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Rockwell Automation + Schlumberger

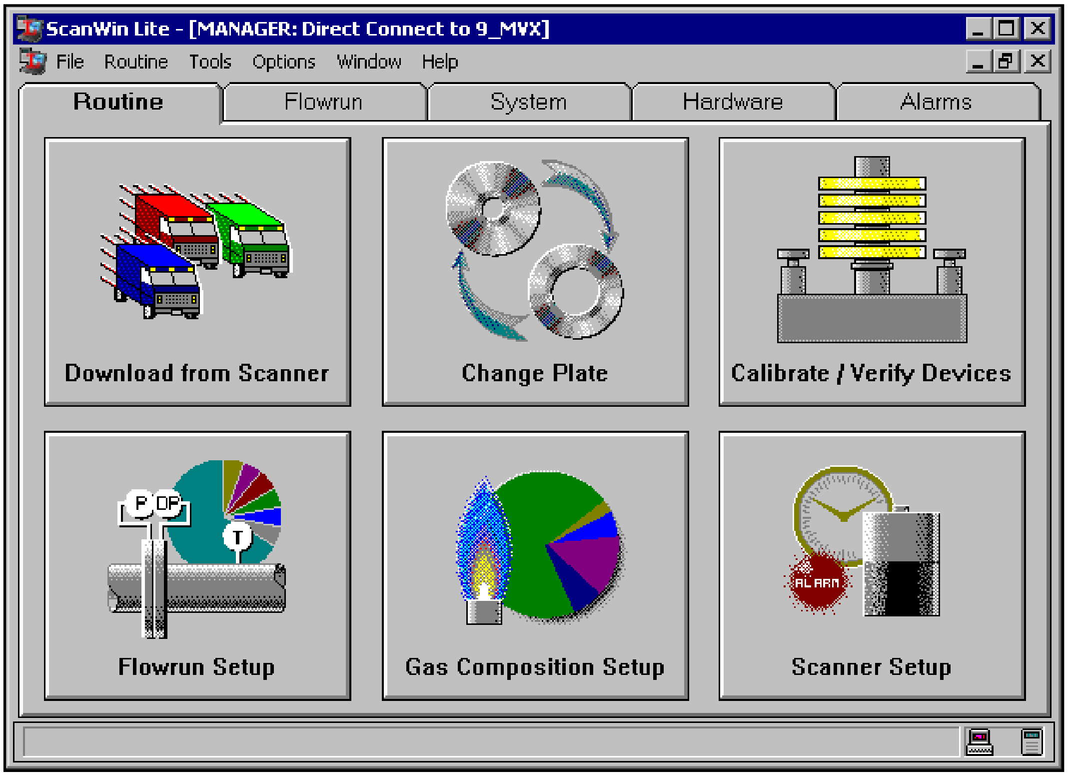
MEASUREMENT SOLUTIONS

Barton®

ScanWin® LITE

Version B3.0.XW

User Manual



Manual No. 30165016, Rev.

INTELLIGENT ACTION

Revision History

The following table shows the revision history for this document:

Date…	***Description…***	***Approved by…***
February 6, 2006	Initial release of version 3.0.0	Warren Loch

Manual No. 30165016, Rev. A
February 2006

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Introduction

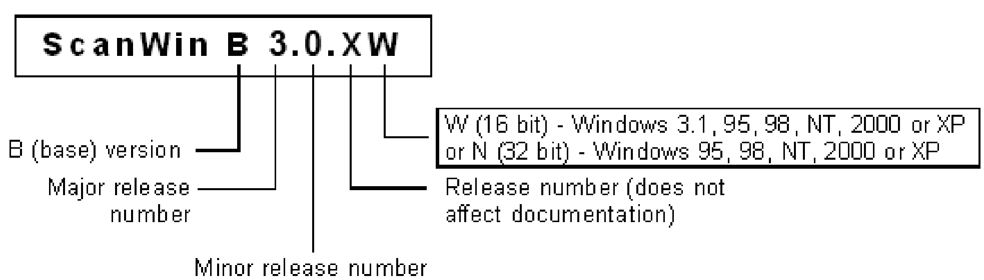
About ScanWin LITE

ScanWin LITE is a software application that allows Scanner users to perform all functions necessary for measurement applications including flowrun data downloads. Its effective "wizards" guide operators through the setup of hardware, flowruns, and primary devices, as well as the collection of hardware, system, and flowrun data. ScanWin LITE also facilitates the upload and download of configuration settings.

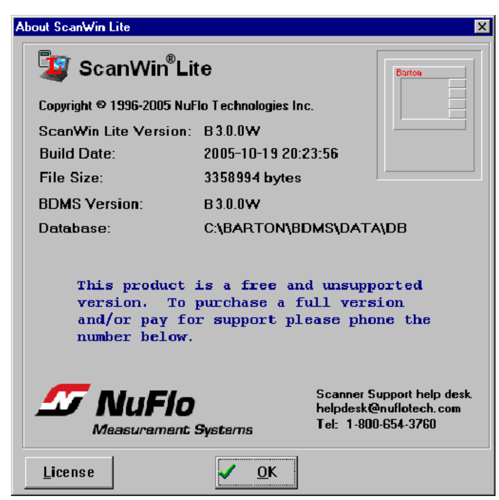
ScanWin PRO, a companion product to ScanWin LITE, combines all of the functionality of ScanWin LITE with advanced features such as a flowrun catalog and relational database that stores historical information for offline review. Other features allow configuration of the Scanners advanced control and data capture functions. See your nearest NuFlo representative for more information.

Versions

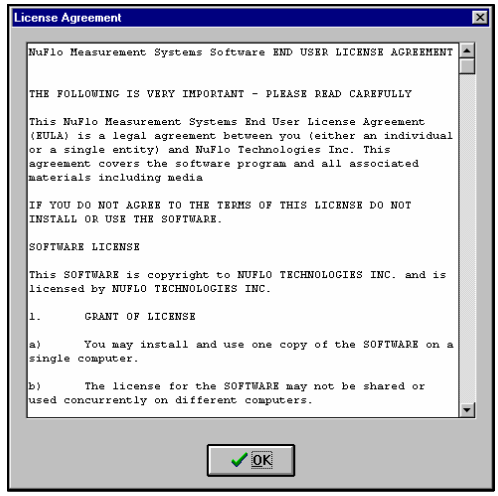
The following graphic explains the sequence and significance of elements in the ScanWin LITE version number.



After starting ScanWin LITE, you can determine its version number, as well as view registration information by accessing ***Help>About…*** from the **Main Menu**. A screen like this will be displayed.



Press the ***License*** button to view NuFlo Measurement Systems software End User License Agreement for this product.

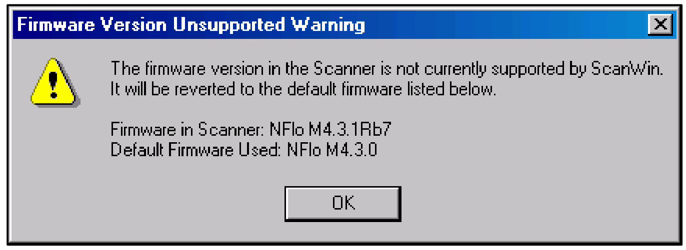


Components Supported in ScanWin LITE

Firmware Version	ScanWin Version	New Features
4.0.0 (NGas)	2.0.x	Initial release of Windows user interface software.
4.1.0 (NFlo, IGas & NGas)	2.2.0	Support for: • Peripheral devices (MVX and MVX-II/3095FB multivariable transmitters) • Peripheral devices (Daniel® Gas Chromatograph and Ultrasonic) • Ability to map Modbus (Standard and ENRON Modbus) • Monitor flowruns • NFlo and IGas firmware
4.1.1 (NFlo, IGas & NGas)	2.2.2	• Status output: Increased limit of width and delay • Flow rate Qb can now be assigned to an alarm • Network power save can now be configured for Modbus networks
4.1.3 (NFlo, IGas & NGas)	2.2.2	Modbus Enhancements: • Add individual data types for date and time • Ability to write to status outputs Peripheral Device Enhancements: • Uses the square root of differential pressure in history log averages
4.1.4 (NFlo, IGas & NGas)	2.2.3	• Enhance GC peripheral device: Stale data check and status alarm. • Add selection to log gravity and Hv to history log when calculated or entered • DPlast, SPlast & Tlast added to flowrun calculation page. • DP calibration, static pressure offset now in millivolts. • ScanMod Modbus network now handles more than 120 registers. • Add successful poll counter that is displayed in the event log for two types: Errors Cleared and Communication Reestablished.
4.2.0 (NFlo, IGas & NGas)	2.2.4	• Support for multiple protocols on a single serial port • Ability to output combiners to other accessories

Firmware Version	ScanWin Version	New Features
4.3.0 (NFlo, IGas & NGas)	2.2.5	• Add ScanPLC (programmable module) support. • Support for new V-Cone® Y (expansion factor) calculation, as well as support for V-Cone® wafer meter added. • Changed RAM memory allocation for Scanners 1140 and 1131. • Functionality added for ENRON Modbus station GC hourly history. • Reconfigured and enhanced Peripheral Devices handling. MVX DP cutoff and out of range flags work properly. • New MVX calibration interface and modified RTD Shift calibration. • BSAP protocol added new lists, enhanced history log access for event, user change and gas components. • ScanWin has added interface to assign a status input to Reset Totals.
4.3.1 (NFlo, IGas & NGas)	2.2.6	• Status output configuration window changed to match changes in firmware. • Changes to the Scanner Configuration Reports to allow for easier duplication of a configuration. • Base temperature selection of 20°C added to all liquid flowruns. (BFlo). • Support added for "P" version of IGas.
4.3.4 (NFlo, IGas & NGas)	3.0.0	• Add support for Scanner 1141. • Peripheral Device NuFlo MVX-II (a modified 3095FB). • NVRAM Lock parameter configuration modified on Scanners 1140/1141.

Firmware Version Unsupported Warning Screen



Upon user logon, ScanWin LITE will determine whether the firmware version installed in the Scanner is supported. If the firmware version installed is not supported by ScanWin LITE, an "unsupported warning" screen will be displayed, by default.

As a result, the functionality of ScanWin LITE will be limited to those features that are supported by the firmware to which it defaults.

If this message becomes an annoyance, it can be turned off by editing the **scanwin.ini** file. The scanwin.ini file is located in the directory in which ScanWin LITE is installed. Open the file and, under the [Firmware Settings] heading, change the value of ***DefaultDebugDialog*** from **1** to **0**.

Mouse and Keyboard Conventions

Although you must use the keyboard to enter text, you can use either the mouse or the keyboard for all other operations.

Using the Mouse

Except for entering text, you can do all your work with the mouse:

To…	***Do this…***
Move the mouse pointer.	Slide the mouse on a smooth surface.
Point to an object on the screen.	Move the mouse to position the mouse pointer on top of the object you want to select.
Click an object on the screen.	Point to an object and click (press and release the left mouse button once).
Double-click an object.	Point to an object and, in rapid succession, click the left mouse button twice.
Select an object from a pull-down menu.	Click on the arrow beside a text box and then on the object you want to select from the list.

The mouse pointer changes shape as you work. The most common forms are:

- An arrow for pointing to objects.
- A flashing cursor.
- An I-beam for editing text.
- A magnifying glass in the Flowrun History Graph.
- An hourglass when you need to wait.

Using the Keyboard

You can also use the keyboard to perform any task:

To…	***Do this…***
Open any main menu.	Press **Alt** and then the underlined letter that appears in the menu.
Move from field to field.	Press **Tab**.
Move backward from field to field.	Press **Shift** and then **Tab**.

About This Guide

The ScanWin LITE User Guide provides you with the information and procedures you need to use ScanWin LITE. Although we describe a common path through the ScanWin LITE system, we do not attempt to educate you about pipeline monitoring concepts.

Audience

This user guide is intended for field technicians and off-site technical staff who are familiar with gathering and monitoring data. Users should have a basic to intermediate knowledge of Microsoft Windows® applications.

Document Conventions

The following table describes the conventions used in this guide:

This…	Indicates…
OFF	The default setting of a parameter. For example, **ON** (***green* check mark**) indicates that the setting of this parameter is ON by default; **OFF** (***red* X**) indicates that the setting of this parameter is OFF by default.
OK or ***Next***	All button names appear in italics.
	Additional information about the subject or special notes that call attention to a particularly important subject; these notes appear in the margin.
*For information on flowrun configuration rules in NGas 4.x.x, see Chapter 10 (**Flowrun Configuration Rules, p156**).*	Where you can get more information about a topic.

Chapter Overviews

Chapter	Description
Introduction	Provides an overview of ScanWin LITE and this documentation.
Chapter 1: Installing ScanWin LITE	Information about system requirements and how to install ScanWin LITE.
Chapter 2: ScanWin LITE Basics	Contains instructions about starting ScanWin LITE, configuring connections, unit categories and exiting from ScanWin LITE.
Chapters 3 through 7 correspond with the **tabs** shown when the Scanner is connected in a **DIRECT** mode.	
Chapter 3: Performing ROUTINE Processes	**Contains details about performing routine processes including changing plates and flowrun gas composition, downloading history and events, calibrating devices, setting up flow snapshots and collecting data to a Data Logger or to a file.**
Chapter 4: FLOWRUN Data	**Contains information about opening, defining and viewing of flowrun history and live data.**
Chapter 5: SYSTEM	**Contains details of how to view and change some system settings.**
Chapter 6: HARDWARE	**Contains information about hardware Inputs, Outputs, Serial Ports and Multifunctional Resources.**
Chapter 7: ALARMS	**Tells how to reset alarms.**
Chapter 8: Communications Setup	Tells how to set up communications for connecting to a local or remote Scanner including devices, ports, families and Scanners as well as creating port groups.
Chapter 9: Scanner Theory	Information about how the Scanner operates.
Chapter 10: NGAS 4.X.X Configuration & Calculations	Details about how flowruns are configured and how calculations are performed when using NGas 4.X.X.
Chapter 11: IGAS 4.X.X Configuration & Calculations	Details about how flowruns are configured and how calculations are performed when using IGas 4.X.X
Chapter 12: NFLO 4.X.X Configuration & Calculations	Details about how flowruns are configured and how calculations are performed when using NFlo 4.X.X.
Chapter 13: MONITOR Flowrun Configuration	Details about configuring a Monitor Flowrun

Chapter 1: Installing ScanWin LITE

- ## Default Units (p27)

System Requirements

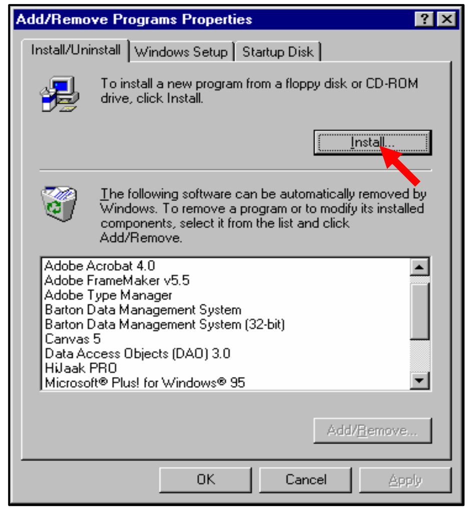
Barton Scanner RTUs rely on the ScanWin LITE or Pro software to configure, monitor, collect data, and create reports for natural gas production. To run ScanWin LITE, ensure that your PC meets the minimum system requirements:

	Minimum Recommended…
Operating System	Windows 2000
CPU	1-GHz or faster Pentium-compatible
Memory	128 MB of RAM (256 MB recommended)
Hard Disk Space	160 MB for installation files plus adequate space for data files
Drive	CD-ROM for install
Display	1024 x 768 (XVGA), 16-bit color display or greater
Browser	Internet Explorer 4 or later
Communication Port	Serial port

ScanWin LITE Installation

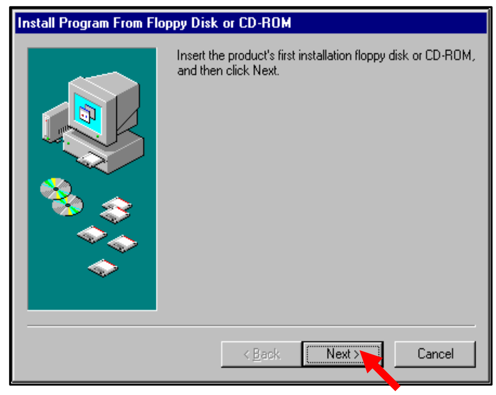
1. Insert the ScanWin LITE CD or the installation floppy disk into the appropriate drive of your computer.
2. Select ***Start*** > ***Settings*** > ***Control Panel*** to display the Control Panel. Double-click the ***Add/Remove Programs*** icon.

3. The **Add/Remove Programs Properties** dialog box is displayed. Click ***Install***.



4. The **Install Program From Floppy Disk or CD-ROM** dialog box is shown.

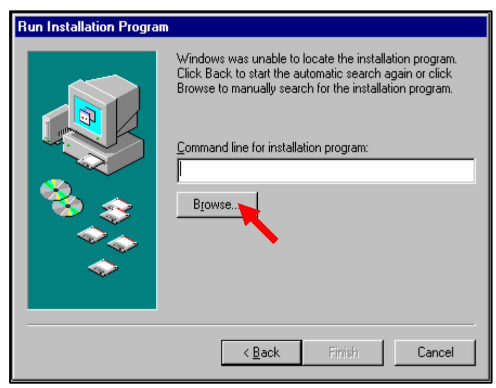
   Insert the floppy disk or the CD-ROM into the correct opening. Click the ***Next*** button.



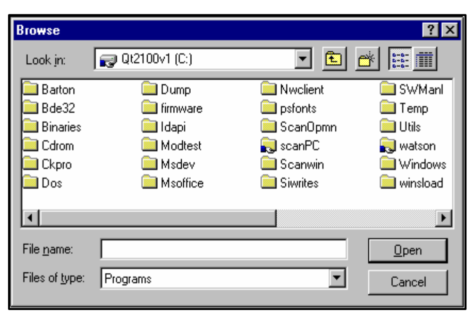
5. If Windows is unable to detect your disk, the **Run Installation Program** dialog box appears.

   If you know the location and name of the installation program, (e.g. **a:\setup.exe**), enter it in the space provided.

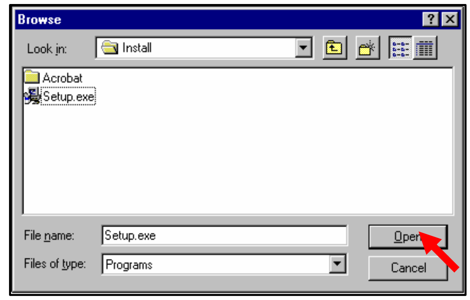
   Otherwise, click on the ***Browse*** button to display the window below.



Select the drive where your floppy or CD-ROM disk is located. Double-click on the folder where the setup file is located.

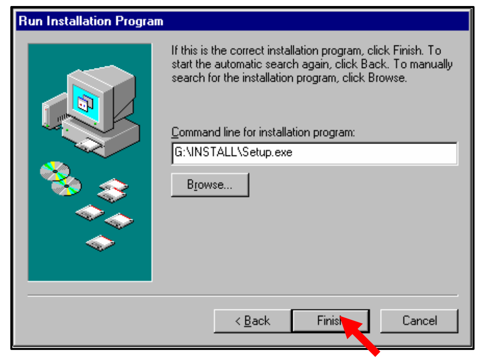


When the folder opens, double-click on the installation program icon (**<u>OR</u>** single-click on the installation program icon and click again on the ***Open*** button). The ScanWin LITE installation program will have "setup" as part of the name and an .exe extension. An example would be ScanWin_B300W_Full_Setup_R0.exe.

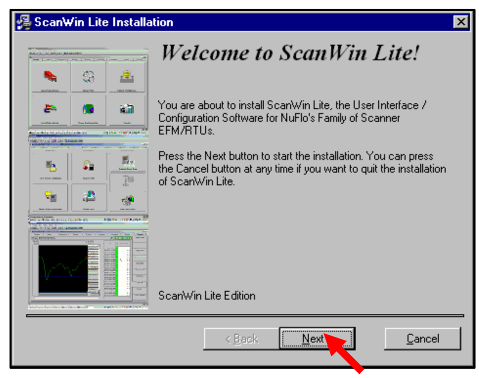


The **Run Installation Program** window is displayed.

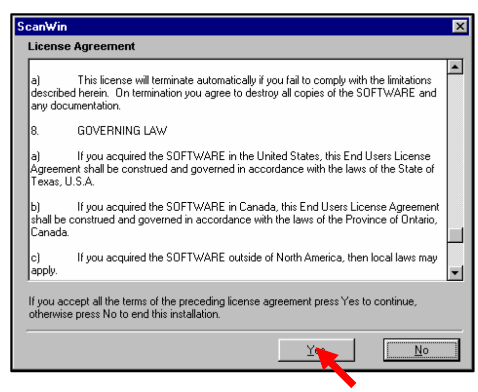
Click ***Finish***.



6. The first window of the **ScanWin LITE Installation** wizard appears. Click ***Next.***

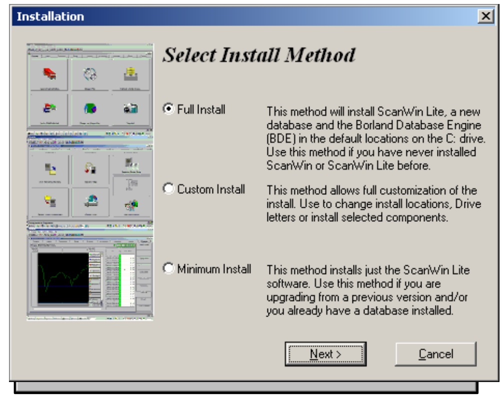


7. A **License Agreement** window appears. Use the slider bar on the right to scroll through the text. Click the ***Yes*** box to continue.



8. ScanWin LITE provides you with three installation options:
   - ***Full Install*** results in a **new** installation of ScanWin LITE and its components to default locations on the C:\ drive.
   - ***Custom Install*** allows you to upgrade from a previous version or to modify an existing installation.
   - ***Minimum Install*** allows you to update just the program files if you already have a previous version of ScanWin LITE installed.

   Choosing ***Full Install*** places the ScanWin LITE program files on Drive C:\ in the **Barton\BDMS\Program\SWLITE** directory. These installations also skip a number of installation steps while taking you to the dialogs showing



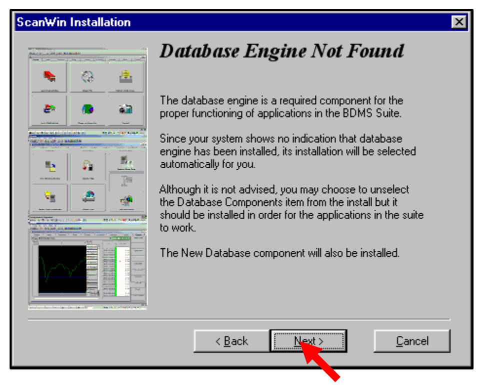
   - **Units Preference** (**Step 11**),
   - **Database Components** (**Step 12**),
   - **Summary** (**Step 19**), and
   - **Ready to Install** (**Step 20**) etc.

> ***Tip***: Other Barton products, such as ScanBase, will also install program files in subdirectories of the **Barton\BDMS\Program** directory. Data files will be placed in subdirectories of the **Barton\BDMS\Data** directory.

   Choosing ***Custom Install*** gives you more control of the installation process and allows you to make decisions about where to install the program and what components to install. If you have chosen to do a custom installation, continue with **Step 9.**

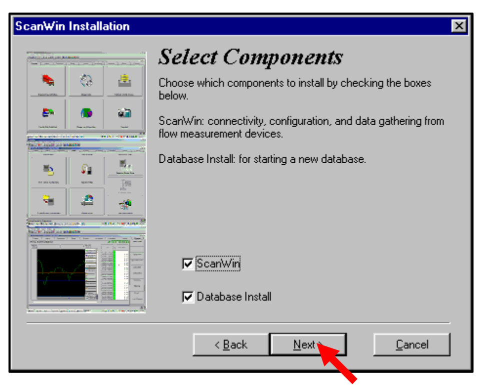
9. If the database engine *has* **NOT** *been installed*, this window will be displayed.

   Note that the database is not used for long-term historical data storage in ScanWin LITE but is required for the communication settings.



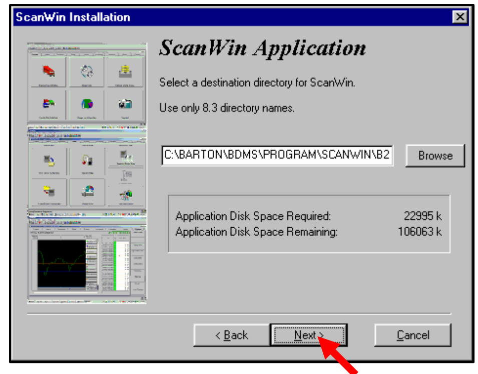
   If the database engine *has* **ALREADY** *been installed*, the **Select Components** window is shown.

   Click ***Next*** to continue. Go to **Step 12** if **Database Install** alone was chosen.



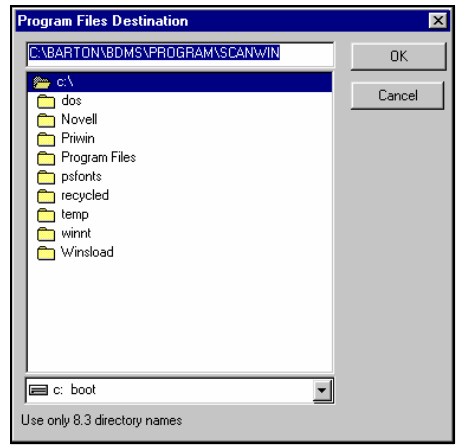
10. If you selected ***ScanWin***, the **ScanWin LITE Application** window appears.

    Click ***Next*** to accept the default drive and go to **Step 11**.

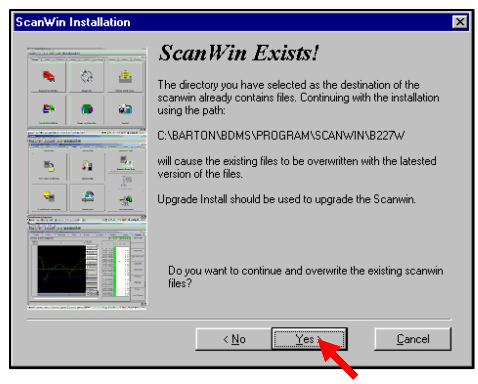


    Otherwise, to change the destination directory, either enter the name of the new directory or click the ***Browse*** button to display the **Program Files Destination** dialog box.

    Enter the **destination drive** and **folder** for ScanWin LITE and click ***OK***. This will take you back to the previous window. Click ***Next***.



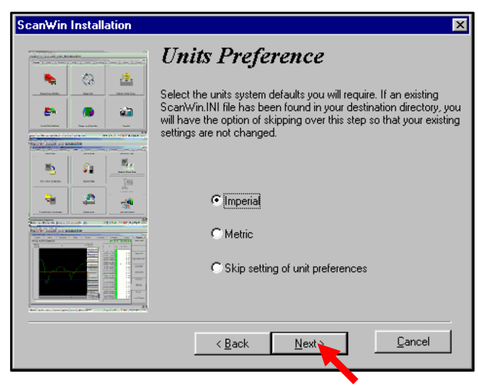
    If the program already exists in the directory, this warning will be displayed.



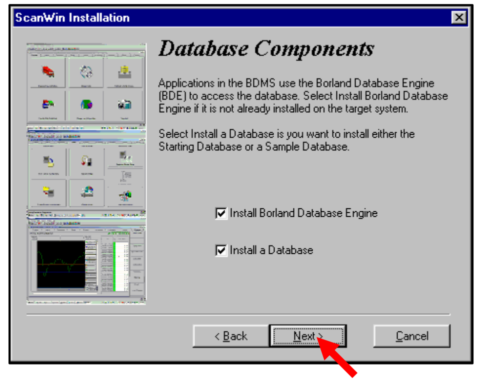
11. If this is a first-time installation, you can choose the default units (***Imperial*** or ***Metric***) in which you will be working. If you are installing over a previous version, you may select the ***Skip setting of units preference*** box to retain your previous settings.

    Make your choice and click ***Next***.

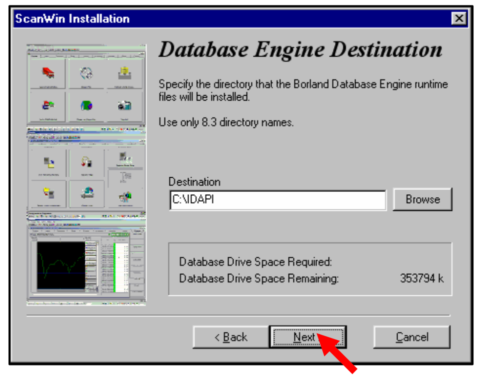
    See **Table 1 – Default Units (page 27)** for details about the default units.



12. If you selected **Database Install**, the **Database Components** window appears.
    Select the **database components** you want to install and click ***Next***.
    Go to **Step 14** if *only* **Install a Database** was selected, otherwise continue.

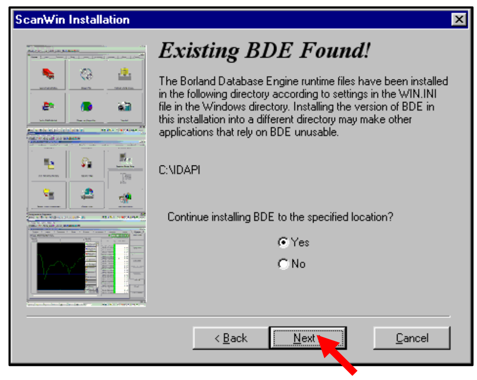


13. If you selected *Install Borland Database Engine*, the **Database Engine Destination** window is displayed.
    Click ***Next***.



You will be warned if there is already an installed Borland Database engine with the following display:

Select either ***No*** or ***Yes*** and then click the ***Next*** button. Note that selecting ***No*** will take you back to the previous wizard.

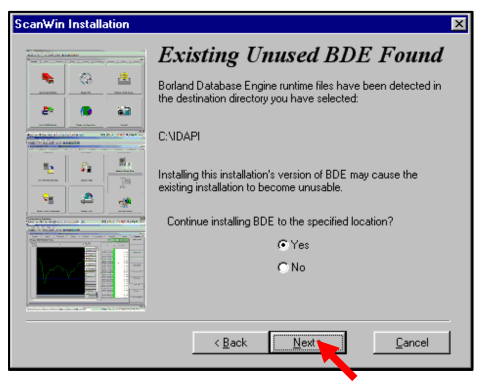


WARNING!

If you already have have the Borland Database Engine (BDE), the following window appears warning you that your ***existing installation will be overwritten***.

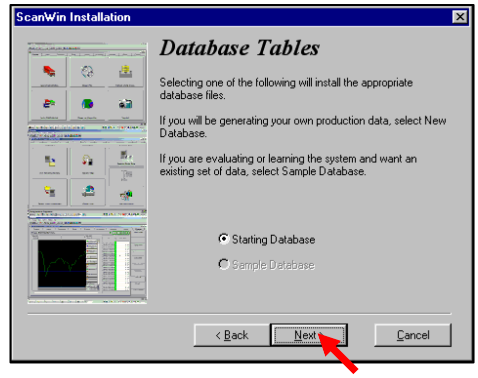
Select ***Yes*** or ***No*** and then click the ***Next*** button.

Note that choosing ***No*** will take you back to the previous wizard.



14. The **Database Tables** window appears.

    Select the type of database you want to install, either **Starting Database** or **Sample Database**. The sample database contains 18 sample Scanners and data that help you learn the functions in ScanWin. Select ***Sample Database*** if you do not have any real data. Select ***Starting Database*** if you have Scanners collecting data. Click ***Next***.



15. The **Database Destination** window appears.

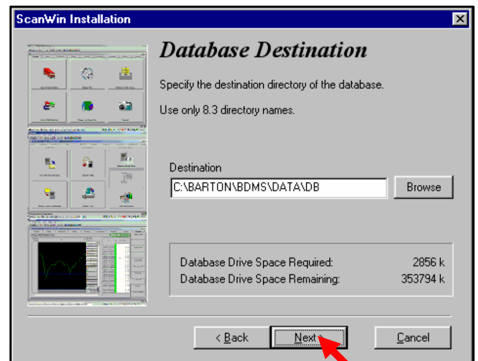
    Enter the **destination drive** and **folder** for the Database Engine.

    Or,

    Click the ***Browse*** button to display the **Program Files Destination** dialog box.

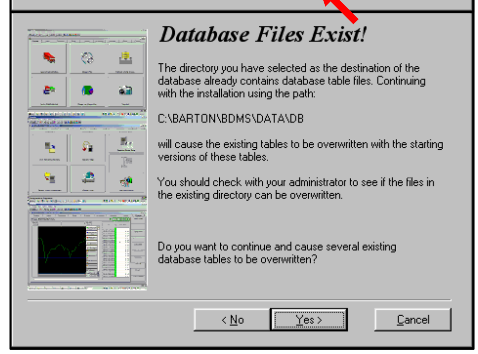
    Or,

    Click ***Next*** to accept the default location



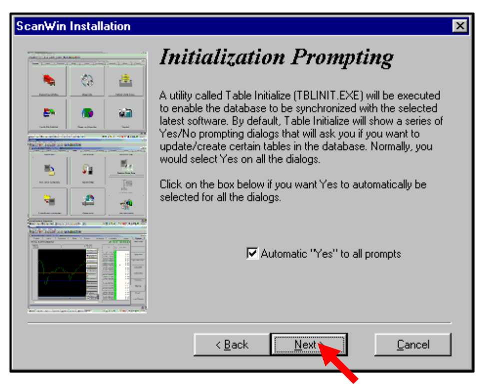
16. The following window is displayed if you have existing database files at the chosen location:

    You are prompted to choose ***No*** if you do not wish to overwrite the existing data.



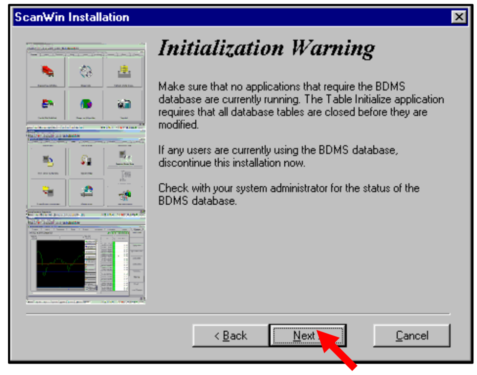
17. The **Initialization Prompting** window appears. If you don't want to see the next dialogs boxes that contain prompts for answering ***Yes*** or ***No*** questions for creating or updating tables, click the ***Automatic "Yes" to all prompts*** check box.

    Click ***Next***.

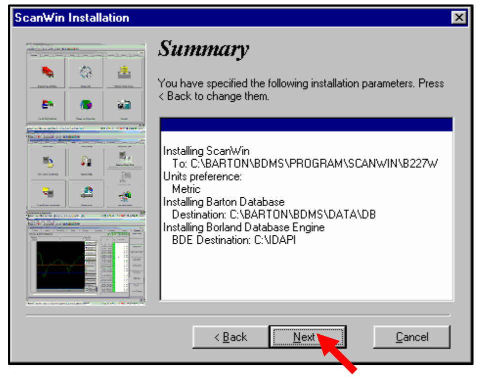


18. The **Initialization Warning** window appears warning you to close all applications using BDMS database tables.

    After taking the appropriate action, click ***Next*** to continue.

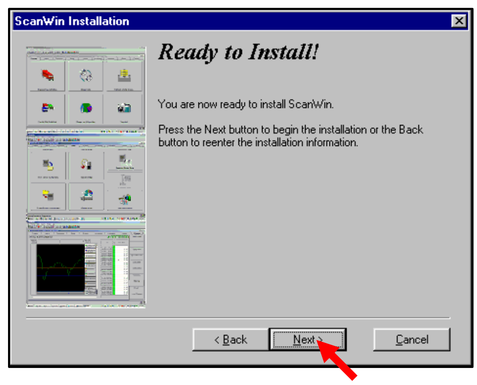


19. The **Summary** window is displayed. Click ***Next***.

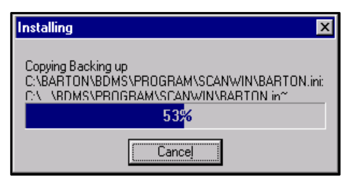


20. A dialog box appears indicating that ScanWin LITE is ready to be installed.

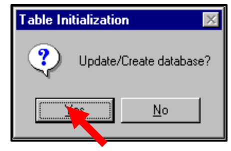
    Click ***Next*** to install the files.



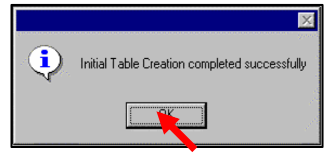
21. The progress of the installation is indicated by the following dialog box:



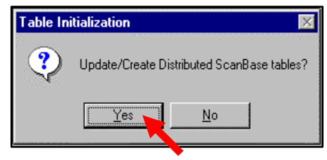
22. If you left the ***Automatic "Yes" to all prompts*** check box blank, a series of dialog boxes appear:
Click ***Yes*** to update or create the database.



A dialog box appears indicating that the initialization was successful:
Click ***OK*** to continue.

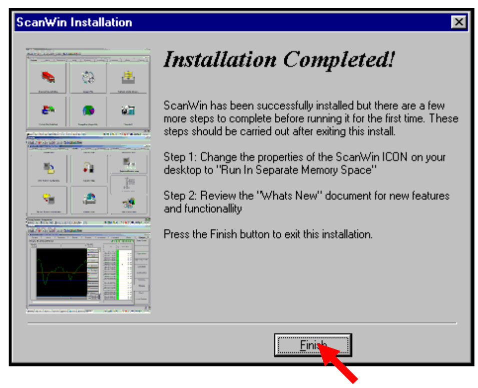


Another **Table Initialization** dialog box appears:
Click ***Yes*** to update or create the database.



A dialog box appears indicating that the initialization was successful:
Click ***OK*** to continue.

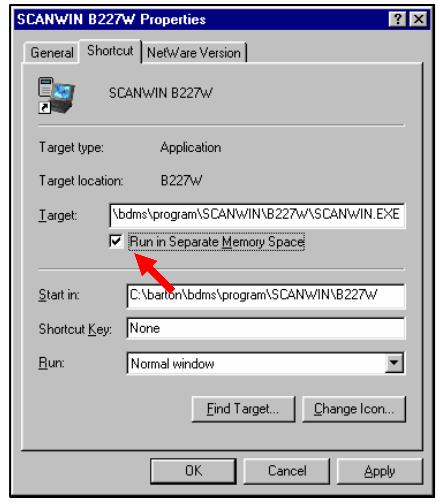
23. The **Installation Completed!** window appears, informing you of a successful installation. You are also given instructions on how to install an electronic version of this manual.
Click ***Finish***. A document will then be opened listing new features to be found in ScanWin LITE.



