RUSKA 2456-LEM

Laboratory Environment Monitor

Users Manual

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Chapter 1
Function

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General Function

This manual contains operation instructions for the RUSKA 2456 Laboratory
Environment Monitors. The RUSKA 2456-LEM monitors the fundamental
environmental parameters; Temperature, Pressure, and Relative Humidity. The sensor
data is collected, processed, and made available on the selectable, RS232 or RS485,
communication port. The data logging functions allow for easy collection, verification of
data integrity and use of historical data.

The LEM can be used as a stand alone device or in conjunction with other monitors. The
monitor can also be used as the Air Density Monitor for the RUSKA 2456 and 2465
models. If higher accuracy pressure data is needed, then a secondary RS232
communications port allows for use with RUSKA 7220 / 6220 Portable Pressure Gauges
and other pressure standards.

How to Contact Fluke

To order accessories, receive operating assistance, or get the location of the nearest Fluke
distributor or Service Center, call:

- Technical Support USA: 1-800-99-FLUKE (1-800-993-5853)
- Calibration/Repair USA: 1-888-99-FLUKE (1-888-993-5853)
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-402-675-200
- China: +86-400-810-3435
- Japan: +81-3-3434-0181
- Singapore: +65-738-5655
- Anywhere in the world: +1-425-446-5500

Or, visit Fluke's website at www.fluke.com.

To register your product, visit http://register.fluke.com.

To view, print, or download the latest manual supplement, visit
http://us.fluke.com/usen/support/manuals.

Safety Information

⚠ Warning

Pressurized vessels and associated equipment are potentially dangerous. The apparatus described in this manual should be operated only by personnel trained in procedures that will assure safety to themselves, to others, and to the equipment.

⚠ Caution

Do not use hydrocarbon lubricants. Use only supplied lubricant, unless otherwise specified in this manual. Always use replacement parts specified by Fluke.

⚠ Warning

When any maintenance is performed, turn off power and remove power cord.

Symbols Used in this Manual

In this manual, a **Warning** identifies conditions and actions that pose a hazard to the user. A **Caution** identifies conditions and actions that may damage the Laboratory Environment Monitors.

Symbols used on the Laboratory Environment Monitors and in this manual are explained in Table 1-1.

Table 1-1. Symbols

Symbol	Description
∼	AC (Alternating Current)
⏚	Earth Ground
⚠	Important Information: refer to manual
🗑	Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.

Components

The LEM product comes with the following accessories:

- Power Plug (input: 110-240 Vac, 50/60Hz) Part #62-315
- Communication Cable (F/F 9DSUB) Part # 8-823
- Software Packet Part # 2456-LEMCAL
- Manual Part # LEM-1D01

PC Requirements

Windows ™ 95, 98, 2000, or XP 130 MHz Pentium or higher

LEM Basics
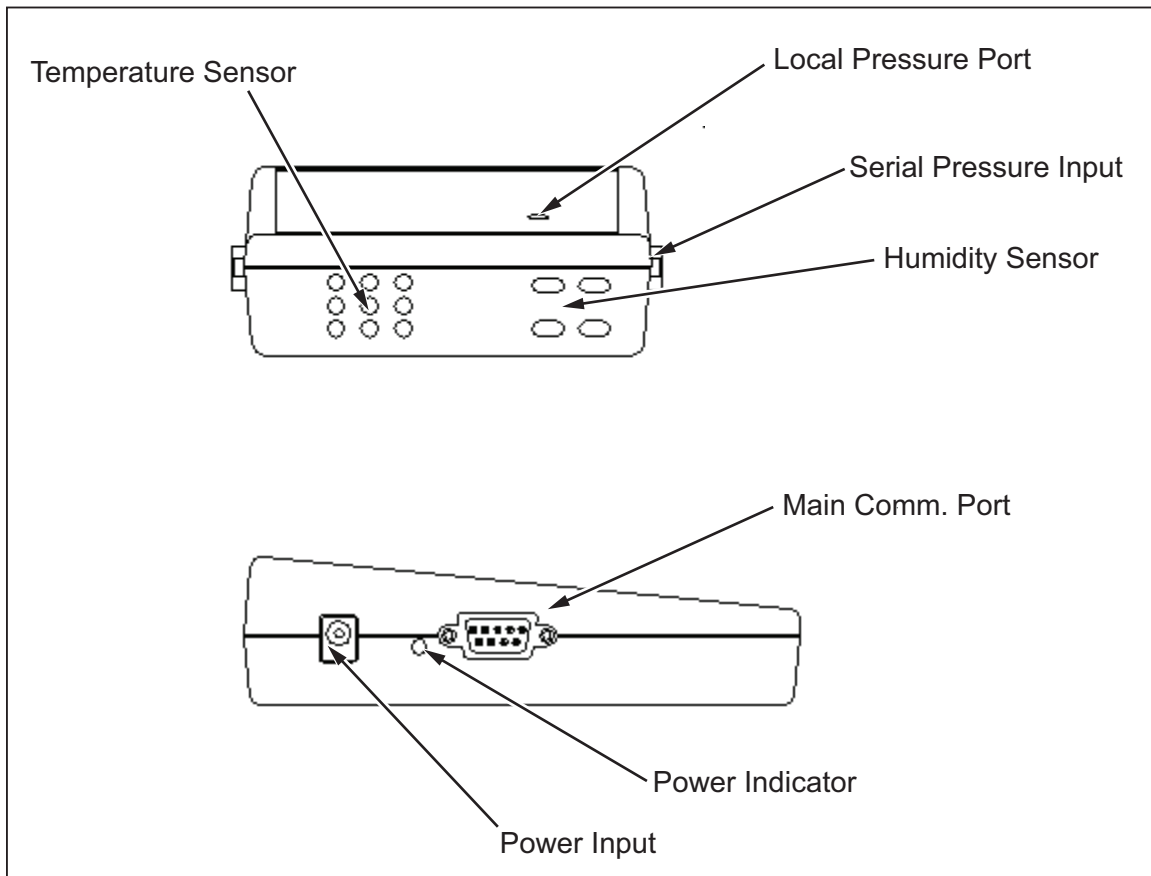
Figure 1-1. LEM General View

gky01.eps

Calibration Data Storage

The calibration data is stored in the LEM. Refer to Chapter 5 for information on the Calibration process and how to access the coefficients.

