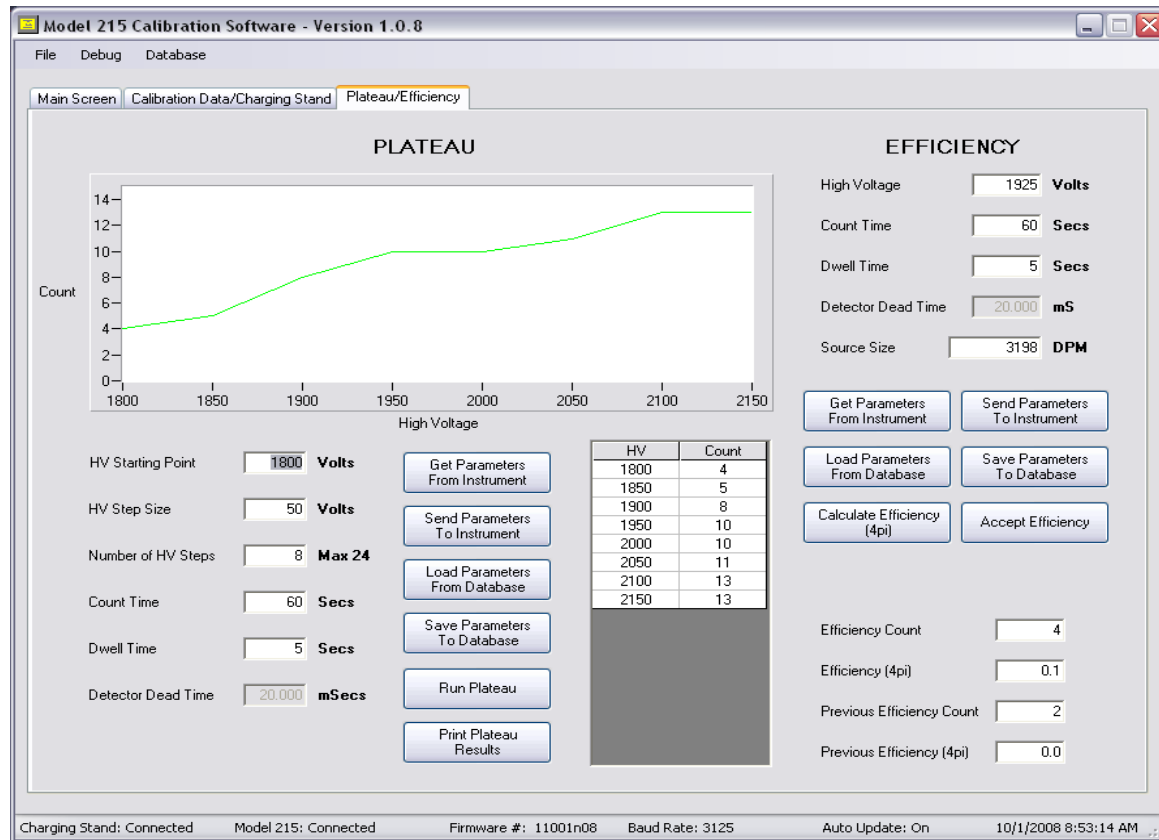
- **Reference Pressure** (kPa, 30-150 kPa)
- **Calibration Due Month** (1-12)
- **Calibration Due Day** (1-31)
- **Calibration Due Year** (2000-2255)

Charging Stand Parameters:

- **Charging Stand Real Time Clock (RTC)** (any valid date and time)
- **Audio Volume** (0-100%)

Plateau/Efficiency Tab

The following image shows an example of the *Plateau/Efficiency* tab.



The *Plateau/Efficiency* tab is divided into two sections, plateau and efficiency. Each section has a unique set of parameters.

Plateau

The Plateau section contains the following parameters (units and value ranges for each parameter are in parentheses):

NOTE: Value ranges are what the software will accept without error.