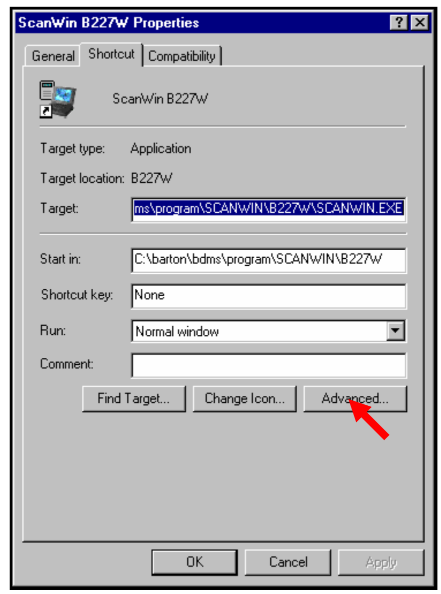
<u>NOTE for Windows NT, 2000 and XP users</u>:
Step 1 of the **Installation Completed!** dialog, is critical if your operating system is **Windows NT, 2000 or XP**.

To perform this step, right-click on the ScanWin icon that was created on the desktop and choose ***Properties***. Select the ***Shortcut*** tab. When located, click the box next to the "***Run in separate memory space***" message so that it is **check marked**.

The Windows NT and 2000 dialog looks like this:



If you are using Windows XP, you will first have to click on the ***Advanced…*** button.



The **Advanced Properties** dialog look like this:
When you are finished, click the ***OK*** button.

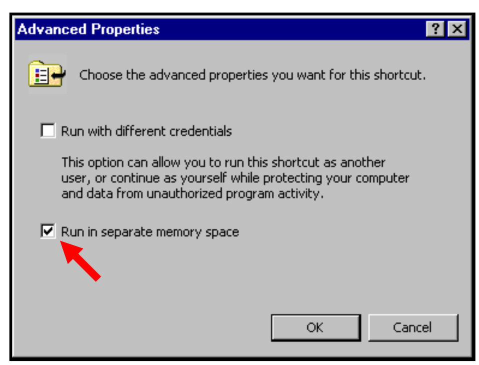


Table 1 - Default Units

The following table lists the default units that will be used when Imperial or Metric Units are selected during installation install (**Step 11**). These units can be changed after the installation by using the Unit Category Configuration interface.

.

Category	Default Imperial Units Abbreviation	Default Metric Units Abbreviation
Temperature	F	C
Volume	MCF	E3M3
Uncorrected Volume	MCF	E3M3
Distance	In	mm
Static Pressure (absolute)	Psia	kPaa
Static Pressure (gauge)	Psig	kPag
Differential Pressure	IWC	kPa
Energy	MMBTU	GJ
Mass	Lbm	kg
Density (absolute)	Lbm / CF	kg / M3
Relative Density (Specific Gravity)	RDg	RDg
Absolute Viscosity	Lbm / FtSec	cP
%Nitrogen	Percent	Percent
%Carbon Dioxide	Percent	Percent
%Methane	Percent	Percent
Volume rate	MCF / d	E3M3 / d
Uncorrected Volume rate	MCF / d	E3M3 / d
Mass rate	Lbm / d	kg / d
Energy rate	MMBTU / d	GJ / d
Mass heating value	BTU / Lbm	MJ / kg
Volume heating value	BTU / CF	MJ / M3
% per Static Pressure	%/Psig	%/MPag
Frequency	Hz	Hz
Percent	—	—
Volume K-factor	Pulses/CF	Pulses/M3
Mass K-factor	Pulses/Lbm	Pulses/kg
Molar Heating Value	BTU/mol	MJ/mol
Monitor	—	—

Chapter 2: ScanWin LITE Basics

Overview of the Startup Procedure

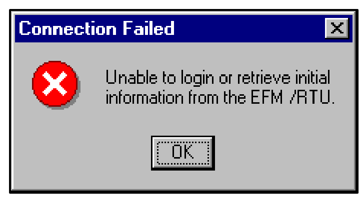
The following chart presents a suggested sequence for the startup of the Flow Computer:

Task	Step	Description	Reference Section
SCANWIN CONFIGURATION	1	Set desired units, if different from install default	**Chapter 1: Installing ScanWin LITE** **Chapter 2 (Unit Category Configuration, p37)**
	2	Check communication settings	**Chapter 2 (Connection Configuration, p31)**
SUPERBOOT	3	If the Scanner has been FLASHED, superboot it if required by firmware upgrade. (Superbooting is generally recommended.)	**Chapter 2 (Starting After a Superboot, p33)**
LOGIN	4	Set Clock **Note**: If Scanner was superbooted, the clock is set as part of the superboot procedure (see Chapter 2 – Getting Started (Starting ScanWin LITE)	**Chapter 5 (Clock, p112)**
SYSTEM SETUP	5	Restore configuration (or manually configure the Scanner as described below)	**Chapter 6 (Restore Scanner Configuration, p83)**
	6	Set Node Name	**Chapter 7 (Node Information, p105)**
	7	Configure System Settings (Gas Day Hour, Power Save, etc.) Ensure that the desired firmware version is installed. If not, FLASH the Measurement RTU with the correct firmware version. Superboot if required by firmware upgrade. (Superbooting is generally recommended.)	**Chapter 6 (Scanner Setup, p79)** **Chapter 7 (Node Information, p105)**
	8	Configure Hardware • enter zero, full-scale, default, calibration/verification options	**Chapter 6: HARDWARE** **Chapter 3 (Calibrate/Verify Devices, p58)**

Task	Step	Description	Reference Section
FLOWRUN SETUP	10	Build Flowrun "framework" (e.g. Add/Remove or Modify a Flowrun)	**Chapter 6 (Flowrun Setup, p45)**
	11	Enter Flowrun Name	
	12	Change Flowrun status to "setup" and ensure other flowrun settings are correct (e.g., Timing, Limits, Estimation)	
	13	Configure all user entered flowrun parameters (e.g., orifice size, gas quality information, etc.)	
	14	Link all live input parameters to desired hardware resources	
	16	Output flowrun parameters to desired Accessories	
CHECK SETUP	17	Ensure that the flowrun is "running" and that the rates are being calculated and the totals are accumulating.	**Chapter 11 (Rates and Totals, p86)**
SAVE CONFIGURATION	18	This allows you to apply your present configuration to other Scanners or to reconfigure your Scanner if it is superbooted.	**Chapter 6 (Save Scanner Configuration, p81)**

Startup Problems Checklist

1. If a Connection Failed message is displayed, check the following:
   - Is the Scanner turned on?
   - Is the battery producing enough voltage to power the Scanner?
   - Are the communication settings correct? Is the baud rate correct?
   - Are your cable connections secured?



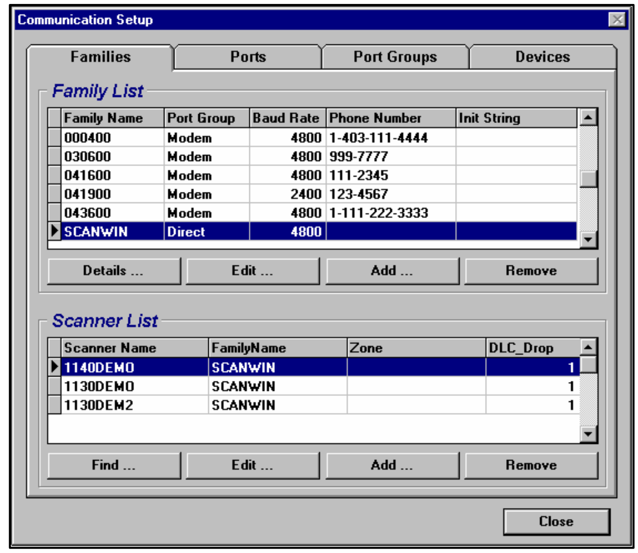
2. If using **Windows NT, 2000 or XP**, ensure that you are running ScanWin LITE in a separate memory space. To do this, carry out the following steps (see **Step 23** of the ScanWin LITE installation procedure):
   - Right-click on the ScanWin LITE icon.
   - Select ***Properties***.
   - Select the ***Shortcut*** tab and then click the "***Advanced…***" button.
   - On the **Advanced Properties** page, check the box that says "**Run in separate memory space**".
   - Click ***OK.*** Then click ***OK*** on the **ScanWin LITE Properties** page.

3. If ScanWin LITE will not close or does not restart when running in **Windows NT, 2000 or XP**, perform the following steps:
   - Access the task list using the ***Ctrl-Alt-Del*** keys.
   - Select the NTVDM.exe process
   - Click the ***End Process*** button.

> **NOTE** **Other applications may use a NTVDM.exe so use caution when performing this step**.

Connection Configuration

To properly communicate with the Scanner in a **direct**, **remote** or **offline** mode, ScanWin LITE's communication settings may have to be configured. The settings are accessible through the **Main Menu** under ***Tools*** > ***Communications Setup*** or through the ***Setup*** button of the **Scanner Connection** window. Either action displays the following window:



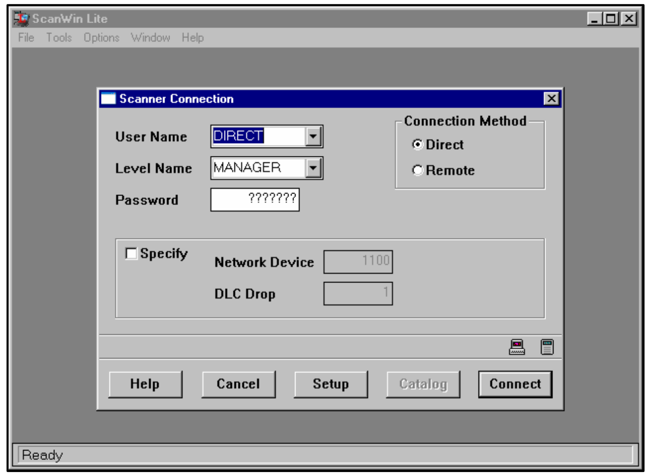
It is important that the following settings are addressed:

Port Group Name	Device Setup Name
Port	Work Station ID
Baud Rate (9600 for NGas 4.0.X after Superboot)	

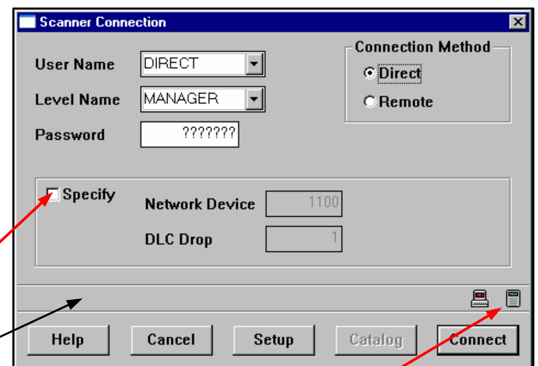
Note that **Direct** connection method requires that "**_DIRECT_"** is present in both the ***Family Name*** and the ***Scanner Name*** in the **Scanner List**. To edit the Family Name or Scanner Name, follow the instructions in **Chapter 8: Communications Setup**.

Starting ScanWin LITE

1. Locate the ScanWin LITE icon  on your desktop. Double-clicking it displays the **Opening Menu** window (background) and the **Scanner Connection** window (foreground).



2. Details of the **Scanner Connection** window include the following:



You need to enter your **User Name** and **Scanner Security Level** that you want to login at, and the **Password** for that level the first time you use ScanWin. They will be stored so the next time you access ScanWin, you can select them from the drop-down list.

See **Step 7** about the "***Specify***" box.

Status of the communication link appears here.

Communication link is active when the arrows  are moving.

Note:
The default security ***Level Name*** is **MANAGER**, **USER1**, **USER2**, **USER3** and **GUEST**.
Initially, **USER1** and **GUEST** have ***READ ONLY*** access, while the **MANAGER**, **USER2** and **USER3** have ***READ/WRITE*** access.
Also, the default password is the same as the Level Name.

See Chapter 7 (**Login Management, page 113**) for more information.

3. Select your user ID from the ***User Name*** drop-down list.
4. Select your security level ID from the ***Level Name*** drop-down list.
5. Enter your user password in the ***Password*** field.
6. In ***Connection Method***, select the method you want to use to work with the data. Select ***Direct*** to connect directly to the Scanner; select ***Remote*** to use a communication device to communicate remotely.

   Click the ***Setup*** button to access the **Communication Setup** dialog. Refer to the **Defining a Family** section (**page 138**). Note that the Family _DIRECT_ is used for Direct Connection Method.

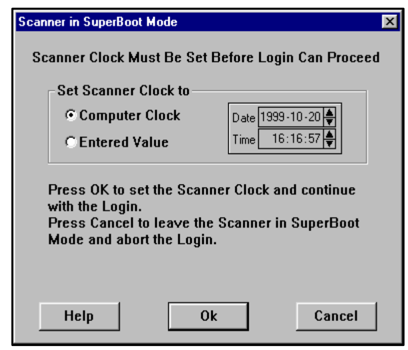
NOTE: You MUST select the ***Specify*** box **if** your firmware is NGas 3.1 or lower **and** the ***Connection Method*** is ***Direct***. The Network Device default is 1100, and the DLC Drop default is 1. These settings must match the settings in the Scanner.

7. Click the ***Connect*** button to connect directly to the Scanner. (*See note on next page about connecting after a **superboot** of the Scanner*.)
   Alternatively, when the **Scanner Connection** window is closed, but the program is running (with the **Opening Menu** window showing, press the ***Open Scanner*** button  on the toolbar
   OR press the F2 key
   OR select ***Open*** in the ***File*** menu to display the **Scanner Connection** window.

Starting After a Superboot

If the Scanner has been superbooted, this window will first be displayed before the normal ***Routine*** tab (see Chapter 3, **page 41**).

You have the option of synchronizing the Scanner with your PC's clock by clicking on the *OK* button while Computer Clock is selected. Alternatively, you may choose Entered Value, enter a different time and/or date and then click the ***OK*** button. Refer to Chapter 7 **(Clock, page 112)** for additional details.



Moving Through ScanWin LITE

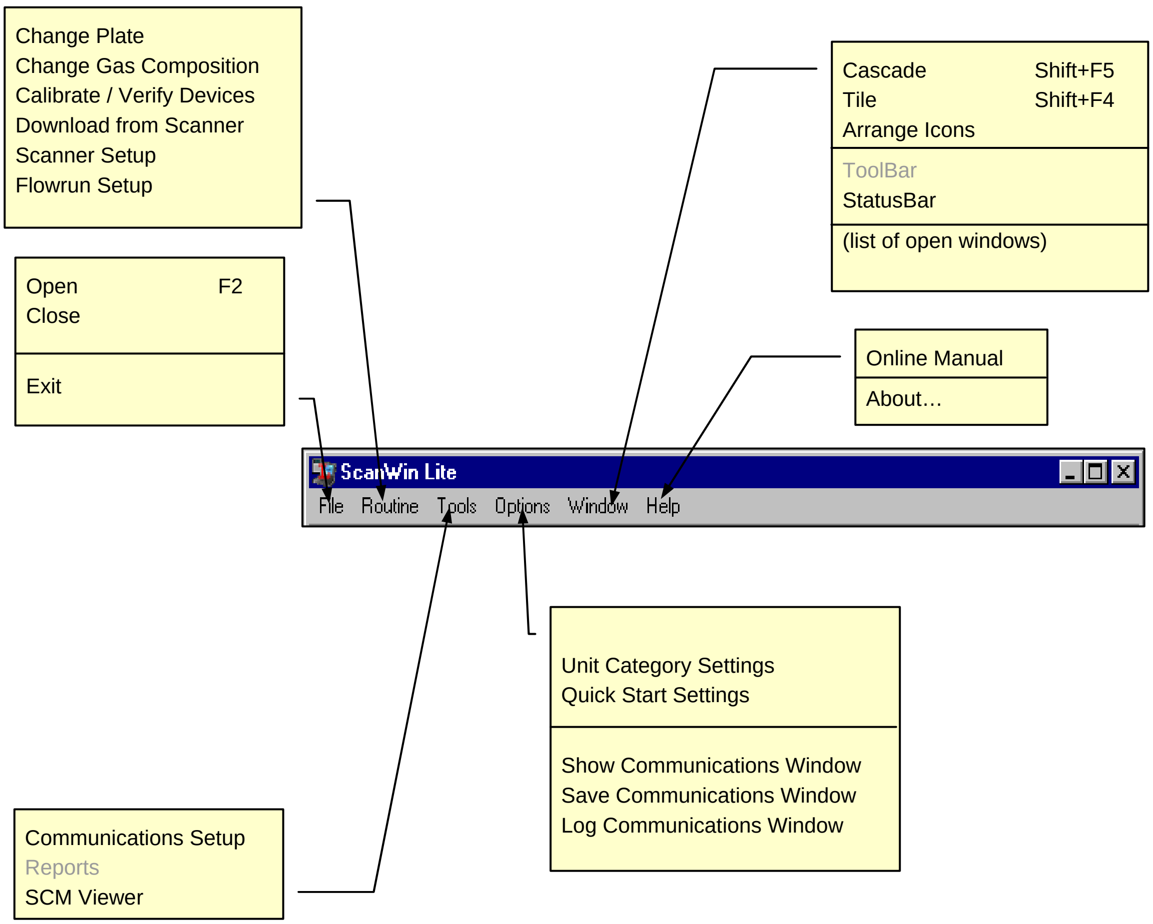
You can move through ScanWin LITE using the ***Main Menu*** bar.

The **Main Menu** can be accessed by clicking on the word (e.g. ***File***) and then moving the mouse to the desired command and clicking on it (e.g. ***Close***).

The commands can also be generated by using keyboard commands. The ***Alt*** key in combination with the underlined letters (***F*** for File, ***R*** for Routine, ***T*** for Tools, etc.) opens the menu for that set. Then, press the underlined letter for the command you wish.

As an example, clicking the ***Alt***, ***R*** and ***D*** keys will initiate the **Calibrate Devices** wizards (refer to **page 58**).

Note: The **Routine** menu is not visible when you are in an offline mode.



Symbols Used by ScanWin LITE

The following symbols are used in ScanWin LITE to select or deselect operations.

This symbol…	Indicates…
	The operation or item has been **selected**.
	The operation or item has **NOT** been **selected**.
	The user will have **READ ONLY** access.

Field Conventions

ScanWin LITE allows a variety of changes to be made in many of the fields in its windows. Symbols are used in some fields to indicate where changes may be made.

A field like this...	Indicates that...
86.487 (yellow arrow pointing down)	The value is out of range. In this case, it is below the zero (low) value.
86.141 (yellow arrow pointing up)	The value is out of range. In this case, it is above the full-scale (High) value.
-0.275 (two yellow arrows pointing down)	The Differential Pressure value is in cutoff.
82.195 (yellow circle)	A default value is being displayed.
-17.778 (yellow question mark)	The live value is assigned to a peripheral device which is not communicating **or** the live value is not known or available. **<u>Note</u>**: For Firmware versions 4.3.1 and earlier, message is displayed for live values assigned to a peripheral device that is not communicating.
127.000 (green triangle in <u>upper left hand</u> corner)	Clicking on box allows you to change the value or presents you with a drop-down window with options from which to choose. **<u>Note</u>**: Clicking on any Units field (the triangle is not shown in these fields) presents you with a drop-down window containing the available units of measurement for that value.
Analog Output (blue-green triangle <u>in lower right hand</u> corner)	Double-clicking on box presents you with a window dialog through which you are allowed to make changes.
Status Input (triangles in <u>both</u> the <u>upper left</u> and <u>lower right hand</u> corners)	Double-clicking on this field will present you with a window dialog through which you can assign and/or edit other types. **<u>Note</u>**: See below for explanation about the Hardware page.
A04+ Status Input ("+" sign after resource name - found ***only*** on the Hardware page)	Double-clicking on the type field gives you a window dialog through which you can make changes for that type. A ***<u>single</u>*** click and a ***<u>pause</u>*** for about 1 second produce a down arrow on the right side of the type field. Clicking on this arrow presents you with a drop-down window with the type options available for that resource.
DCEPS (green triangle in lower right hand corner pointing <u>downwards</u> - found on Network Settings tab under Systems)	Clicking on this field containing the downward pointing triangle displays the settings that are available. The field then changes to DCEPS (arrow now points to the <u>right</u>) and additional items become available.
DCEPS (green triangle in lower right hand corner pointing to the <u>right</u> - see previous line)	Clicking on this field causes the expanded settings to revert to the original single line.

Colors Used in ScanWin LITE

ScanWin LITE makes use of colors to add meanings to values. The following table tells about these colors:

This color…	Indicates values that are…
Green	Dummy placeholders generated by ScanWin LITE before any connection is made to a Scanner or database. Green text appears when an offline connection could not find the value in the database or momentarily with a direct or remote connection.
Blue	From the database. Blue text appears with an offline connection.
Teal	Currently being retrieved from the Scanner. Teal text appears briefly with a direct or remote connection.
Black	Retrieved from the Scanner. Black text appears with a direct or remote connection.
Purple	Not retrieved from the Scanner. Purple text appears with a direct or remote connection when you try to get a value but it could not be retrieved from the Scanner.
Red	Red is also used to alert you to invalid conditions that exist while the program is running. For example, ***active alarms*** and ***exceptions*** are shown respectively in the **Alarms** and the **Diagnostics** pages in red text. Hardware inputs or outputs with Invalid Live values will also be displayed in Red (this is usually caused by the upper and/or lower ranges not being defined)

Options Menu Items

Unit Category Configuration

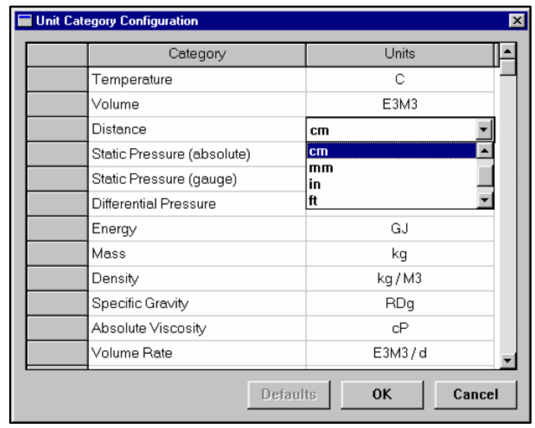
During installation, ScanWin LITE allows the selection of ***metric*** or ***imperial*** units. Refer to Table 1 - Default Units **(page 27)** for details about these units.

After logging in, the measurement units for a flowrun may be changed by the user.

In addition, default units can also be configured. The new default units will appear only after ScanWin LITE is closed and restarted.

Setting the Units

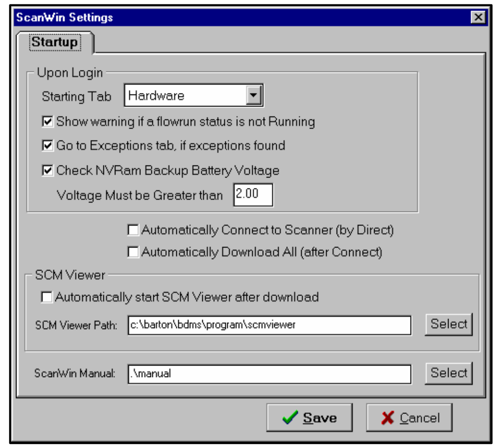
1. On the Main Menu, select ***Options*** > ***Unit Category Settings***. This window is displayed.
2. Click on the field displaying a unit to display the dropdown menu. Click on the unit of your choice.
3. When all your changes have been made, click ***OK*** to end. (Choose ***Default*** if you wish to apply these choices to all of your flowruns.)



<u>Note</u>: These unit selects do ***NOT*** apply to the History Graph view nor the Table view found in the ***Flowrun*** > ***History*** tabs. To set History units, use ***Options*** > ***History Data Settings*** found in the **Main Menu**.

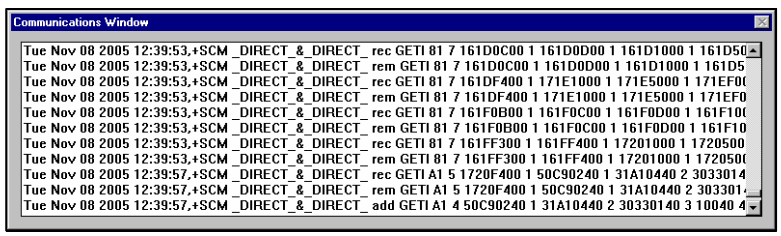
Quick Start Settings

ScanWin LITE provides a **Quick Start Settings** configuration dialog (accessed through ***Options*** > ***Quick Start Settings***). The scanwin.ini file can be edited using this dialog.



Using the Communications Window Option

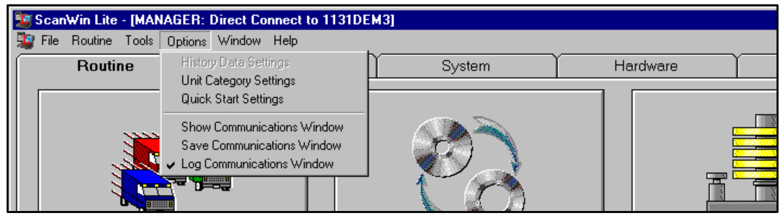
ScanWin LITE has a built-in communications window that is useful in tracing problems. This window is turned on and off from the Main Menu by selecting ***Options*** > ***Show Communications Window***. When turned on, it looks like.



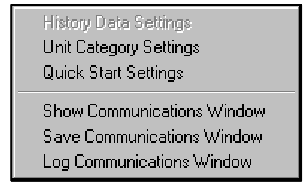
There are two methods of saving the information that this tool can produce.

1. Choosing ***Options*** > ***Save Communications Window*** from the Main Menu saves all the information in memory from the time the Scanner was started (or from the last time this command was issued) until the time the request was made. The information is saved, by default, to a file named **swlcomwindow_yyyymmddhh*mm*ss.txt** (where **yyyy** is the year, **mm** is the month, **dd** is the day, **hh** is the hour, ***mm*** is the minute and **ss** is the second when the file is saved). This file is found in the c:\Barton\BDMS\Data\Reports\Comlogs\Scanwin directory. Each time this command is given, a new file is created.
2. Choosing ***Options*** > ***Log Communications Window*** from the Main Menu causes data to be written to a text file named **swlcom.log**. This file is also found in the c:\Barton\BDMS\Data\Reports\Comlogs\Scanwin directory. The recording of data to this file can be started and stopped over a particular testing period. While the check mark is visible as shown below, data is being appended to the file.

(Data is being written to **swlcom.log**)



(No data is being written to **swlcom.log**)



Each time logging is initiated, the new data will be ***appended*** to this file. If you need separate files, **swlcom.log** should be renamed before starting a new log session.

Leaving ScanWin LITE

You can leave ScanWin LITE at any time.

To leave ScanWin LITE

- From the Main Menu, choose ***File*** > ***Close*** to close the current connection(s). Then select ***File*** > ***Exit*** to leave ScanWin LITE.

  Or
- Close the connection(s) using the ***Exit*** button (lower one), and then use the main window's Exit button (topmost one) to close the program.

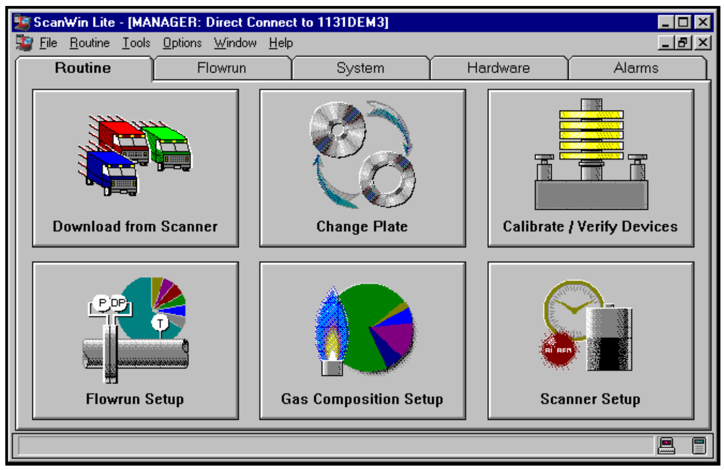
Tip: It is recommended that ***all connections*** be closed ***before*** exiting the main program window.

Chapter 3: Performing ROUTINE Processes

- Data Collection (p42)
- Flowrun Setup (p45)
- Changing Plate (p52)
- Changing Gas Composition (p54)
- Calibrating/Verify Devices (p58)
- Scanner Setup Options (p79)

When you connect to a Scanner using ScanWin LITE and select the Routine tab, you will be presented with a page of routine options as shown here.

Click on the button of the routine you wish to access.



Note that these functions may also be accessed from **either** the Main Menu (by clicking on **Routine** to display the submenu, and then clicking on the desired function) **or** through the toolbar by clicking on the icon of the intended routine.

Data Collection

ScanWin LITE version B3.0.0W allows you to download hourly history, daily history, events and user changes for the flowruns you have selected. This information can then be viewed with the SCM Viewer, a Windows-based application included on the ScanWin installation CD. For instructions on using this utility, see the SCM Viewer user manual.

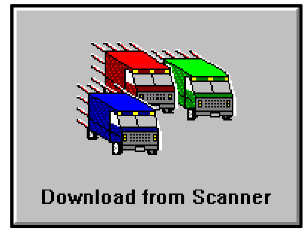
- The Hourly and Daily **History** log contains flow data that is used to audit measurements in hourly and daily increments repectively, reproduce volume/mass/energy flow information and recalculate flow data, if necessary.

> ***Note:*** **With ScanWin LITE, all Scanner History data (Hourly, Daily Flowrun History, Events and User changes) is saved *only to the SCM download file* and is viewed using the SCM Viewer.** The filename and extension of the SCM history download binary file is **nnnnnnxx.scm** where **nnnnnn** are the first six characters of the Scanner's node name

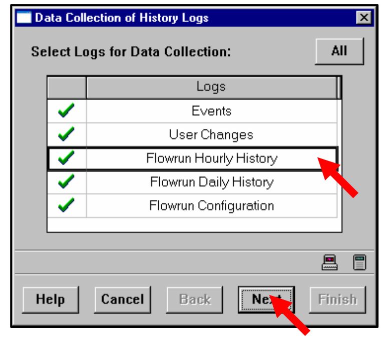
- The **Events** log provides a record of process alarms, system alarms and other external alarms.
- The **User Changes** log records changes to the Scanner configuration. A "user change" is defined as any action performed by the user, which, directly or indirectly, causes the flow computer to calculate or operate differently from the way it was operating prior to the change; i.e., anything that affects any of the numbers in the flowrun(s). When the User Change Log is getting full (status can be checked via the ***Diagnostics*** > ***Memory Status*** tabs), ScanWin will issue a warning. If the log is full, user changes will not be permitted until the data has been collected from the log. This ensures that the audit trail is continuous.

Download From Scanner

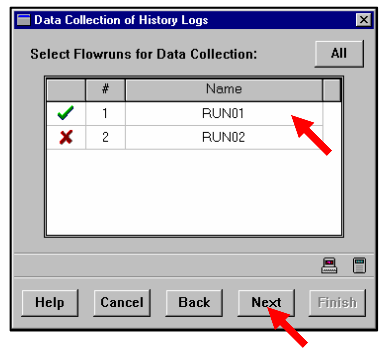
1. Access ***Download from Scanner*** as explained on **page 41**.



2. The first **Data Collection of History Logs** window is shown.
   Click on the line containing the history logs to show a **green check mark** (for the history logs that you wish to download). By default, all the lines will begin with a ***red X***.
   Clicking on the **All** button in the upper right hand corner of the window inserts a **green check mark** for each of the logs.
   Click ***Next*** when you are done.



3. This dialog box is displayed.
   Click the ***check mark*** beside the flowruns that you do not want to download (a ***red X*** appears).
   Or
   Click ***All*** to select all the flowruns. ***Green check marks*** appear beside the selected flowruns.
   Click ***Next*** to continue.

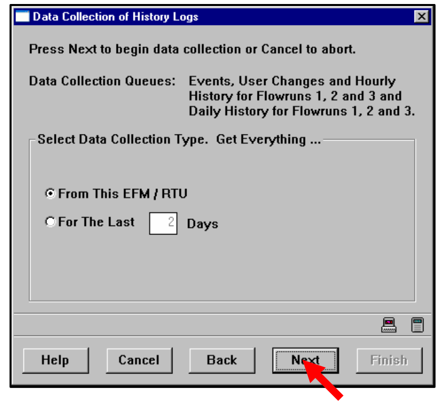


4. The **Setup** dialog box is displayed.

   Select one of the following download types (Note that some options may not be available. Refer to the **Downloads** option on **page 38**):

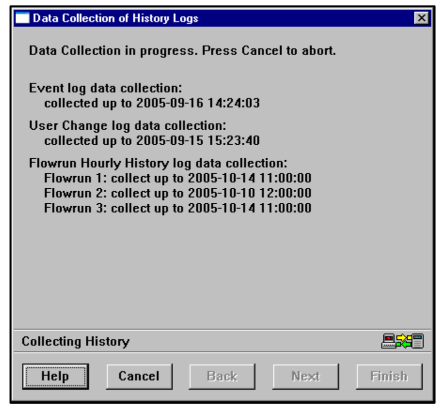
   - ***From This EFM/RTU***. This results in a complete download of all the history in the unit.
   - ***For The Last -- Days***. If you select this option, enter the number of days worth of data you want to download.

   Click the ***Next*** button when you have made your choice.



5. ScanWin LITE downloads the data to your computer for the period specified and informs you when the process is complete.

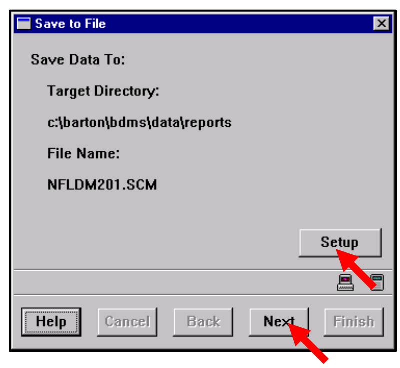
   Click ***Next*** when you are prompted to do so.



6. You are then presented with a choice of where to send your data.

   If you accept the suggested filename and location of the file, click on the ***Next*** button; otherwise select ***Setup*** and insert your own filename and/or file location.

7. Click ***Finish*** when the process is complete.



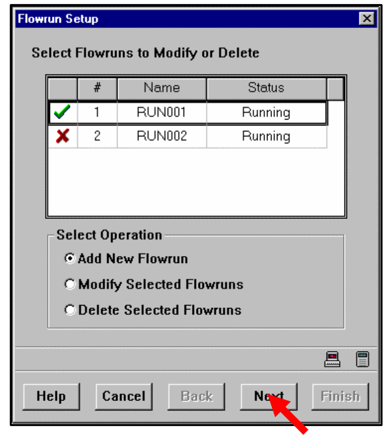
Flowrun Setup

ScanWin LITE provides a wizard that helps you to set up the flowruns for the Scanner.

To configure a flowrun:

1. Access ***Flowrun Setup*** as described on **page 41**.
2. The menu to select **Add**, **Modify**, or **Delete** flowruns appears. Click on the line containing the flowrun to select a green check mark or a red X.. A ***green check mark*** indicates that the flowrun can be modified or deleted. A ***red X*** indicates that the flowrun cannot be changed or deleted. Also, select the operation to perform on the selected flowrun(s).

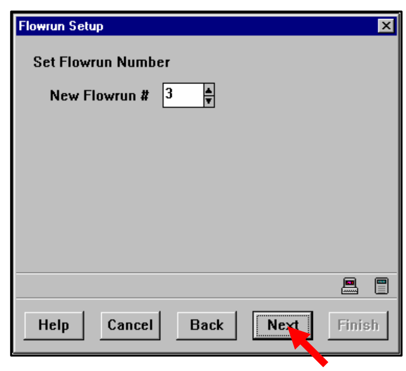
   Click ***Next*** after making your choices.



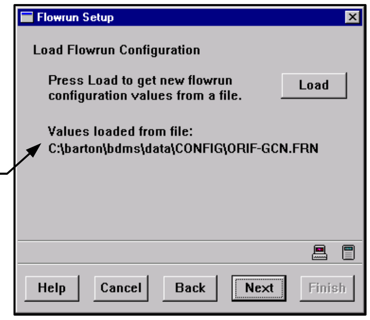
- ***Add New Flowrun*** (click ***Next***, go to Step 3)
- ***Modify Selected Flowrun*** (click ***Next***, go to **Step 4**)
- ***Delete Selected Flowrun*** (Resulting dialog is: **Are you sure you want to delete the flowrun #x?** Select ***yes*** or ***no***. If ***yes*** is selected, dialog appears informing you of the deletion of flowrun #x).

3. Enter the **flowrun number** of the flowrun you are adding.

   Click Next.

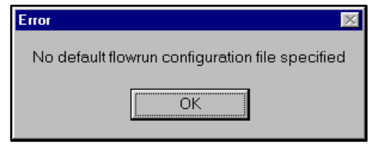


4. ScanWin LITE will normally display a screen like this.
   Click on the ***Next*** button to accept this configuration and go to **Step 5**.

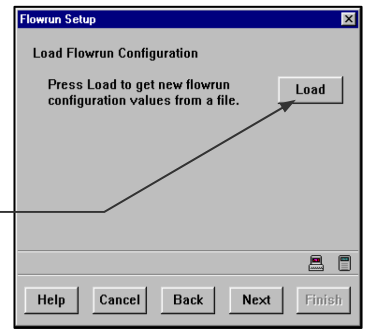


Flowrun configuration information will be stored in the ***Barton\BDMS\Data\Config\Flowrun*** directory (default is Drive C).
A flowrun configuration file can be recognized by its **.FRN** extension. The file name is determined by the user.

If a configuration file does not already exist, you will be warned with an error message display like this.

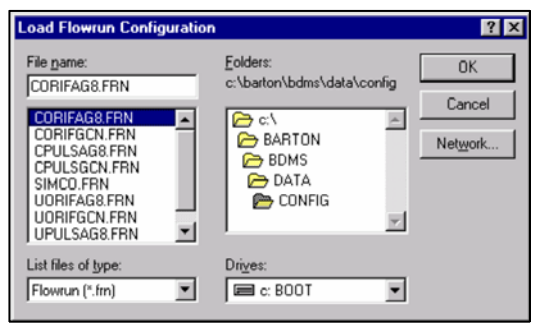


When you click the ***OK*** button, you are shown this screen.
Click on ***Next*** (and go to **Step 5**) to load ScanWin LITE's default configuration or click on the ***Load*** button to load a previously saved configuration.



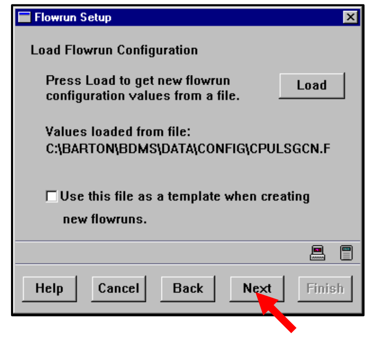
Click on the **Load** button to choose a new configuration file.

You will be shown a screen similar to the following:
Find the directory containing your configuration file (extension ***.frn***), and click on it. Then click on the ***OK*** button.