Main Comm Port

The main communication port is user selectable for RS232 or RS485, using a switch located on the bottom of the LEM (see Figure 1-2). Cycle the power to activate a change in the communication port.

The provided communication cable allows for the monitor to be directly connected to a standard PC - DB9 - RS232 port.
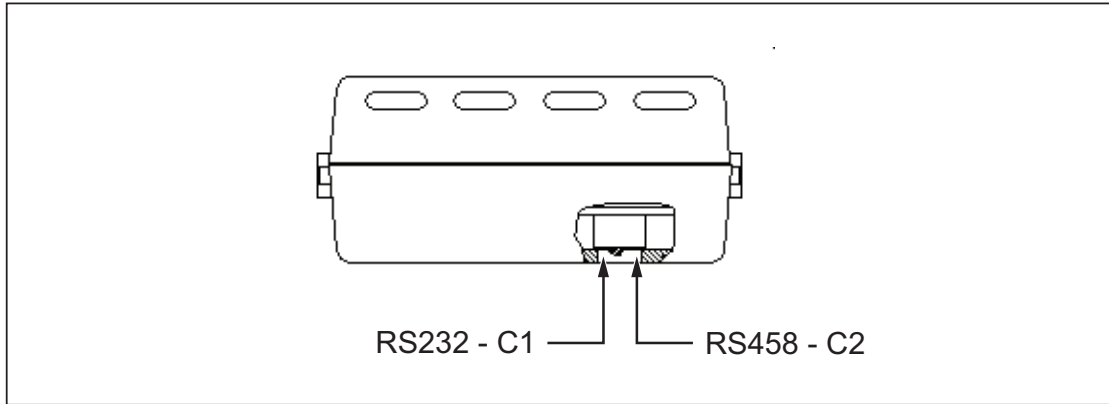
gky02.eps

Figure 1-2. LEM Communication Switch

Optional USB cables are available: Part # 8-825 - USB to RS232 (requires Windows 98 or higher).

Power

The Power LED will illuminate when power is applied through either the power plug or the main communication port.

Refer to Chapter 6, Connector Specification, for connector and pin out details.

Chapter 2
Getting Started

Introduction

The following explains how to setup PC operation with RUSKA LEMCal software and a single LEM.

Interconnect

The standard interface cable for the LEM is a DB9 F/F cable. The green indicator light should come on when the power plug is connected.

Software Installation

1. Insert CD into drive.

   The AutoRun function should begin the installation.

2. If the AutoRun function does not begin then Select Start and Select Run.

   Type D:\Setup (where D is your CDROM directory)

3. Double Click on the new LemCal icon in the RUSKA Instrument Program group.

At this point, the System should display data. If not, or if customization is desired then continue with the section below.

Software Setup

Help Menus

The LEM software contains extensive help menus that provide detailed information about each function.

Serial Port Setup

From the menu select Setup | Communication.
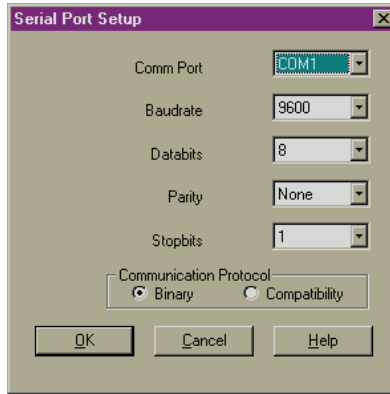
gky04.bmp

Figure 2-1. Serial Port Setup

The default settings are shown. Change the Comm Port to match the host computer. The Baudrate, Databits, Parity and Stopbit defaults should be set as shown in Figure 2-1.

Communications Protocol

See Appendix, Remote Commands, for a description of the Communication Protocol.

LEM Addressing

From the Menu select Setup | Options.

LEM

The factory default address is 33.

This address can be changed to any address between 0 and 99.

The 0 address is the global address. When a command is issued with the 0 address all instruments on the communication bus will respond.

To view the address and Calibration Coefficients go to Calibrate | View Coefficients (Figure 2-2).

To change the address, double click on the Address Window and modify, answer "Yes" to editing coefficients, and enter a new address. Click on the "Write coefficients to Sensor" icon to write the new address to the LEM. This will take several seconds.

This function can be password protected. Refer to the section Password Protection.
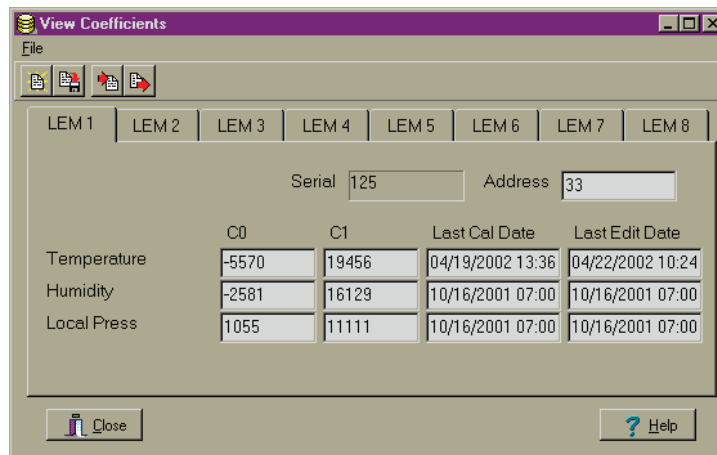
gky05.bmp

Figure 2-2. View Coefficients

LEMCAL Software

The factory default address is 33. The LEM and LEMCAL Software default to this Address. The LEMCAL Software needs the address set in the SETUP/OPTIONS screen of the LEM with which it will communicate. If this address is set to 0 then all LEMs on the communication bus will respond.
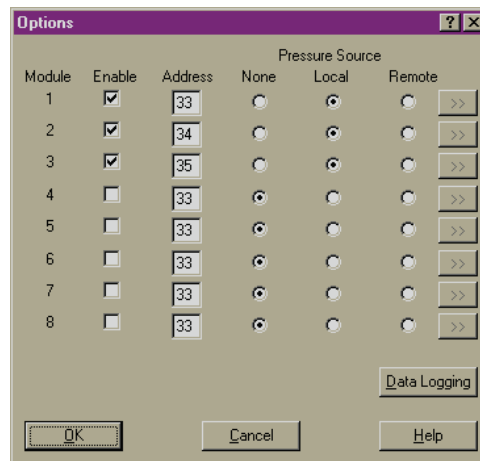
gky06.bmp

Figure 2-3. Options

Selecting a Pressure Source

From the Menu select Setup | Options.