- **HV Starting Point** (Volts, 1300-1900 V)
- **HV Step Size** (Volts, 1-100 V)

- **Number of HV Steps** (1-24)
- **Count Time** (secs, 1-655)
- **Dwell Time** (secs, 1-65,535)
- **Detector Dead Time** (mSec, 20.0 mSec)

The Plateau section contains the same four buttons as the *Calibration* tab, allowing the user to read parameters from and save parameters to both the parameter backup database and the instrument itself. To run a plateau, click the Run Plateau button, located at the bottom of the plateau button column. Note that the button caption now reads “Stop Plateau.” This button allows the user to stop the plateau before it completes. After the Run Plateau button is pressed, the plateau parameter text boxes are automatically loaded with the current instrument data. When a plateau starts, a text box appears at the bottom of the screen to alert the user as to the length of time remaining for completion of the current step.

After each step in the plateau, the instrument sends over the plateau results, which are then stored in a grid located to the right of the plateau parameter buttons. A graph of the results is also generated and displayed above the plateau parameters. When the plateau is complete, the final grid and graph will be displayed, the caption of the Stop Plateau button will change to Run Plateau, and another button will appear, giving the user the option to print the plateau results. Plateau results from a stopped plateau can also be printed when the plateau stops.

If a plateau step is missed by either the software or the instrument, the plateau will automatically be stopped, and one last step will be displayed on the grid. In this case, the last step in the grid will have a red background to let the user know that there was a problem with the plateau.

Efficiency

The Efficiency section contains the following parameters (units for each parameter are in parentheses):

- **High Voltage** (volts, 0-2500 V)
- **Count Time** (secs, 1-65,535 secs)
- **Dwell Time** (secs, 1-65,535 secs)
- **Detector Dead Time** (mS, 20.0 mS)
- **Source Size** (DPM, 1-4,294,967,295 DPM)

The Efficiency section contains the same four buttons as the Calibration and Plateau tabs, allowing the user to read parameters from and save parameters to both the parameter backup database and the instrument. To calculate efficiency, click on the Calculate Efficiency button. When an efficiency calculation has started, the caption of the Calculate Efficiency button will now read “Stop Efficiency.” This allows the user to stop an efficiency count at any time. The current efficiency parameters from the instrument will load into the appropriate text boxes, and efficiency counting will begin.

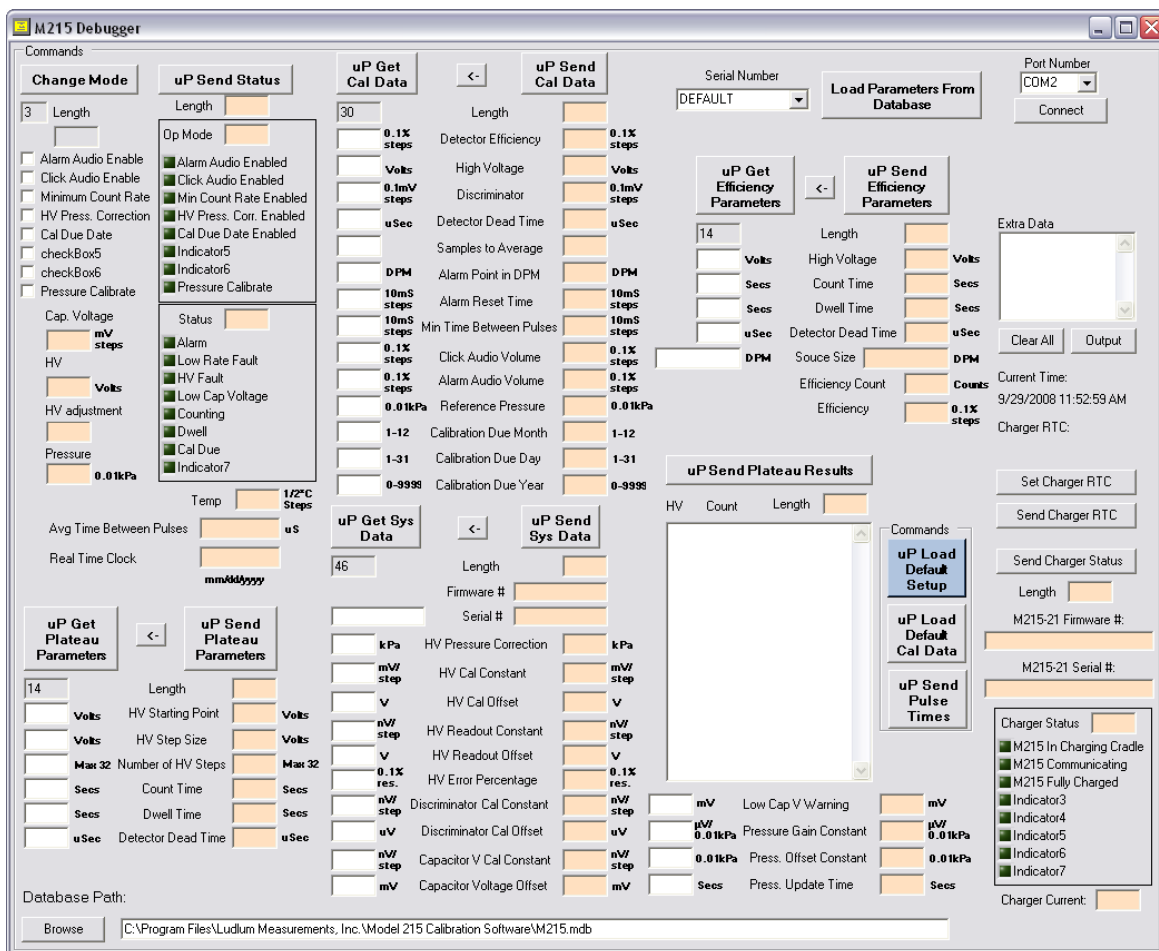
Five new text boxes will appear. The first text box shows the efficiency count time remaining. When efficiency counting is over, the resulting efficiency count and calculated value is displayed in the second and third text boxes, respectively. The fourth and fifth text boxes display the efficiency count and efficiency from the last efficiency calculation. A sixth button also appears, which allows the user to accept the newly calculated efficiency. Clicking the Accept Efficiency button will change the Detector Efficiency parameter under the Calibration Data tab. The new Calibration Data will then be sent to the Model 215 instrument.