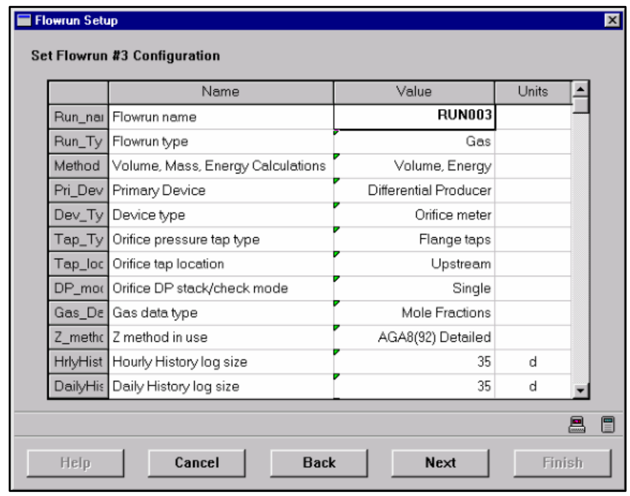
<u>***Note***</u>: Default flowrun configuration files begin with "C" (Canadian) or "U" (U.S.) and differ in their Base Pressure and Base Temperature.
"C" files have Pbase and Tbase values of 101.325 kPaa and 15°C respectively.
"U" files have Pbase and Tbase values of 14.73 psia and 60°F respectively.

The following dialog gives you the option of loading a new file (by clicking ***Load***) or using this file to continue (by clicking ***Next***). Note that you are also given the choice of using the displayed file as a template for future flowrun setups (first click on the line with the box and a check mark will appear, then click the ***Next*** button).



5. Enter flowrun configuration values.
   When finished, click ***Next***.

Refer to
- Chapter 10: NGas 4.X.X Configuration & Calculations
- Chapter 11: IGas 4.X.X Configuration & Calculations
- Chapter 12: NFlo 4.X.X Configuration & Calculations
- Chapter 13: Monitor Flowrun Configuration
for rules affecting the flowrun.



WARNING!!

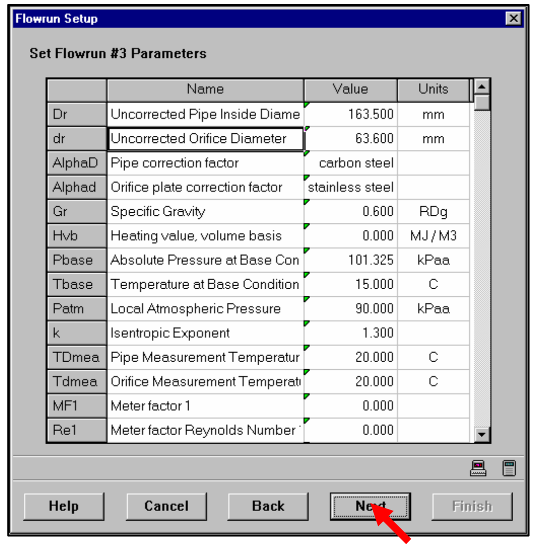
Modifying the following flowrun components will result in the **LOSS** of current history data. Before modifying your flowrun, you should download and save your current history data using the Data Collection wizard (see **Chapter 3: Performing ROUTINE Processes**).

- Volume, Mass, Energy Calculations
- Orifice or Pulse
- Z Method in Use
- Flowrun Type
- Hourly History Log Size
- Daily History Log Size
- Qb/Press Peak Logging
- Density Source
- Gas Component Mode
- Gravity Mode
- Hourly History Log Interval

> ***Note***: ScanWin LITE will also notify you of this potential loss with this warning when you click the ***Next*** button.

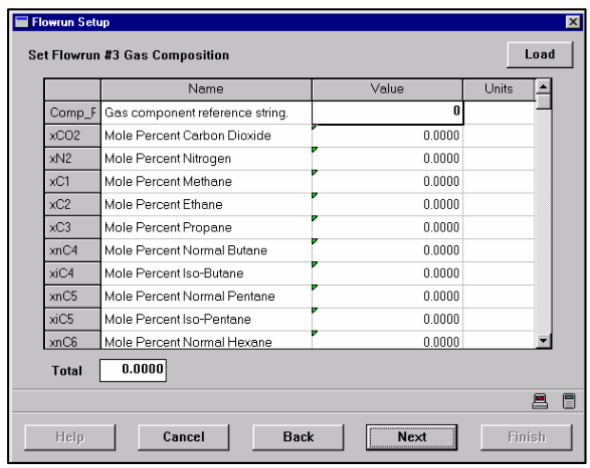
6. A window allowing you to set the **Flowrun Parameters** is then shown.

   Enter your values and click ***Next*** when you are done.



> See **Chapter 10: NGas 4.X.X Configuration & Calculations**
>
> and **Chapter 11: IGas 4.X.X Configuration & Calculations**
>
> **and Chapter 12: NFlo 4.X.X Configuration & Calculations**
>
> for Flowrun data values.

7. The next display is for gas composition values. A new flowrun will have a default value of zero for each gas. If a flowrun is being modified, this window will contain the present values for the gases.

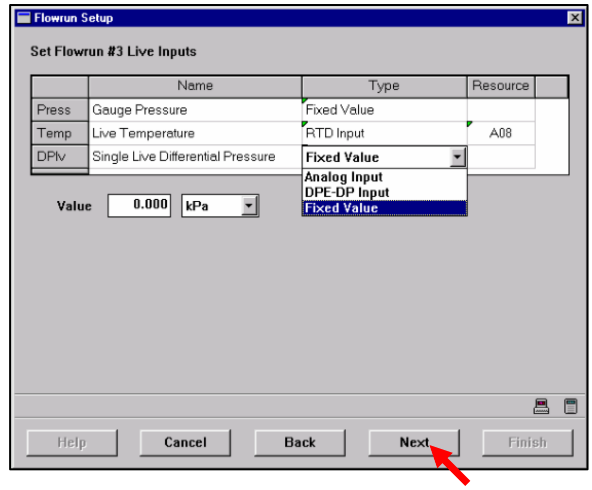


Enter information in the fields using the following for a guide:

In this field…	***Enter…***
Gas component reference string	An identifying reference to the gas composition that you will use for this flowrun.
Real Gas Relative density	The value of the relative density of the gas at base conditions. Note that this field appears if the Gravity Mode was selected as **entered** in Step 4 (Configuration).
Volumetric Heating value	The heating value of the gas. Note that this field appears if the Heating Value mode was selected as **entered** in Step 4 (Configuration).
Mole Fraction (gas)	The percentage of the gas. As you enter the value, a total appears in the box in the lower left-hand corner of the window. If your total does not add up to 100 or 1.0, a window appears warning you of this fact. You are given the choice of using the values entered or editing them.

8. You are then prompted to set the **Live Inputs** in the following window. Under the **Type** heading, click on a field to show a drop-down box. Click on your choice and press the ***Enter*** key (or click on another field). The appropriate fields will appear in the lower half of the window.

   See note below. Click ***Next*** when you are finished.



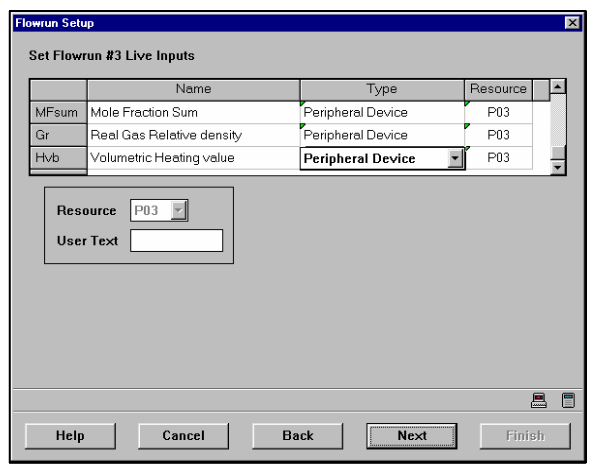
The input Type and Resource for the flowrun are displayed, by double-clicking on the desired row of the table. The availability of this function is indicated by the green triangles in the top left corner of the table cells. The hardware information appears and you select the following for each input listed in the Name column. Select from:

- Analog input
- **RTD input** (temperature only)
- **Pulse input** (pulse input only)
- Fixed input
- **Barton DPE** (Differential and Static Pressure)
- **Peripheral Device** (Barton MVX Multivariable Transmitter, Transmitter, Daniel Ultrasonic, Daniel Gas Chromatograph and MVX-II/3095FB Multivariable Transmitter)

Check that the input hardware resource type exists before displaying options.

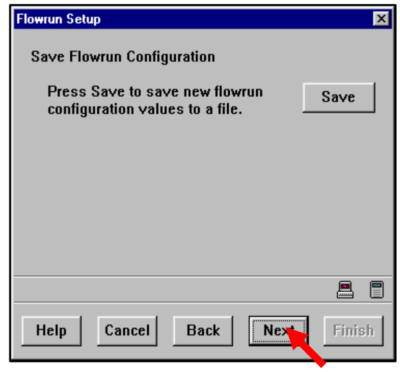
- The Resource – Slot and resource number
- Fill in the Hardware details, zero, full-scale etc.

Also, note that in **Step 5**, if you had selected **From GC** in the ***Gas Component Mode*** field when using a Gas Chromatograph, you can assign the live input to that peripheral device by using its Mole Fraction Sum. At Step 5, it is also possible to specify that the Gravity and Heating Value modes be given live inputs. In a similar manner, the inputs can be from the Gas Chromatograph.



9. ScanWin LITE then gives you the option of saving the configuration to a file or to the Scanner.

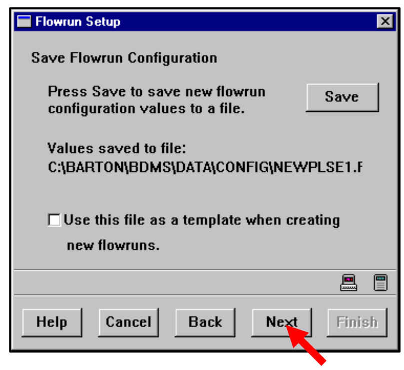
   To save the file to the Scanner, click the ***Next*** button and go to **Step 11**.



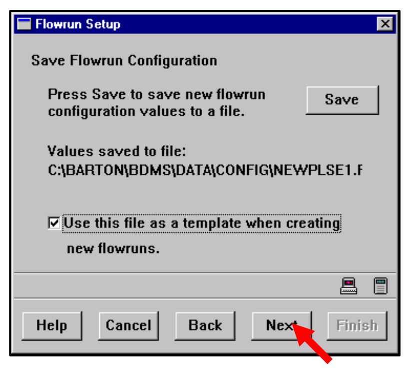
   To save this configuration to a file, click on the ***Save*** button. You will then be asked to name your configuration file.

   Type in your filename and click the ***OK*** button.

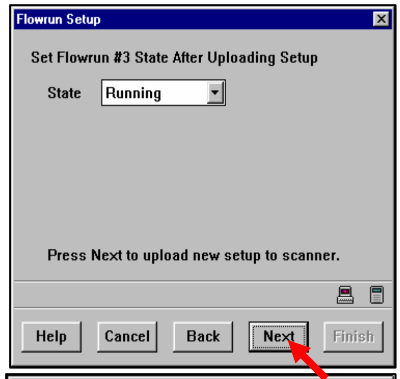
10. Before you continue, ScanWin LITE gives you the opportunity to use this configuration as a template for future flowruns.



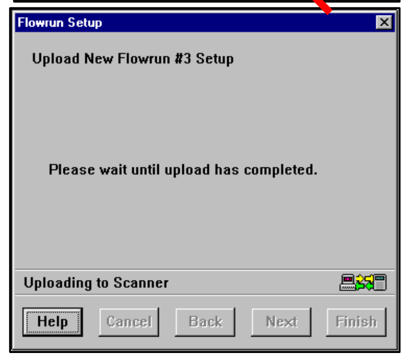
   To select this option, click on the line "**Use this file as a template…**" to place a check mark in the box. Click the ***Next*** button to continue.



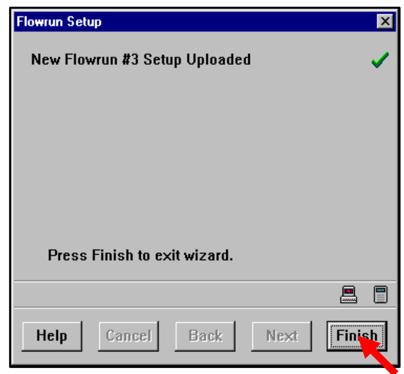
11. You are prompted to set the flowrun state after the upload to the Scanner has been completed. Click ***Next*** when you are ready.



12. Wait until the configuration is complete. Message is not shown for Flowrun setup in Offline mode.



13. When the setup information is uploaded to the Scanner, this window is displayed.
    Click ***Finish*** to return to the **Setup** page.



Note: After the flowrun has been set up, ***VERIFY*** that your **Live Inputs** and **Rates and Totals** are being updated on the Flowrun page (refer to Chapter 11). This is especially important after you have created or modified flowruns to include peripheral devices such as the **MVX**.

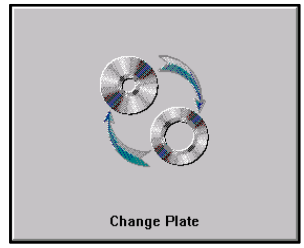
Change Plate

ScanWin LITE provides a wizard that helps you change the orifice plate of an orifice meter. This procedure shuts down the flowruns that are being serviced and restarts them on the completion of the task. If the **Estimate During Plate Change** setting (via the **Flowrun Setup**, **page 45**) has been turned *on* (**green** check mark), then flow estimation will take place while the flowruns are offline. If this option is set to *off* (**red** X), no volume will be estimated during a plate change while the flowruns are offline.

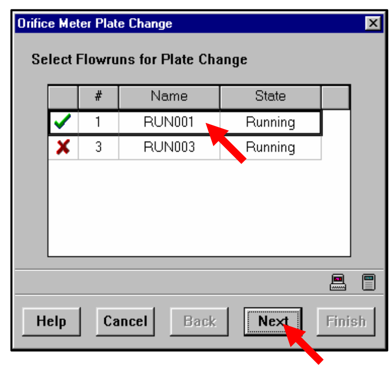
The flowrun status is always changed to ***running*** upon completion of the orifice plate change routine regardless of its previous state.

To change the orifice plate:

1. Select ***Change Plate*** as described on **page 41**.



2. At the **Select Flowruns for Plate Change** dialog box, select the flowruns for which you want to change the orifice plate. By default, all the lines will initially contain a **red X**. Clicking on the lines of the flowruns you will change causes a **green check mark** to appear. Click the ***check mark*** or ***X*** to toggle from one to the other. Click ***Next*** when you are done.



3. At the prompt, enter the **new orifice plate size**.

   In the **New Value** field,

   <u>either</u>

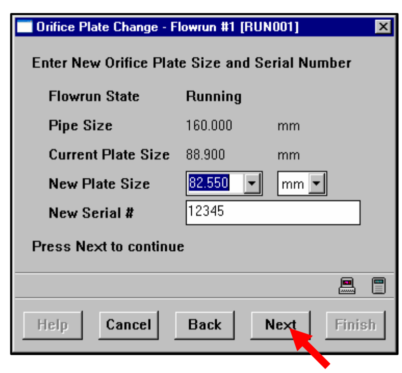
   enter the new orifice plate size

   <u>or</u>,

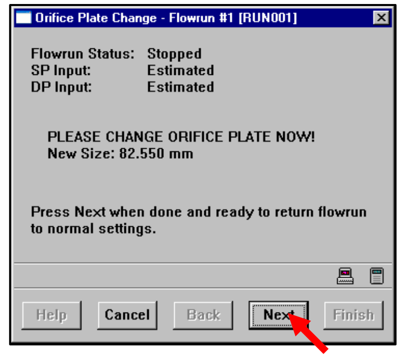
   select the size of the new orifice plate from the drop-down list.

   The serial number of the new plate may be entered in the space provided.

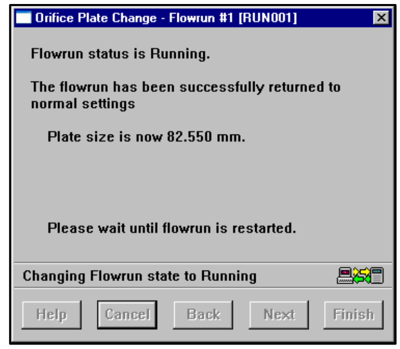
   Click ***Next*** to continue.



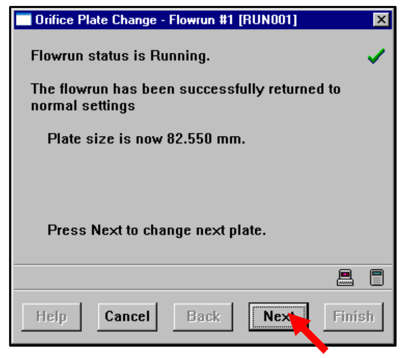
4. The flowrun is then stopped and you are prompted to install the new plate.
   After the **plate** has been **changed**, click ***Next*** to continue.



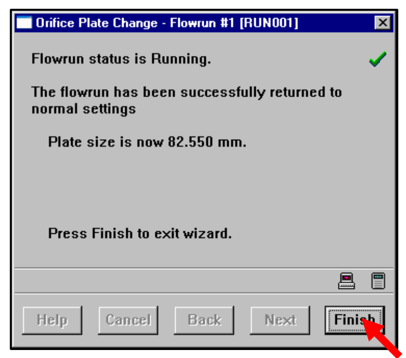
5. After the new plate size is uploaded to the Scanner, you are prompted to wait until the flowrun is restarted.



6. If you are changing plates in more than one flowrun, the following window is displayed prompting you to click on the ***Next*** button to select the next flowrun.
   You will then repeat **Steps 3** to 5 for the new flowrun.



7. After the last plate has been changed, the following window is displayed.
   Click ***Finish*** to return to ScanWin LITE.



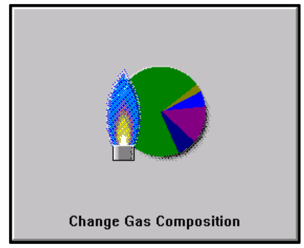
Change Gas Composition

ScanWin LITE provides a wizard that allows you to easily change the gas composition for any flowrun.

The runs affected are switched offline during the gas composition change. Provided the estimation feature has been enabled (via the **Flowrun Setup** wizard (**page 45**)), flow will be estimated for the period the flowruns are offline. The flowrun status is always changed to ***Running*** upon completion of the Gas Data Change routine regardless of its previous status.

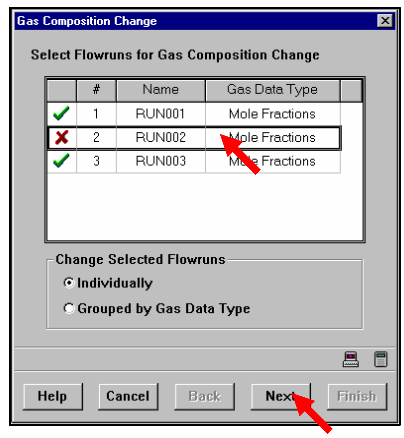
To change the gas composition:

1. Choose the ***Change Gas Composition*** icon (or ***Change Gas Composition*** in the Main Menu) as described on **page 54**.



2. The first **Gas Composition Change** window is shown.

   Select the flowruns you want to change. By default, all the flowruns will start with a **red X**. Click on the lines containing the flowruns you want to change. A **green check mark** will appear to indicate that the gas composition of those flowruns will be changed.



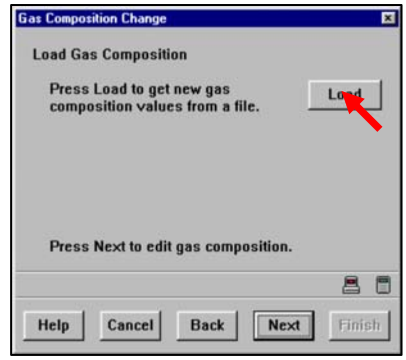
3. Select the method for changing the gas composition for Scanners with multiple flowruns and the same gas data type, specifically:

Click this…	To…
Individually	Set a different gas composition for each flowrun.
Grouped by Gas Type	Set the same gas composition in all flowruns with the same gas data type.

   Click ***Next*** to continue.

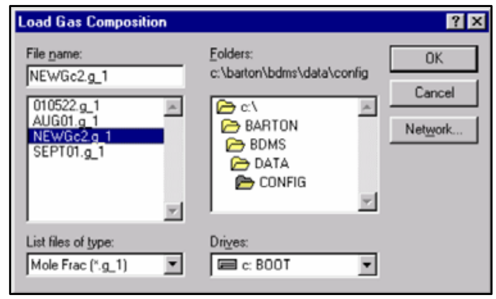
4. The following dialog box is displayed.

   To edit the present gas composition, click ***Next*** and go to **Step 6**. To get the gas composition values from a file, click ***Load***.



   This dialog box is shown.

   Locate the gas composition file you want and select the file. Click ***OK***.



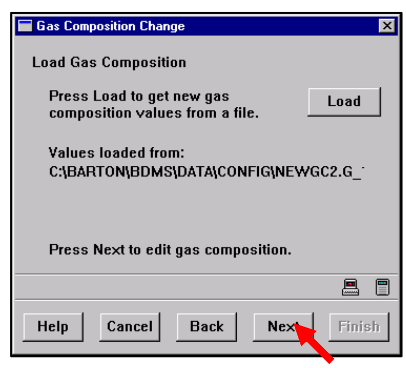
Note: Gas Composition files have a **.g_#** extension where "#" depends on the Gas Data Type chosen in the **Flowrun Setup**. These gas data types will produce the following extensions (g_#):

Manual	**(.g_0)**	Mole Fractions	**(.g_1)**
GCN	**(.g_2)**	GHC	**(.g_4)**
GHN	**(.g_6)**	Pc, Tc	**(.g_7)**
Extended Mole Fractions	**(.g_8)**		

Gas Composition files are stored in the **Barton\BDMS\Data\Config\Gascomps** directory on the drive on which ScanWin is installed (drive C is the default).

5. ScanWin LITE informs you that the values from the file have been loaded.

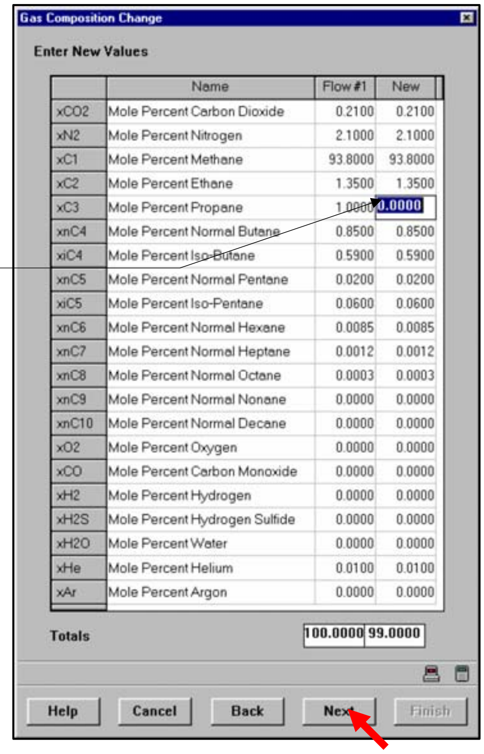
   Click ***Next*** to continue.



6. The following dialog box is displayed.

   In the ***New*** column, enter the new values. The total value must be 100. The Scanner calculation internally rationalizes any compositions that do not equal 100.

   Click ***Next*** to continue.

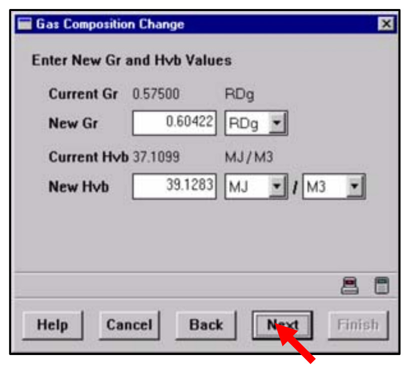


*Enter the new values in the **New** Column*

Note: If the total does not add up to 100 or 1.0, ScanWin LITE displays an error message. You must confirm that the desired total does not equal 100 or 1.0.

7. Go to **Step 8** unless **Gr** and **Hvb** were assigned as ***ENTERED*** in the Configuration page of the **Flowrun Setup**, **page 45**. The following display will prompt you to enter the new values for Specific Gravity (Gr) and Heating Value (Hvb).

   Enter the new values. Click the ***Next*** button when you are done.

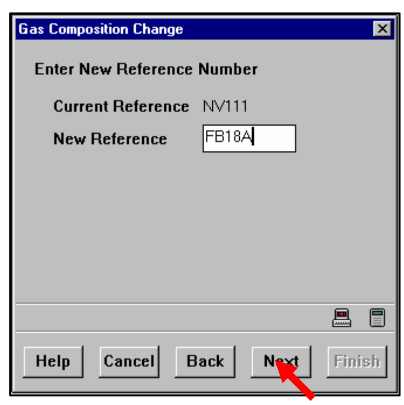


This dialog is ***ONLY*** displayed if Gr and Hvb were assigned as ***ENTERED*** in the Flowrun Setup.

8. The following dialog box is then displayed.

   In the ***New Reference*** field, enter a reference number for the new gas composition. You can also leave this field blank.

   Click ***Next*** to continue.

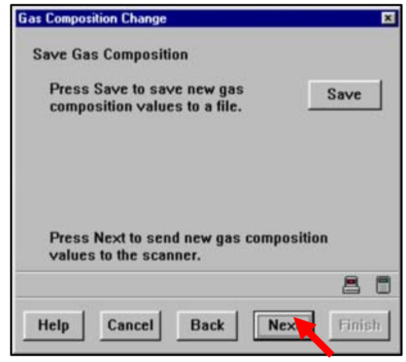


The following dialog box is shown.

Click ***Next*** to send the new gas composition to the Scanner.

Go to **Step 12** if you are changing only one gas composition.

Go to **Step 11** if you are changing the gas compositions of multiple flowruns (**Step 2**).



If you want to save the new gas composition to a file click the ***Save*** button.

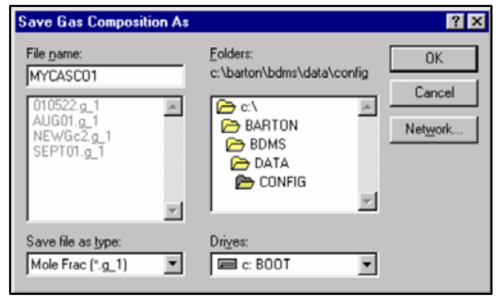
This dialog box is displayed:

In ***Folders***, select the folder to which you want to save the gas composition.

In ***File name***, enter a name for the new gas composition.

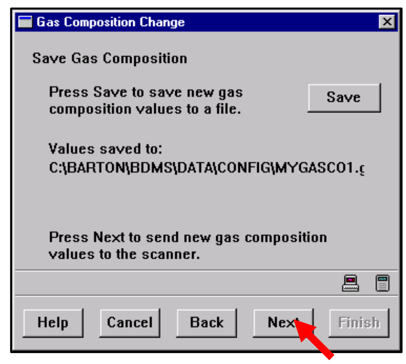
From the ***Save file as type*** drop down list, select the gas data type.

Click ***OK*** and you will be informed that the file has been saved.



9. This dialog confirms the saving of your new gas composition file.

   You will be taken to **Step 12** if this is the only flowrun you are editing or it is the last one in a series of flowrun changes.

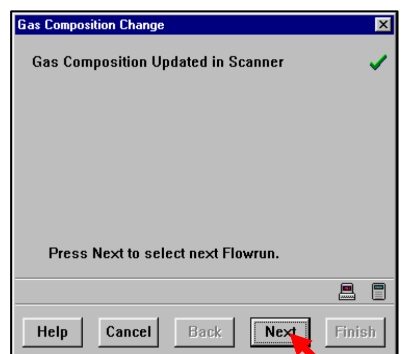


10. If you are performing multiple gas composition changes, the following message prompting you to select a new flowrun is shown.

    Click ***Next*** to change the gas composition of another flowrun.

11. Repeat **Steps 4** - 10 to change the gas composition for each of the flowruns you selected.

12. Click ***Finish*** after the last change has been made.



Calibrate/Verify Devices

ScanWin LITE provides wizards that lead you through the steps to calibrate or verify transmitter and transducer inputs. The calibration options allow you to set the number of calibration points and the sequence in which you execute this function.

Note: Calibration report files are stored in the **barton\bdms\data\reports\calibr** directory on the drive where ScanWin LITE was installed (Drive **C**, by default).

These files are denoted with a "**.cbr**" extension. When opened with a text editor, such as Notepad, they look like the example in the **Sample Calibration Report** (**page 78**) section.

Note: The flowrun history, during a calibration, can be configured to default to a set value or be stopped. Setting this up can be done by accessing **ScanWin Settings** (***Options*** > ***ScanWin Settings*** > ***General*** > ***Wizards***). Refer to **Quick Start Settings (page 38)**.

The types of input devices that can be calibrated are:

Analog Input Calibration, **page 59** (1-5V or 4-20 mA with optional load resistors)

- Static Pressure
- Temperature
- Specific Gravity
- Heating Value

Analog Differential Pressure Input Calibration, **page 65** (zero and span compensation based on static pressure)

- Differential Pressure

RTD Temperature Input Calibration, **page 69** (100 ohm 0.00385 or 0.003902 Ω/Ω°C curve probe)

- Temperature

Barton DPE Cell Calibration, **page 71**

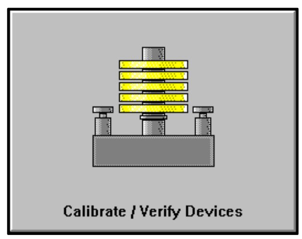
- Static and differential pressure

Linear Pulse Input Calibration, **page 76** (segmented multiple K factors)

- Flow rate

To calibrate an input device, select the **Calibrate Devices** icon or Calibration (Main Menu) as described on **page 41**.

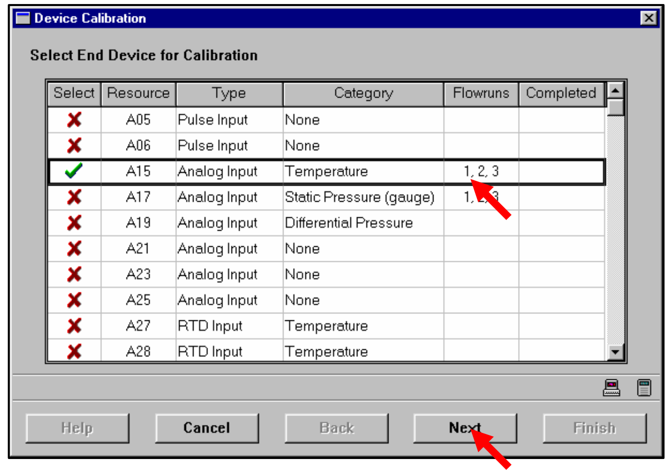
For an **Analog Output Calibration**, see **page 102**.



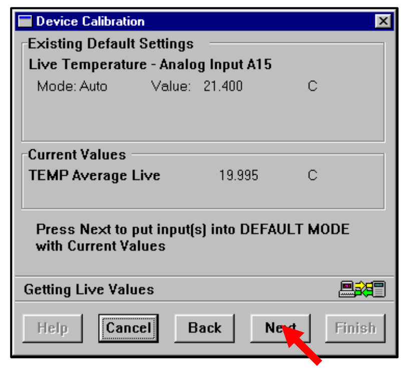
Analog Input Calibration

An analog calibration can be applied to any measured variable that can be assigned to an analog input (e.g. Static Pressure, Temperature, Specific Gravity, %CO_2, etc.).

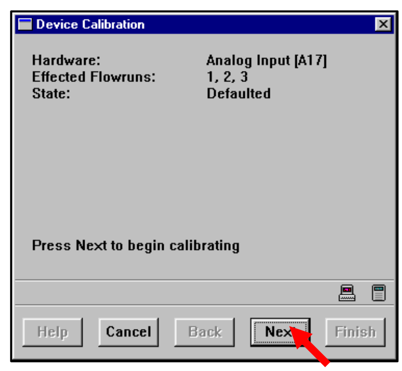
1. Access the calibration wizard as explained on page 41.
2. When the **Select End Device for Calibration** window is displayed, click on the line containing your analog input device. Then click on ***Next***.



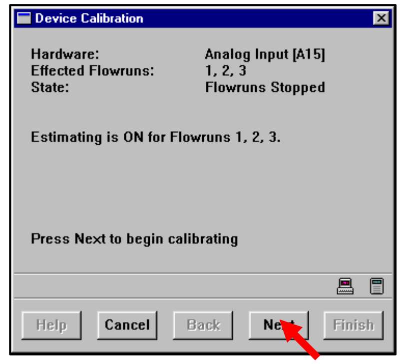
3. ScanWin LITE will inform you of the existing current and default values for the resource. The default value will be used to estimate the flowrun while the calibration is being performed.



4. A page summarizing the resource chosen, the affected flowrun(s) and their state(s) is displayed.

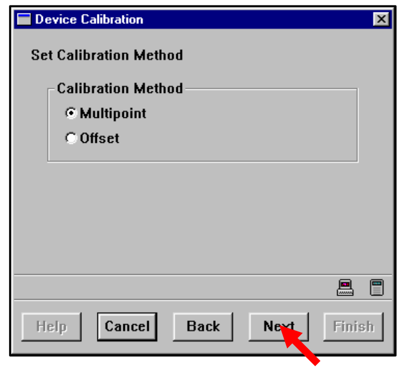


If you have configured the ScanWin settings to stop the flowruns during a calibration, this summary page will be displayed.

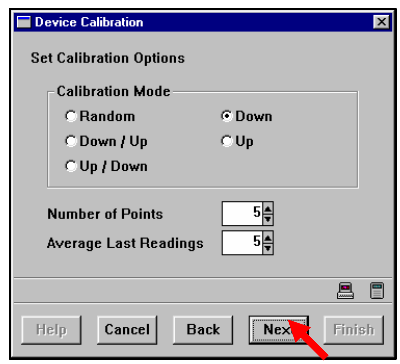


Click ***Next*** when you are ready to continue.

5. A dialog asking you to choose the calibration method is displayed. After making your choice, click on the ***Next*** button.
For an **Offset** calibration, refer to **Offset Method, page 64**.

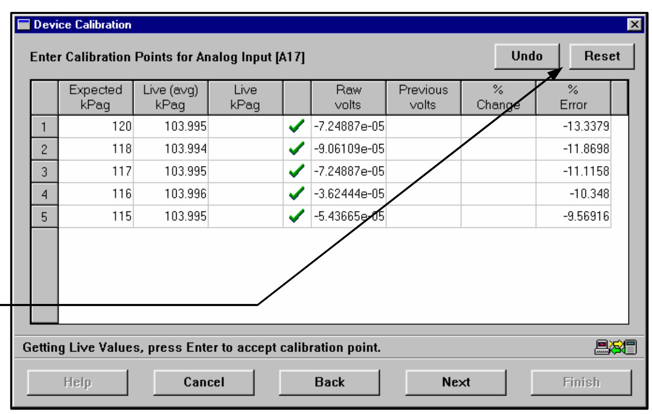


6. Choose the kind of calibration you wish to perform, the number of points you want to include, and how many readings you want to average for each point.
Click the ***Next*** button when you are ready to continue.



This window allows you to enter your calibration values.
Enter the Expected value for the first calibration point. Then press the **Enter** or **Return** key on your keyboard.

Undo allows you redo your current line and ***Reset*** clears all the new values and replaces them with your original ones.



The cursor will go to the check column (4th column). Press the **Enter** or **Return** key on your keyboard to accept the point. A check mark will appear for that point and the cursor will go to the next point.

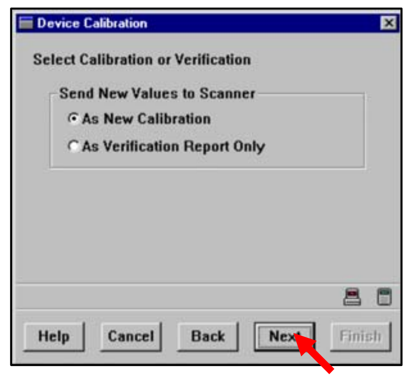
Calibration and Verification Notes

a.	Enter the value of the point to be calibrated / verified in the ***Expected*** column, the units of measurement are shown in brackets, e.g. kPa. If a calibration has been performed in the past, the values from the previous calibration are displayed.
b.	The **Live Value** is the live value of the transmitter, in the same units as expected value, will be displayed in the column to the right of Expected. This value is updated every 1 to 2 seconds.
c.	**Live (avg)** shows the average of the last user selected number of readings
d.	After the **Expected Value** is input and the ***Enter*** key is pressed, the cursor will go to the check column (4th column). When the Average value is satisfactory, you press ***Enter*** to accept the point. A check mark will appear for that point and the cursor will go to the next point.
e.	The raw value is averaged value in raw units read by the measurement RTU, volts for analog inputs or ohms for RTD inputs.
f.	The **Previous Raw** value is the Raw value from the previous calibration.
g.	**% Change** is the percent difference between the **Raw** and **Previous Raw** values.
h.	**% Error** is the percent difference between **Expected** and **Averaged Value**.
i.	If the expected values are different from the previous calibration or this is the first calibration, the % change cannot be calculated.

When all the points have check marks, click ***Next***.

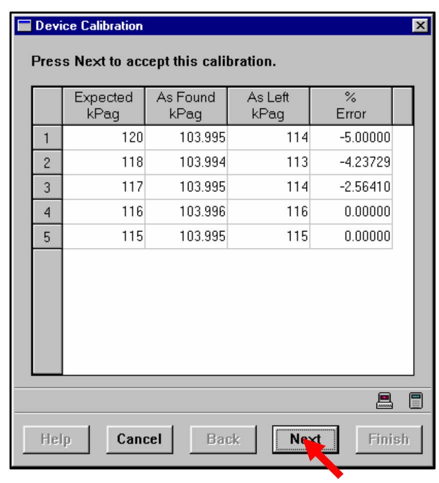
7. You are then prompted to send these calibration values to the Scanner. Alternatively, you may choose to obtain a Verification Report, in which case, you will be taken to Step 1 of the **Common Calibration Procedures – page 62**.

   Click ***Next***.



8. If you have chosen to save these values "As New Calibration," ScanWin LITE prompts you to accept your calibration values.

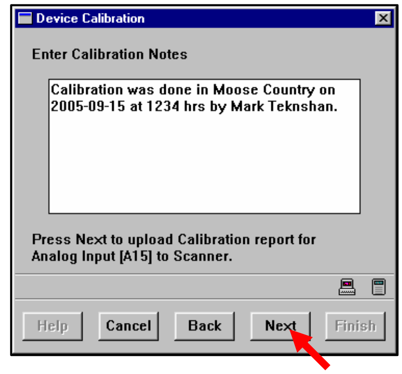
   Click ***Next*** to accept the calibration values displayed. If they are not acceptable, click the ***Cancel*** button to start a new calibration.



Common Calibration Procedures

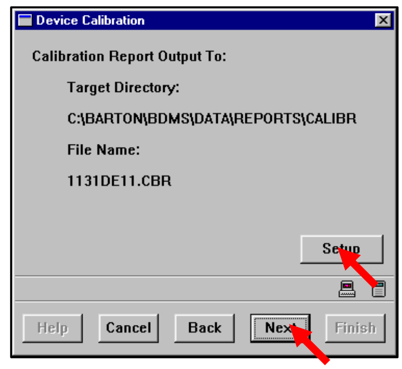
1. You are then prompted to enter notes about the calibration. This includes information such as general observations, model and serial number of the calibration equipment. Up to 127 characters may be entered. These notes become part of the Calibration Report.