Select the Local or Remote pressure sources for each enabled LEM by clicking on the appropriate column. The Local sensor location is shown in Chapter 1, Figure 1-1, and specified in Chapter 8. Refer to Chapter 4 for a description of the Remote Pressure function.

Selecting Units

From the Menu select Setup | Units.
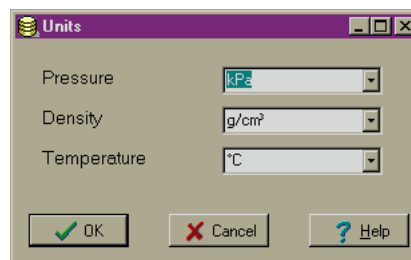
gky07.bmp

Figure 2-4. Units

Select desired units from the available choices for each environmental parameter. Changing units will also change the data written to the logfile. Refer to Chapter 2, Logging Data.

Limits

From the Menu select Setup | Limits.
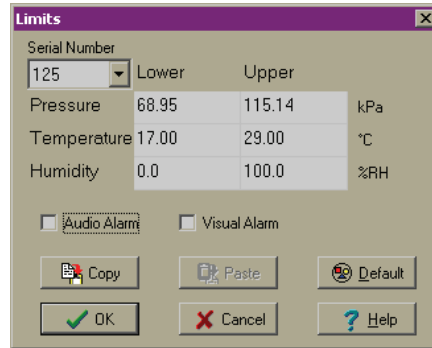
Figure 2-5. Limits

gky08.bmp

Select values for the upper and lower limits for Pressure, Temperature, and Relative Humidity.

Setup

The Serial Number for the desired LEM is selected in the box in the top, left corner. Click the arrow, and the available LEMs will be displayed. When a specific instrument is selected, the current limits are displayed, and may be edited.

The Audio Alarm is enabled by checking the Audio Alarm checkbox. This alarm generates a standard beep using the computer speaker.

The Visual Alarm is enabled by checking the Visual Alarm checkbox. This alarm is displayed on the main screen by changing the background color of the Serial Number to yellow whenever a limit is exceeded. The background will remain yellow until it is either disabled or reset. Double-clicking the Serial Number will reset the visual alarm, but does not disable it.

The Audio and Visual alarms can be set by double-clicking the message panel at the lower-left corner of the main screen, until the desired setting is selected.

The limit values for one instrument may be copied to another instrument's limit values, by using the Copy and Past buttons. Closing the Limit form will erase values from the copy buffer.

Pressing OK will check the new values for out-of-range and inconsistent values. If a problem is detected, an error message is displayed.

Pressing CANCEL will leave the Limits unchanged.

Pressure DEFAULT will return all limits, for the selected instrument, back to default values.

Error Limit Logging

Crossing a limit value, will trigger a record being entered in the log file, if enabled. Refer to Chapter 2, Logging Data.

Password Protection

Two types of password protection are supported—Calibration and Program Exit.

Calibration Password

From the Menu select Setup | Password | LEM
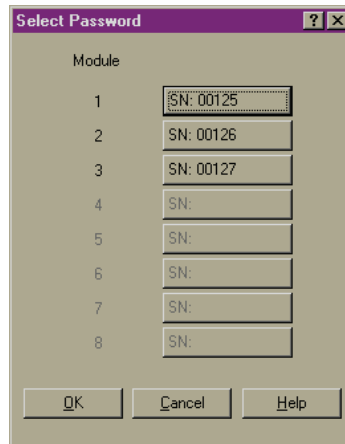
gky09.bmp

Figure 2-6. Select Password

The password protection will prevent the changing of the calibration data and address. The default password is "0" (zero). When the password is "0" the password protection is turned off.

When setting the password for the first time, "0" must be entered as the Old Password.

The password can be reset to "0" as long as the current password is known.

The password can be up to eight alpha/numeric characters long and is case sensitive.

Program Exit Password

From the Menu select Setup | Password | Program Exit

gky10.bmp

Figure 2-7. Change Exit Password

This password protection will prevent closing LEMCal software. This is most useful when the Logfile function is being used, and a record without gaps is desired. The default password is "0" (zero). When the password is "0" the password protection is turned off.

When setting the password to the first time, "0" must be entered as the Old Password.

The password can be reset to "0" as long as the current password is known.

The password can be up to eight alpha/numeric characters long and is case sensitive.

Viewing Real Time Data
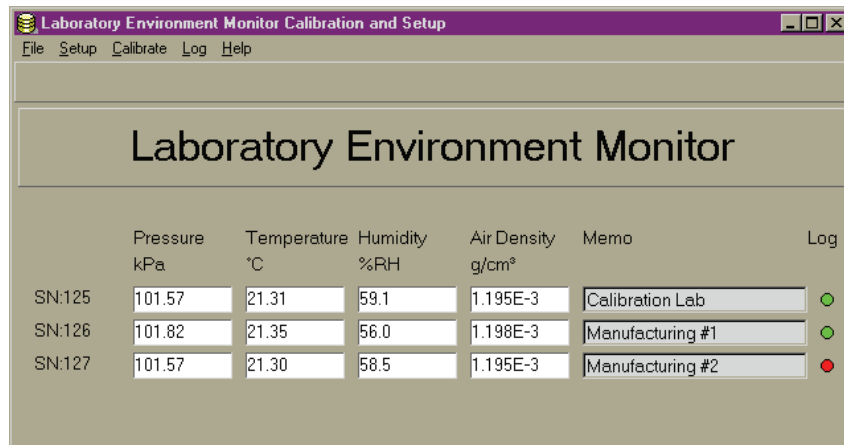
gky11.bmp

Figure 2-8. Main Screen

The Memo line allows a user to enter a descriptive to identify each LEM. This description is associated with the Serial Number and is stored in the *.ini file on the host computer.