Debugger Program

As mentioned earlier, the Model 215 Calibration Software also includes access to the Model 215 debugger. **NOTE:** This debugger is for advanced users only.

To load up the debugger program, click on the Debug menu at the top of the screen, then click on Launch Debugger. If there is a serial connection to the instrument, that serial connection is closed and auto-updating is disabled.

The image below shows an example of the Model 215 Debugger screen.



In the Model 215 Debugger program, the Get Data and the Send Data buttons are from the perspective of the Model 215 instrument. For example, to send new plateau parameters to the Model 215 instrument, the user would click on the “uP Get Plateau Parameters” button, and clicking on the “uP Send Plateau Parameters” button would load the current plateau parameters from the Model 215 instrument.

In addition to sending data to the Model 215 instrument, the Get Data buttons also saves a copy of the data to the Model 215 database, which is the same database used by the Model 215 calibration software.

NOTE: When you change any data in the Model 215 with the debugger software, the debugger software will automatically load the current system data from the Model 215 and will use the serial number it retrieves as the location to store the data in the database. If you plan to take advantage of the database feature, it is recommended that the first step performed when using the debugger software is to click the “uP Send Sys Data” and verify that the Model 215 has the appropriate serial number. If the serial number needs to be changed, make this change prior to performing any other debugger actions.

The Model 215 Database contains five data tables, one for each of the following parameter groups: Operating Mode, Plateau, Efficiency, Calibration, and Status parameters. As a result, each of the Get Data buttons ONLY save data to the appropriate data group in the database.

Parameters may be loaded from the database by selecting a serial number in the combo box at the top of the screen, then clicking on the Load Parameters From Database button. If there are parameters saved in the database for the selected serial number, the white text boxes for each of the five parameter groups will be loaded with those parameters. Otherwise, the white boxes will remain blank.

The location of the database used by the Model 215 debugger software is determined by the Database Path text box located at the bottom of the debugger software. To change the path where the database file resides, click on the Browse button and choose the folder that contains the Model 215 Database file.

To allow the user full control over the Model 215 Database, the Model 215 Database Software is also provided. A screen shot of the Model 215 Database Software is provided on the next page.