   Click ***Next*** when you are done.



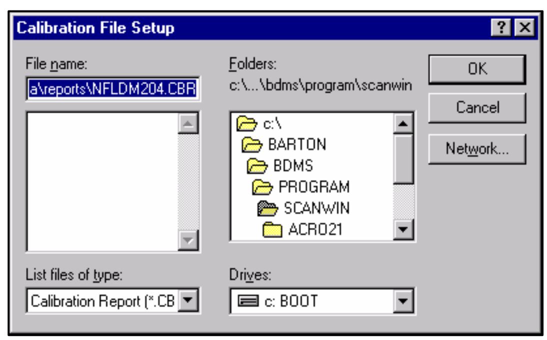
2. You are then prompted to select a destination for the calibration file. By default, ScanWin will send the report to Drive A with the name XXXXXXyy.cbr where XXXXXX is the first 6 letters of the Node name and yy is a generated incremental number. If you agree with the name of the file and its destination, click ***Next*** and go to **Step 4**.

   Click the ***Setup*** button if you do not wish to have the file saved in the target directory, or wish to change the filename.



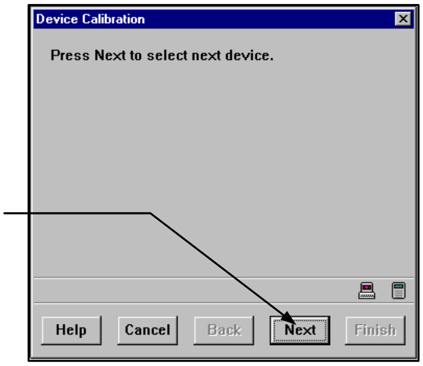
A dialog like the following appears allowing you to change either the filename or the destination.

Click ***OK*** when you are done, or ***Cancel*** if you do not want to change anything. You will then be taken back to the previous dialog.

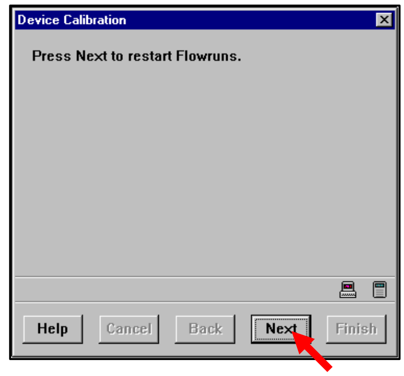


3. You are then prompted to either
   Press ***Next*** to select another device for calibration

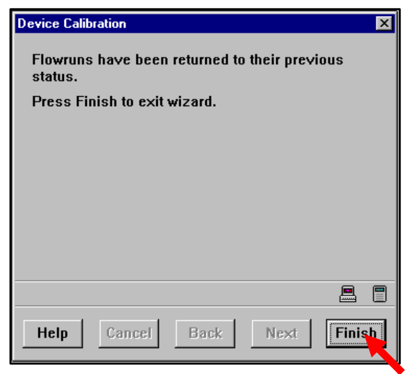
   > If more than one flowrun was selected in **Step 2** of the **Analog Input Calibration** section, then clicking on ***Next*** takes you back to **Step 3** of that section.



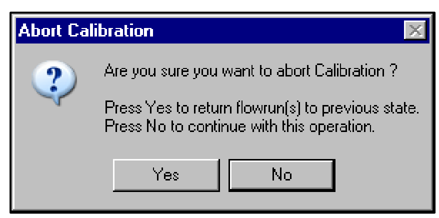
   OR
   Press ***Next*** to restart the flowrun(s).



4. After the flowruns have been restarted, you are prompted to complete the process.
   Click ***Finish***.



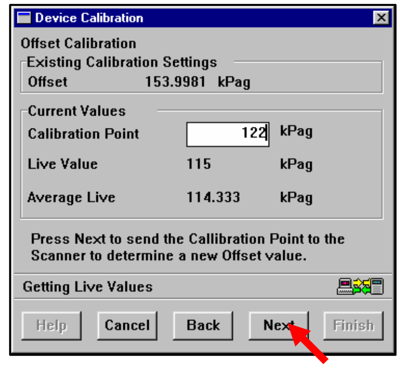
5. If ***Cancel*** is selected at any time during the Calibration process, the **Abort Calibration** dialog is displayed.



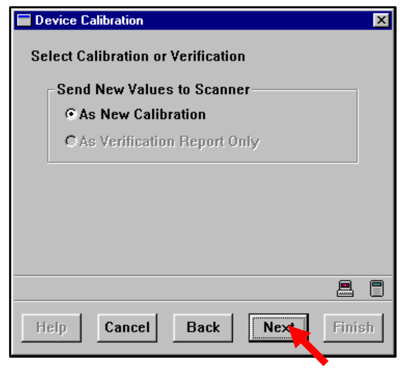
Offset Method

When you choose the Offset calibration method for an analog input, the following dialogs will be displayed:

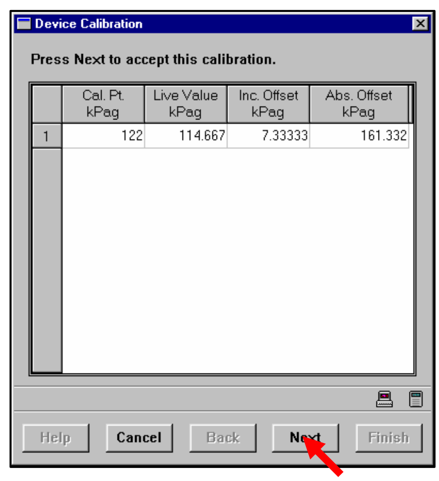
1. You are shown the existing calibration settings.
   Enter your new calibration point in the box.
   Click the ***Next*** button.



2. You are asked to confirm this value as a new calibration.
   Click the ***Next*** button.

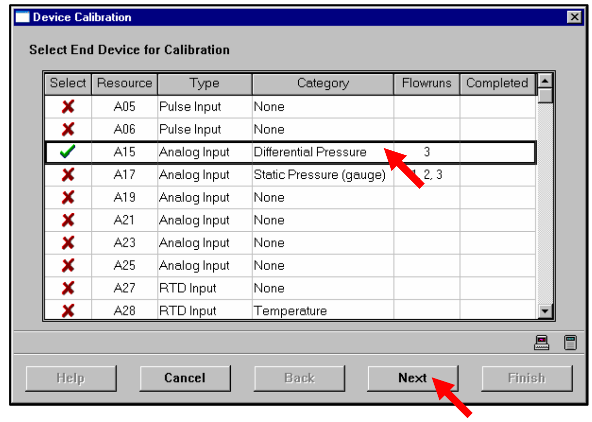


3. ScanWin LITE asks you to confirm you value as the new calibration.
   If you agree with the calibration, click ***Next*** and you will be taken back to the **Calibration and Verification Notes**, **(page 61)** section to finish the procedure.
   If you disagree with the calibration, click Cancel to start a new calibration.

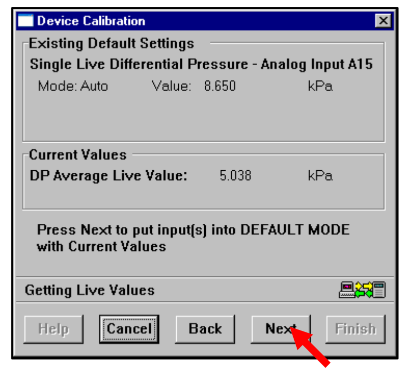


Analog Differential Pressure Input Calibration

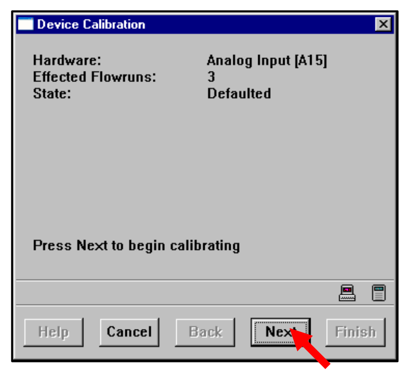
1. Select **Calibration** as described on **page 41**.
2. When the **Select End Device for Calibration** window appears, select ***Differential Pressure*** to calibrate the differential pressure. A **green** check mark will appear in the Select column. Click ***Next***.



3. If you have selected to keep the flowrun running during the calibration, ScanWin LITE will display this dialog summarizing the default settings of the flowrun.



4. A dialog summarizing your settings will then be displayed. This one shows that you are will be using your default settings.

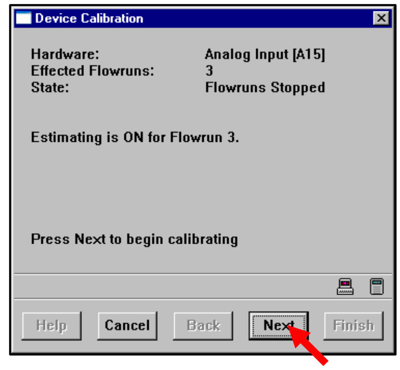


<u>Or</u>

If you chose to stop the flowruns while calibrating the device, ScanWin LITE will display this dialog informing you that the flowruns have been stopped. The dialog also advises if an estimation will be done while the flowrun is stopped.

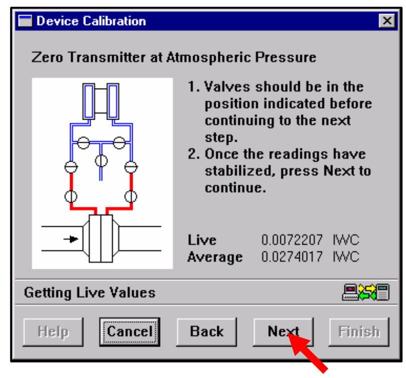
Click ***Next***.

Note: Estimating will occur only if the previous state was set to ***Running***.



5. The transmitter must now be zeroed at atmospheric pressure. ScanWin LITE displays a schematic indicating the valve configuration required to equalize the pressure on the differential pressure transmitter and vent it to atmosphere.

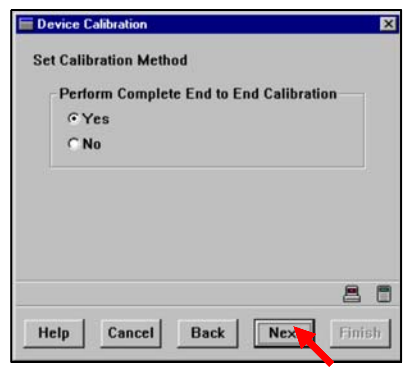
   When this instruction has been carried out, click ***Next***.



6. You are then asked whether to perform an **End to End Calibration**.

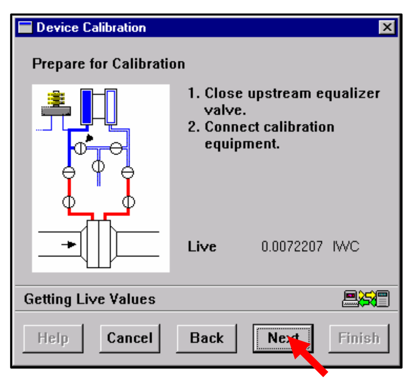
   If you choose ***not*** to perform an **End to End Calibration**, proceed to **Step 9**. Click the ***Next*** button to continue.

End to End Calibration is possible only on **released** versions of ***IGas, NGas*** and ***NFlo 4.0.1 and above***.

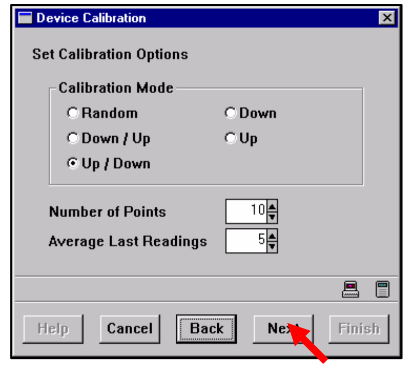


7. A dialog prompts you to prepare for the **End to End Calibration** by closing the high-pressure equalizer valve as shown.

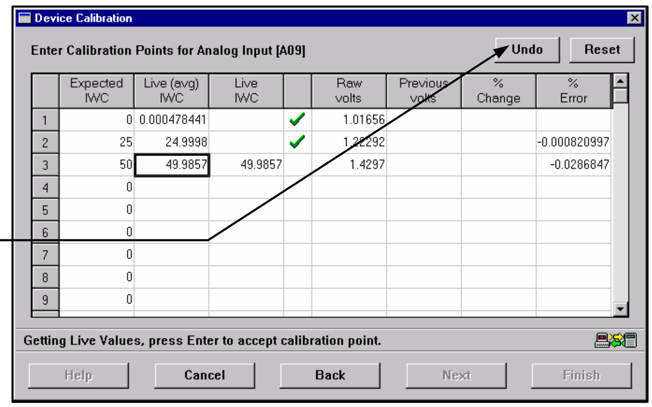
   When instructions have been performed, click ***Next***.



8. ScanWin LITE displays a dialog to **Set Calibration Options.** Choose a calibration mode and click ***Next***.



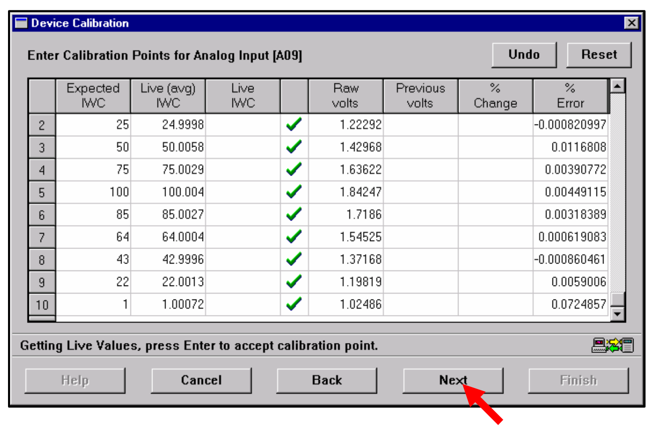
9. ScanWin LITE displays the Enter Calibration Points for Analog Input dialog:



Undo allows you redo your current line and ***Reset*** clears all the new values and replaces them with your original ones.

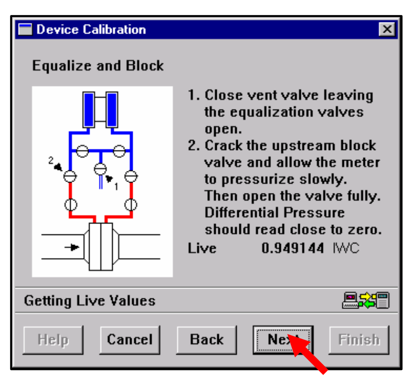
Enter the Expected value for each calibration point, then press the **Enter** or **Return** key on your keyboard. The cursor will go to the check column (4th column). Press ***Enter*** to accept the point. A checkmark will appear for that point and the cursor will go to the next point. Refer to the Calibration and Verification Notes (page 61).

Click on the ***Next*** button when you are done.

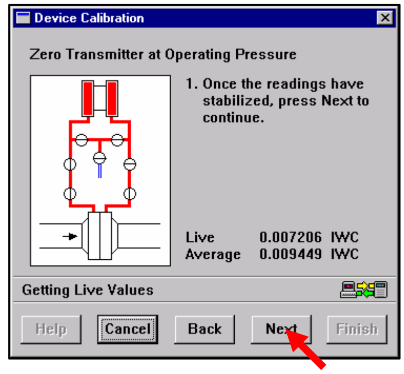


10. ScanWin LITE displays schematics prompting you to close the vent valve and equalize pressure between the high side and the low side of the transmitter.

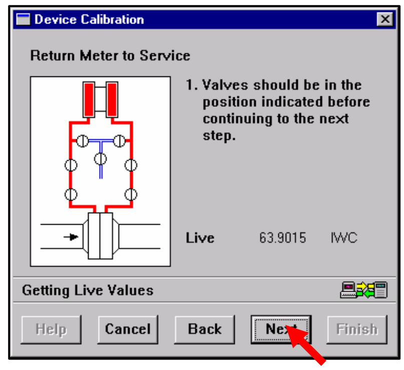
You are also directed to zero the differential pressure transmitter /transducer at operating pressure. (Note that a **block** valve is the same as an isolation valve). When these instructions have been carried out, click ***Next***.



11. You are then asked to **zero** the transmitter.
    When you are ready, click ***Next***.

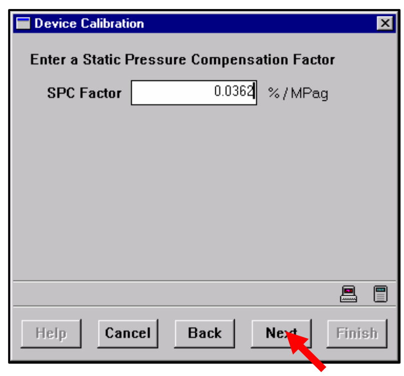


12. ScanWin LITE then instructs you to return the meter (transmitter) to service:
    Click ***Next*** when you have performed these steps.



13. ScanWin LITE displays a window asking you to enter the static pressure span correction (SPC) factor.
    Click ***Next***.

Use a value of 0 for no correction.
A typical value would be ~ 0.03 %/Mpag.

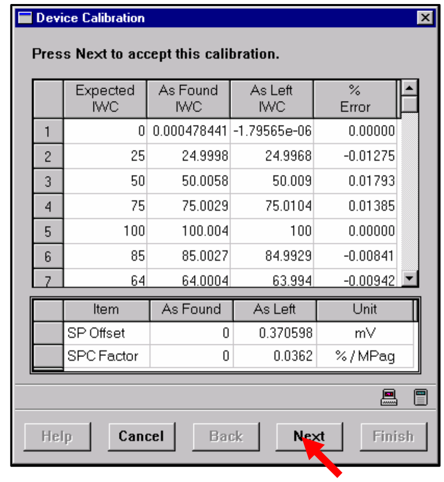


14. ScanWin LITE displays a window asking whether you want to update the Scanner with the new calibration values or save the verification report.
    Click ***Next***.

15. If **New Calibration** is selected the ***As Left*** values will be displayed. Current method is to send the calibration to the Scanner Measurement RTU to calculate the ***As Left*** values. ScanWin LITE then retrieves the ***As Left*** values for display.

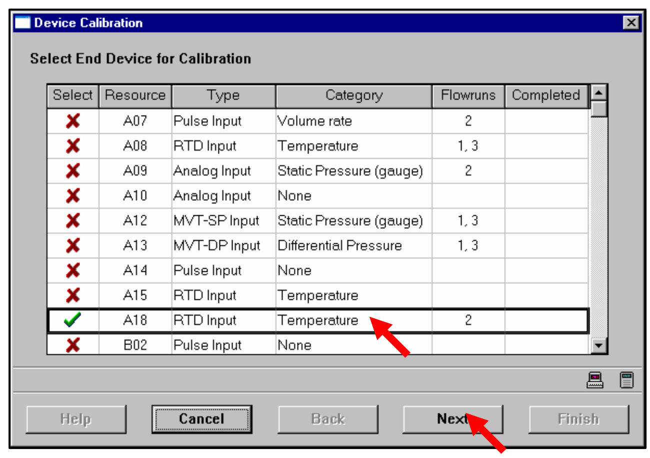
    Click ***Next***.

16. ScanWin LITE then takes you through a set of Common Calibration Procedures **(page 62)** that enable you to enter Calibration Notes or to save a Calibration Report and give you the option of calibrating another device or ending the process.



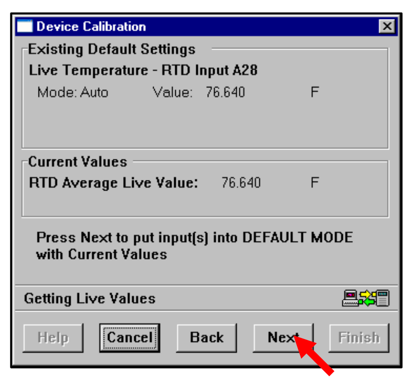
RTD Temperature Input Calibration

1. Select **Calibration** as described on **page 41**. Click ***Calibrate Devices*** to select the device to calibrate.
2. Select **RTD Input Type** for the desired flowrun to calibrate the temperature. Click ***Next***.



3. If you have chosen to keep the flowruns running and use default values for live inputs in the flowrun history (see note on **page 58**), this dialog will be displayed

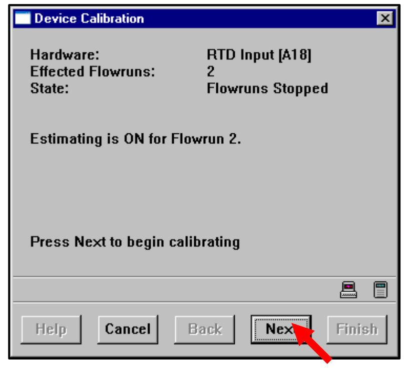
   Click ***Next*** to go on.



4. Depending on how your flowrun configurations are set up for estimation, ScanWin LITE will shut down the calculations for the flowruns and display a dialog informing you that estimation is **ON** or **OFF**. If estimation is ON (see **Flowrun Setup**), the Scanner will estimate the inputs and totals during the calibration/verification.

   If you are using live default values, it will inform you that the state is **defaulted**.

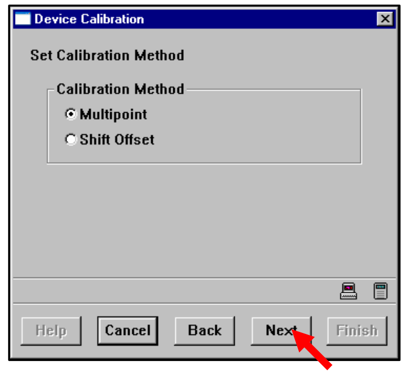
   Click ***Next***.



5. You are given a choice of calibration methods.

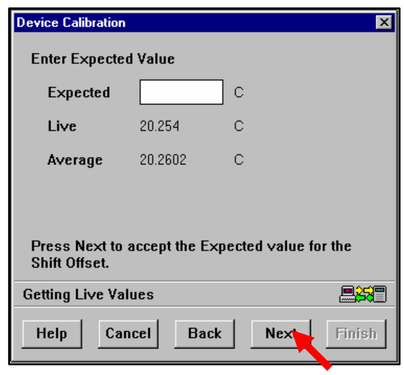
   Choosing to do a Multipoint calibration will take you through steps similar to that of an **Analog Input Calibration, page 59**.

   Click ***Next***.



6. If ***Shift Offset*** is chosen as the Calibration method, you are then prompted to enter a reference temperature. Note that a typical Shift calibration would use an ice bath at 0°C (32°F).

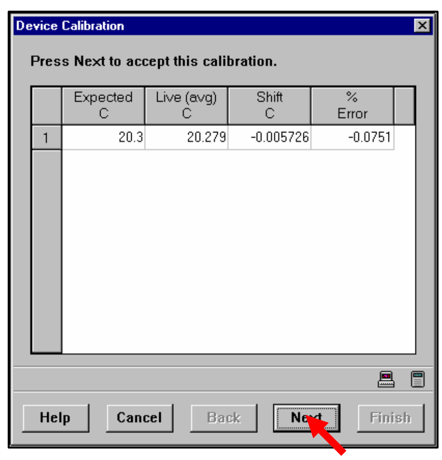
   Click ***Next***.



7. ScanWin LITE then prompts you to accept the calibration values.

   Click ***Next***

8. ScanWin LITE then takes you through a set of Common Calibration Procedures **(page 62)** that enable you to enter Calibration Notes, save a Calibration Report, calibrate another device, or end the process.

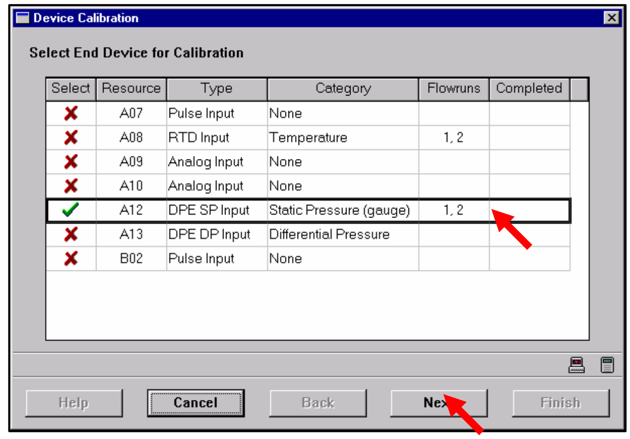


Barton DPE Cell Calibration

DPE Static Pressure

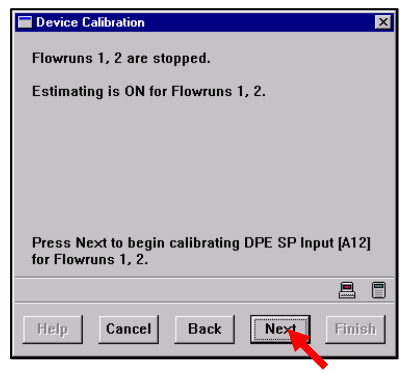
1. Start the ScanWin LITE Calibration wizard as described on **page 41**.
2. At the **Select End Device for Calibration** window, click on the DPE SP Input line so that a ***green check mark*** is displayed.

   Click ***Next***.



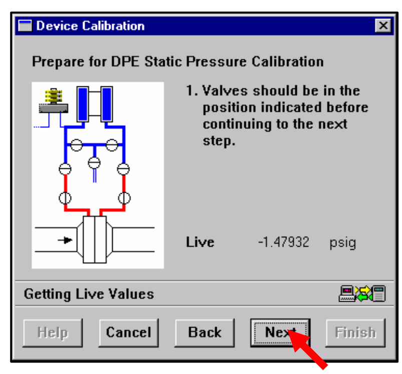
3. ScanWin LITE informs you that it is stopping the flowrun(s) and tells you when it is done.

   Click ***Next***.

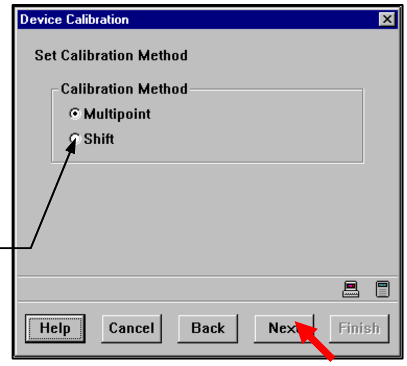


4. Then you are instructed to position the valves as shown in the following diagram.

   Click ***Next***.

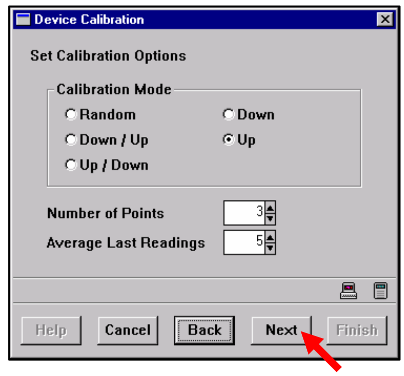


5. You are given the option of doing a **Multipoint** calibration, which is like an analog calibration or a **Shift** calibration, which allows you to calibrate at a single point and offset the static pressure curves.
   Click ***Next*** to continue.

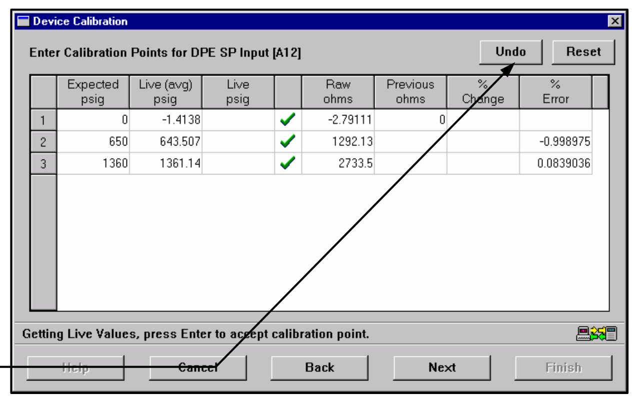


If you choose to do a **Shift** Calibration, go to **Step 11**.

6. A window allowing you to set the type of calibration is shown. Click the ***Next*** button after you have made your choices.

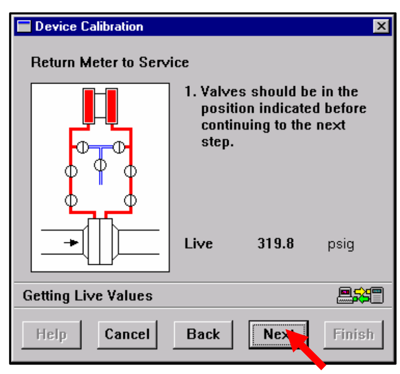


7. ScanWin LITE displays a window that enables you to enter the calibration points. A 5-point random calibration is shown as an example:
   See the Calibration and Verification Notes section (page 61).
   When all your points have been entered and have check marks, click the ***Next*** button.

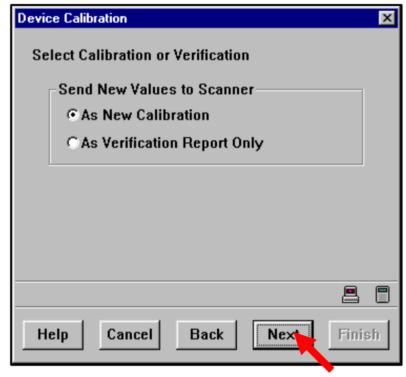


Undo allows you redo your current line and ***Reset*** clears all the new values and replaces them with your original ones.

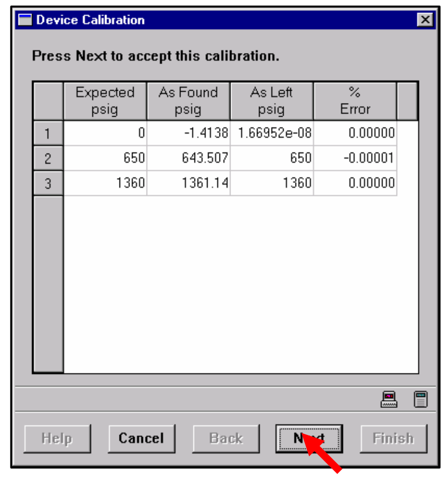
8. You are instructed to return the valves to the positions as shown in the diagram.
   Click ***Next***.



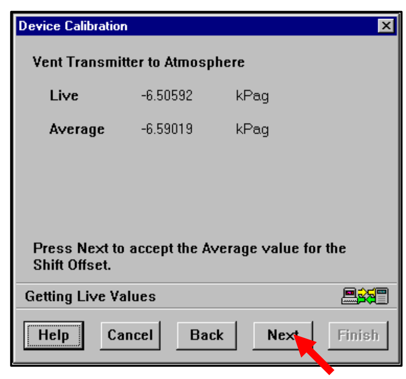
9. You are then prompted to accept the new calibration values.
   Click ***Next***.



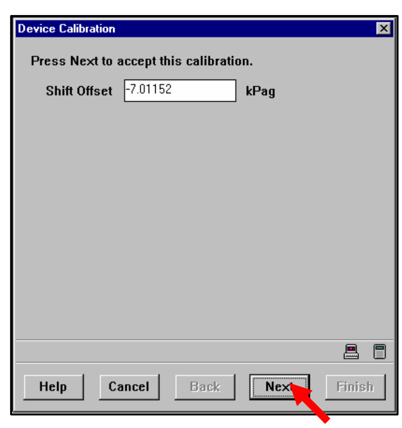
10. The new calibration values are then displayed for your acceptance. Click ***Next*** to accept these and go to **Step 14** or ***Cancel*** to end the calibration wizard.



11. If you have chosen to do a <u>**Shift**</u> calibration, the following dialog is presented.
    When you have carried out the instruction, click on the ***Next*** button.
12. You will then be prompted to **Return Meter to Service** (see **Step 8** dialog).

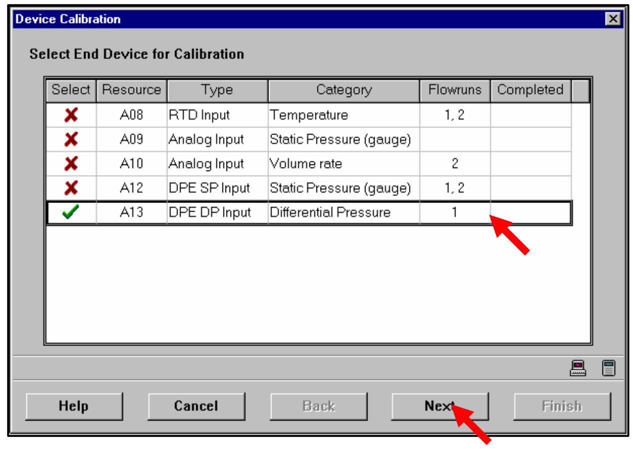


13. Next, you are asked to accept the calibration.
    Click the ***Next*** button.
14. ScanWin LITE then takes you through a set of Common Calibration Procedures **(page 62)** that enable you to enter Calibration Notes, save a Calibration Report, calibrate another device, or end the process.

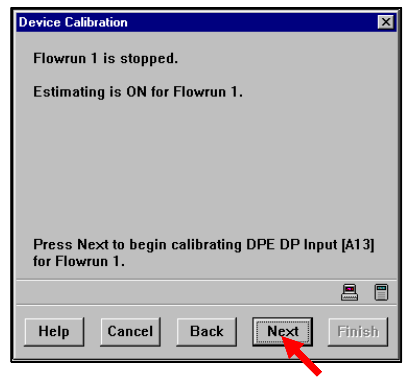


DPE Differential Pressure

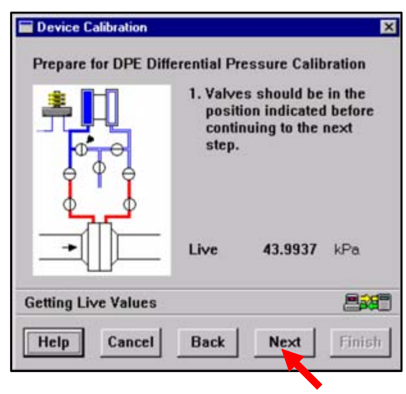
1. Begin the calibration process as explained on **page 41**.
2. At the **Select End Devices for Calibration** window, select the DPE DP input line. When the **green** check mark appears, click on the ***Next*** button.



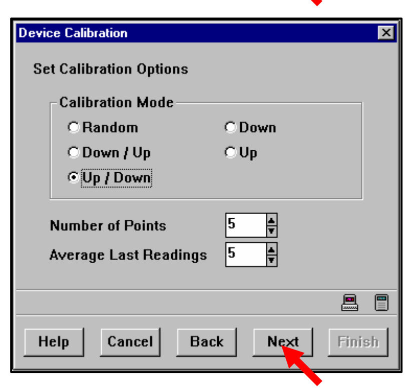
3. In preparation for the calibration, ScanWin LITE stops the flowrun and turns on estimation (if this was chosen in the setup).
   Click ***Next***.



4. You are prompted to set the valves in the indicated positions.
   Click the ***Next*** button when you are ready.



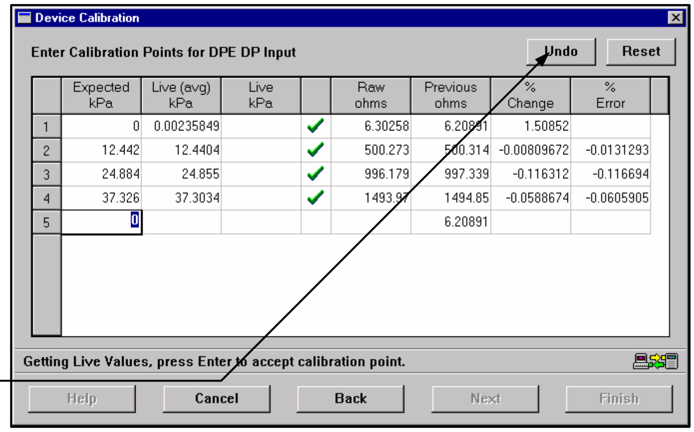
5. The next window prompts you to set the options relating to the calibration you are about to perform:
   Click the ***Next*** button when you are finished.



6. Enter your calibration points and press the Eenter key.

   For an explanation of the table, see the Calibration and Verification Notes section **(page 61)**.

   When all your points have been entered and have check marks, click the *Next* button.



Undo allows you redo your current line and ***Reset*** clears all the new values and replaces them with your original ones.

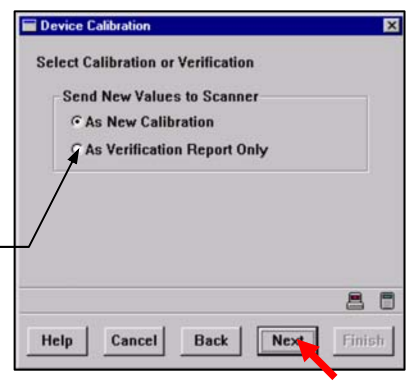
7. You are then prompted to set the valves in the indicated position to return the meter to a functional state.

   Click the ***Next*** button when you have done so.

8. You are then asked to specify whether the new values are to be used as a new calibration or for a verification report.

   Select the appropriate radio button and click ***Next***.

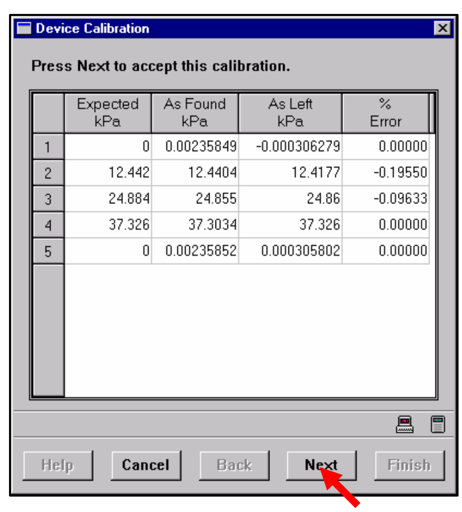
If you are doing a ***Verification Report***, go to Step 10 below. Note that you will be asked to make ***Verification*** notes instead of *Calibration* notes.



9. If you choose to accept the values as a new calibration, a summary of the calibration is then presented.

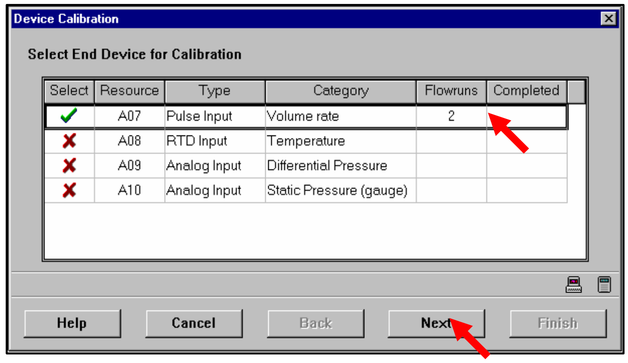
   If the values are acceptable, click the ***Next*** button. To reject them, click***Cancel***.

10. ScanWin LITE then takes you through a set of Common Calibration Procedures **(page 62)** that enable you to enter Calibration Notes, save a Calibration Report, calibrate another device, or end the process.