The green indicator at the end of each line identifies if the LEM data is being logged. See Chapter 2, Data Logging

*** If the Data Line turns yellow then the data being displayed is out of the following ranges: $17\ ^oC <$ temperature $<29\ ^oC$
$0\% <$ relative humidity $< 100\%$
10 psi $<$ pressure < 16.7 psi

*** If the Data Line turns red then communication has been lost with the LEM.

Logging Data

The Data Logging function captures Temperature, Pressure, Relative Humidity and Air Density (Chapter 7.1 - NBS Pub. 700-1)

Setup

From the Menu select Log (Figure 2-9).
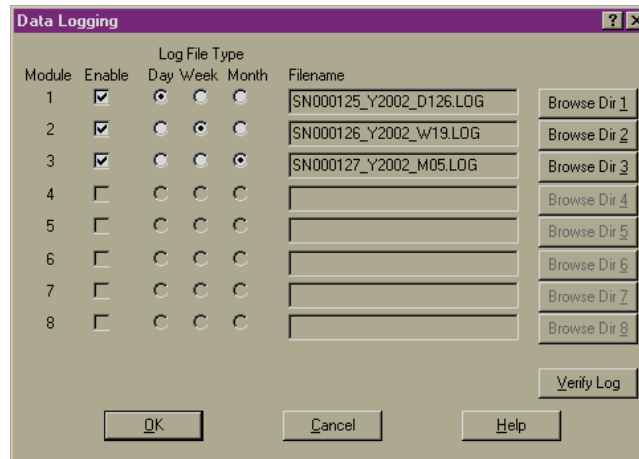
Figure 2-9. Data Logging

gky12.bmp

The Module number, in the left hand column, is referenced to each LEM as defined in Figures 2-3 and 2-62-6. To begin logging data for a particular LEM, select the Enable button.

Intervals

LEM data can be logged into a Day, Week, or Monthly file.

Timing and data information are based upon the clock of the host computer.

Day: Readings are taken at 1 minute intervals.
The active file is saved and a new file is crated at midnight of each day.

Weekly: Readings are taken at 5 minute intervals.
The active file is saved and a new file is created at midnight of each Saturday.

Monthly: Readings are taken at 15 minute intervals.
The active file is saved and a new file is created at midnight of the last day of each month.

File Names

The file names are generated automatically using the following formats:

Day: *SerialNumber_Year_Day of Year.LOG*
Example: SN054323_Y2002_D137.LOG

Week: SerialNumber_Year_Week of Year.LOG
Example: SN054323_Y2002_W47.LOG

Month: SerialNumber_Year_Month of Year.LOG
Example: SN054323_Y2002_M05.LOG

Default Location

By default, the log files are placed in

C:\Program Files \ RUSKA Instruments \ LEM Cal **** LEMDataLog \ ...

To change this location, select <Browse Dir> button. Figure 2-9.

File Verification

From the Data Logging screen (Figure 2-9) select Verify Log.

Select the *.LOG file that needs to be verified. Upon completion of the verification a notice of verification will be displayed or a file *.ERR will be created and saved in the LOG directory. This file will identify which lines of the *.LOG file have been corrupted or altered. If any errors are detected then the corrupted lines are stored in a *.ERR file.

Multiple LEMs

The LEMCal software supports up to 8 LEM modules at the same time when using RS485. Refer to Chapter 1, Main Comm Port, for selecting RS485 mode.

Cabling

For Multi-Drop Systems refer to Appendix A for available components. For custom cabling, refer to Chapter 6, DB9 Connections, for the pin-out of the Main Communication Port on the LEM.

Addressing

Since the default address for each module is "33", each module will need to have its address set to a unique number between 0 and 100. This must be done with only one non-unique module on the communication bus at a time. Refer to Chapter 2, LEM Addressing. Each LEM must have a unique address and LEMCAL Software must be told which addresses are active on the communication bus.

Communications

Set the communications interface to RS485 for use with the 2456 and 2465. Refer to Chapter 1, Main Comm Port, for LEM communication setup. Power for the LEM is supplied from the 2456 or 2465, over the communications cable. Use a standard DB9M / DB9F cable.

Winprompt Interface

Refer to the WinPrompt manual for detailed instructions. WinPrompt Version 2.12 or later is required. WinPrompt software calculates mass to pressure and pressure to mass values, and automatically displays real time piston gauge parameters measured by the Model 2456 Deadweight Gauge Monitor or the Model 2465 AutoFloat Controller.

RUSKA 2456 and 2465 Upgrade for LEM Compatibility

To upgrade a 2456/2465 from the original Air Density Model to the LEM, use part number 2465-200-KIT1 for all 2465's and the Single Channel 2456. Use part number 2465-200-KIT2 for the Dual Channel 2456.

Remote Pressure Capture

Remote Pressure Capture

From the Menu select Setup | Options (refer to Figure 4-1). Set the Pressure Source as Remote. Click the extension arrows to the right of the selected LEM. The Remote String Dialog box will appear.
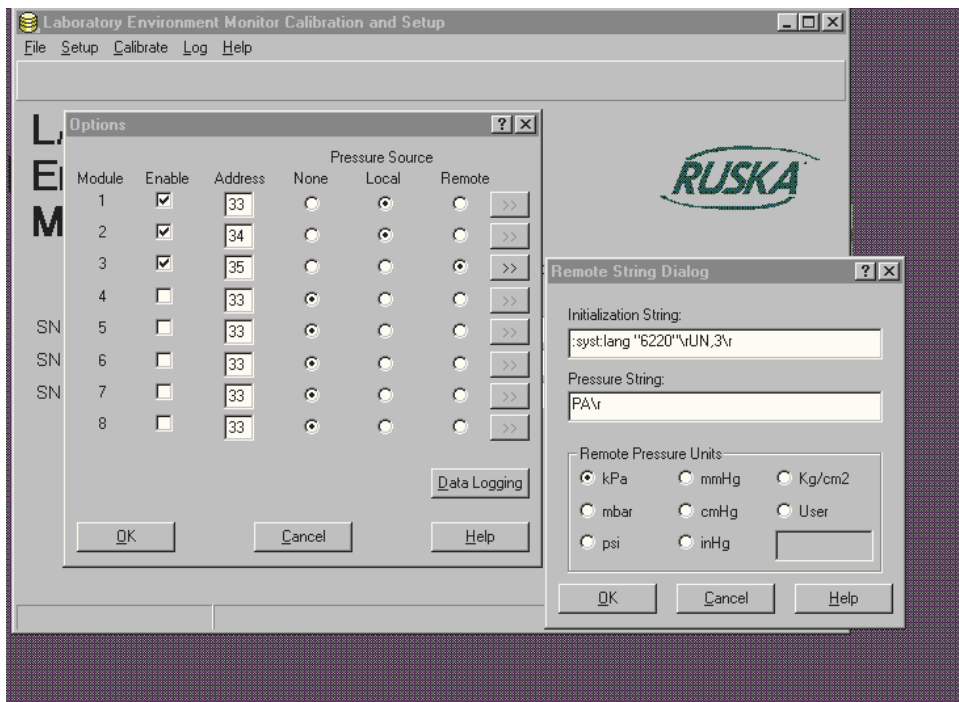
gky13.bmp