Model 215 Database Software
_ □ ×

Serial Number
 DEFAULT

Database Path:
 C:\Program Files\Ludlum Measurements, Inc.\Model 215 Calibration Software\M215.mdb

Operating Mode

- Alarm Audio Enabled
- Click Audio Enabled
- Minimum Count Rate Enabled
- HV Pressure Correction Enabled
- Calibration Due Date Enabled
- Pressure Calibration Enabled

Plateau Parameters

HV Start Point **Volts**

HV Step Size **Volts**

Number Of HV Steps **Max 24**

Count Time **Secs**

Dwell Time **Secs**

Detector Dead Time **µSecs**

Efficiency Parameters

High Voltage **Volts**

Count Time **Secs**

Dwell Time **Secs**

Detector Dead Time **µSec**

Source Size **DPM**

Calibration Data

Detector Efficiency **0.1% Steps**

High Voltage **Volts**

Discriminator **0.1mV Steps**

Detector Dead Time **µSecs**

Samples To Average **1-16**

Alarm Point **DPM**

Alarm Reset Time **10ms Steps**

Min. Time Between Pulses **10ms Steps**

Click Audio Volume **0.1% Steps**

Alarm Audio Volume **0.1% Steps**

Reference Pressure **0.01 kPa**

Calibration Due Month **1-12**

Calibration Due Day **1-31**

Calibration Due Year **2000-2255**

System Data

Serial Number Discriminator Cal Offset **µV**

HV Pressure Correction **kPa** Capacitor Voltage Cal Constant **µV/Step**

HV Cal Constant **mV/Step** Capacitor Voltage Offset **mV**

HV Cal Offset **V** Low Capacitor Voltage Warning **mV**

HV Readout Constant **nV/Step** Pressure Gain Constant **µV/0.01 kPa**

HV Readout Offset **V** Pressure Offset Constant **0.01 kPa**

HV Error Percentage **0.1% Res.** Pressure Update Time **Secs**

Discriminator Cal Constant **nV/Step**

Section 6 Recycling

Ludlum Measurements, Inc. supports the recycling of the electronic products it produces for the purpose of protecting the environment and to comply with all regional, national and international agencies that promote economically and environmentally sustainable recycling systems. To this end, Ludlum Measurements, Inc. strives to supply the consumer of its goods with information regarding reuse and recycling of the many different types of materials used in its products. With many different agencies – public and private – involved in this pursuit, it becomes evident that a myriad of methods can be used in the process of recycling. Therefore, Ludlum Measurements, Inc. does not suggest one particular method over another, but simply desires to inform its consumers of the range of recyclable materials present in its products, so that the user will have flexibility in following all local and federal laws.

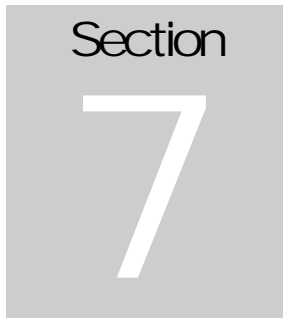
The following types of recyclable materials are present in Ludlum Measurements, Inc. electronic products, and should be recycled separately. The list is not all-inclusive, nor does it suggest that all materials are present in each piece of equipment:

Batteries	Glass	Aluminum and Stainless Steel
Circuit Boards	Plastics	Liquid Crystal Display (LCD)

Ludlum Measurements, Inc. products, which have been placed on the market after August 13, 2005 have been labeled with a symbol recognized internationally as the “crossed-out wheellie bin.” This notifies the consumer that the product is not to be mixed with unsorted municipal waste when discarding. Each material must be separated. The symbol will be placed near the AC receptacle, except for portable equipment where it will be placed on the battery lid.

The symbol appears as such:





Section
7

Parts List

	Reference	Description	Part Number
Model 215 Alpha Frisker	UNIT	Completely Assembled Model 215 Alpha Frisker	48-3531
		Completely Assembled Model 215-20 Charging/Calibration Stand	48-3566
Model 215 (Main Board), Drawing 110 X 099	BOARD	Completely Assembled Circuit Board	5110-099
CAPACITORS	C1	.01 μ F, 500V	04-5696
	C2	.01 μ F, 3KV	04-5762
	C3	100pF, 3KV	04-5532
	C4-C6	.01 μ F, 500V	04-5696
	C7	.01 μ F, 3KV	04-5762
	C8-C9	.01 μ F, 500V	04-5696
	C10	1 μ F, 35V	04-5656
	C11-C12	.01 μ F, 500V	04-5696
	C13	.01 μ F, 3KV	04-5762
	C14	10PF, 100V	04-5673
	C15-C16	.01 μ F, 500V	04-5696
	C17	.01 μ F, 50V	04-5664
	C18	1 μ F, 35V	04-5656
	C19-C21	.01 μ F, 500V	04-5696
	C22	.001 μ F, 100V	04-5659
	C23	.01 μ F, 500V	04-5696
	C24	.1 μ F, 50V	04-5663
	C25	.01 μ F, 500V	04-5696
	C26	68 μ F, 10V	04-5654
	C27-C28	.01 μ F, 500V	04-5696
	C29	68 μ F, 10V	04-5654