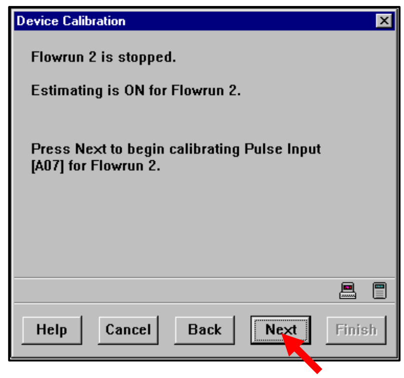


Linear Pulse Input Calibration

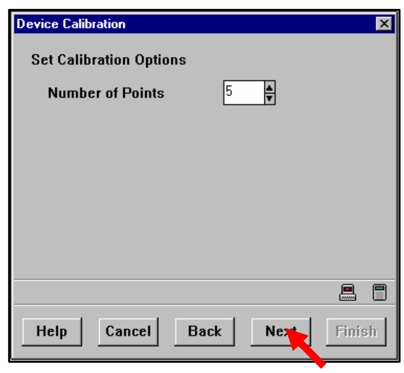
1. Begin the calibration function as explained on **page 41**.
2. At the **Select End Devices to Calibrate**, select the line containing your Pulse Input device.
   When the **green** check mark appears, click ***Next***.



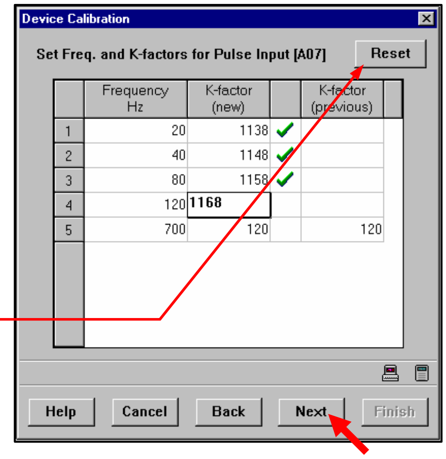
3. ScanWin LITE shuts down the calculations for the flowrun and displays a dialog box informing you of the shutdown.
   Click ***Next***.



4. You are then asked to enter the number of calibration points:
   Click ***Next***.



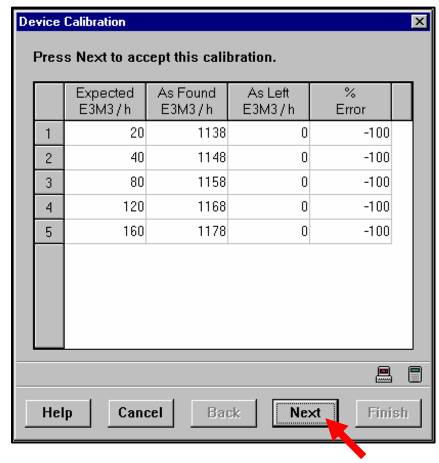
5. Enter a **K-factor** for each calibration point.
   Click ***Next*** when you are finished.



> ***Note***: Press ***Enter*** after each KFactor. A ***check*** appears in the cell.

> The ***Reset*** button restores all the settings to their previous values.

6. You are then presented with a summary of the calibration.
   Click ***Next*** to accept these values.



7. ScanWin LITE then guides you through a set of Common Calibration Procedures **(page 62)** that enable you to enter Calibration Notes, save a Calibration Report, calibrate another device, or end the process.

Calibrating an Analog Output Device

See Chapter 4 for an **Analog Output calibration (page 102).**

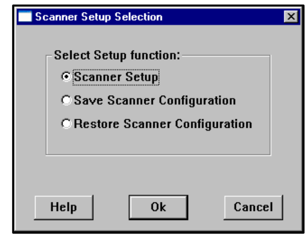
Sample Calibration Report

```
Scanner 1100 Analog Input Multi-point Calibration Report

This input has been assigned to:
Node : 40DEMO, Flowrun #01 (RUN001)
Channel location : Node 40DEMO, Slot A, Resource #09
Channel category : Static Pressure (gauge)
User Text        : Calibration was done in Moose Country on April 1, 2002 by Mark Teknshan
User Change Number    : 442 - 443
Transmitter zero      :      0.000 psig
Transmitter fullscale :   1000.000 psig
Number of calibration points : 5 (Down)


   Calibration Point      As Found            As Left            Raw Reading
      psig                psig                psig                  Volts
 ---------------------------------------------------------------------------------------

     1000.000           1000.019           1000.000                3.001
      750.000            749.986            750.000                2.501
      500.000            500.038            500.000                2.001
      250.000            250.024            250.000                1.501
        0.000              0.003              0.000                1.001



Effective Date        : 2002-07-19 14:10:15
User Identification   : Manager (via network)
```

Scanner Setup Options

After the user is connected to the Scanner, the Scanner can be configured. ScanWin LITE provides a wizard that helps you to either ***set up*** a Scanner, ***save*** a Scanner configuration (**page 81**), or ***restore*** (**page 83**) a Scanner configuration. If you are connected to a Scanner that has been previously configured, current information is automatically shown.

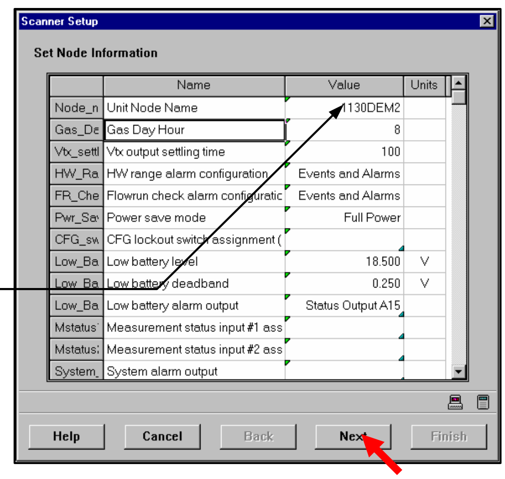
To access the setup options, choose ***Scanner Setup*** from the Setup tab as described on **page 41** **or** select ***Tools*** > ***Scanner Setup*** from the menu bar.



Scanner Setup

To set up a Scanner:

1. Select Scanner Setup and press OK. You are prompted to fill in the Scanner or system information. See Chapter 5 for additional information about **Node Information (page 105)**.



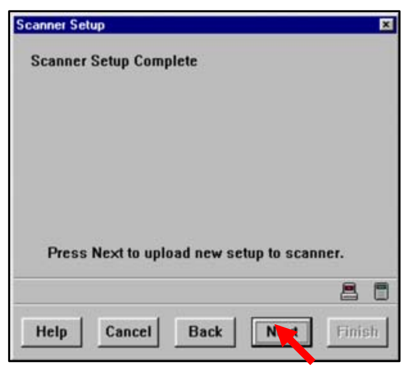
Because the **Configuration** file and **Reports** use the ***first 6 characters*** of the **Node Name**, users should use the ***7th character and up*** to identify the company, site, project, etc.

Use the following table to guide you in the setup of the Scanner:

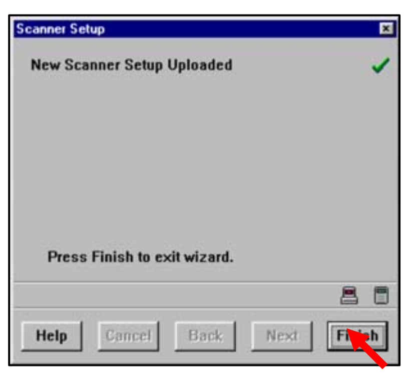
This field…	*Refers to the…*
Unit Node Name	Name of the Scanner (up to 14 characters).
Gas Day Hour	Gas day for reporting volumes; for example, a Gas Day Hour of 8 goes from 8:00 a.m. April 1 to 7:59 a.m. April 2. A value of 0 - 23 may be used. The default is **8**.
Vtx output settling time	Settling time used in the Power Save Mode to establish how long a transmitter takes to send a stable reading after it is turned on. Default is **100 ms**.
HW Range Alarm Configuration	Selection of the handling of hardware range alarms. Options are **Off**, **Show in Event Log**, **Show in Alarms Page** and **Events and Alarms**.
Flowrun Check Alarm Configuration	Selection of the handling of flowrun check alarms. Options are **Off**, **Show in Event Log**, **Show in Alarms Page** and **Events and Alarms**.
Power Save Mode	Use of FULL or LOW battery power (low power save mode used when there is limited power available, e.g. solar power).

This field…	Refers to the…
Power Supply Type[1]	Type of power supply installed. Options are • 12V 30-55 Ahr • 12V 60+ Ahr • 6V 10-20 Ahr • 6V 21+ Ahr • No Battery • Custom
Analog In / RTD Select [A15 – A17][1]	Hardware assignment for resources A15 to A17. Options are ***RTD*** or ***2 Analogs***.
Analog In / RTD Select [A18 – A20][1]	Hardware assignment for resources A18 to A20. Options are ***RTD*** or ***2 Analogs***.
Vtx output override	Vtx (Power to transmitters) is always **ON**, even in Low power.
Local RTC display mode	Real-time Clock displaying the time as AM/PM or ML (24-hour Military Time)
CFG Lockout Switch assignment	Resource that is handling the lock switch.
Low Battery Level	Voltage at which a Low Battery Alarm is triggered. The default on an 1140 flow measurement RTU is 6.1V and 11.5V for an 1130/1131unit. Value is configurable.
Low Battery Deadband	Voltage difference above the Low Battery Level that must be achieved for a Low Battery Alarm to disappear.
Low Battery Alarm Output	Resource to which a Low Battery Alarm is assigned.
Measurement Status Input #1 Assignment	Resource to which a Status Warning input #1 is assigned.
Measurement Status Input #2 Assignment	Resource to which a Status Warning input #2 is assigned
System Alarm Output	Resource to which the System Alarm output is assigned.

2. Click ***Next***. A dialog prompts you to click ***Next*** to upload a new setup.



3. Click ***Finish*** when prompted to do so.



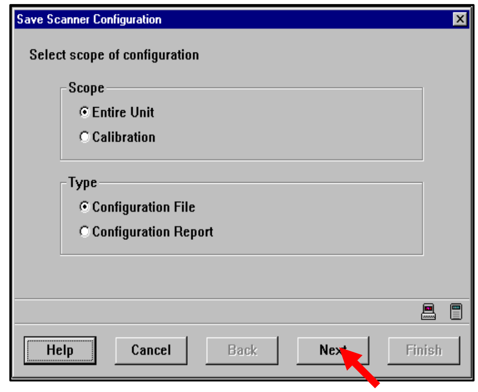
[1] Shaded rows are applicable to the Scanner 1141 only.

Save Scanner Configuration

ScanWin LITE allows you to save the configuration of the entire Scanner. Note that you have to be logged in at the **Manager** level to perform this procedure (see **page 82**).

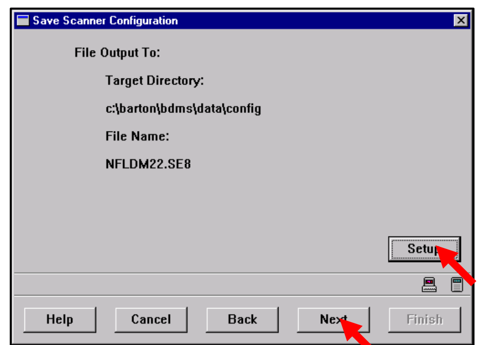
1. Access ***Save Scanner Configuration*** as described on **page 79**.
2. You can save the configuration of the entire unit or save your calibration only. In addition, you may send your configuration to a file or to a report.

   Click ***Next***.



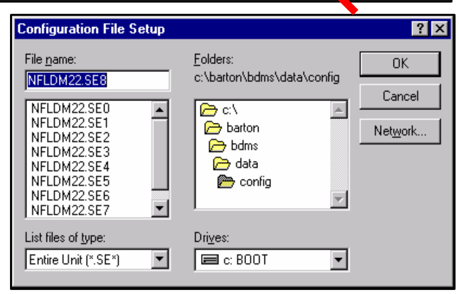
3. ScanWin LITE tells you the name of the new file and where it will be located.

   If this is acceptable, click ***Next*** and go to **Step 5**; if it is not, click ***Setup***.

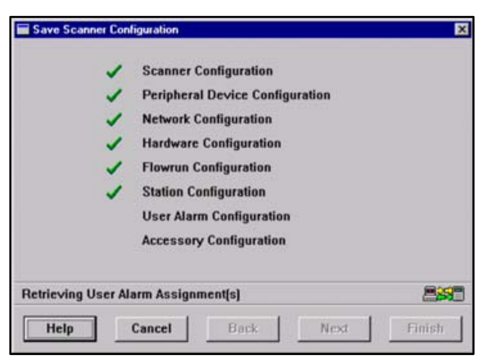


   A window will appear, allowing you to change the location and name of the file (it is recommended that you use the directory **x:\barton\bdms\data\config\scanner** where x is your drive letter).

   Click ***OK*** when you are finished and then ***Next*** at the window with your new filename and its location.

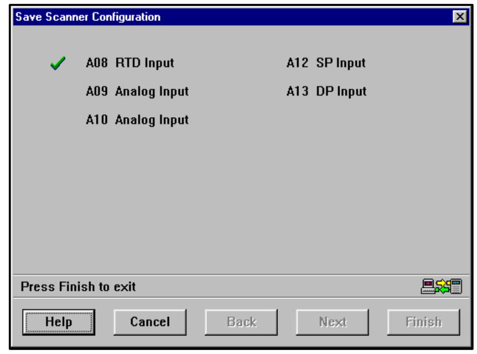


4. You are then shown the progress of the save operation. **Green** check marks will appear as each segment of the unit's configuration is saved.



If you chose to save the configuration of your calibration(s), a screen like the following will appear.

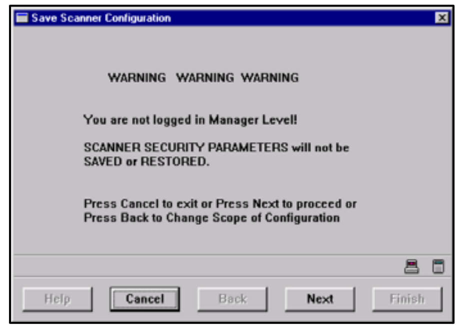
When all is done, click ***Finish*** to end this procedure.



Non-Manager Login Warning

If you are not logged in as a Manager, this message is displayed during the **Save** or **Restore Configuration** procedure.

Clicking ***Next*** allows everything to be saved or restored **EXCEPT** the **Scanner Security Parameters** (User Level and Password).



Files Created When Saving Scanner Configuration

Files created by saving the Scanner configuration are, by default, placed in the **\Barton|BDMS\Data\Config\Scanner** directory on Drive C. The files are named **nnnnnnnn.ext** where **nnnnnnnn** are the first eight characters in the Node Name and **.ext** is the file extension. The file extensions depend on which options were chosen in Step 2 of the previous **Save Scanner Configuration (page 81)** section.

The following table explains the file extensions:

Options Chosen (Scope/Type)	***Extension***[2]	***Description***
Entire Unit/Configuration File	.SE#	Binary file used during restoration
	.TE#	Text version of the binary file; used to verify binary
Calibration/Configuration File	.TC#	Binary file used during restoration
	.TC#	Text version of the calibration binary
Entire Unit/Configuration Report --------*and*-------- Calibration/Configuration Report	.ST#	Formatted text
	.TT#	Unformatted text

[2] "#" denotes an incremental number from 0 to 9

Restore Scanner Configuration

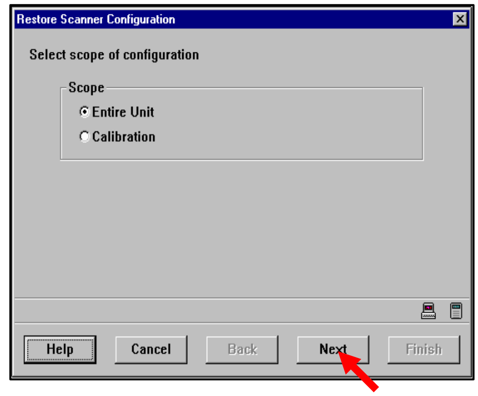
ScanWin LITE allows you to copy a configuration back to a Scanner. Alternatively, you can copy the same configuration to more than one Scanner. Note that you have to be logged in at the **Manager** level to perform this procedure (see **page 82**).

> It is ***STRONGLY*** recommended that you superboot your Scanner before restoring a Scanner's configuration.

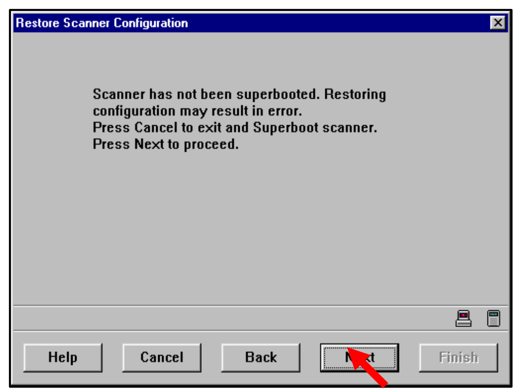
To restore the Scanner's configuration:

1. Begin the ***Restore Scanner Configuration*** process as described on **page 79**.
2. You are then shown this screen:

   Click ***Next***.

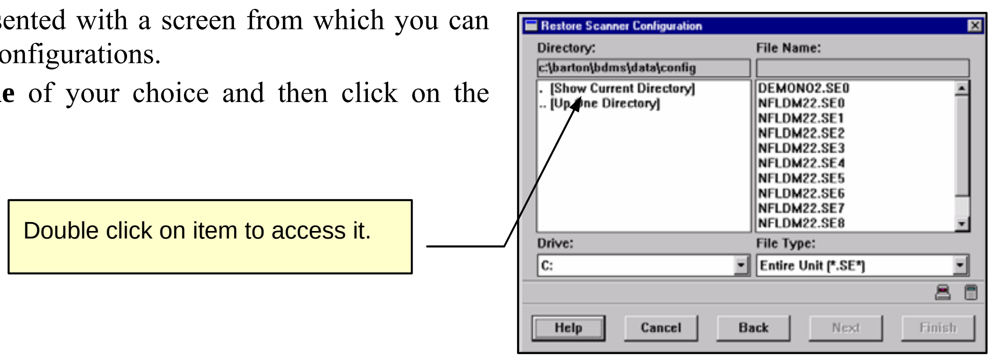


3. If you have superbooted the Scanner, go to the next step; otherwise, the following warning is displayed:



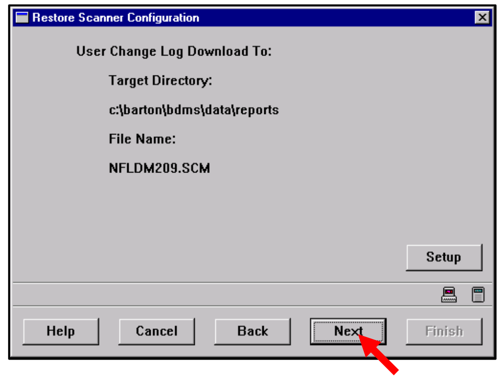
4. You will then be presented with a screen from which you can choose the available configurations.

   Click on the **filename** of your choice and then click on the ***Next*** button.



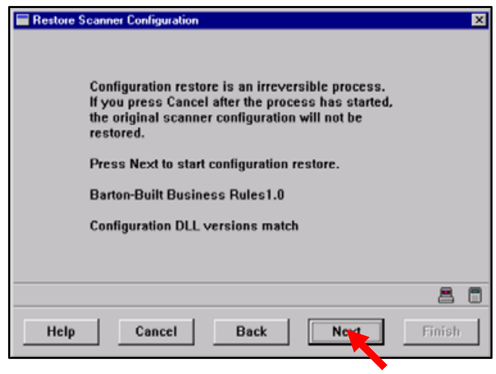
5. A window informing you of where the User Change Log will be stored is shown.

   Click ***Next*** to continue, or use the ***Setup*** button to choose another location.



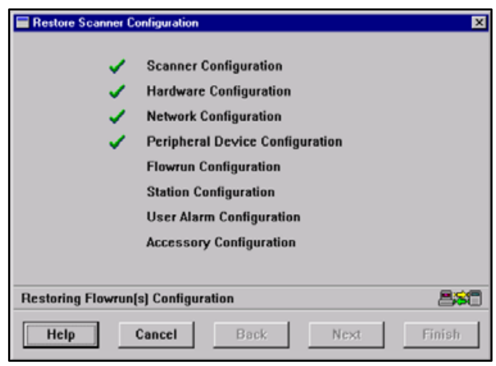
6. ScanWin LITE warns you that once started, the restoration process ***CANNOT*** be undone.

   Click ***Next*** to continue.



7. A progress screen is shown as the configuration data is sent to the Scanner. A **green** check mark will appear as each segment is completed.

   Click ***Finish*** when the upload of data to the Scanner is done.



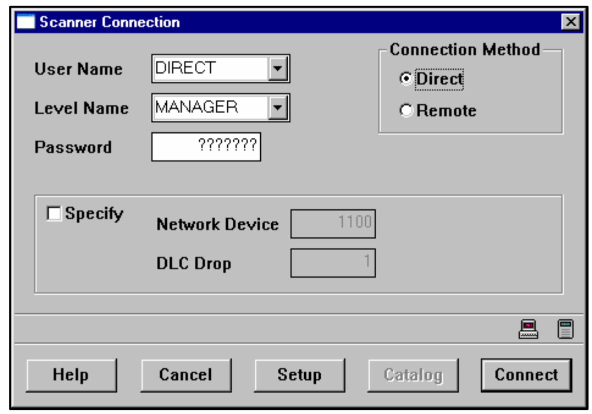
Chapter 4: FLOWRUN Data

Opening a Flowrun

Before you can view flowrun data, you need to connect to a Scanner, either ***directly*** or ***remotely***.

To open a flowrun:

1. Select ***File*** > ***Open*** (or press the **F2** key) to display the **Scanner Connection** dialog box. Or, click on the  icon in the toolbar (see **page 32**).
2. Locate the Scanner for which you want to display the history data.
3. Double-click the Scanner name.
4. Click the ***Flowrun*** tab to display the **Flowrun History Data** window.



Flowrun History Data

ScanWin LITE allows you to access these flowrun data and settings from a Scanner in the field:

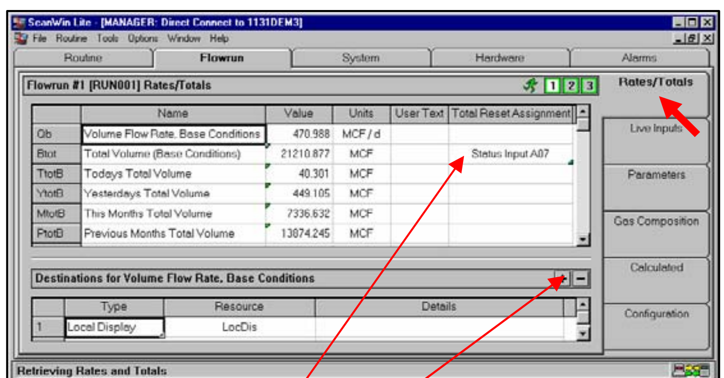
- **Rates and Totals**
- **Live Inputs**
- **Parameters**
- **Gas Composition**
- **Calculated Values** and
- **Configuration**

To view these values, you must be connected ***remotely*** or ***directly*** to the Scanner. These values are continually updated as new data are received.

Rates and Totals

To view rates and totals:

1. Open a flowrun. For information about opening a flowrun, see **Opening a Flowrun, page 85**.
2. Click the ***Rates and Totals*** tab to display the **Rates/Totals** page.
   Values from the database appear in **blue** *italics*; values from the Scanner appear as **black** *text*. See **Chapter 2: Colors Used in ScanWin LITE (page 36)** for an explanation of the colors.
3. If required, select a unit from the drop-down list associated with a value. This new unit overrides the display units in the Scanner for this viewing only. As soon as you leave this session, the values default back to the units set in the Scanner.



Refer to the next section - **Total Reset Assignment**.

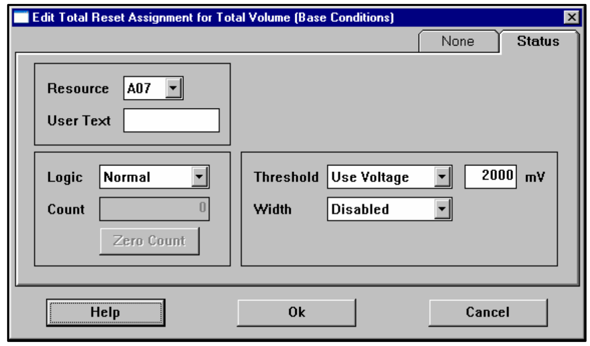
Total Reset Assignment

Resetting of some accumulating totals via a Status Input is possible with this feature. Acceptable totals are indicated by a ***green*** triangle in the lower right corner (see *above*) of the cell. **DAILY HISTORY totals are not impacted by the use of this reset.**

Double-clicking on an eligible cell displays this dialog.

To disable this feature, choose the ***None*** tab and click ***OK***. To reenable this rest feature, fill out the values (refer to the **Status Input Setup** section (**page 122**) and click ***OK***.

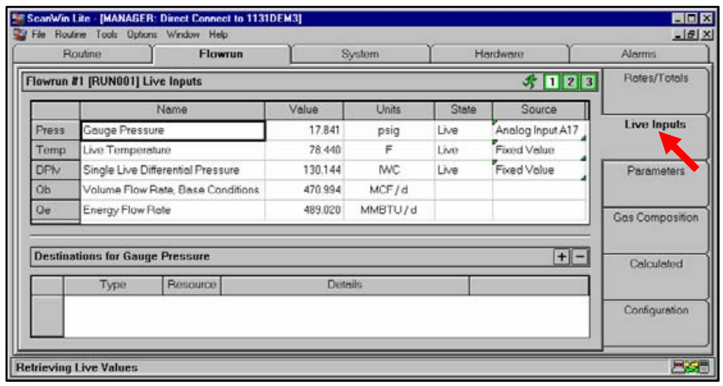
It is recommended that the **Logic** be set to ***Inverted*** and the **Width** be ***Enabled*** (~100 ms).



Live Inputs

To view live inputs:

1. Open a flowrun. For information about opening a flowrun, see **Opening a Flowrun (page 85)**.
2. Click the ***Live Inputs*** tab to display the **Live Inputs** page.
3. If required, select a unit from the drop-down list associated with a value. This new unit overrides the display units in the Scanner for this viewing only. As soon as you leave this session, the values default back to the units set in the Scanner.

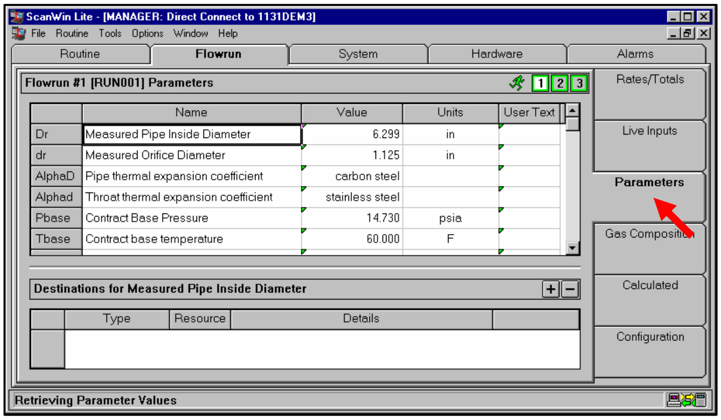


Parameters

To view flowrun parameters:

1. Open a flowrun. For information about opening a flowrun, see **Opening a Flowrun (page 85)**.
2. Click the ***Parameters*** tab to display the **Parameters** page.

   See Chapter 2: **Colors Used in ScanWin LITE** (**page 36**) for an explanation of the colors.
3. If required, select a unit from the drop-down list associated with a value. This new unit overrides the display units in the Scanner for this viewing only. As soon as you leave this session, the values default back to the units set in the Scanner.

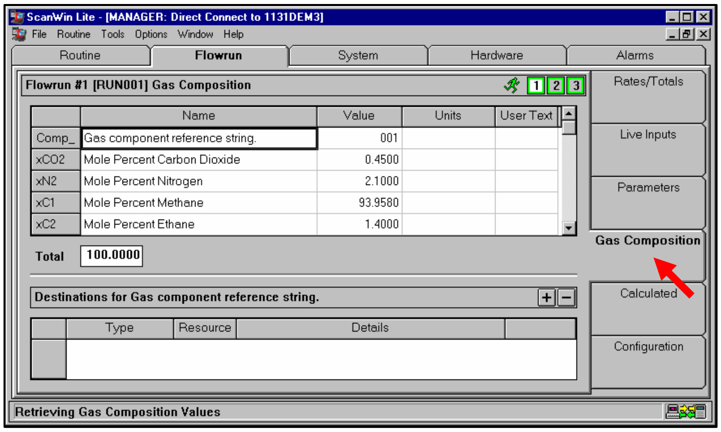


Gas Composition

To view gas composition:

1. Open a flowrun. For information about opening a flowrun, see **Opening a Flowrun (page 85)**.
2. Click the ***Gas Composition*** tab to display the **Gas Composition** page.

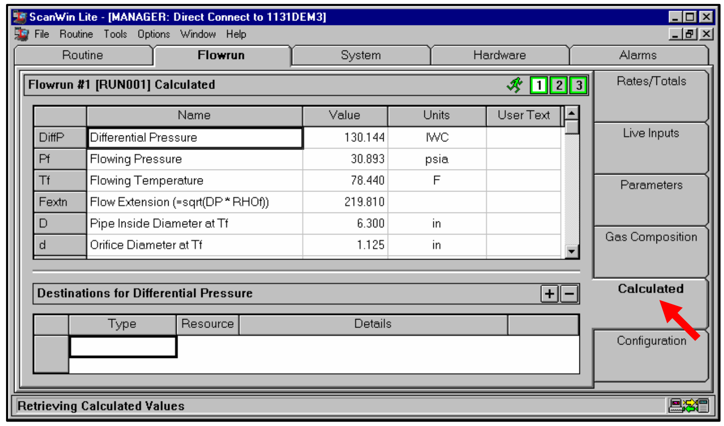
   For information about changing the gas composition, refer to the **Change Gas Composition** section **(page 54)**.



Calculated Values

To view flowrun calculated values:

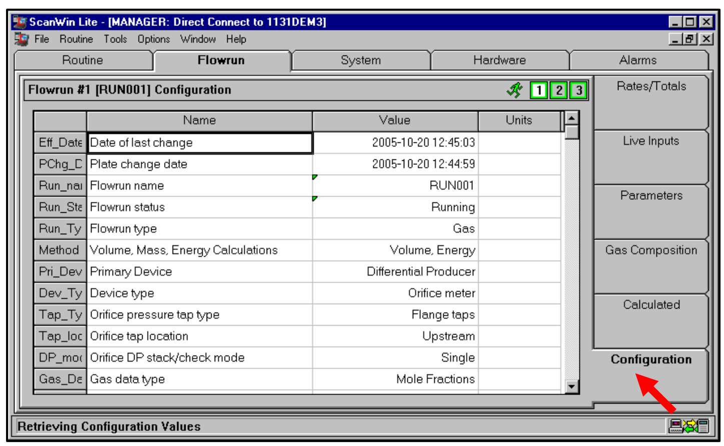
1. Open a flowrun. For information about opening a flowrun, see **Opening a Flowrun (page 85)**.
2. Click the ***Calculated*** tab to display the **Calculated Values** page.
3. If required, select a unit from the drop-down list associated with a value. This new unit overrides the display units in the Scanner for this viewing only. As soon as you leave this session, the values default back to the units set in the Scanner.



Configuration

To view flowrun configuration data:

1. Open a flowrun. For information about opening a flowrun, see **Opening a Flowrun (page 85)**.
2. Click the ***Configuration*** tab to display the **Configuration** page.



See **Chapter 10: NGas 4.X.X Configuration & Calculations** or **Chapter 11: IGas 4.X.X Configuration & Calculations** or **Chapter 12: NFLO 4.X.X Configuration & Calculations** for details.

Assigning Inputs, Outputs and Alarms

From the ***Flowrun*** tab, flowrun inputs, **flowrun outputs (page 95)** and **alarm outputs (page 99)** can be assigned. It is possible to assign outputs from the following flowrun tabs:

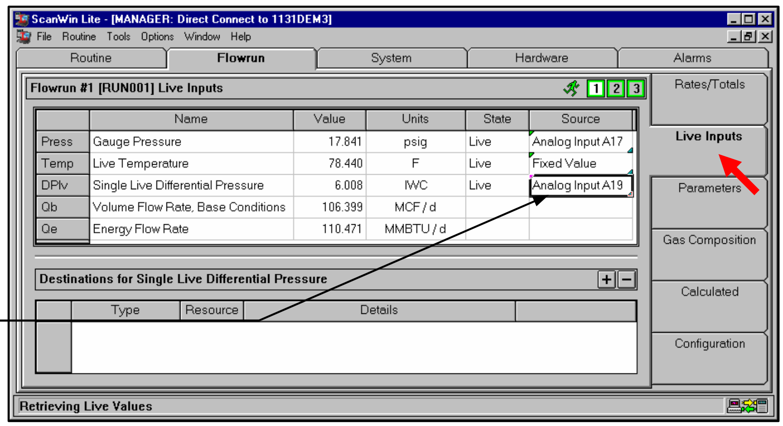
- **Rates and Totals**
- **Live Inputs**
- **Parameters**
- **Gas Composition**
- **Calculated Values**

Refer to Chapter 6 for **Assigning Multifunctional Resources (page 121)**.

Assigning Flowrun Inputs

1. Click the ***Flowrun*** tab.
2. Click the ***Live Inputs*** tab to display the **Live Inputs** page.
3. Select the input that you want to assign.

Double-clicking on a cell in this column (**Source**) allows you to **edit** the source window.

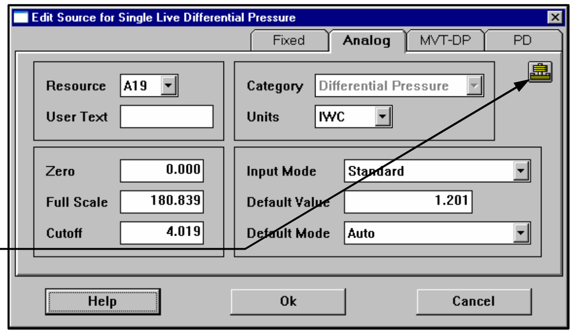


4. The following information is displayed for the **Live Inputs** tab:

This column…	***Displays the…***
Name	The long and short name or description used by the application.
Value	Numeric value for the input. This can be a maximum of 15 digits. * or similar symbol indicates a value is not live (fixed or default)
Units	Units of measurement for the input. Units can be selected for viewing, but are not saved
User Text	User entered text you want for the input.
Source	The resource or terminals that the input is connected to.
Destination	The outputs assigned to a variable.

Assigning Analog Inputs

1. Click the ***Live Inputs*** tab.
2. Double-click the ***Source*** to edit the input source. ScanWin LITE displays the **Edit Source** window.
3. Click the tab for the type of input (analog).



Clicking the icon shows the current calibration values for this device. See **Step 5**.

4. Edit the following information as required:

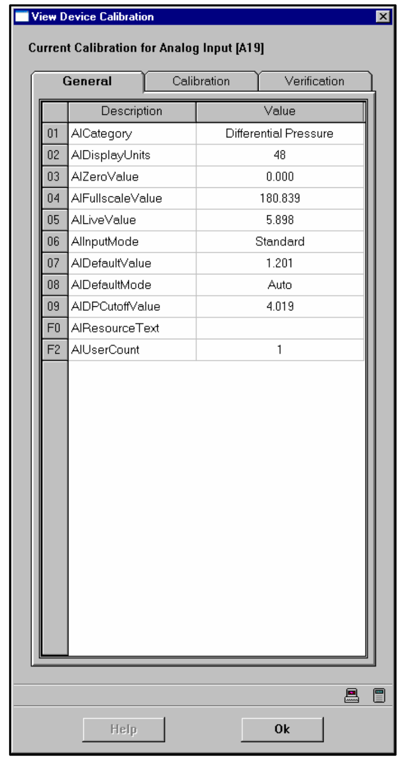
In this field…	*Enter the…*
Resource	Slot in the Scanner. For single-board Scanners like the Scanner 1130, the main board is always Slot A with expansion cards in Slot B and Slot C.
User Text	Text to be associated with this resource (maximum of 8 characters).

Category	Type of input
	• Analog input type can be:
	  • differential pressure
	  • static pressure
	  • temperature
	  • density
	  • mass heating value
	  • volume heating value
	  • percent nitrogen, carbon dioxide or methane
	  • volume rate
	  • mass rate
	  • fixed input

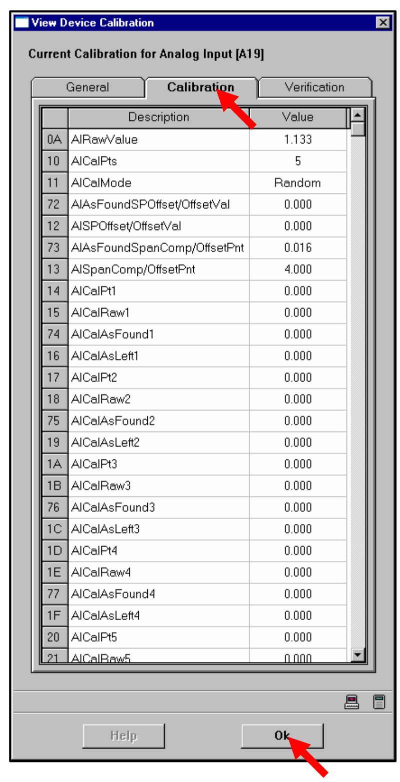
Units	Measurement units for display.
Zero	Transmitter (transducer) zero value that corresponds to a 4 mA or 1 Vdc input.
Full Scale	Transmitter (transducer) full-scale value that corresponds to a 20 mA or 5 Vdc input.
Cutoff (Differential Pressure)	Cutoff value for differential pressure inputs. When the live input falls below the cutoff point, zero is sent to the flowrun calculations for flow extension and flow rate instead of the live value. This is usually set to 0.5 to 2 percent of full scale to prevent false calculations.
InPut Mode	Input Mode is defaulted to *standard* until a calibration is performed then it is changed to "*calibrated*". • Standard • Calibrated (No SP) • Calibrated
Default Value	Value that is sent to the flowrun in place of a live value when the live input goes out of range (auto default mode) or default mode is on.

In this field…	Enter the…
Default Mode	Default mode. This can be: • Disabled • Auto • On

5. Click the ***Calibration*** icon  in the upper right corner of the window to get general information about the device.



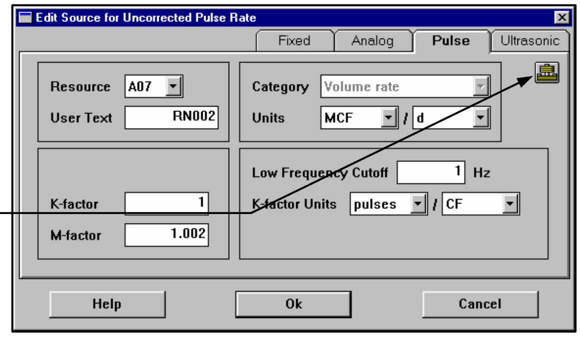
6. Clicking on the ***Calibration*** tab gives more information about the device, including calibration point information.
7. Click ***Ok*** to return to the **Live Inputs** page.
8. In a similar manner, calibration data on this resource may be checked by clicking on the ***Verification*** tab.