Figure 4-1. Remote String Selection

Use with a RUSKA Portable Pressure Gauge 7220 or 6220
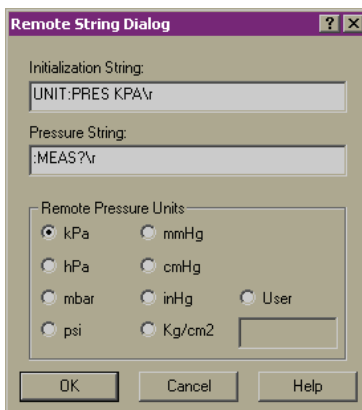
gky14.bmp

Figure 4-2. Remote String Dialog

Initialization String	Transmitted from LEM to remote pressure sensor to initialize the remote sensor.
Pressure String	Transmitted from LEM, on a continuous basis, to retrieve pressure readings.
Remote Pressure Units	Specifies the units that are being returned from the remote pressure sensor. The selection of the User units requires the entry of a conversion factor. The User units, when multiplied by the conversion factor, result in kPa. (Refer to Chapter 9 for conversion factors.)

Initialization String

RUSKA 6220

'UN,3\r' - This sets the units to kPa.

RUSKA 7220 Using SCPI Protocol

'UNIT:PRES KPA\r'
This sets the 7220 to kPa units.

RUSKA 7220 Using 6220 Emulation Mode

':SYST:LANG "6220"\rUN,3\r'
This sets the 7220 to 6220 emulation mode and to kPa units.

Refer to the 6220 and 7220 manuals for other options.

Pressure String

RUSKA 6220 and 7220 in Emulation Mode

The pressure command string is '**PA\r'**.

RUSKA 7220 in SCPI Mode

The pressure command string is '**:MEAS?'**.

Cabling

Connecting the RUSKA 6220 to the LEM Pressure Serial Port

Table 4-1. RUSKA 6220 25 Pin RS-232 Connector

PIN	DESCRIPTION
2	Transmitted data (to PPG)
3	Receive Data (from PPG)
4*	RTS (must be set for PPG to transmit)
5*	CTS (always set by PPG)
7	GND

*Connect Pins 4 & 5 together.

Table 4-2. RUSKA 6220 DB25 and LEM DB9 Connections

6220 DB25	LEM DB9
2	3
3	2
7	5

Refer to 6220 Manual and Chapter 6, DB9 Connections, of this manual for additional information.

RUSKA 7220 to the LEM Pressure Serial Port

Connecting the RUSKA Model 7220 to the LEM pressure serial port requires a Null modem adapter or Null modem cable DB9 M / DB 9 F. Only Pins 2 and 3 must be swapped in the Null Modem cable.

Use with Other RS232 Output Transducers

Protocol

The LEM can retrieve pressure data from other "smart" pressure sensors, as long as the return string can be parsed. The string returned to the LEM must be in ASCII characters.

The LEM breaks down the returned string as follows:

1. Delete Prefix—all non-numeric characters are deleted up to the first numeric character.

2. The Exponent character (E or e) is located.

3. A one or two digit numeric exponent is read following the Exponent character.

Examples of valid returned strings:

```
101.23
101.23kPa
1.0123E02
PA, 1.0123e02 kPa
PA, 101.23
```

Scaling

Once the raw value is retrieved from the string then units or a scaling factor must be given. Refer to Chapter 4, Remote Pressure Units.

Communication Port Configuration

This configuration applies only to the Remote pressure Input and is set as follows:

BAUD RATE	-	2400
DATABITS	-	8
PARITY	-	None
STOPBITS	-	1

Chapter 5
Calibration

Span

Pressure - On Board Sensor

Calibration Point 1:   10.5 +/-0.25 psia

Calibration Point 2:   15.0 +/-0.25 psia

Temperature

Calibration Point 1:   17 +/- 2 degC

Calibration Point 2:   29 +/- 2 degC

Zeroing

Temperature measuring devices are impacted by self heating. The rise in temperature, measured by the sensor, is a function of the amount of heat generated by the probe and the ability of the probe to dissipate this heat. Air flow around the probe improves the heat dissipation and thus lowers the rise in temperature. When a temperature probe is calibrated in a high flow chamber and used in a low flow environment, then the error due to self heating is maximized. This error can be minimized by zeroing the sensor in the operating environment with respect to an appropriate standard.

The LEM software allows the technician to perform a zero offset. The zero offset is prompted following the span calibration. After the span calibration is finished, the high air flow chamber can be turned off and the LEM can be zeroed in a low air flow environment that is typical of its operating environment.

The reference probe should be placed at a distance of 3 or more inches in front of the LEM temperature sensor.

Both the span calibration and zeroing operation are password protected.

Humidity

The humidity calibration must be done after the Temperature calibration. The two calibration points must be different by at least 25%RH.

A suggested method:

Point 1: applied vacuum -> 0%RH

Point 2: ambient humidity (25%RH or higher)

Calibration Data

In order to view the calibration coefficients, select Calibrate | View Coefficients.
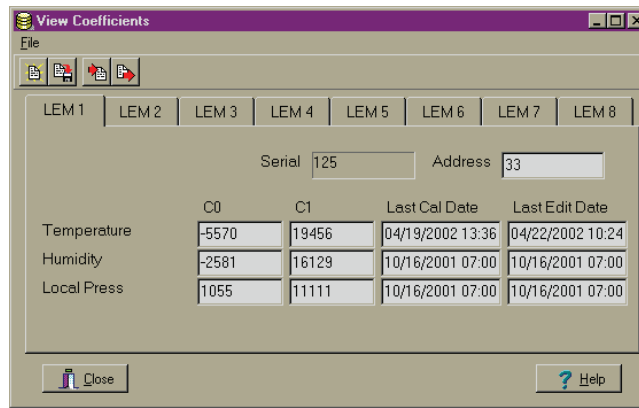
gky15.bmp

Figure 5-1. View Coefficients

The menu bar selections allow the coefficients to be read and written to disk and read and written to the LEM, assuming that the proper password is known.