	Reference	Description	Part Number
	C30-C35	.01 μ F, 500V	04-5696
	C36	0.1 μ F 100V	04-5792
	C37	.01 μ F, 500V	04-5696
	C38-C41	0.1 μ F, 100V	04-5792
	C42	1 μ F, 50V	04-5708
	C43	15PF, 100V	04-5721
	C44	1 μ F, 50V	04-5708
	C45	68 μ F, 10V	04-5654
	C46	15 PF, 100V	04-5721
	C47	1 μ F, 50V	04-5708
	C48	.047 μ F, 50V	04-5662
	C49	10 μ F-T, 25V	04-5655
	C50	.033 μ F, 100V	04-5797
	C51	100pF, 100V	04-5661
	C52	0.1 μ F, 100V	04-5792
	C53	100 μ F, 16V-T	04-5794
	C54-C55	0.1 μ F, 100V	04-5792
	C56	4.7 μ F, 50V	04-5796
	C57	0.1 μ F, 100V	04-5792
	C58	1 μ F, 50V	04-5708
	C59	.22 μ F, 50V-C	04-5694
	C60	4.7 μ F, 50V	04-5796
	C61	0.1 μ F, 100V	04-5792
	C62	10pF, 100V	04-5673
	C63	10 μ F, 10V	04-5757
	C64	0.1 μ F, 100V	04-5792
	C65	330pF, 100V	04-5657
	C66	4.7 μ F, 50V	04-5796
	C67	.0015 μ F, 100V	04-5680
	C68-C71	10F, 2.5V	04-5798
	C72	.001 μ F, 2KV	04-5698
	C73	0.1 μ F, 100V	04-5792
TRANSISTORS	Q1	SST201	05-5929
	Q2	CMXT3904	05-5888
	Q3	Si2301BDS-TI	07-6486
	Q4	MMBT3904LT1	05-5841
DIODES	CR1-CR7	COMP2005S	07-6468


	Reference	Description	Part Number
SWITCH	SW1	48BFSP1M6QT	08-6839
CRYSTAL	Y1	XTAL-4 MHZ	01-5264
INTEGRATED CIRCUITS	U1	HSDL-3201-021	07-6464
	U2	MCP2122-E/SNG	06-6692
	U3	KM4110	06-6554
	U4	LMC7111BIM5X	06-6410
	U5	MAX985EUK-T	06-6459
	U6	MAX5842LEUB	06-6705
	U7	LT1304CS8	06-6394
	U8	MAX809REUR-LF	06-6690
	U9	INA126UA	06-6726
	U10	PIC18LF2520-I/SO	06-6696
	U11	SM5420-030-A-P-S	2311127
	U12	MAX4544EUT-T	06-6639
	U13	MCP9800AOT-M/OTG	06-6687
	U14	SN74AHC1G14	06-6556
	U15	TPS61005DGS	06-6689
	U16	LT1790BIS6-2.5	06-6691
	U17	MAX629ESA	06-6707
	U18	LT1976EFE	06-6688
	U19	MIC1557BM5	06-6457
RESISTORS	R1	100K, 1/4W, 1%	12-7834
	R2	10M, 1/4W, 1%	12-7996
	R3	1M, 1/4W, 1%	12-7844
	R4	1K, 1/4W, 1%	12-7832
	R5	10M, 1/4W, 1%	12-7996
	R6	15K, 1/4W, 1%	12-7998
	R7	10M, 1/4W, 1%	12-7996
	R8	2K, 1/4W, 1%	12-7926
	R9	5G, 10%	12-7228
	R10	150K, 1/4W, 1%	12-7833
	R11	100K, 1/4W, 1%	12-7834
	R12	5.1M, 1/8W, 2%	12-7979
	R13	100K, 1/4W, 1%	12-7834
	R14	121K, 1/8W, 1%	12-7014
	R15	1M, 1/4W, 1%	12-7844