Assigning Pulse inputs

1. Click the ***Live Inputs*** tab
2. Double-click the ***Source*** to edit the input source. ScanWin LITE displays the **Edit Source** window:

Clicking the icon shows the current calibration values for this device.



3. Edit the following fields as required:

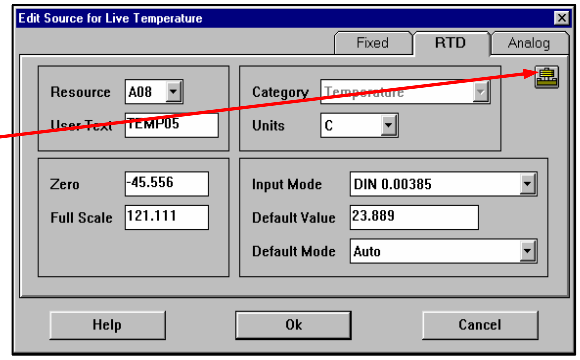
In this field…	***Enter the…***
Resource	Slot in the Scanner. For single-board Scanners like the Scanner 1130, the main board is always Slot A with expansion cards in Slot B and Slot C.
User Text	Text you want associated with this input (maximum 8 characters).
Category	Type of input • Volume rate • Mass rate
Units	Measurement units for display.
K-factor	Current K-factor in use, in pulses/unit volume. If number of calibration points is greater than one, the K-factor is based on the multipoint calibration. If a calibration point is one, the K-factor is an entered value.
M-factor	Meter factor or Scaling factor (usually 1) that adjusts the input device calibration without changing the K-factor (pulses/unit factor). E.g. M-factor of 0.5 would cut the uncorrected flow rate in half.
Frequency	Raw input frequency in Hertz (Hz). The hardware sets a limit on the minimum frequency that can be displayed. Note the flowrun calculations are based on the pulse count, not the frequency.

4. Click ***Ok*** to return to the **Live Inputs** page.

Assigning RTD Inputs

1. Click the ***Live Inputs*** tab.
2. Double-click the ***Source*** or ***Temperature*** to edit the input source. ScanWin LITE displays the **Edit Source** window.

   Clicking icon in the upper right corner of window shows the current calibration values for this device. See Steps 5 and 6 of **Assigning Analog Inputs**, **page 91**.



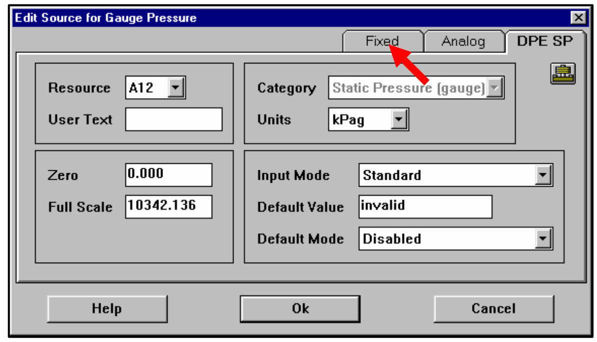
3. Edit the following fields as required:

In this field…	*Enter the…*
Resource	Slot in the Scanner. For single-board Scanners like the Scanner 1130, the main board is always Slot A with expansion cards in Slot B and Slot C.
User Text	Text you want to be associated with this resource (maximum of 8 characters).
Category	Type of input • RTD input type is for temperature
Units	Measurement units for display.
Zero	Zero temperature (default is –50°F or -45.556°C)
Full Scale	Full Scale temperature, default and user entered values maximum depend on Model of Scanner
InPut Mode	Input Mode is defaulted to 0.00385 (DIN) until a calibration is performed then it is changed to calibrated. • DIN 0.00385 • SAMA 0.003902 • Calibrated • DIN+Shift 0.00385 • SAMA+Shift 0.003902
Default Value	Value to be sent to flowrun if the live input goes out of range or if the Default Mode is set to ON. Out-of-range limits for the 4-20 mA signal are 2% below zero (3.68 mA or 0.92 volts) and 3% above full scale (20.48 mA or 5.12 volts.)
Default Mode	Default Mode of **DISABLED**, **AUTO** or **ON**. When ***ON***, the default value is sent to the flowrun regardless of the live input value (useful for forcing an input to a known state, testing calculations, etc.). In the ***AUTO*** mode, the live value input is sent to the flowrun unless it goes out of range (-2.0% and +3.0%), in which case the default value is substituted. When ***DISABLED***, the default value is never used and the flowrun will receive invalid readings if the transmitter goes out of range.

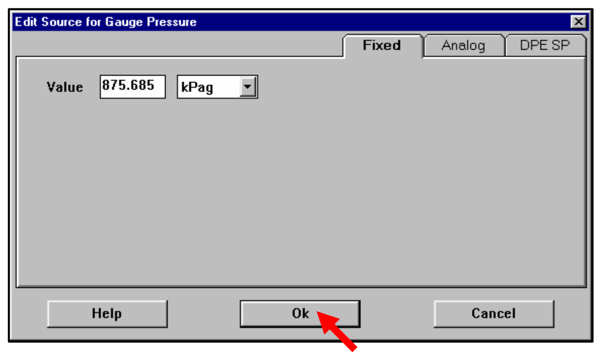
4. Click ***OK*** to return to **Live Inputs** page.

Assigning Fixed Inputs

1. Click the ***Live Inputs*** tab.
2. Double-click the ***Source*** to edit the input source. ScanWin LITE displays the **Edit Source** window:
3. Select the ***Fixed*** tab.



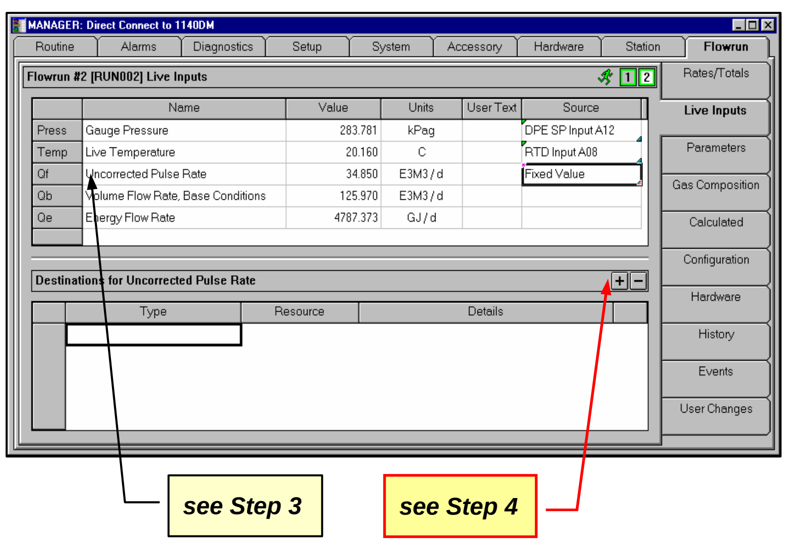
4. Enter the desired value for the fixed input and click ***Ok***.



Assigning Flowrun Outputs

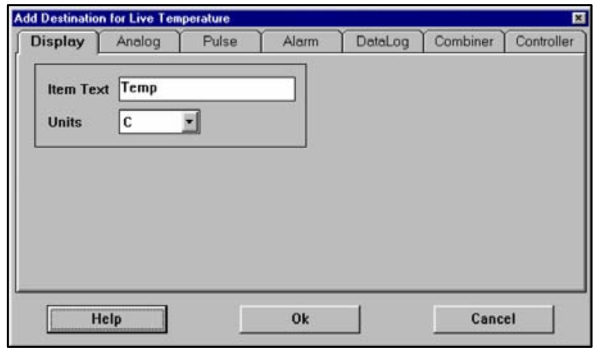
1. Click the ***Flowrun*** tab.
2. Click the ***Live Input*** tab to display the **Live Input** page.

   See **Assigning Multifunctional Resources, page 121** for details.
3. Select the flowrun variable to be assigned to an output.
4. Click on the [+] button in the Destination section to display the **Edit Destination** dialog. Depending on the installed devices in your Scanner, the following selections may be available to you: a) Output to **Local Display**; b) **Analog** output; c) **Pulse** output; d) **Alarm** output;



Assigning Local Display Outputs

1. In the **Add Destination** or **Edit Details** window, click the ***Display*** tab to add an output or edit an existing output.



2. Edit the following information as required:

In this field…	***Enter the…***
Item Text	Text you want associated with this alarm (maximum of 8 characters).
Units	Measurement units for display.

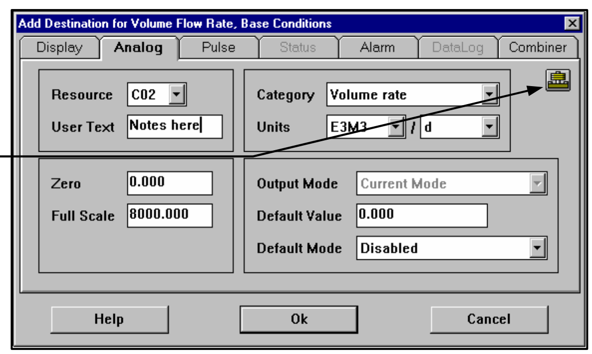
3. Click ***Ok*** to return to the **Flowrun** page.

Assigning Analog Outputs

1. In the **Add Destination** or **Edit Details** window, click the ***Analog Output*** tab to add an output or edit an existing output.

Clicking the icon allows you to calibrate an analog output device.

After the **Analog Output** is assigned and configured, the flowrun must be changed to **Stopped**, then to **Running** OR reset the Scanner in order for it to begin working.



2. Edit the following information as required:

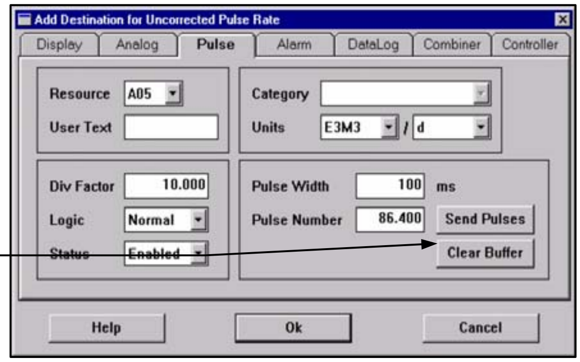
In this field…	***Enter the…***
Resource	Slot in the Scanner. For single-board Scanners like the Scanner 1130, the main board is always in Slot A with expansion cards in Slot B and Slot C.
User Text	Name of alarm output, 12 characters maximum
Category	Analog output type: • None • Differential Pressure • Static Pressure (gauge) • Temperature • Density • Mass Heating Value • Volume Heating Value • % Nitrogen, • % Carbon Dioxide • % Methane • Percent • Volume rate • Mass Rate
Units	Measurement units for display.
Zero	Zero value that produces a 4 mA or 1 Vdc output.
Full Scale	Full scale value that produces a 20 mA or 5 Vdc output.
Output Mode	Select 4-20 mA current or 1-5 Vdc voltage mode.
Default Value	Default value for the output when the default mode is ON.
Default Mode	DISABLED or ENABLED choice from the drop-down window.

3. Click ***Ok*** to return to the **Flowrun** page.

Assigning Pulse Outputs

1. In the **Add Destination** or **Edit Details** window, click the ***Pulse Output*** tab to add an output or edit an existing output.

Clear Buffer button clears the pulse output buffer. This may be necessary if circumstances create a very large number of counts. e.g. Setting **Div Factor** to zero puts an infinite number of counts into the buffer.



See **Assigning Multifunctional Resources, page 121** for details about assigning a Pulse Output.

2. Edit the following information as required:

In this field…	*Enter the…*
Resource	Slot in the Scanner. For single-board Scanners like the Scanner 1130, the main board is always in Slot A with expansion cards in Slot B and Slot C.
User Text	Name assigned to this output (8 characters maximum).
Category	Pulse output type. This can be: • Mass • Volume • Energy • Controller (if available) • No Type
Div Factor	Division factor used to adjust the pulse rate of the output. A Div. Factor of 10 results in 1 pulse transmitted for every 10 counts received from the flowrun. A fractional Div. Factor will speed up the count rate.
Logic	Logical action of the pulse output (either **Normal** or **Inverted**).
Status	Status of the pulse output (**DISABLED** or **ENABLED**). When Disabled, pulses are not transmitted, but are saved in the buffer until the pulse output is again enabled. This allows an output device to be removed and later replaced without any loss of output data.
Pulse Width[3]	Value of the minimum pulse width to be detected. This may be set to 8, 16, 32, 64, 100, 200, 400, 800, 1000, 2000, 5000 or 10000 msec. (Note: 8 and 16 msec settings are available only on the Scanner 1140 .)
Pulse Number	The number of pulses to be outputted.

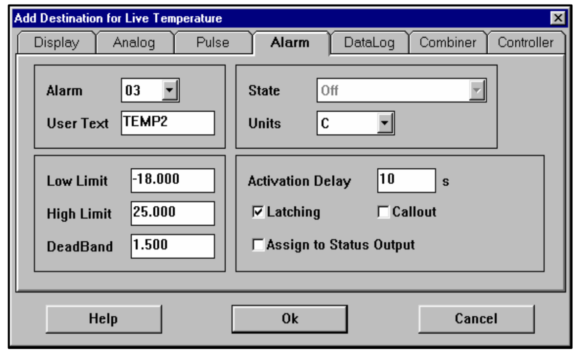
3. Click ***Ok*** to return to the **Flowrun** page.

[3] Scanner 1140 pulse outputs are performed either automatically by the FPGA or manually by the CPU. If the pulse width is less than or equal to 64 msec, then the automatic mode is used. If it is higher than 64 msec, then the CPU must manually toggle the pulse output, which can use up power if you have a lot of pulsing to do. ***<u>It is recommended lowering this value to 64 msec.</u>***

Note that Scanner 1131 supports automatic pulsing for pulse widths up to 1600 msec.

Assigning Alarm Outputs

1. In the **Add Destination** or **Edit Details** window, click the ***Alarm Output*** tab to add an output or edit an existing output.



2. Edit the following information as required:

In this field…	*Enter the…*
Alarm	Number of the alarm (a maximum of 16 alarms may be assigned by the user).
User Text	Text you want associated with this alarm (maximum of 8 characters).
State	Alarm output type. This can be • Off • On (Too Low) • On (Too High) • Undefined
Units	Measurement units for display.
Low Limit	Value for the lower limit of the normal range. If the value drops below this limit, an alarm is triggered.
High Limit	Value for the upper limit of the normal range. If this value is exceeded, an alarm is triggered.
Deadband	Deadband value for the alarm range.
Activation Delay	Time before alarm is triggered after the limits have been exceeded.
Latching	Click box if you want alarm to be latched (alarm will require acknowledgment before it can be removed).
Callout	Click box if you want the alarm to trigger a callout via the communication port.
Assign to Status Output	Click this check box if you want to send the output to a status output.

3. Click ***Ok*** to return to the **Flowrun** page.

Assigning Outputs to Accessories

In the **Edit Details** table, click the desired accessory tab to assign a flowrun variable to an Accessory (Data Log, Combiner or Controller).

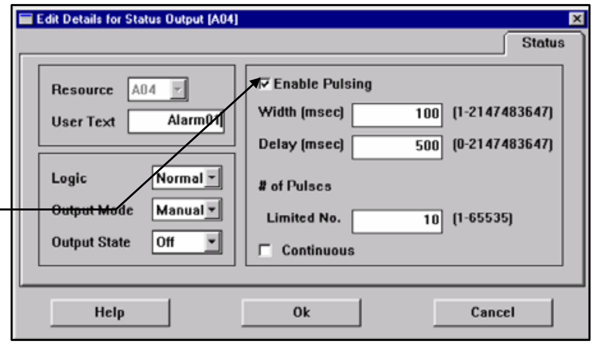
Viewing, editing, or deleting accessories is **<u>not</u>** possible from the destination table.

Assigning Status Outputs

1. In the **Add Destination** or **Edit Details** window, click the ***Status Output*** tab to add an output or edit an existing output.

   See **Assigning Multifunctional Resources, page 121** for details about assigning a **Status Output** resource.

   Checking this box is **only** used to control the display of pulse parameters. Removing the check mark does **not** turn the pulses OFF.



2. Edit the following information as required:

In this field…	*Enter the…*
Resource	Slot in the Scanner. For single-board Scanners like the Scanner 1130, the main board is always in Slot A with expansion cards in Slot B and Slot C.
User Text	Text you want to associate with this resource (a maximum of 8 characters).
Logic[4]	Logical action of the output (**NORMAL** **=1** or **INVERTED** **=0**). Note that if the logic is changed while in a MANUAL mode and an OFF state, the modification will be saved but the result will not be displayed immediately.
Output Mode[4]	Status of the output. In **LIVE** **=1** mode, the state of the output is controlled by alarm conditions in the variable(s) assigned to the output. In **MANUAL** **=0** mode, the state of the output can be set by the user.
Output State[4]	**ON** **=nonzero value** or **OFF** **=0** state of the output. See note below for changing the following shaded settings:
Width	Pulse width in 100-millisecond increments. Maximum value is 2147483647 milliseconds.
Delay	Time, in 100-millisecond increments, between pulses. Maximum value is 2147483647 milliseconds. A value of 0 disables the delay function.
# of Pulses	Number of pulses that are output when status is turned on (1 to 65535). Or, check the ***Continuous*** box to turn on continuous pulsing.

Note: ***Manual Output*** must be set to **OFF** to change these values.

- Set Manual Output to **OFF** and click ***Ok***.
- Reopen dialog and change values. Click ***Ok***.
- Reopen dialog and set Manual Output to **ON**. Click ***Ok***.

3. Click ***Ok*** to return to the **Flowrun** page.

[4] number in **=n** represents value used by EFM/RTU for communication protocols (e.g. ScanCom and Modbus)

Procedures to Change Status Output Parameters

These procedures apply **ONLY** to versions of ScanWin ***older than*** version B2.2.6W and to firmware versions 4.0.0 through 4.3.0.

These procedures should be followed to change the status output configurations for:

- Status Output parameters of "Width", "Delay" and "# of Pulses".
- Output Status from "Live" to "Manual"

With Status Output in Live Mode

As a **general rule,** when the Status Output is **Live** and assigned to a User Alarm, parameter changes are effective at the ***next*** alarm.

1. When the User Alarm is in the **OFF** state, the Status Output will also be **OFF**.
   - Click the ***Hardware*** tab and double-click the Status Output to be changed.
   - When the **Edit Details for Status Output** dialog appears, change the parameters and then click ***OK***.

   Note: The changes made to the Status Output parameters will take effect the next time the alarm is turned **ON**.
2. When the User Alarm is in the **ON** state, with pulsing enabled (value of "Width" is greater zero), and a change to the Status Output parameters is required:
   - Change the User Alarm to the **OFF** state and follow the steps in No. 1 above.
3. When the User Alarm is in the **ON** state, and **immediate** changes to the Status Output are required:
   - Click the ***Hardware*** tab and double-click the Status Output to be changed.
   - When the **Edit Details for Status Output** dialog appears, change the parameters and then click ***OK***.
   - Select the ***Alarms*** tab and then click the ***Clear Alarms*** button.

   Note: The alarm state will be reset and restarted. The changes will be implemented upon restart.
4. When the User Alarm is in the **ON** state and a change from **LIVE** mode to **MANUAL** mode is desired:
   - Click the ***Hardware*** tab and double-click the Status Output to be changed.
   - From the drop-down list in the **Output Mode** box, select ***Manual***. The **Output State** box will appear with an On or Off value. Click the ***OK*** button for ScanWin LITE to set the manual mode.
   - Double-click the **same** Status Output on the Hardware page again. When the **Edit Details for Status Output** dialog appears, the value of the Manual Output State **may not** be the same as that of the Scanner EFM/RTU. Toggle the selection and click ***OK*** to close the dialog box.
   - Again, double-click the Status Output. Then, once again, toggle the Manual Output State and click the ***OK*** button. Now the Status Output of the Scanner EFM/RTU **will be the same** as ScanWin LITE.
   - **IF** the Output State was in the **ON** state (from the previous step), reopen the **Edit Details for Status Output** dialog and set the Output State to ***OFF***. If the Output State was already **OFF** in the previous step, skip this step..
   - Finally, double-click on the same Status Output, and make the desired changes to the **Width**, **Delay** and **# of Pulses**. Click ***OK*** to send the new parameters to the Scanner.

To change from *Manual* to *Live* mode:

- Open the **Edit Details for Status Output** dialog and change the Output Mode to **LIVE**. If the User Alarm is in the **ON** state, the new pulse operation will be effective **<u>immediately</u>**. Otherwise, the change will occur the next time the alarm is turned **ON**.

With Status Output in Manual Mode

<u>Generally</u>, the Manual Output must be **OFF** ***<u>before</u>*** changing the Status Output parameters.

Thus, the following steps are required:

1. Click the ***Hardware*** tab and double-click the Status Output to be changed.
2. When the **Edit Details for Status Output** dialog opens, check the Output State when in Manual mode.
   - If it is **OFF**, go immediately to Step 3. If the Output State is **ON**, set it to **OFF** and click the ***Ok*** button.
3. Open the **Edit Details for Status Output** dialog again as explained in Step 1.
   - Change the **Width**, **Delay** and **# of Pulses** parameters as required and click the ***Ok*** button.
4. Open the **Edit Details for Status Output** dialog and change the Output State to **ON**. Click the ***Ok*** button.

Analog Output Calibration

An analog output calibration (and verification) is possible **only** from the page on which analog outputs are assigned or edited (see preceding section).

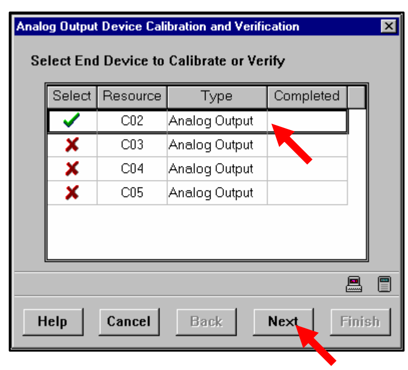
Preparation

1. Connect a current measuring device (e.g. Promac or DVM) in the output loop by connecting it in series with the wired loop or, if not wired, by connecting Vtx, on ASO1 pins 1, 2 or 3 to ASO1 pins 10, 12 or 14.
2. Connect the meter (+) from ASO1 pins 11, 13 or 15.
3. Return the meter (–) to an available ground (GND) on the 1130 motherboard.

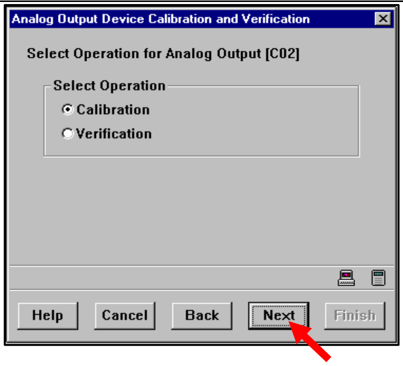
Calibration

1. To calibrate an analog output device, click on the  icon. The **Select End Device** screen is displayed:

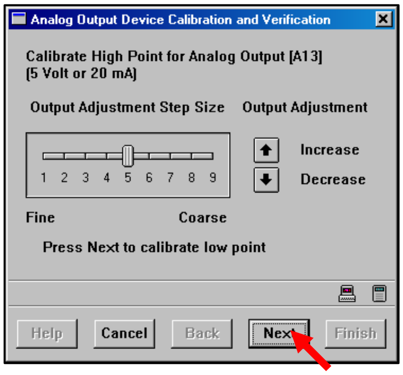
   Click on the line containing the device to be calibrated. Selected outputs will show a green arrow. Then click on the ***Next*** button.



2. When prompted to select the operation to be performed, make sure **Calibration** is indicated and click the ***Next*** button.

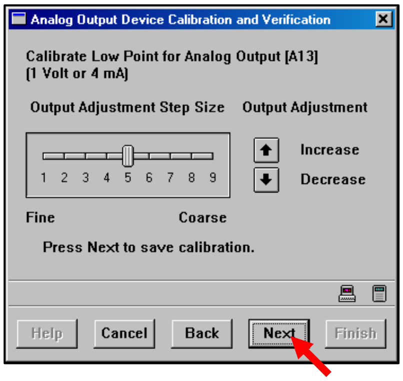


3. A window like the one on the right is displayed for **High Point Calibration**.
   The current for the channel should go to ~20 mA. Set the slider for an appropriate jump size. Use the UP or DOWN arrows to make the current meter read 20.0 mA. When you have done so, press ***Next***.

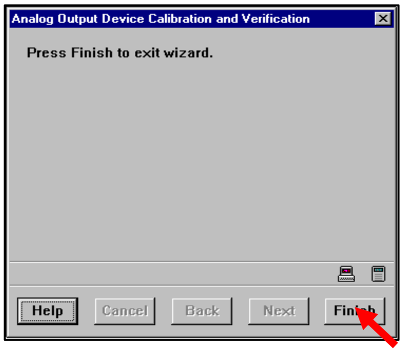


4. A window like the one on the right is displayed for **Low Point Calibration**.

   Use the ***UP*** and ***DOWN*** arrow keys to make the current meter read 4.0 mA. Repeat the ***High*** and ***Low*** Point calibrations until both are giving the correct readings. When you have done so, press ***Next***.

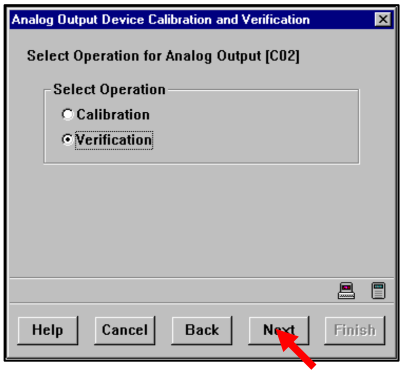


5. The screen to end the process is then shown. Click ***Finish*** to end the calibration.

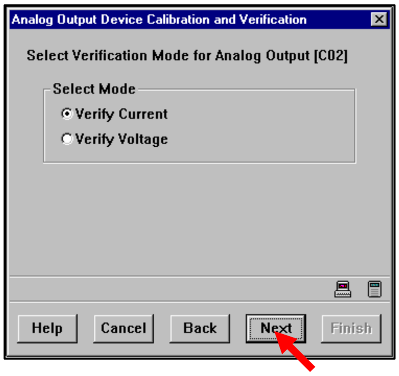


Verification

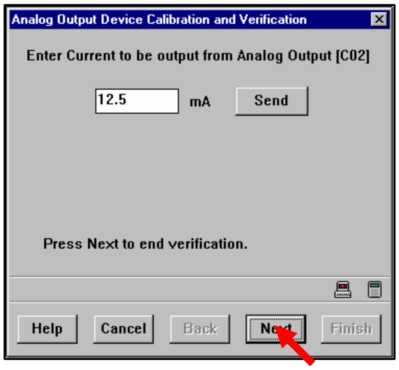
1. Repeat Steps 1 and 2 of the **Calibration (page 102)** process in the last section.
   In Step 2 (previous section), indicate that you wish to do **Verification** and click ***Next***.



2. The screen on the right is displayed:
   Make certain that ***Verify Current*** is selected and click the ***Next*** button.



3. You are then asked to input a current to send to the meter.
   Click ***Send*** and this amount should register on the meter. If it is not the same, your calibration process should be repeated. Otherwise, click ***Next*** to end the verification process.



Chapter 5: SYSTEM

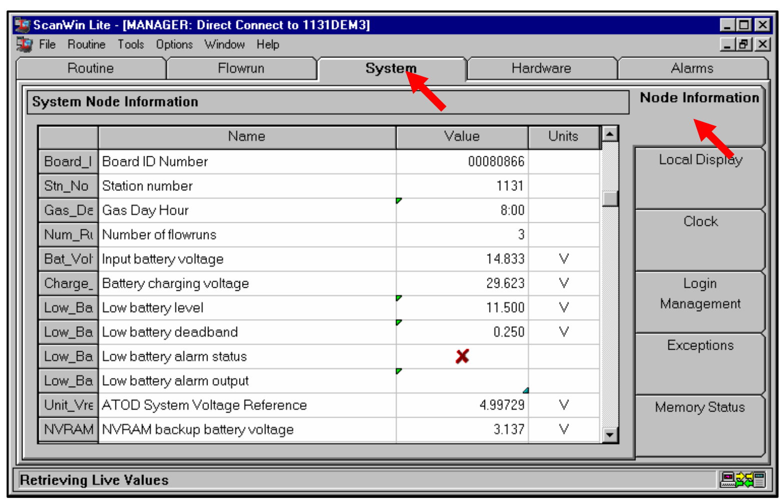
From the ***System*** tab (top) you are able to view and make changes to the **Node Information, Local Display, Clock, Login Management, Exceptions** and **Memory Status.** These are accessed by clicking on the respective tabs on the right side of the System Node Information screen.

Node Information

Node information is used to identify the Scanner in history logs, reports, etc. Information about the software, such as the version, and serial numbers should be recorded.

To view and/or change the Node information:

1. Click on the ***System*** tab first.
2. Then click the ***Node Information*** tab on the right side to display this page.



Note: Most changes to the information in this window must be made through the **Scanner Setup (page 79)** wizard found in the **Setup** tab.

3. Examine the following information. If a ***green*** triangle appears in the corner of the Value field, the value in that field can be changed from that screen. Values in other fields may be changed through the ***Scanner Setup*** tab (see Chapter 3).

> ***Note*: Node Name** *and* **Board ID** *are keys used by the database to append data to existing files.*

This field…	***Refers to the…***
Unit Node Name	Name assigned to the Scanner.
Scanner Model Number	Series number from the Scanner Family of measurement RTUs.
Software Version	Software version the Scanner is currently using.
Unit Serial Number	Manufacturing number found on the ID tag on the outer case of the Scanner. Non-Barton products may or may not have an equivalent number.
Board ID Number	Manufacturing number assigned to the motherboard of the Scanner. First 4 digits refer to the date of manufacture.
Station Number (TCPL)	First 4 digits of a numerical node name.
Gas Day Hour	Gas day for reporting volumes. E.g. a typical gas day hour of 8:00 for April 1 goes from 8:00 a.m. April 1 to 7:59 a.m. April 2. A value of 0:00 – 23:00 may be used.
Number of Flowruns	Number of flowruns associated with the Scanner.
Power Supply Type[5]	Type of power supply used. This is selectable as ***6v***, ***12v*** or ***No Battery*** by the user during the Scanner Setup (**page 79**).
Input Battery Voltage	Battery voltage of the Scanner, for RTUs with charge controller and an integral battery). For Scanner 1130 or 1131 RTUs using a dc power supply option (with no charge controller /integral battery) this is the external supply voltage to the RTU.
Battery Charging Voltage	External supply voltage to the Charge Control board (including Scanner 1140G). Typically the external supply voltage is from a solar panel. For Scanners that do not have an integral battery this value will be 0 (except for the 1140G, which has a capacitor in place of the battery)
Battery Charging Current[5]	Amount of amperes at which the battery is being charged. Note that this is not available on all 1141 hardware.
Power Supply Charger Status[5]	State of the charging system that is installed. May be reported as ***Disabled***, ***Trickle***, ***Bulk***, ***Overcharge*** or ***Float***. Refer to the Scanner 1141 manual for more information.
Low Battery Level	Voltage at which a Low Battery Alarm is triggered. The default on an 1140 flow measurement RTU is 6.1V and 11.5 for an 1130 unit. Value is configurable.
Low Battery Deadband	Voltage difference above the Low Battery Level that must be achieved for a Low Battery Alarm to disappear.
Low Battery Alarm Status	Setting of the Low Battery Alarm - **ON** (***green check mark***) or **OFF** (***red X***).
Low Battery Alarm Output	Resource to which a Low Battery Alarm is assigned.
ATOD System Voltage Reference	Value of the internal voltage reference source for each flow computer.
NVRAM Backup Battery Voltage	Voltage of the NVRAM backup battery. See **NVRAM Lithium Battery** Voltage below.
Analog In / RTD Select [A15 – A17][5]	Hardware assignment for resources A15 to A17. Selectable as ***RTD*** (A15) or ***2 Analogs*** (A16 and A17) during the Scanner Setup (**page 79**).
Analog In / RTD Select [A18 – A20][5]	Hardware assignment for resources A18 to A20. Selectable as ***RTD*** (A18) or ***2 Analogs*** (A19 and A20) during the Scanner Setup (**page 79**).

[5] Shaded rows are applicable to the Scanner 1141 only.

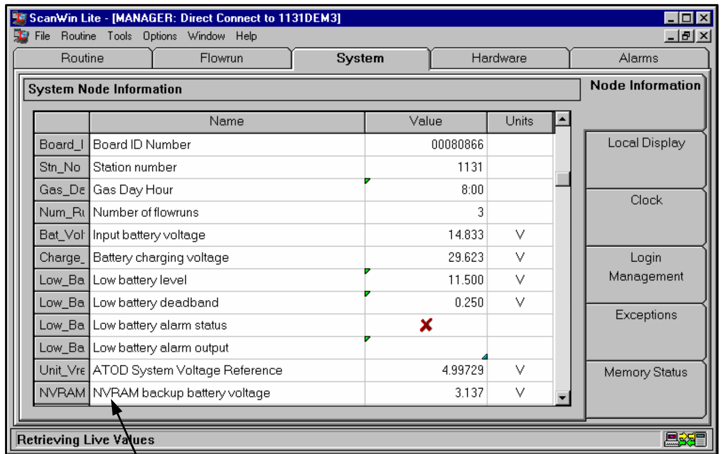
This field…	Refers to the…
CFG Lockout Status	Setting of the configuration lock switch: **ON** (***green* check mark**) or **OFF** (***red X***). When ON, the RTU **cannot** be superbooted and the flowrun configuration **cannot** be changed.
CFG Lockout Switch assignment	Resource that is handling the lock switch.
User Change Log Lock Status	Setting of the user change log lock. When **ON** (***green* check mark**), the amount of user changes is limited (*see* **page 118**); when **OFF** (***red X***), the user change log ***wraps*** as it becomes filled, and causes the loss of data. ***Note***: This is writable only when the CFG Lockout Switch is unlocked in firmware version 4.1.3 and above.
Last User Change Number	Number of the last User Change record that is stored in the Scanner.
Vtx Output Settling Time	Settling time used in the Power Save Mode to establish how long a transmitter takes to send a stable reading after it is turned on. Default is 100 ms.
Ambient Temperature	Temperature at which the unit is operating.
Measurement Status Input #1 Assignment	Resource to which a Status Warning input #1 is assigned.
Measurement Status Input #2 Assignment	Resource to which a Status Warning input #2 is assigned
HW Range Alarm Configuration Flowrun Check Alarm Configuration	Options for these are **Off**, **Show in Event Log**, **Show in Alarms Page** and **Events and Alarms**.
System Alarm Status	Setting of the System Alarm - **ON** (***green* check mark**) or **OFF** (***red X***). ***Note***: This is **ON** when any alarm is ***active*** in the Alarms tab.
System Alarm Output	Resource to which the System Alarm output is assigned.
Measurement Change Counter (TCPL)	Number of changes made to any hardware resource user text (does not include other HW parameters - just text), a system node name, a flowrun name and to flowrun configurations made via PUTS (does not include changing data values, only the creation structure).
Power Save Mode	Use of **FULL** or **LOW** (power save mode) usage of battery power.
Vtx output override	**All Banks** on or **None**. Scanners 1130 and 1131 also have Bank 1 and Bank 2. ***Note***: The Vtx terminal of the RTU provides power to end devices. Scanners with ***these*** should have the Vtx output override set to **ON** so that it is always on. The ***Power Save Mode*** is set to **LOW**.
Local RTC display mode	The local real-time clock. It displays the time in 12 (AM/PM) or 24-hour (ML) format.
Local RTC day of week	Day of the week.
Certification Time/Date	Certified Time/Date stamp.
Power Supply Firmware Version[6]	Version number of the firmware installed in the Scanner 1141 integral power supply module.

[6] Shaded rows are applicable to the Scanner 1141 only.

NVRAM Lithium Battery Voltage

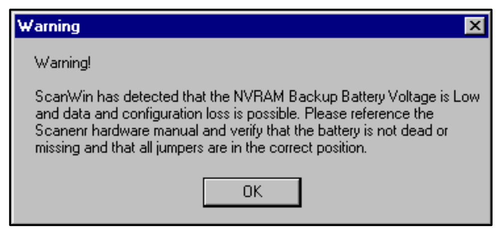
When measuring the NVRAM battery voltage with a voltmeter (this measurement can be performed with the battery in the holder while the Scanner is operating), the voltage will be 0.3 to 0.7 volts higher than when it is measured by the firmware. The value read by the Scanner firmware is the actual (backup) voltage applied to the NVRAM and PIC (for operation as an RTC) and includes the voltage drops from the Schottky diodes that are part of the intrinsic safe circuit.

Note that with lithium batteries, the voltage drops off dramatically so there is never much "low voltage" warning. The NVRAM battery voltage above 2.0 Vdc indicates the configuration is still backed up; a voltage of zero means that the battery is dead, not installed, or the jumper is missing.



Available in **Firmware 4.1.4** and above.

This warning will be given during the login operation if the battery voltage falls below the specified level (2.0 Vdc recommended). Refer to the **Quick Start Settings** dialog (**page 38**).



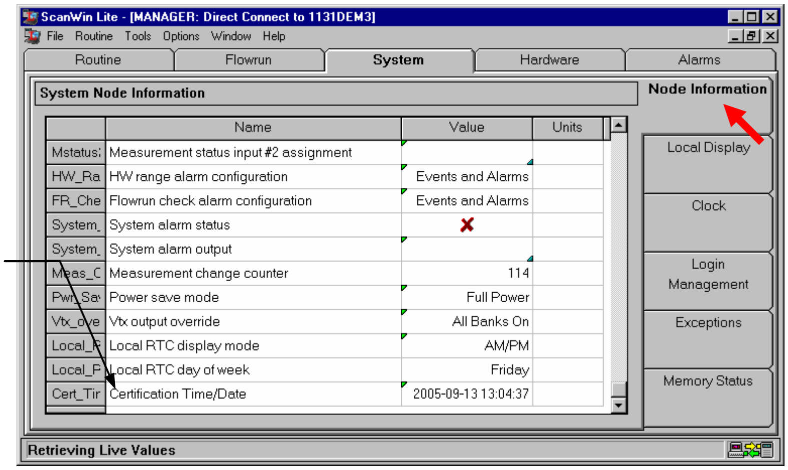
Certification Time/Date

The ***Certification Time/Date*** feature is used to insert a time/date signature on the **Systems Node Information** page.

To do this procedure:

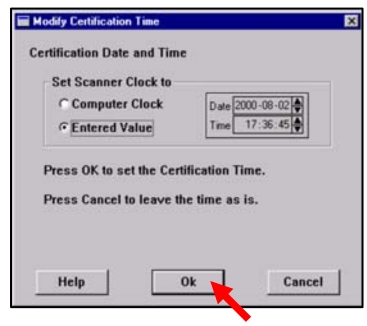
1. Locate the row that contains the ***Certification Time/Date*** field.

Applicable to firmware version **4.1.0 and above**



2. Double-click on the cell in the **Value** column. This will result in the following window being displayed.

   In the **Set Scanner Clock to** area, click on **Entered Value** if you do not want to used the Computer Clock's time and date. If you do so, click on the value to be changed and use the up or down arrow keys to change to your new value. When done, click on the ***OK*** button.