Chapter 6
Connector Definition

Power Plug

The power plug is a barrel type receptacle:

ID = 2.5 mm, OD = 5.5 mm, Depth = 10.0 mm, Inside - Positive

DB9 Connectors

Table 6-1. DB9 Pinout

Pin #s DB9	DB9 male RS 485	DB9 male RS 232	DB9 female (RS 232)
1*	+PWR IN	+PWR IN	NC
2**	A	TX	RX
3**	A	RX	TX
4	GND-PWR	GND-PWR	GND
5	GND-SIG	GND-SIG	GND
6	NC	NC	NC
7	NC	NC	NC
8**	B	RX	NC
9	GND-PWR	GND-PWR	GND

* Supply pin (PIN 1 DB9 female) is fused with re-settable fuses. Maximum operating current is 50 mA.

** Pin 3 of the primary connector (DB9 male) is switched between Pins 2 and 8. This allows compliance with RUSKA ER-3097 : "DB9-232/485-Pin Out Standard".

Pressure Port

The pressure port is a friction fit - press on tube connection.

Motorola® package definition CASE 482A-01

Use RUSKA tubing, part # 86-1011 - 3mm ID tubing or equivalent.

Chapter 7
Air Density Calculation

LEM Internal Calculation vs. RUSKA PC Software Calculation

The Air Density calculation available directly from the LEM is a best fit curve approximation as described below in Chapter 7, Air Density Available Directly from LEM.

The Air Density output available from RUSKA PC Software (WinPrompt, LEM PC, etc.) uses the definition available per National Bureau of Standards, NBS Special Publication 700-1, Industrial Measurement Series (November 1984).

Air Density Available Directly from LEM

Air density is available directly from LEM (without LEMCAL or WinPrompt Software).

T   = Temperature (16-bit integer, scaled °C*100)

H   = True RH (16-bit integer, scaled %*100)

P   = Pressure (16-bit integer, scaled kPa*100)

D   = Density (16-bit integer, g/m^3)

$$D = \frac{\left(P*4916 - \left(\frac{T*2096}{2^{16}} - 20 \right) * H \right) * \frac{46460}{2^{16}}}{T + 273.15}$$

Note

Formula is valid for temperatures 18-28 ^{o}C.

Chapter 8
Specifications

Sensors

Operating Range:

	Temperature:	18-28 ^{o}C
	Pressure:	690-1070 mbar (20.4 - 31.6 inHg)
	Humidity:	5-95% RH

Performance:

Precision

	Temperature:	+/-0.1 ^{o}C
	Pressure:	+/-1.4 mbar (+/-0.04 inHg)
	Humidity:	+/-3% RH

Total Uncertainty:

	Temperature:	+/-0.5 ^{o}C/year
	Pressure:	+/-2.7 mbar (+/-0.08 inHg)/year
	Humidity:	+/-10% RH/year

Notes:

(1)   Precision is defined as the combined effects of linearity, repeatability and hysteresis.

(2)   Expression of accuracy (uncertainty) conforms with the recommendation of the ISO Guide to the Expression of Uncertainty in Measurement and includes RSS of precision, stability, temperature effects, and the calibration standard to 2 sigma (95%). The expanded uncertainty in the standards utilized by RUSKA to calibrate the LEM is typically 0.1 ^{o}C, 2.4% RH, 1.4e-3 kPa.

Storage Environment:

-20 - 70 ºC; 0 - 95% relative humidity, non-condensing

Electrical Power:

10 - 30 Volt DC input; 250mA max

2456-LEM
Manual*

Data Update Rate:

New Data available at 1 second intervals. Includes Temperature, Humidity, Pressure, Air Density.

Available Units:

from Module :	ºC x100, %RH x100, kPa x100, g/m^3
from *.dll:	ºC, %RH, kPa, g/m^3
from PC Software :	ºC, ºF;
	%RH;
	mmHg, cmHg, inHg, kPa, hPa, mbar, psi, kg/cm^2;
	g/cm^3, kg/m^3, lb/in^3

Warm Up:

Typically 30 minutes.

Placement:

The proper orientations for the LEM are

1. Set flat on the table, sitting upon the rubber feet

2. Hanging on the wall with the temperature sensor pointing down.

Calibration Period:

1 year

8-2

Remote Commands

Remote Commands

There are two general standards supported.

The <u>Binary protocol</u> requires fewer bytes, therefore requiring less time to transmit each message.

The <u>Compatibility protocol</u> requires more bytes per message, but allows the module to co-exist on the same RS485 bus with other DruckBus compatible components.

DruckBus Binary Standard

Command:

```
&<Addr><Size><Cmd>[<Parm1>[<Parm2>...]]<Chk>
```

Reply:

```
%<Addr><Size><Cmd><Parm1>[<Parm2>...]<Chk>
```

Example: (hexadecimal bytes)

```
26 01 01 56 70
25 01 05 76 02 03 04 CB 99
```

DruckBus Compatibility Standard

Command:

```
$<Addr><Size><Cmd>[<Parm1>[<Parm2>...]]<Chk>CR
```

Reply:

```
!<Addr><Size><Cmd><Parm1>[<Parm2>...]<Chk>CR
```

Example:

```
$01015670cr
!010576020304CB99cr
```

Terminology:

<Addr>	Ascii	2 characters specifying the address (00 to 99, 00=Global). Replies always specify the address of the unit, never 00.
	Binary	1 byte specifying the destination address of the command or the source address of the reply (00 to FF, 00=Global). Replies always specify the address of the unit, never 00.
<Size>	Binary	Number of bytes after the size byte not including the <Chk>

<Cmd>	Ascii	2 Ascii characters specifying command.
	Binary	1 Ascii byte specifying command (Uppercase on command, lowercase on reply).
<Parm x>	Ascii	Variable-length Ascii formatted parameters.
	Binary	Fixed-length binary parameter.
<Chk>	Binary	1 binary byte LRC (exclusive-or of all bytes including start)
CR	Ascii	Carriage Return required
	Compatibility	Carriage Return required
<start>	Start	Binary mode

        Command = '&' ; Reply = '%'

      Compatibility mode

        Command = '$' ; Reply = '!'

Timing

Slaves must wait at least 1 character time before replying (for RS-485 line turnaround) and must reply within 50 ms.