	Reference	Description	Part Number
	R16	10 OHM, 1/8W, 1%	12-7836
	R17	1M, 1/4W, 1%	12-7844
	R18	953K, 1/8W, 1%	12-7950
	R19	332 OHM, 1/4W, 1%	12-7854
	R20	150K, 1/4W, 1%	12-7833
	R21	124K, 1/4W, 1%	12-7032
	R22	100K, 1/4W, 1%	12-7834
	R23	221K, 1/4W, 1%	12-7845
	R24-R25	10K, 1/4W, 1%	12-7839
	R26	1K, 1/4W, 1%	12-7832
	R27	100 OHM, 1/4W, 1%	12-7840
	R28	1K, 1/4W, 1%	12-7832
	R29	1.96K, 1/4W, 1%	12-7065
	R30	10K, 1/4W, 1%	12-7839
	R31	1K, 1/4W, 1%	12-7832
	R32	10K, 1/4W, 1%	12-7839
	R33	1K, 1/4W, 1%	12-7832
	R34	10K, 1/4W, 1%	12-7839
	R35	1M, 1/4W, 1%	12-7844
	R36	10K, 1/4W, 1%	12-7839
	R37	309K, 1/4W, 1%	12-7231
	R38	1M, 1/4W, 1%	12-7844
	R39	243K, 1/8W, 1%	12-7112
	R40	93.1K, 1/4W, 1%	12-7211
	R41	100K, 1/4W, 1%	12-7834
	R42	475K, 1/4W, 1%	12-7859
	R43	26.7K, 1/8W, 1%	12-7884
	R44	56.2K, 1/4W, 1%	12-7873
	R45	100K, 1/4W, 1%	12-7834
	R46-R51	243 OHM, 1/4W, 1%	12-7905
	R52	10K, 1/4W, 1%	12-7839
	R53	221K, 1/4W, 1%	12-7845
CONNECTORS	P1	1128-52-0319 WHITE	18-9251
	P2	1128-52-0310 BLK	18-9252
	P3	53014-0610	13-8974
	P4	640457-2 MTA100	13-8147
	P5	640457-3 MTA100	13-8165
INDUCTORS	L1-L2	DS1608C-333	21-9096

	Reference	Description	Part Number
	L3	4.7 μ H	21-9066
TRANSFORMER	T1	XFMR-30132R	21-9925
Model 215-20 LED/Audio Board Drawing 110 X 176	BOARD	Completely Assembled LED/Audio Board	5110-175
CAPACITORS	C1	47 μ F, 20V	04-5714
	C2	10 μ F, 10V	04-5757
	C3	47 μ F, 20V	04-5714
	C4	0.1 μ F, 100V	04-5792
	C5	4F, 2.5V	04-5808
	C6, C7	10 μ F, 10V	04-5757
INTEGRATED CIRCUIT	U1	LM358DG	06-6312
	U2	MSP430F2012RSA	06-6729
	U3	24FC1025	06-6717
RESISTOR	R1	221K, 1/4W, 1%	12-7845
	R2	100K, 1/4W, 1%	12-7834
	R3-R7	4.75K, 1/4W, 1%	12-7858
	R9-R11	22.1 Ohm, 1/4W, 1%	12-7055
	R12	33.2 Ohm, 1/8W, 1%	12-7837
	R15	100 Ohm, 1/4W, 1%	12-7840
	R16	2.21K, 1/4W, 1%	12-7835
	R18	100 Ohm, 1/4W, 1%	12-7840
	R19	47.5K, 1/4W, 1%	12-7872
CRYSTALS	Y1, Y2	MS2V-T1S	01-5740
TRANSISTORS	Q1	RK7002A	05-5931
	Q2-Q5	CMXT3904	05-5888
	Q6	SI2302ADS-T1	07-6487
DIODES	CR1-CR3	SD103-AW	07-6420