3. If the **Configuration Lock Switch** is enabled, the following message will be displayed.

Local Display

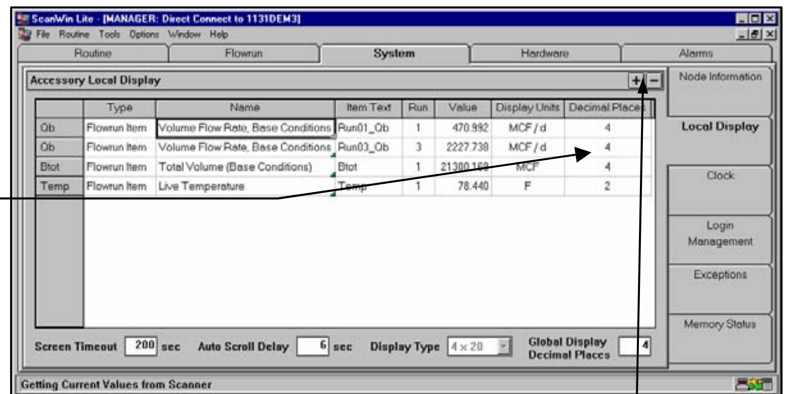
From the Local Display tab, you are able to view those items, including non-flowrun items, which have been set up to be displayed at the Scanner, add or remove items from this list, as well as configure the display output. Local Display items can also be added or removed from the Flowrun tab (see **Assigning Local Display Outputs, page 96**).

Note: By default, the Scanner display will show (a) the **Node Name**; (b) the **Battery Voltage**; (c) the **Time/Date**, and (d) the configuration for the **serial ports**.

Changing the Local Display Settings

1. Open the ***Local Display*** page as described on **page 105**.

Note: These pertain to the display on the **SCANNER** and not to what is shown in ScanWin.

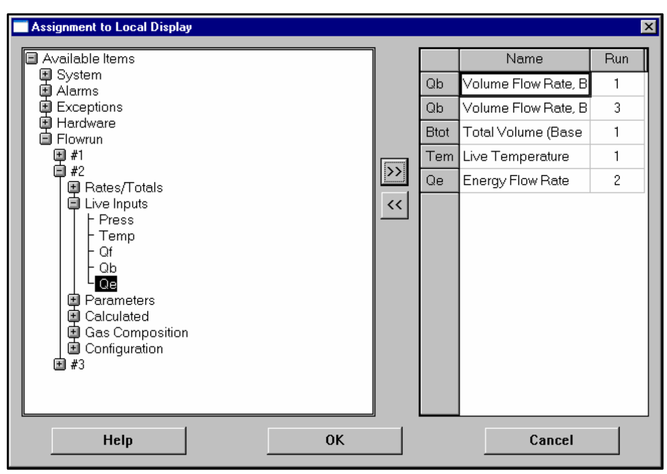


Refer to Step 3 (+) or **Step 8** (-) for information about the use of these buttons.

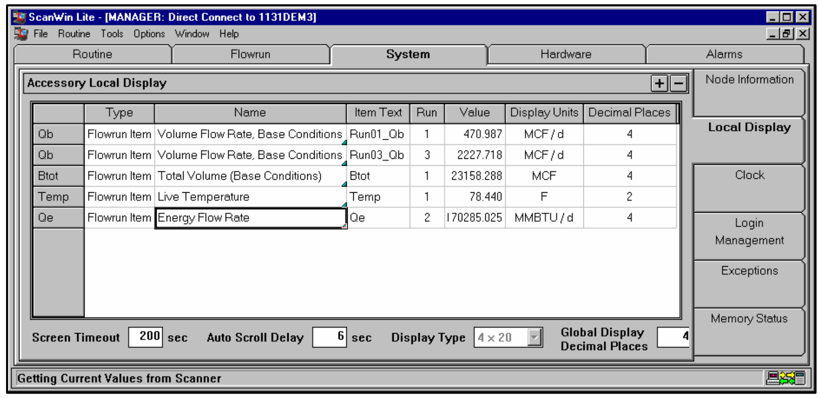
2. At the bottom of the window, enter the following information as required:

In this field…	*Refers to the…*
Screen Timeout	Length of time in seconds before the display goes blank when the keypad is unused. Enter 0 to disable the time-out feature.
Auto Scroll Delay	Time each parameter is displayed before scrolling to the next parameter (seconds).
Display Type	Type of display that is installed on the Scanner. Types may be either ***Graphics, 4x20, 2x16*** or ***No Display.***

3. Click on the ⊞ button to add new items to the local display. The window like the one on the right is displayed.
4. From the **left** portion of the window, click on the item you wish to display. Then click on the >> button. This results in the item being added to the **right** portion of the window. To remove an item from the right window, click on it, and then click on the << button.

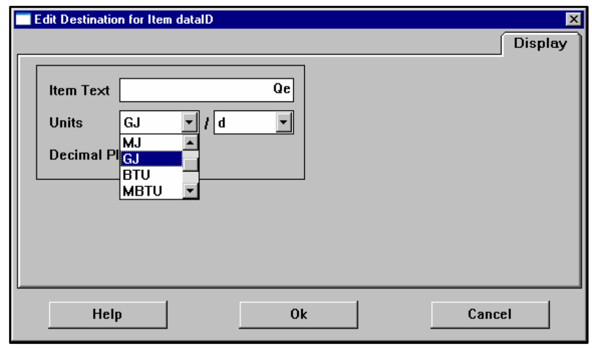


5. After you have made your choices, click on the ***OK*** button.

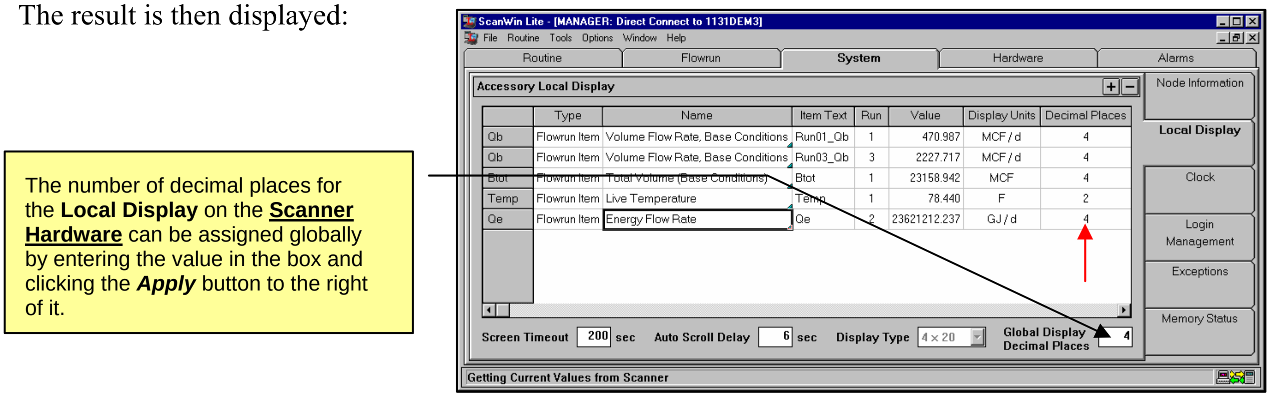


6. Double-clicking on a Name field (***green triangle*** in lower right corner) opens the following **Edit Destination for Item dataID** window:

   You may now edit the **Item Text** or **Units**. Click the ***OK*** button when done.



7. The result is then displayed:



8. To remove an item from the Local Display list, first click on the item; then click on the button. This window is displayed:

   Click on the ***Yes*** or ***No*** buttons.

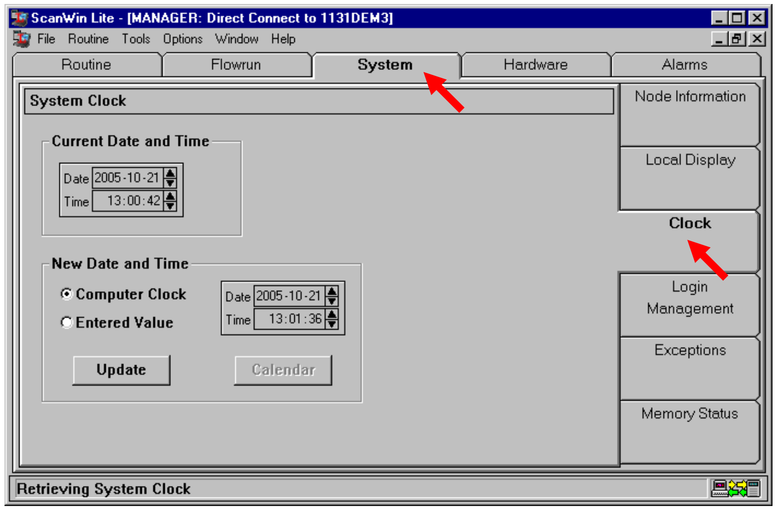
Clock

You can view the system clock to see what time (and date) the Scanner is using and change it if necessary.

1. Click the right ***Clock*** tab of the ***System*** page to display the **System Clock** page.

   The **Current Date and Time** column shows the date and time that is currently stored in the Scanner.

   Note: The time is in a **24-hour** format.

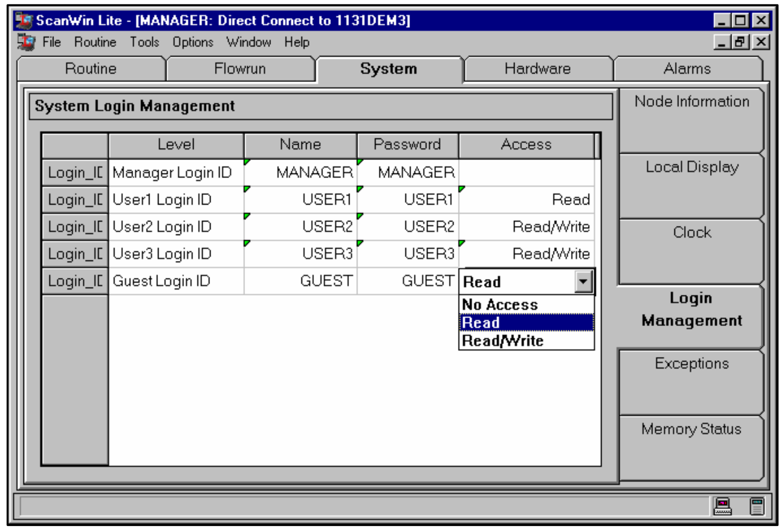


2. In the **New Date and Time** area, clicking on Computer Clock shows the date and time that is present in the computer's memory. Pressing the ***Update*** button will transfer this time and date to the Scanner.
3. If you wish to enter a different time and/or date into the Scanner, select the **Entered Value** radio button. Then, click on **Calendar** to choose a different date **or** select the year, month or date. Or, click on the value to be changed; then use the up or down arrows to change that value. In a similar manner, the hours, minutes or seconds may be changed. Press the ***Update*** button to send this new date or time to the Scanner.

Login Management

The **Login Management** display window is accessible only by the **MANAGER**. *Initially*, the ***Level names*** and ***passwords*** are the same (MANAGER – MANAGER, USER1 – USER1, etc.).

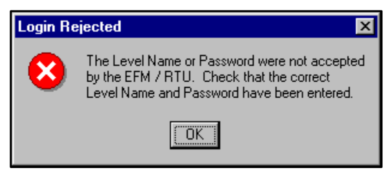
By clicking on the fields (shown with the green triangle in the upper right corner), the **MANAGER** can change level names and passwords. Level names and passwords may each have a maximum of eight characters.



By **default**, User2 and User3 **both** have *read/write* access. However, **User2** is logged in at the **Tech** level (Technician has ***write*** access to the ***Routines*** and **read** access to everything else). **User3** has *read/write* access to everything ***except*** the **Login ID's** and **Passwords**. **User1** and the **Guest** have *read only* access.

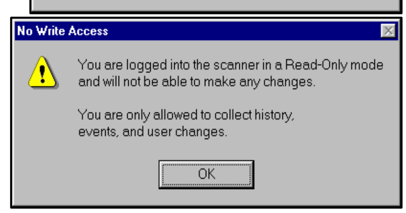
The access level for each of these can be changed by the MANAGER to ***No Access***, ***Read/Write*** or ***Read***.

If a user's Access Level is set at ***No Access***, the user will receive this message after logging in.

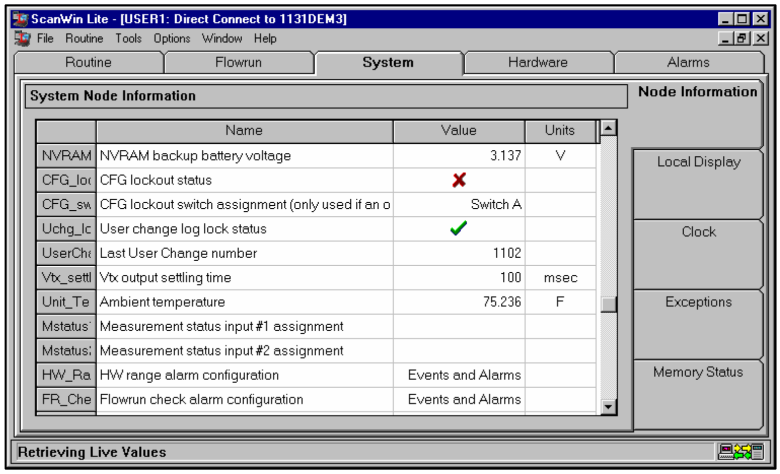


If assigned as User2 with ***Read/Write*** access, the following message will appear at the time of connection to the Scanner:

If a user is assigned ***Read Only*** access, the following message will appear at the time of connection to the Scanner:

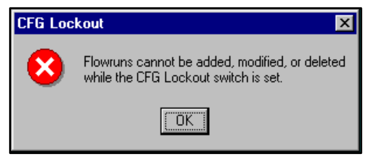


When logged in at a level other than **MANAGER**, the **System** page will not display the **Login Management** tab:



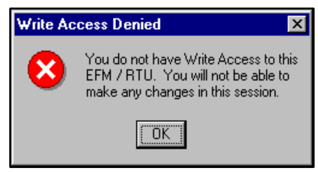
With the Configuration Lock Switch **ON**, both the following messages are displayed:

(a) when an attempt is made to make any flowrun modification



and

(b) if any effort is made to modify the User Change Log Lock Status from the Node Information tab of the System page.



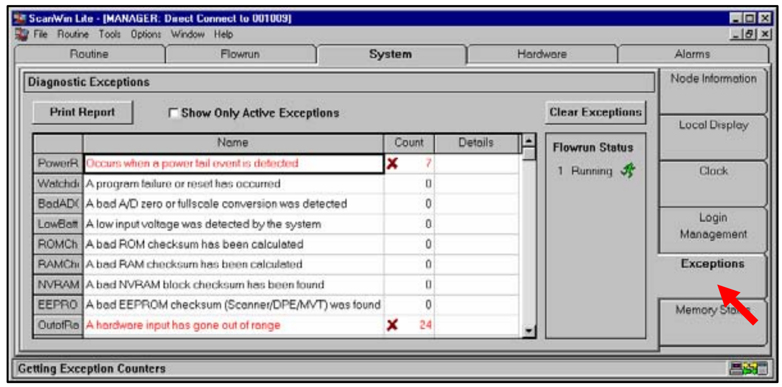
Note: When the Configuration Lock Switch is **ON**, the **MANAGER** will have the same access as **USER3**.

Exceptions

If you are connected **directly** or **remotely** to a Scanner, the Exceptions tab provides you with information about the Scanner.

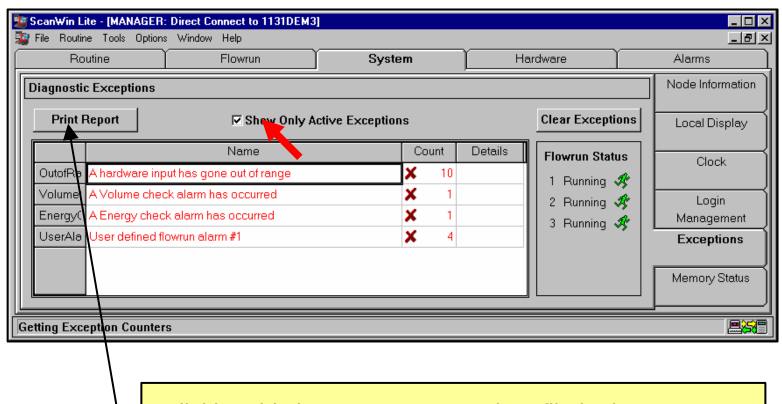
1. Clicking on the ***Exceptions*** tab gives this display.

   Shown is the **status** of the flowruns plus a list of **diagnostic exceptions** or errors that have occurred. Note that all **active** exceptions are shown in red.



2. Clicking on the box in the upper left corner shows only the active exceptions.

   To clear all active exceptions, click the ***Clear Exceptions*** button.



Clicking this button creates an .htm file in the **C:\barton\bdms\DATA\REPORTS\EXCEPT** directory. See No. 4 of this section for a sample report.

3. The following is a list of the exceptions that may be displayed:

Exception	**Description**
Power Restart	Occurs when a power fail event is detected
Watchdog Restart	A program failure or reset has occurred*
Bad A/D Calibration	A bad A/D zero or fullscale conversion was detected*
Low Battery Alarm	A low input voltage was detected by the system
ROM Checksum	A bad ROM checksum has been calculated*
RAM Checksum	A bad RAM checksum has been calculated*
NVRAM Block Error	A bad NVRAM block checksum has been found*
EEPROM Checksum	A Scanner or DPE EEPROM checksum was bad on startup*
Out of Range	A hardware input has gone out of range
SW Fault	A software fault was detected*
DP Check	A Differential Pressure check alarm has occurred
Volume Check	A Volume check alarm has occurred
Mass Check	A Mass check alarm has occurred
Energy Check	A Energy check alarm has occurred
User Alarm 1 to 16	User defined flowrun/combiner alarm

4. This is a sample of the report generated when you press the **Print Report** button:

Scanner Exceptions Report

==

ScanWin

Node Name : 1131DEM3
Firmware : NFlo M4.3.4RaAb
Board ID Number : 00080866

Created on: 11/08/2005 23:17

==

Exception	Count
Occurs when a power fail event is detected	0
A program failure or reset has occurred	0
A bad A/D zero or fullscale conversion was detected	0
A low input voltage was detected by the system	0
A bad ROM checksum has been calculated	0
A bad RAM checksum has been calculated	0
A bad NVRAM block checksum has been found	0
A bad EEPROM checksum (Scanner/DPE/MVT) was found on startup	0

* These exceptions should not normally occur. If they do, a hardware or software problem may exist. Checking the event log will provide more detailed information.

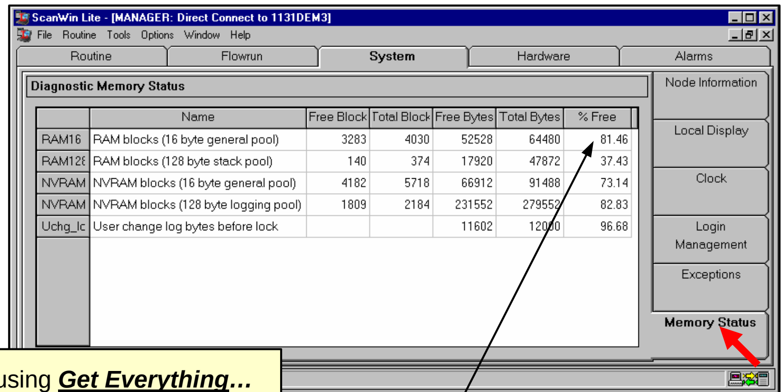
A hardware input has gone out of range	**10**
A firmware fault was detected	0
A Differential Pressure check alarm has occurred	0
A Volume check alarm has occurred	**1**
A Mass check alarm has occurred	0
A Energy check alarm has occurred	**1**
User defined flowrun alarm #1	**4**
User defined flowrun alarm #2	0
User defined flowrun alarm #3	0
User defined flowrun alarm #4	0
User defined flowrun alarm #5	0
User defined flowrun alarm #6	0
User defined flowrun alarm #7	0
User defined flowrun alarm #8	0
User defined flowrun alarm #9	0
User defined flowrun alarm #10	0
User defined flowrun alarm #11	0
User defined flowrun alarm #12	0
User defined flowrun alarm #13	0
User defined flowrun alarm #14	0
User defined flowrun alarm #15	0
User defined flowrun alarm #16	0

Memory Status

If you are connected **directly** or **remotely** to a Scanner, the Memory Status tab provides you with information about the Scanner.

Click on the ***Memory Status*** tab to determine how much memory (**RAM** and **NVRAM**) is both available and free in the Scanner.

In addition, ScanWin LITE shows how much memory is available for the **User Change Log**. Thus, you are able to gauge when it is necessary to perform a download.



When the user change log is full, Data Collection using ***Get Everything… From This EFM / RTU*** must be performed before parameter changes can be made. See the Setup dialog box on page 50.

Memory Usage in Scanners

The amount of RAM and NVRAM available depends upon the software and the hardware options installed in each Scanner. This can be checked for each Scanner by looking at the Memory Status screen.

A Scanner 1130 can have either 32K, 64K, 96K or 128K of NVRAM and either 32K or 64K of RAM. Depending on the firmware, the Scanner 1131 and the Scanner 1140 may have the following amounts of RAM.

Firmware	***1140 RAM***	***1131 RAM***
Versions 4.2.0 and below	32K / 64K	64K / 96K
Versions 4.3.0 and above	64K / 96K	128K / 160K

Below is the amount of memory available for Scanners 1130, 1131 and 1140 with the maximum amount of NVRAM and RAM stuffed. (Note that NVRAM = Total Memory - RAM)

1130 (64K RAM/128K NVRAM)		***1131*** (96K RAM/416K NVRAM)		***1140*** (64K RAM/192K NVRAM)	
TYPE	***FREE/TOTAL***	***TYPE***	***FREE/TOTAL***	***TYPE***	***FREE/TOTAL***
RAM16:	XXXX/2423	RAM16:	XXXX/3036	RAM16:	XXXX/2420
RAM128:	XXXX/127	RAM128:	XXXX/255	RAM128:	XXXX/127
NVRAM16:	XXXX/1758	NVRAM16:	XXXX/6983	NVRAM16:	XXXX/1758
NVRAM128:	XXXX/746	NVRAM128:	XXXX/2255	NVRAM128:	XXXX/1249

Approximate memory usage for various accessories: Memory usage available for accessories is independent of the Scanner model (1130, 1131 or 1140). All numbers are in terms of memory **blocks** (which are either 16 or 128 bytes each and are displayed in the Memory Status screen). To convert blocks to bytes, multiply the number of blocks by 16 or 128. All numbers are estimates, which are accurate to within about ± 10%.

	RAM 16	***RAM 128***	***NVRAM 16***	***NVRAM 128***
Basic System Overhead[7]	~810	~80	~280	~150
Creating Event Log Creating User Change Log	Included in the basic system overhead			
Creating Flowrun Hourly History[8]	0	0	20	((items * 4 + **15**) * days * logsperday) / 120
Creating Flowrun Daily History[8]	0	0	20	((items * 4 + **15**) * days) / 120
Running AGA8(92) Detailed Flowrun	65	18	0	0
Running Manually Entered Flowrun	49	18	0	0
Creating Data Logger	0	10	19	(items * days * logsperday) / 31
Running Data Logger	0	10	0	0
Adding Local Display Item	0	0	2	0
Creating Combiner	0	0	8	0
Running Combiner	0	0	0	0
Creating Controller	4	0	18	0
Running Controller	0	0	0	0
Creating ScanCom Network	0	0	7	0
Running ScanCom Network	341	28	0	0
Creating Modbus Network	0	0	7	0
Running Modbus Network	80	18	0	0
Creating Enron Modbus Network	0	0	42	0
Running Enron Modbus Network	80	0	0	0
Running Modbus Gas Chromatograph	195	12	45	0
Running Alarm Callout	4	0	6	0

[7] This depends upon the version of software installed and what accessories are in that software. This is the amount of memory allocated to static accessories (i.e., those that don't have to be created by the user such as the Gas Chromatograph, Local Display, etc.). This can be accurately estimated by superbooting the Scanner and deleting all the default flowruns. These numbers are more like a maximum.

[8] The **'15'** includes date-time, measurement status and flowtime.

Chapter 6: HARDWARE

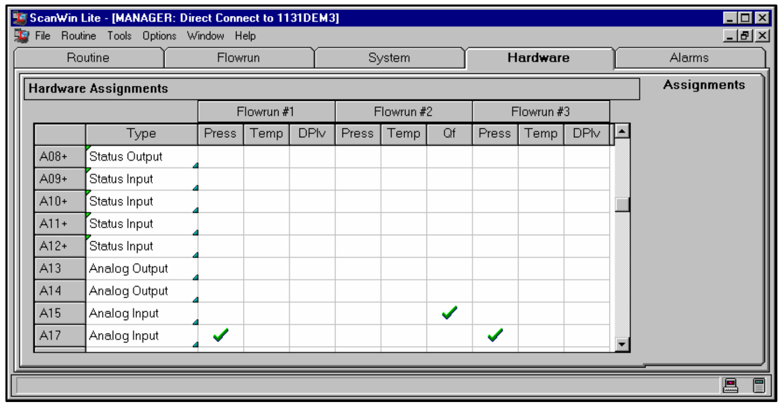
ScanWin LITE gives users the ability to view all inputs and outputs, including resources on expansion boards.

Assigning a hardware resource to a flowrun must be performed from the ***Flowrun*** tab. For more details, refer to **Chapter 4 – Assigning Inputs, Outputs and Alarms (page 90)**.

Note: The Slot and Resource have been combined into one list box.

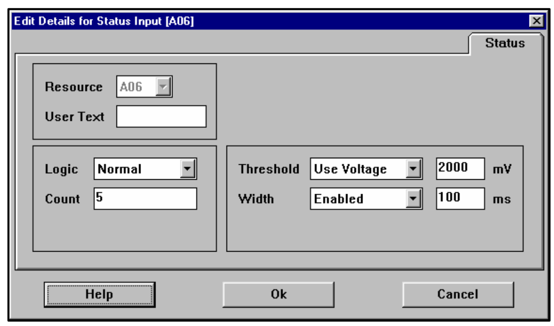
Assignments Tab

When the Hardware tab is opened, the resources being used in each flowrun are displayed. Check marks are used to indicate the assignments.



Multifunctional Resource Types

Multifunctional resources are resources that can be assigned as pulse outputs or status inputs/outputs. For example, the 1130 Scanner has two multifunctional resources located at the A15 and the A16 slots. In this case, they can be assigned as Pulse or Status Outputs.



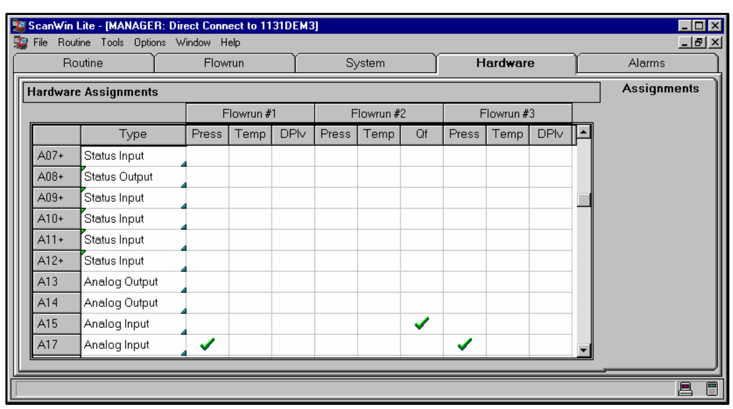
Multifunctional resources can be assigned ***ONLY*** from the **Hardware - Assignments** page.

Assigning Multifunctional Resources

1. Click on the ***Hardware*** tab. Then select the ***Assignment*** tab (if necessary).

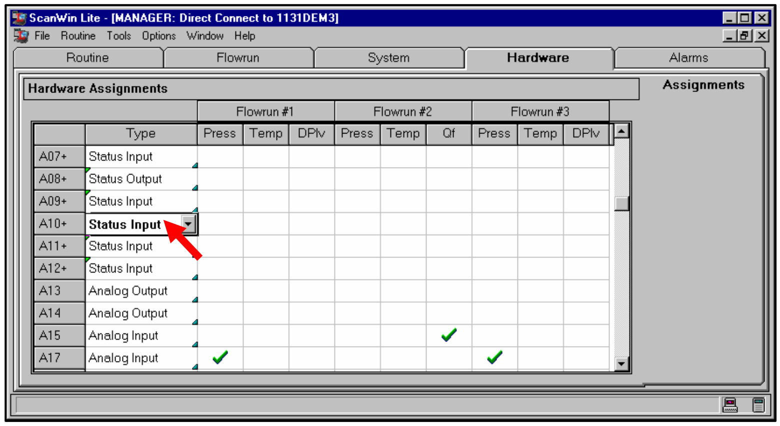
   On the 1131 Scanner, Resources A07 through A12's short tags are marked with a plus (+) sign to denote that they are multifunctional resources.

   In this example, the A07 through A12 boxes in the ***Type*** column have **green triangles** in the **upper left** corners. These triangles indicate that each of these



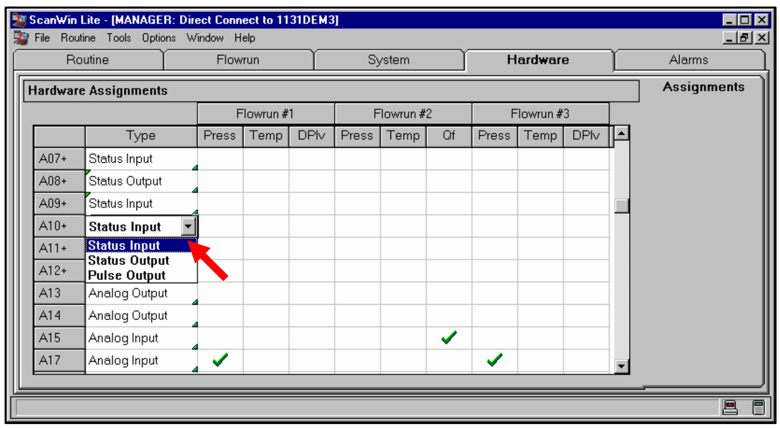
resources are unused and may be selected as either Pulse outputs or as Status inputs/outputs. The triangle disappears when a resource is assigned.

2. To assign a resource, click on the ***Type*** field of the resource you wish to assign. A pull-down arrow will appear to the right of the resource.



3. Click on the resource type field a second time or click on the down arrow) to view the assignment options available.

   Click on the resource type of your choice.



4. Double-clicking in the box allows you to configure the resource as an input. Refer to Step 3 of the **Status Input Setup** section below.

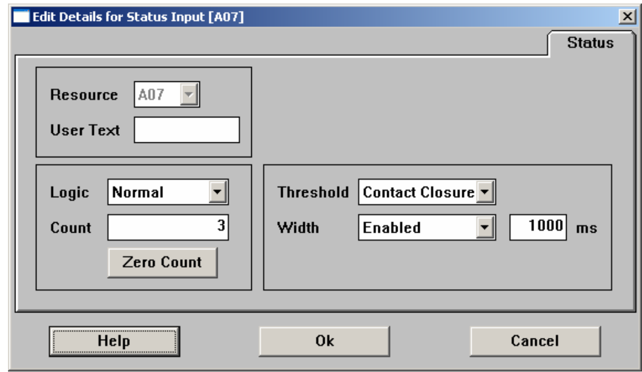
> ***Note***: See **Assigning Inputs, Outputs and Alarms – (page 90)** for details about assigning the resources.

Status Input Setup

Status inputs have the ability to count slow-going input pulses based on a minimum pulse width. Note that Status Input is used for the following:

- the CFG lockout switch assignment (on the Scanner 1130)
- the Measurement Status input assignment (#1 and #2)
- bi-directional flowrun (for flow direction indicator)

1. Connect to a Scanner. Click on the ***Hardware*** tab.
2. To configure a status input, open the desired ***Status Input*** resource by ***double-clicking*** on the **Status Input** box.
3. You will be presented with the following:



Use the following as a guide for changing the settings:

User Text	***User entered text***
Logic[9]	Logical action of the input (either **Normal** **=1** or **Inverted** **=0**).
State[9]	Displays the current state of the input (**ON** **=1** or **OFF** **=0**).
Threshold	Threshold voltage (0, 2.0, 7.0, or 10.0 volts) or Contact
Width	The minimum pulse width to be detected from 400 msec up to 60000 (60 seconds).
Count	The number of pulses detected since the count was last cleared. To clear the count, simply press the Zero count button.

Click ***Ok*** when you are finished.

Note: The pulse counting feature is active whenever the width parameter is set to a number other than zero. When it is active, it is a drain on the power/CPU of the Scanner (especially at low pulse widths). It is recommended that the width be set to zero unless the pulse counting or switch detection of the pulse input is required. The user may have to reset the width after uploading an old configuration.

The count and width parameters are accessible over ScanCom. Please refer to ***ScanCom 3.42 ADEPT Implementation manual, Appendix D - Status Input (Resource Type 1) Parameter****s* for further details.

If the user text of a status input has text entered and there are no other users assigned to the status input, the event log will record when the status input changes state. Note that the status input is sampled once every 1/2 second or so.

[9] number in **=n** represents value used by EFM/RTU for communication protocols (e.g. ScanCom and Modbus)

Chapter 7: ALARMS

System and Flowrun Alarms

The ***Alarms*** tab allows you to view, clear, and define the output of system and flowrun alarms. Hardware alarms become ***Active*** when a device goes out of range. Flowrun alarms can be configured to be user-acknowledging (latched) or self-acknowledging. Flowrun alarms can be set as latched in the Alarm Configuration accessed from the Flowrun > Add Destinations dialog.

Viewing Alarms

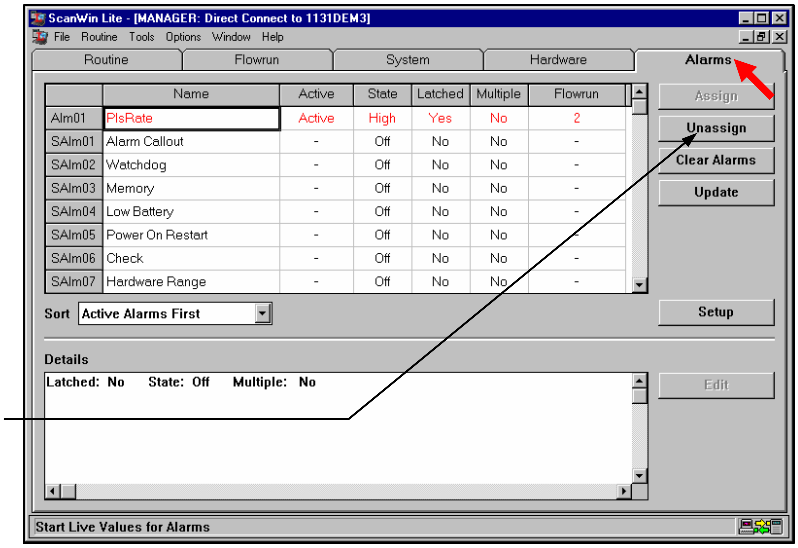
Click the ***Alarms*** tab to display this dialog.

Note: Alarms are indicated by the word "**Active**" in the second column.

The alarms may be ***sorted*** on one of three criteria:

- **Active** alarms first or
- **Flowrun** alarms first or
- **System** alarms first.

See the **Unassigning Alarms** section on the next page.



There are up to 16 user-configured alarms and nine pre-configured alarms.
The following table describes the pre-configured alarms that exist in ScanWin LITE.

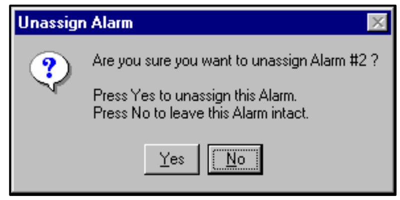
Alarm Description	*Notes*
Alarm Callout Status	Set to latched+on if active alarms in alarm callout.
Watchdog Alarm	Set to latched+on if watchdog alarm in Alarm queue.
Memory Alarm	Set to latched+on if RAM/ROM/NVRAM alarm in Alarm queue.
Low Battery Alarm	Set to latched+on if low battery alarm in Alarm queue.
Power On Alarm	Set to latched+on if power on restart occurred.
Check Alarm	Set to latched+on if any flowrun check alarm in Alarm queue.
Hardware Range Alarm	Set if any hardware range alarm in Alarm queue.
Measurement Status 1	Set to latched+on if measurement status in 1 is on.
Measurement Status 2	Set to latched+on if measurement status in 2 is on.

Clearing Alarms

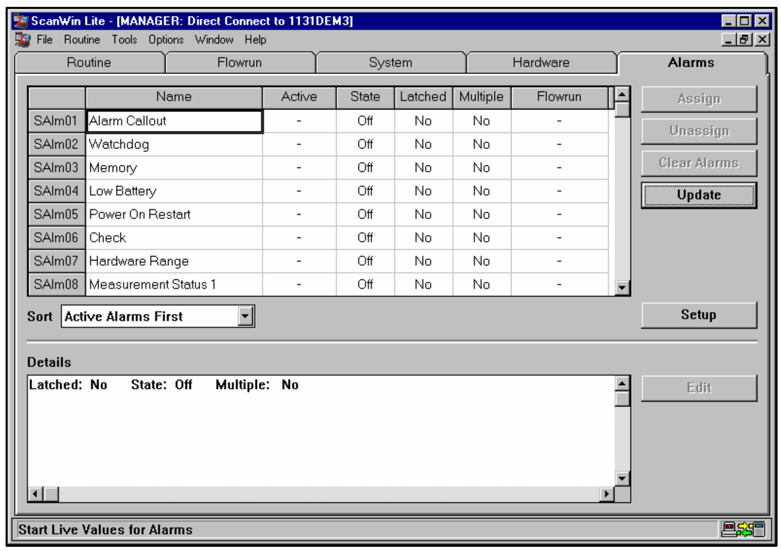
Pressing the ***Clear Alarms*** button removes the **Active** indicator of an alarm. If the **Active** status remains on, this is an indication that the setting causing the alarm remains in effect, or that the alarm is set for ***latching***. Latched alarms require acknowledgment by the user before they can be removed.

Unassigning Alarms

A user alarm may be cleared from this page by first selecting the alarm in any of the fields in that line (refer to picture on **page 125**). Then click the Unassign button on the right side of the window. This warning is given.

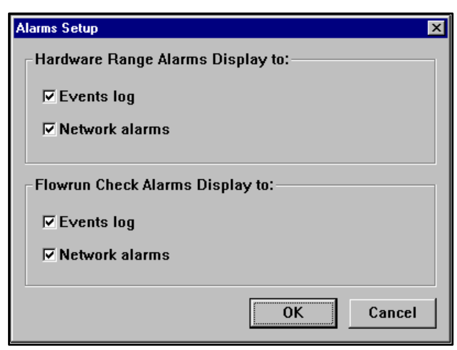


Click ***Yes*** to remove the assignment.



Output of Alarms

The ***Setup*** button allows the user to specify whether alarms are displayed in the **Events Log** or the **Networks Alarms**. Click the ***Setup*** button to display this box. Then, check the appropriate boxes to indicate your choices, and click ***OK***.