Global Command Responses

Units respond to Zero, the global address, the same as their assigned address. This means that global addressing can be used when only 1 unit is on the bus.

DruckBus Binary Mode Commands

(Commands may be translated to Compatibility Mode for transmission)

@ - Set Address

Command: <start><addr><Size>@<NewAddr><Model><Value><Chk>
Reply: None.

Command <Size>: 8

<NewAddr> is an 8-bit unsigned number. <Model> is a 2-byte integer containing the model number, least significant byte first. <Value> is a 4-byte integer specifying a pressure in kPa * 100 or a serial number, least significant byte first. Normally, this command is sent using the global address. This command sets the address of the unit to the specified address with the following conditions:

1. If the model number and value are both zero, all units receiving this command will set their address.

2. If the model number in the command is not zero and the model number of the unit matches the specified model, the address is set.

3. If the model number matches and if the pressure specified in the command is not zero and the full scale pressure of the unit is greater than, or equal to, the specified pressure and the current address of the unit is 254 or 255, the address is set.

4. If the model number is zero, and a non-zero value is specified, and the value matches the serial number of the unit, the address is set.

These conditions allow for the addresses of each different model to be set individually and the units of the same model to be set by pressure range. If two units have the same model and pressure range the address can still be set by serial number.

A – Read ADC Counts

Command: `<start><addr><Size>A<chk>`
Reply: `<start><addr><Size>a<status><temp><rh><pressure><chk>`
Command `<Size>`: 1
Reply `<Size>`: 10
`<status>` is three unsigned 8-bit values.

Status1:
    Bit 0: ADC channel 0 Extended Input Range Indicator (EXR0)
        0: $0 < V_{in} <= V_{ref}$
        1: $V_{in} > V_{ref}$ or $V_{in} < 0$
    Bit 1: ADC channel 0 Sign Indicator (SIG0)
        0: $V_{in} < 0$
        1: $V_{in} > 0$
    Bit 2: ADC channel 1 Extended Input Range Indicator (EXR1)
    Bit 3: ADC channel 1 Sign Indicator (SIG1)
    Bit 4: ADC channel 2 Extended Input Range Indicator (EXR2)
    Bit 5: ADC channel 2 Sign Indicator (SIG2)
    Bit 6: ADC channel 3 Extended Input Range Indicator (EXR3)
    Bit 7: ADC channel 3 Sign Indicator (SIG3)

Status2:

    Bit 0: 1 = Calibration in Progress
    Bit 1: 1 = Zero in Progress
    Bit 2: 1 = Remote Port Selected (v1.4)

    Bit 3-7:   Reserved

Status3:
    Bit 0: 1 = Command Error
    Bit 1: 1 = EEPROM Write Error
    Bit 2: 1 = EEPROM Read Error
    Bit 3: 1 = Power-on Reset
    Bit 4: 1 = RS232 Receive Error
    Bit 5: 1 = Calibration Error
    Bit 6:   Reserved
    Bit 7: 1 = Long (multiple) EEPROM accesses

`<temp>` is a 16-bit unsigned value
`<rh>` is a 16-bit unsigned value
`<pressure>` is a 16-bit unsigned value

C – Configure Instrument

Command: `<start><addr><Size>C<cfgByte><chk>`
Reply: `<start><addr><Size>c<cfgByte><chk>`

Command `<Size>`: 2
Reply `<Size>`: 2
Defines which pressure source to use. `<cfgByte>` is an 8-bit unsigned value.
`<cfgByte>`
    = 0   No pressure source selected
    = 1   Local pressure
    = 2   Auxiliary pressure
    = 3   Remote pressure
    = 254   Load LEM Memory from EEPROM
    = 255   Poll for currently selected pressure source

D – Read Air Density

Command: <start><addr><Size>D<chk>
Reply: <start><addr><Size>d<status><density><chk>
Command <Size>: 1
Reply <Size>: 6
<status> is three unsigned 8-bit values. (See Command A)
Returned data is a 16-bit unsigned value, least significant byte first.

E – Read EEPROM

Command: <start><addr><Size>E<addr1><chk>
Reply: <start><addr><Size>e<data><chk>

Command <Size>: 3
Reply <Size>: 9
<addr1> is 16-bit address, least significant byte first.<data> is 8 bytes read from EEPROM.
To read the eeprom, set the high byte of <addr> to 00H
To read low memory, set the high byte of <addr> to F0H
To read extended memory, set the high byte of <addr> to F1H.
Address should be an 8-byte boundary.

K - Calibrate

Command: <start><addr><Size>K<channel><point><value><chk>
Reply: <start><addr><Size>k<status><counts><chk>

Command <Size>: 5
Reply <Size>: 6
<channel> and <point> are 8-bit values.
<channel> selects channel to be calibrated. P for pressure, H for humidity, T for temperature.
<point> is 1 for first point, 2 for second point.
<value> is a 16-bit signed integer using scaled (*100) units matching select channel.
<status> is three unsigned 8-bit values. (See Command A)
<counts> is an unsigned 16-bit value.

P – Set Initialization and Remote Pressure Strings

Command: <start><addr><Size>P<seq><strlen><strseq><chk>
Reply: <start><addr><Size>p<status><chk>

Command <Size>: 11
Reply <Size>: 4
<seq> identifies which 8 byte substring is being transmitted. Acceptable Values for the Remote String are 0, 1, 2. Acceptable Values for the Initialization String: 3, 4, 5.

<strlen> is the actual length of the command string, in bytes, that will be transmitted from the LEM to the remote pressure sensor over the software serial port. Acceptable values: 1-24.

<strseq> is an 8 byte section of the string to be transmitted. The string to be transmitted must be 24 characters long, using a pad character to fill out the string. The first eight bytes are transmitted with <seq> set to 0 for the Remote Pressure string and 3 for the Initialization string, the middle eight bytes are transmitted with <seq> set to 1 for the Remote Pressure string and 4 for the Initialization string, and the last eight bytes are transmitted with <seq> set to 2 for the Remote Pressure string and 5 for the Initialization string. All three <seq> substrings for each string must be transmitted in sequential order. Either string may be updated without updating the other.