	Reference	Description	Part Number
MISC	VR1	TPS77025	05-5935
	DS1	Red LED	07-6520
	DS2	Amber LED	07-6521
	DS3	Green LED	07-6522
	DS4	Blue LED	07-6538
	J1	CON7	13-8633
	J2	640456-2MTA	13-8073
	J3	SLM-104-01-S-S	13-8986
	L1	56mH	21-9040
	Model 215-20 Charger Board, Drawing 110 X 142	BOARD	Completely Assembled Charger Board
CAPACITORS	C1	0.1 μ F, 100V	04-5792
	C2	470pF, 2KV	04-5720
	C3	68 μ F, 16V-T	04-5768
	C4	10 μ F-T, 25V	04-5655
	C5-C6	100 PF, 3 KV	04-5735
	C7	68 μ F, 16V-T	04-5768
	TRANSISTOR	Q1-Q2	Si4850EY
INTEGRATED CIRCUITS	U1	LM2937ES-12	05-5932
	U2	MAX4372TEUK-T	06-6669
	U4	MIC1557BM5	06-6457
	U5	CD4093BQ	06-6716
	U8-U9	TPS2828DBVR	06-6715
RESISTORS	R1	0.25 OHM, 1W, 1%	12-7203
	R5	90.9K, 1/4W, 1%	12-7224
	R6-R7	14.7 K, 1/4 W, 1%	12-7068
CONNECTORS	P1	640457-4 MTA100X4RA	13-8089
	P2-P4	PAD	18-9160

	Reference	Description	Part Number
Model 215-20 Communications Controller Board Drawing 110 X 173	BOARD	Completely Assembled Communications Controller Board	5110-172
CAPACITORS	C1	1 μ F, 10V	04-5809
	C2	0.1 μ F, 100V	04-5792
	C3-C7	1 μ F, 10V	04-5809
	C8	1 μ F, 35V	04-5656
	C9	1 μ F, 10V	04-5809
	C10	10 μ F-T, 25V	04-5655
	C11	100 μ F, 16V-T	04-5794
	C12	1 μ F-T, 35V	04-5656
	C14, C15	15PF, 100V, 5%	04-5721
TRANSISTORS	Q2-Q5	CMXT3904	05-5888
INTEGRATED CIRCUITS	U2	MCP2122-E/SNG	06-6692
	U3	HSDL-3201-008	06-6693
	U4	SN74AHC1G14	06-6556
	U5	MAX3232EIDW	06-6702
	U7	MAX809REUR-LF	06-6690
	U8	PIC18LF2320-I/SO	06-6696
RESISTORS	R2-R4	22.1K, 1/4W, 1%	12-7843
	R5, R6	1K, 1/4W, 1%	12-7832
	R8	100 Ohm, 1/4W, 1%	12-7840
	R12	221K, 1/4W, 1%	12-7845
	R15-R18	4.75K, 1/4W, 1%	12-7858
	R18-R21	22.1 Ohm, 1/8W, 1%	12-7055
	R22	33.2 Ohm, 1/8W, 1%	12-7837
CRYSTAL	Y2	4MHz Crystal	01-5264
MISC	D1	CMPSH-3 Diode	07-6489
	DS1	Amber LED	07-6521
	DS2	Red LED	07-6520
	DS3	Green LED	07-6522
	DS4	Blue LED	07-6538
	P1	53014-0610	13-8974
	P2	640456-4MTA 100	13-8088
	P3	07FE-BT-VK-N 7P	13-8633
	J1, J2	RAPC712	13-8445
	J3	640456-4MTA 100	13-8088

A graphic for Section 8 Drawings. It features a grey square on the left containing the word "Section" at the top and a large white number "8" in the center. To the right of the square, the word "Drawings" is written in a large, grey, sans-serif font. A horizontal line is positioned below the word "Drawings".

Section
8
Drawings

Model 215, Drawing 110 X 109

Model 215-20, Drawings 110 X 120

Model 215 Main Board, Drawing 110 X 099 (3 sheets)

Model 215 Main Board Layout, Drawing 110 X 100 (2 sheets)

Model 215-20 LED/Audio Board, Drawing 110 X 175

Model 215-20 LED/Audio Board Layout, Drawing 110 X 176 (2 Sheets)

Model 215-20 Charger Board, Drawing 110 X 142

Model 215-20 Charger Board Layout, Drawing 110 X 143

Model 215-20 Communications Controller Board, Drawing 110 X 172

Model 215-20 Communications Controller Board Layout, Drawing 110 X 173 (2 sheets)