<status> is three unsigned 8-bit values. (See Command A)

R - Read ADC Reference Values

Command: \<start>\<addr>\<Size>R\<chk>
Reply: \<start>\<addr>\<Size>r\<temp>\<rh>\<press>\<chk>

Command \<Size>: 1
Reply \<Size>: 7
All values are 16-bit signed integers using scaled (*100) units.
\<temp> is degrees C
\<rh> is %
\<press> is kPa.

S - Read Remote Pressure with Displayed Precision

Command: \<start>\<addr>\<Size>S\<chk>
Reply: \<start>\<addr>\<Size>s\<status>\<press>\<decimals>\<chk>

Command \<Size>: 1
Reply \<Size>: 9
\<status> is three unsigned 8-bit values. (See Command A)
\<press> is 32-bit unsigned integer using scaled (*10^decimals) units. Units is kPa.
\<decimals> is 8-bit signed integer

V - Get Version Info

Command: \<start>\<addr>\<Size>V\<chk>
Reply: \<start>\<addr>\<Size>v\<versionmajor>\<versionminor>\<HWVer>
\<SubModel>\<model>\<chk>
Command \<Size>: 1

Reply \<Size>: 7

\<versionmajor> is an unsigned 8-bit unsigned value
\<versionminor> is an unsigned 8-bit unsigned value
\<HWVer> is an unsigned 8-bit unsigned value
\<SubModel> is an unsigned 8-bit unsigned value
\<model> is a 2-byte flag used to differentiate between software with different command sets.

W - Write EEPROM

Command: \<start>\<addr>\<Size>W\<addr1>\<data>\<chk>
Reply: \<start>\<addr>\<Size>w\<data>\<chk>

Command \<Size>: 11
Reply \<Size>: 9
\<addr1> is a 16-bit address, least significant byte first.
\<data> is 8 bytes read from EEPROM.

To write the eeprom, set the high byte of \<addr> to 00H.
To write low memory, set the high byte of \<addr> to F0H.
To write extended memory, set the high byte of \<addr> to F1H.
Address should be an 8-byte boundary.

Z - Zero

Command: \<start>\<addr>\<Size>Z\<channel>\<value>\<chk>
Reply: \<start>\<addr>\<Size>z\<status>\<counts>\<chk>

Command \<Size>: 4
Reply \<Size>: 6
\<channel> is an 8-bit value.
\<channel> selects channel to be calibrated. P for pressure, H for humidity, T for temperature.
\<value> is a 16-bit signed integer using scaled (*100) units matching select channel.
\<status> is three unsigned 8-bit values. (See Command A)
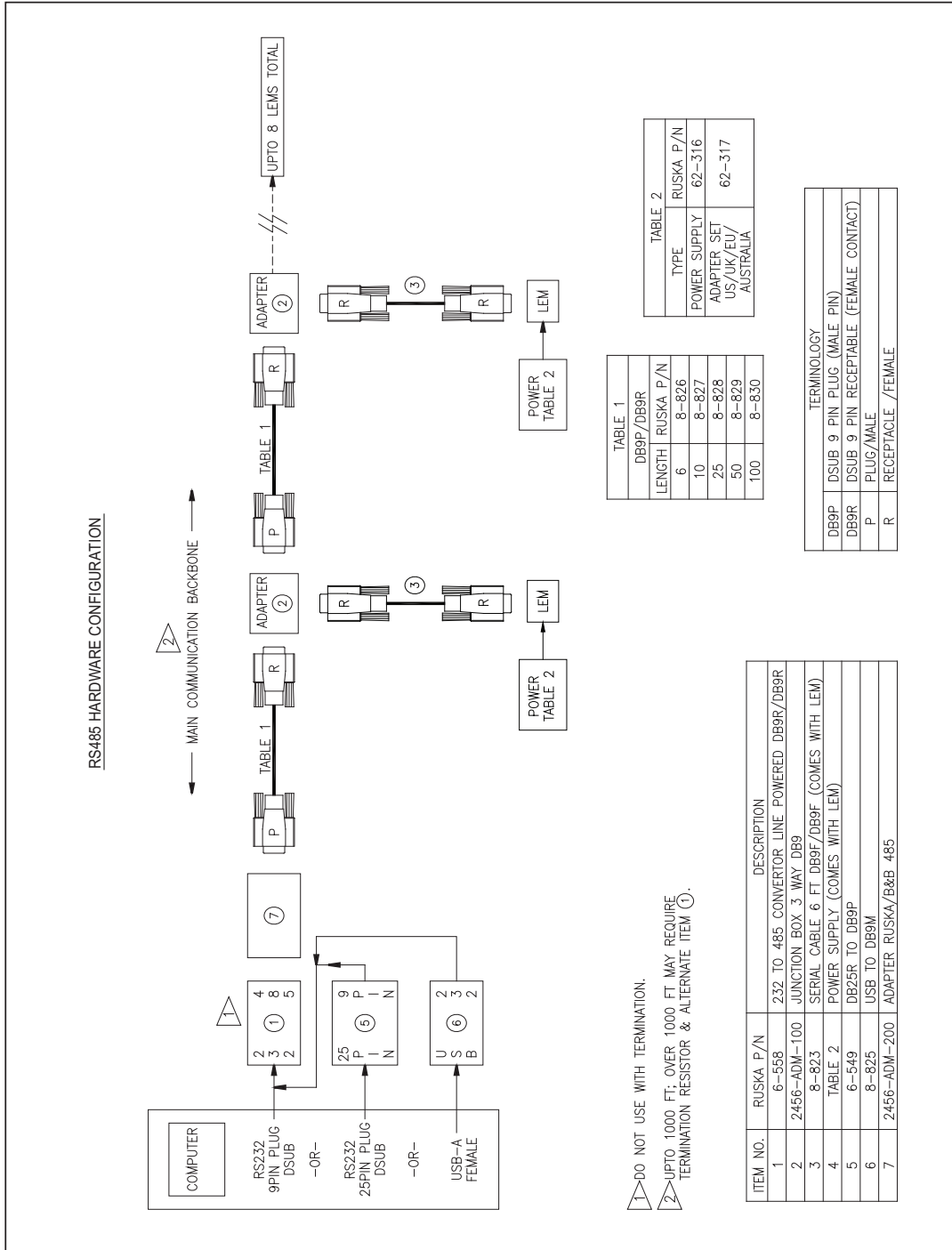\<counts> is an unsigned 16-bit value.

RS485 Multi-Drop Configuration

gky03.eps

Figure 9-1. RS485 Multi-Drop Configuration