Chapter 8: Communications Setup

About Communications

ScanWin LITE is a graphical interface between you and the hardware. It allows you to

- connect **DIRECTLY** to a single Scanner to (a) configure it; (b) view live values, and (c) collect historical data. The SCM Viewer, is included on the ScanWin LITE installation CD for viewing the historical data downloaed with ScanWin LITE. For instructions on using SCM Viewer, see the SCM Viewer manual.
- connect **REMOTELY**, to different Scanners through a configured communication media (e.g. modem, radio, etc.). You are able to perform all the functions of a **direct** connection, including analysis and troubleshooting.

Defining Devices

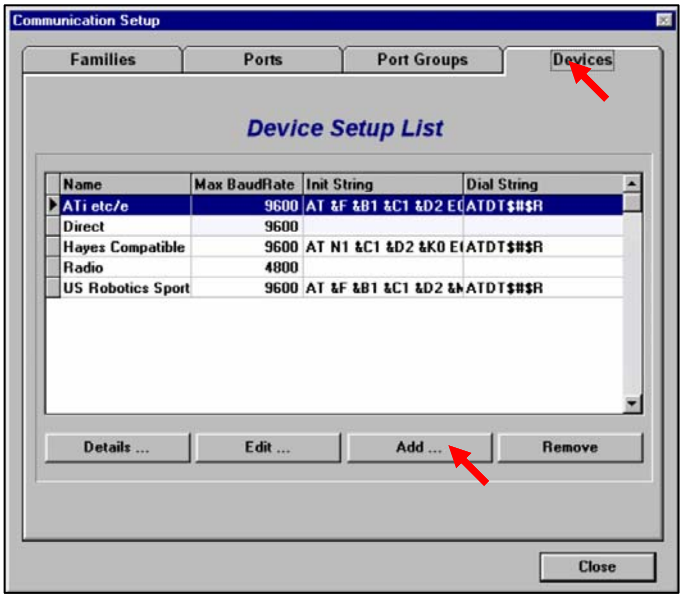
Communication devices that are supported by ScanWin LITE include radios, modems, direct connections, and multi-drop line drivers.

Adding a Device

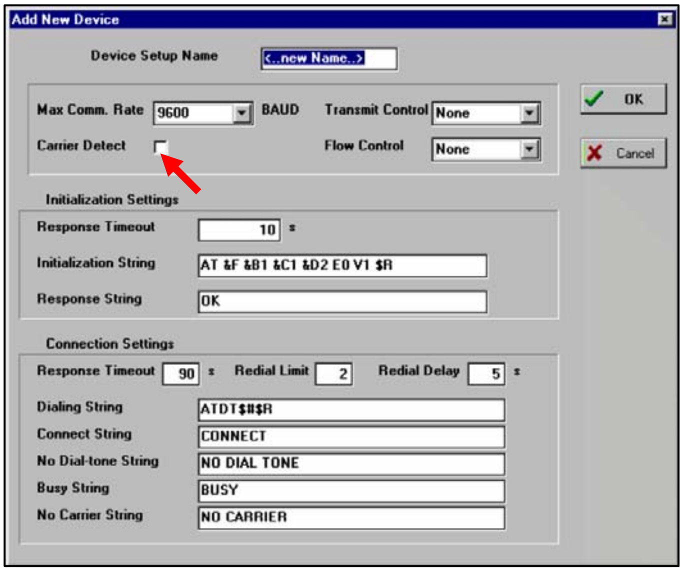
If your communications device is not listed in the Device Setup List shown below, you can add it by editing the attributes of another device and saving the setup under a new device name.

To add a new device:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box shown at right.
2. Click the ***Devices*** tab to display the **Devices Setup List**.
3. Click the name of the device that has attributes that are most similar to those of the new device.



4. Click ***Add*** to display the **Add New Device** dialog box.
5. Enter a name for the new device in the **Device Setup Name** field.
6. Click ***Carrier Detect*** if the device is a modem. An X appears in the check box.



Modify the attributes as required:

In this field…	***Enter the…***
Max Comm Rate	Maximum baud rate that the modem can handle.
Transmit Control	Type of transmit control: • Select none for modems. • Select DTR to detect transmit and receive. • Select RTS to return transmit and receive. Use this option for radios.
Flow Control	Type of flow control: • Select none when you use ScanWin LITE. • Select DTR to detect transmit and receive. • Select RTS to return transmit and receive. Use this option for radios.
Response Timeout	Number of seconds that the host system will wait for a signal back response after an initialization string is sent to the modem. This is usually 10 seconds.
Initialization String	Command sequence that the host sends to the modem at the Scanner to prepare it to communicate. This command reconfigures the modem. ScanWin LITE waits for an OK signal back (usually within 10 seconds).
Response String	Response string from the modem. The host system must receive this before data transmission can begin. The only response used is OK. If the ***OK*** is received, ScanWin LITE creates the Dial string using the unique telephone number for that Scanner. If the ***OK*** is not received, ScanWin LITE logs a time out error and the communications attempt is stopped.
Response Timeout	Number of seconds that the host system will wait to receive a connection response from the modem. This is usually 90 seconds.
Redial Limit	Maximum number of times that the host will dial if the dialing fails. If you enter 2, the host will dial 3 times.
Redial Delay	Number of seconds that the host will wait before attempting to redial. This is usually 5 seconds; the maximum setting is 60 seconds to avoid a time out in ScanWin LITE.
Dialing String	Command sequence used to make the telephone call to the Scanner. If your communication system requires you to dial 9 before the number, include the 9 in the dial string, for example: $1 ATDT, $#$R does not have the 9. $1 ATDT9, $#$R has the 9 inserted.
No Dial-tone String	String you want returned if there is no dial tone. This is usually **NO DIAL TONE**.
Busy String	String you want returned if there is a busy signal. This is usually BUSY.
No Carrier String	String you want returned if the modem dialed but could not maintain a connection within the specified time limit. This is usually **NO CARRIER**.

7. Click ***OK***.

Common Initialization Settings for Modems

The following initialization settings ***apply only to dial-up modems***. If the device is ***not*** a dial-up modem, leave the fields blank.

This string…		***Does this…***
Initialization String	AT	Precedes all modem commands.
	SF	Indicates what follows are variations from factory settings.
	SC1	Turns the carrier detect light on the modem on and is useful for analyzing problems
	SCO	Sets the carrier detect light to on at all times
	DT	Indicates a dial tone modem.
	DP	Indicates a pulse or rotary telephone.
	SD2	Allows the computer to hang up the modem using the DTR setting and a required code.
Response String		***OK*** or nothing.
	EO	Sends a command not to echo commands. When a command is sent to the modem, it can be echoed back so the person can see what was typed. This can cause ScanWin LITE problems so it is important to use this string.
	V1	Requests verbose result codes to display as lines of text to make the feedback from the system user-friendlier for troubleshooting.
	V0	Requests numeric result codes for troubleshooting.
	&K0	Turns all flow control off. This setting does not exist on all modems. If available, use it.
	&B1	Lists the serial port speed setting of the modem for ATI modems only. This is the speed at which the modem actually connects to another modem.
	$R	Adds an Enter (end of message) code at the end of the initialization string. This is a special code used by ScanWin LITE.
	&Q0	Compresses data. Do not use data compression.

Special guidelines for setting up initialization strings include:

- The host system must never answer automatically.
- Do not use data compression.
- Do not use flow control (either software or hardware).
- Do not echo commands.

Example:R1$CAT&F1EO$R

Where

$R = Enter

$1 = Wait One Second

$CAT = Clear Buffer

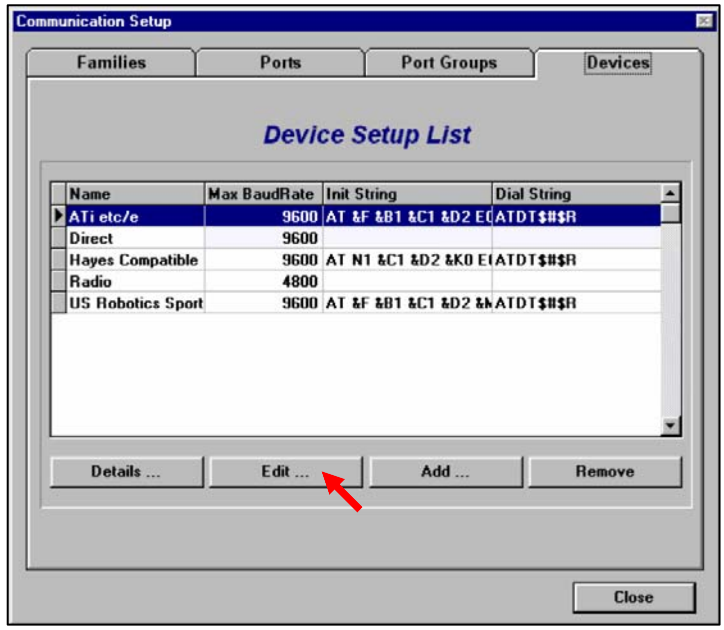
&F1EO$R = Send Initialization Screen

Editing Device Attributes

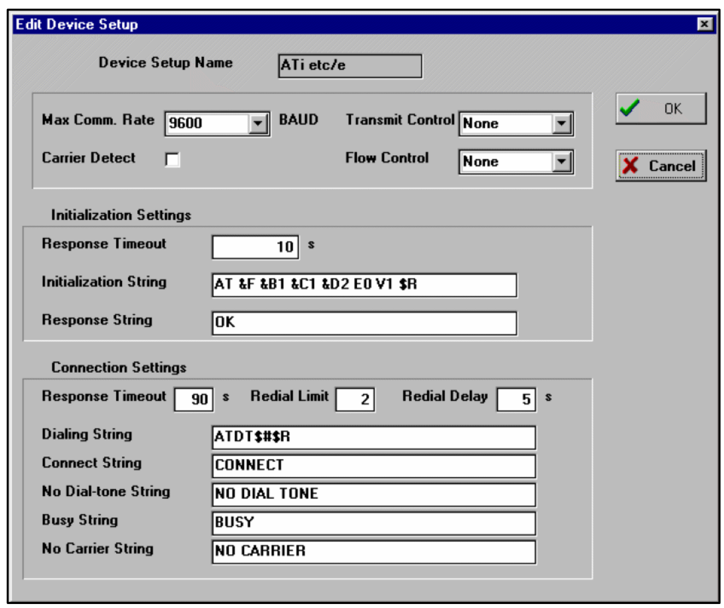
You can edit the attributes of your communications device.

To edit device attributes:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Devices*** tab to display the **Device Setup List**.
3. Click the device name for which you want to edit the attributes.



4. Click ***Edit*** to display the **Edit Device Setup** dialog box.
5. Modify the attributes as required.
6. Click ***OK***.

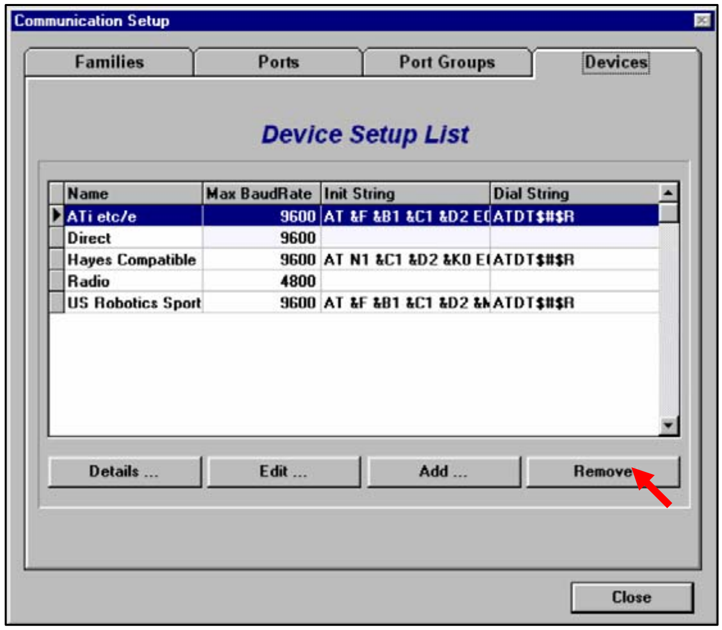


Deleting a Device

If you no longer need a communications device that is listed in the Device Setup List, you can remove it.

To delete a device:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Devices*** tab to display the **Devices Setup List**.
3. Click the device name that you want to remove.
4. Click ***Remove***. ScanWin LITE displays a dialog box asking you to confirm the deletion.
5. Click ***Yes*** to remove the device.



Defining Port Groups

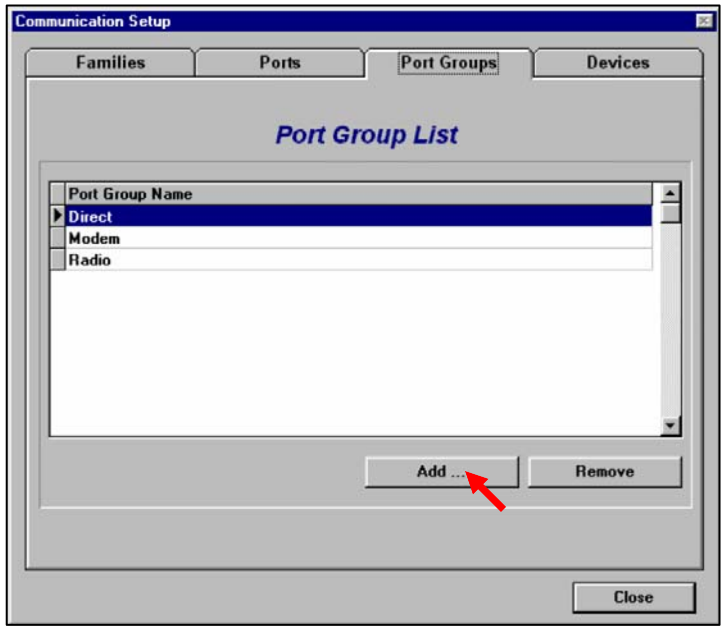
You can define port groups to pool dial out modems together so that any port or modem attached to the same PC can call any Scanner. This rule only applies to modems. Line drivers, radios, and direct connections must have a specific port assigned to a specific Scanner and cannot pool ports together.

Adding a Port Group

You can add new port groups in the ***Port Groups*** page on the **Communications Setup** dialog.

To add a new port group:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Port Groups*** tab to display the **Port Group List**:



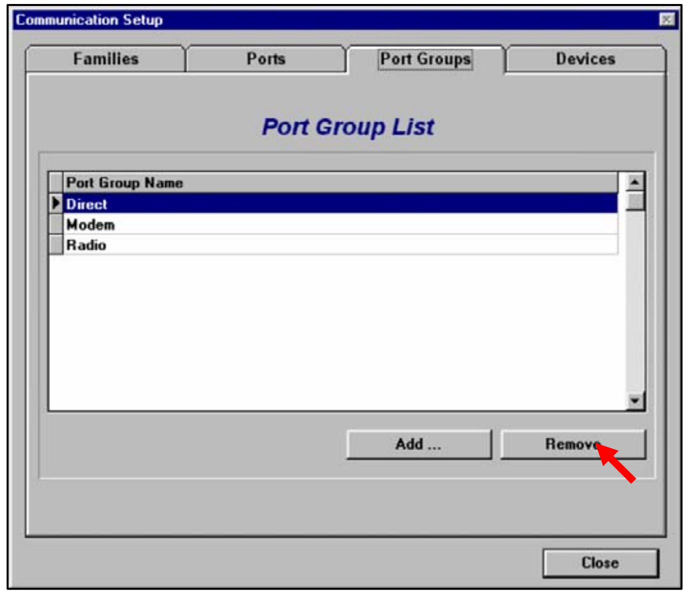
3. Click ***Add*** to display the **Add New Port Group** dialog box.
4. Enter a name for the new port group in the **Port Group Name** field.
5. Click ***OK***.

Removing a Port Group

You can remove port groups in the **Port Groups** page on the **Communications Setup** dialog.

To delete a device:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Port Groups*** tab to display the **Port Group List**.
3. Click the port group you want to remove.
4. Click ***Remove***. ScanWin LITE displays a dialog box asking you to confirm the deletion.
5. Click ***Yes*** to remove the device.



Defining Ports

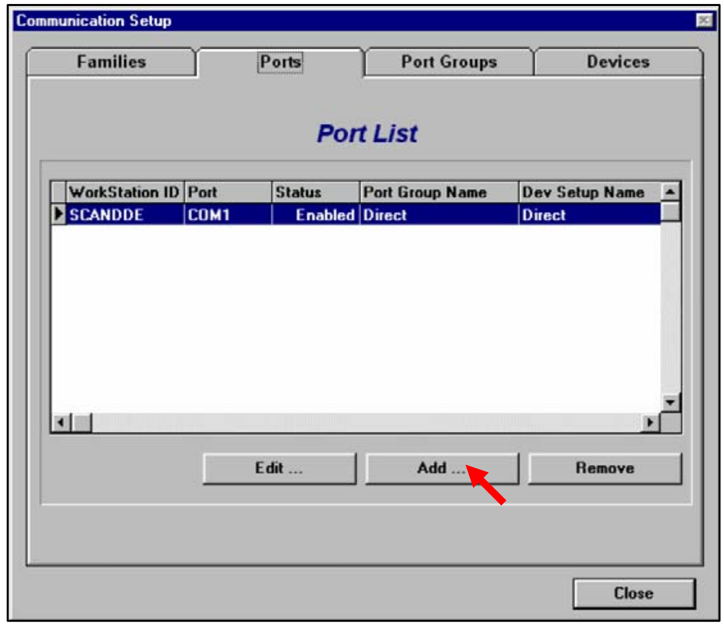
After you have defined the port groups, you can configure ports in the **Communications *Setup*** dialog box. On the **Ports** page, you can add a new port, modify an existing port, or remove a port.

Adding a Port

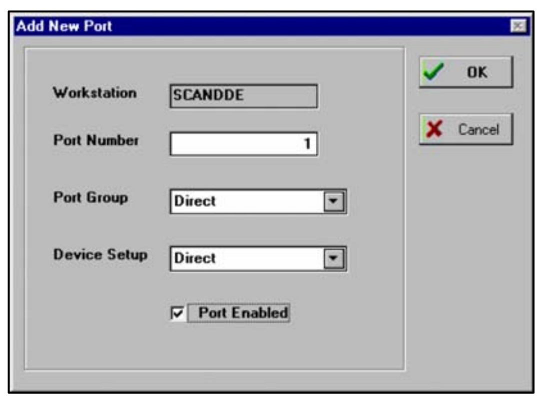
If your communications port is not listed in the **Ports List**, you can add it.

To add a new port:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Ports*** tab to display the **Port List**.



3. Click ***Add*** to display the **Add New Port** dialog box:



4. Enter the following information as required:

In this field…	Enter the…
Workstation	PC name on which ScanWin LITE is installed. If more than one ScanWin LITE will be operating over the network at the same time, each must have a unique Workstation name.
Port Number	Serial port number (4 maximum) on the PC connected to the communications equipment.
Port Group	Name that identifies a pool of dial-out modems that allow any port or modem in that group that is attached to the same PC to call any Scanner.
Device Setup	Devices that are connected to the ports.

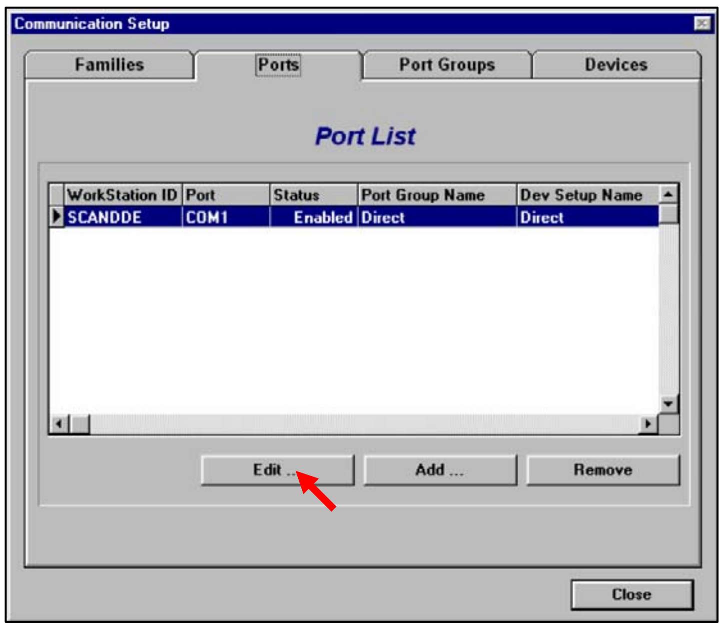
5. Click ***Port Enabled*** to activate the port. An **X** appears in the check box when the port is active.
6. Click ***OK***.

Editing Port Attributes

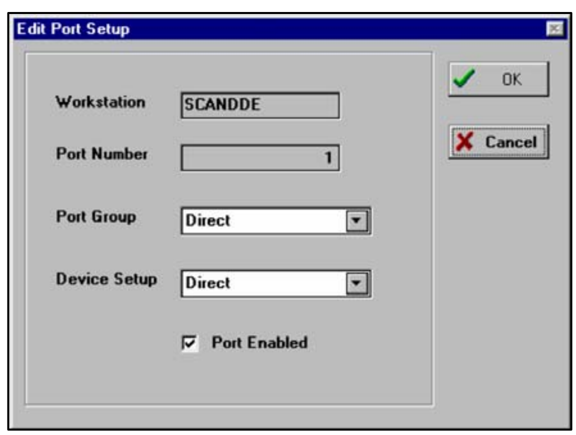
You can edit any port attributes in the **Edit Port Setup**.

To edit port attributes:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Ports*** tab to display the **Port List**.
3. Click the port name for which you want to edit the attributes.



4. Click ***Edit*** to display the **Edit Port** dialog box.
5. Modify the attributes as required.
6. Click ***OK***.

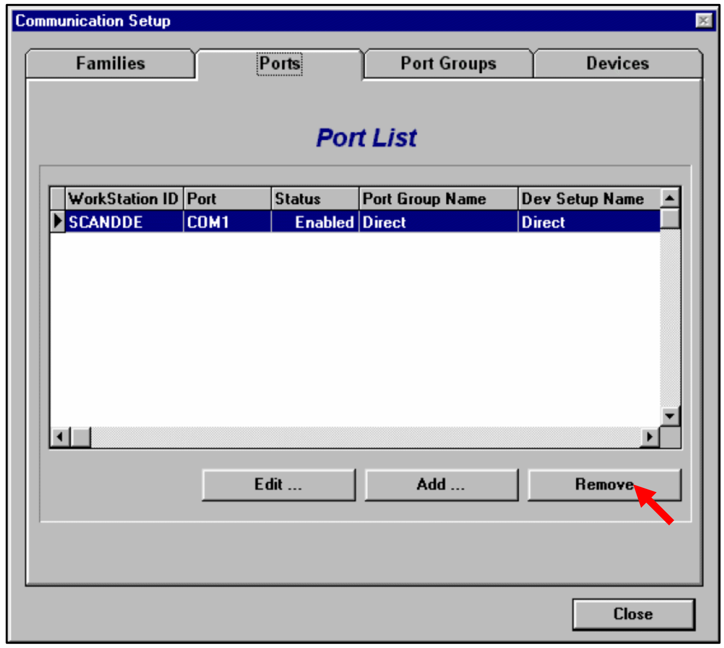


Removing a Port

If you no longer need a communications port that is listed in the **Port List**, you can remove it.

To remove a device:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Ports*** tab to display the **Ports List.**
3. Click the port name that you want to remove.
4. Click ***Remove***. ScanWin LITE displays a dialog box asking you to confirm the deletion.
5. Click ***Yes*** to remove the port.



Defining a Family

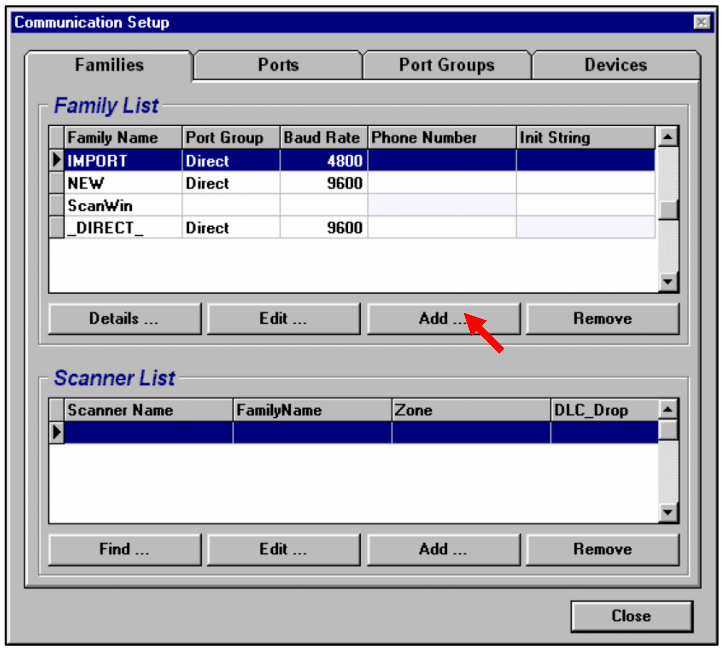
A family is a group of Scanners that can be broadcast at the same time using a single communications link over a broadcast radio system or a multi-drop network. A single telephone number connected to a single Scanner is also considered a family.

Adding a Family

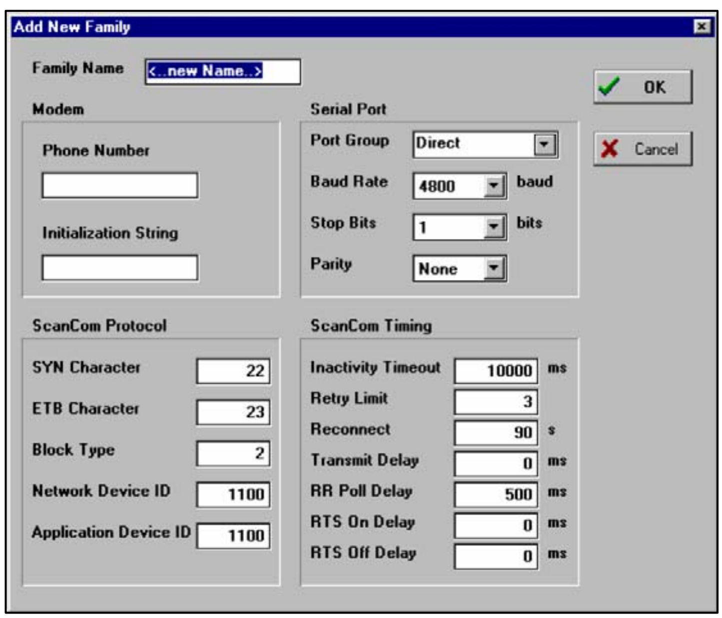
You can add a family in the **Families** page of the **Communication Setup** dialog.

To add a new device:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Families*** tab to display the **Family List**:



3. Click ***Add*** to display the **Add New Family** dialog box.
4. Enter a name for the new family in the **Family Name** field.



Note: Family **_DIRECT_** is used for direct connection. DO NOT DELETE! See the **Connection Configuration (page 31)** dialog at startup.

5. Enter the following information as required and then click ***OK***.

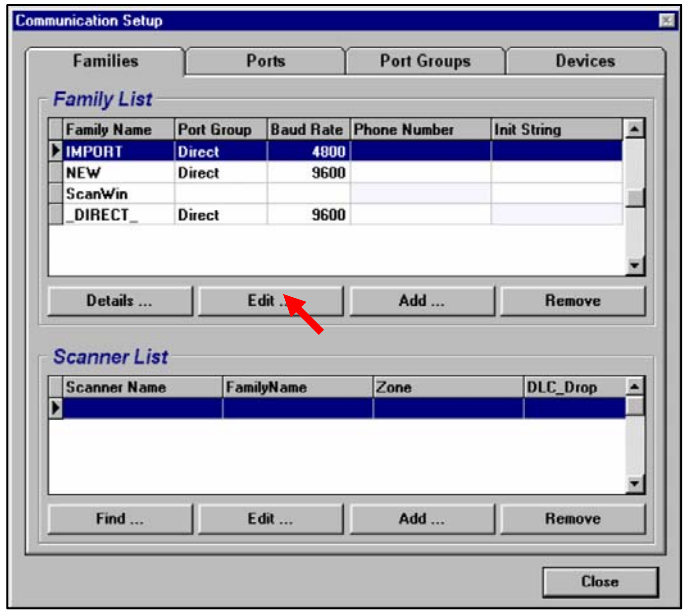
In this field…	***Enter the…***
Modem Phone Number	Telephone number for the Scanner including any special dialing conventions, such as 9 for an outside line.
Modem Initialization String	Initialization string used to initialize the modem.
Port Group	Name of the port group so there is no restriction on which port must be used to complete the communications link.
Baud Rate	Exact speed that will be used to communicate with the Scanner rather than the maximum potential speed of the host modem.
Stop Bits	Stop bits. This should always be set to 1.
Parity	Parity. This should always be set to None.
SYN Character	Do not change this unless advised by a NuFlo technician. SYN Character is the hex character at the start of a packet of data.
ETB Character	Do not change this unless advised by a NuFlo technician. ETB Character is the hex character at the end of a packet of data.
Block Type	Do not change this unless advised by a NuFlo technician. Block Type indicates the size of the packet.
Network Device ID	Do not change this unless advised by a NuFlo technician. Network Device ID sets the network and device for transmission.
Application Device ID	Do not change this unless advised by a NuFlo technician. Application Device ID sets the application and device for transmission.
Inactivity Timeout	Number of seconds that ScanWin LITE waits for a response from the Scanner. The setting should never be less than 5000 and never greater than 20,000. This number should be increased only if repeater delays or satellite delays require it.
Retry Limit	Number of times that ScanWin LITE should try to connect. If the retry limit is reached, the client application is notified and another reconnection attempt occurs after the specified number of seconds.
Reconnect	Number of retries. If there is no response from the Scanner, ScanWin LITE advises all client applications of the failure and automatically makes the indicated number of retries.
Transmit Delay	Delay period between receipt of a response from the Scanner and sending the next command. This value is always zero for a modem and greater than zero if you have a radio repeater system. Systems that can only communicate one direction at a time cannot switch instantly from receive to transmit mode.
RR Poll Delay	Delay period that indicates how long ScanWin LITE will keep the network open and waiting for a response before it communicates again. If this setting is too fast, the Scanner will constantly be polled and likely get busy signals. An ideal setting is usually 500 - 1000 milliseconds.
RTS On Delay	Delay period that indicates how long it takes the radio transmitter to be turned on. This setting is only used with radio systems. Radio systems require a delay after the radio is keyed and before data is sent and again after the data is sent.
RTS Off Delay	Delay period that indicates how long it takes the radio transmitter to be turned off. This setting is never used for modems, only for radio systems and is typically set for 15 milliseconds.

Editing a Family

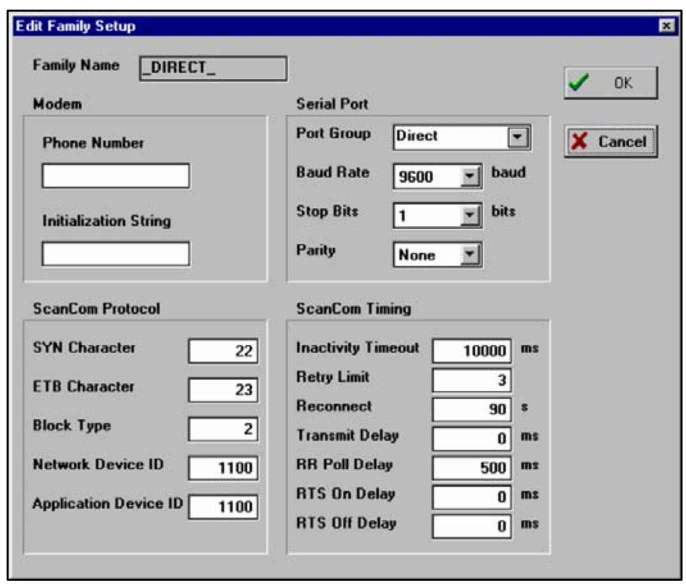
You can edit the family attributes in the **Families** page of the **Communications Setup** dialog.

To edit family attributes:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Families*** tab to display the **Family List.**
3. Click the family name for which you want to edit the attributes.



4. Click ***Edit*** to display the **Edit Family Setup** dialog box.
5. Modify the attributes as required:
6. Click ***OK***.

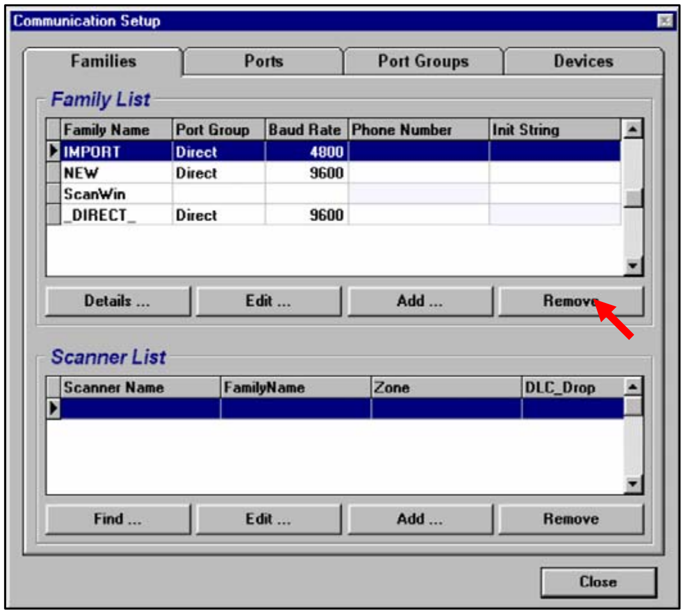


Deleting a Family

You can remove a family in the **Families** page of the **Communications Setup** dialog.

To delete a family:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Families*** tab to display the **Family List**.
3. Click the family name that you want to remove.
4. Click ***Remove***. ScanWin LITE displays a dialog box asking you to confirm the deletion.
5. Click ***Yes*** to remove the family.



Defining Scanners

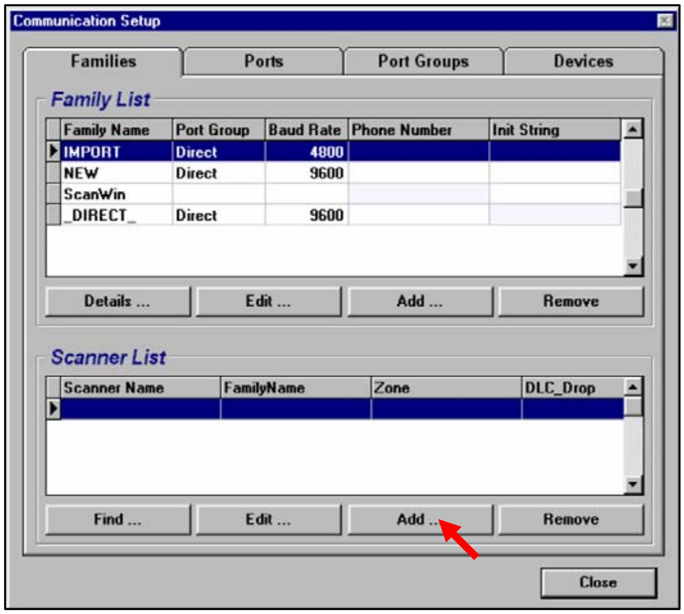
ScanWin LITE allows you to assign Scanners to a family by adding a Scanner to the **Scanner List** in the **Communications Setup** dialog.

Adding a Scanner

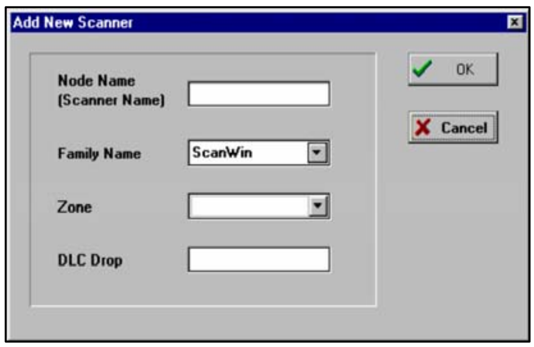
You can add a Scanner to a family in the **Families** page of the **Communications Setup** dialog.

To add a new Scanner:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the **Families** tab to display the **Scanner List**:



3. Click ***Add*** at the bottom of the **Scanner List** to display the **Add New Scanner** dialog box.
4. Enter a name for the new Scanner in the **Node Name** field.
5. Select the family name to which you want to add the Scanner from the **Family Name** drop-down list.
6. Enter a number for the DLC drop (default=1). This must be the same DLC specified in the Scanner settings. This number is critical if there is more than one Scanner assigned to a family as this number defines each Scanner uniquely.
7. Click ***OK***.

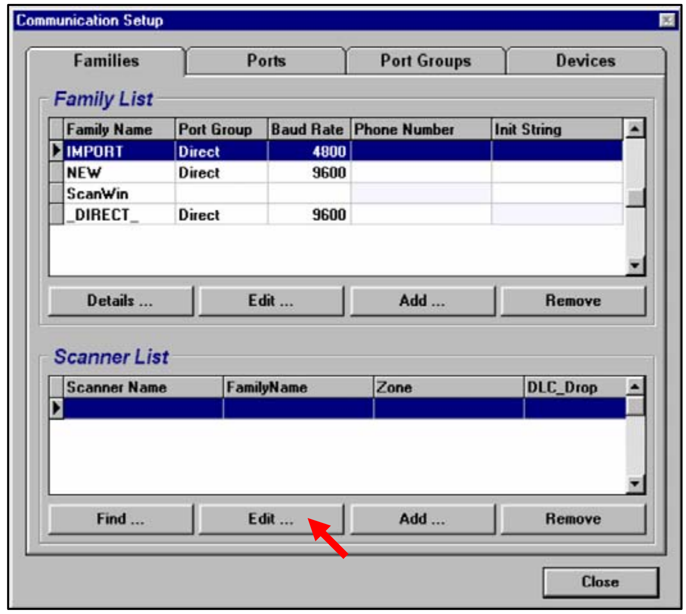


Editing Scanner Attributes

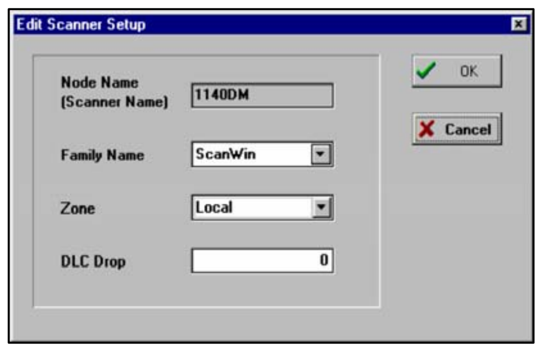
You can edit the Scanner attributes in the Families page of the **Communications Setup** dialog

To edit Scanner attributes:

1. Select ***Tools*** > ***Communications Setup*** to display the **Communication Setup** dialog box.
2. Click the ***Families*** tab to display the **Scanner List**.
3. Click the name of the Scanner for which you want to edit the attributes.



4. Click ***Edit*** to display the **Edit Scanner Setup** dialog box.
5. Modify the attributes as required.
6. Click ***OK***.



Chapter 9: Scanner Theory

About the Scanner

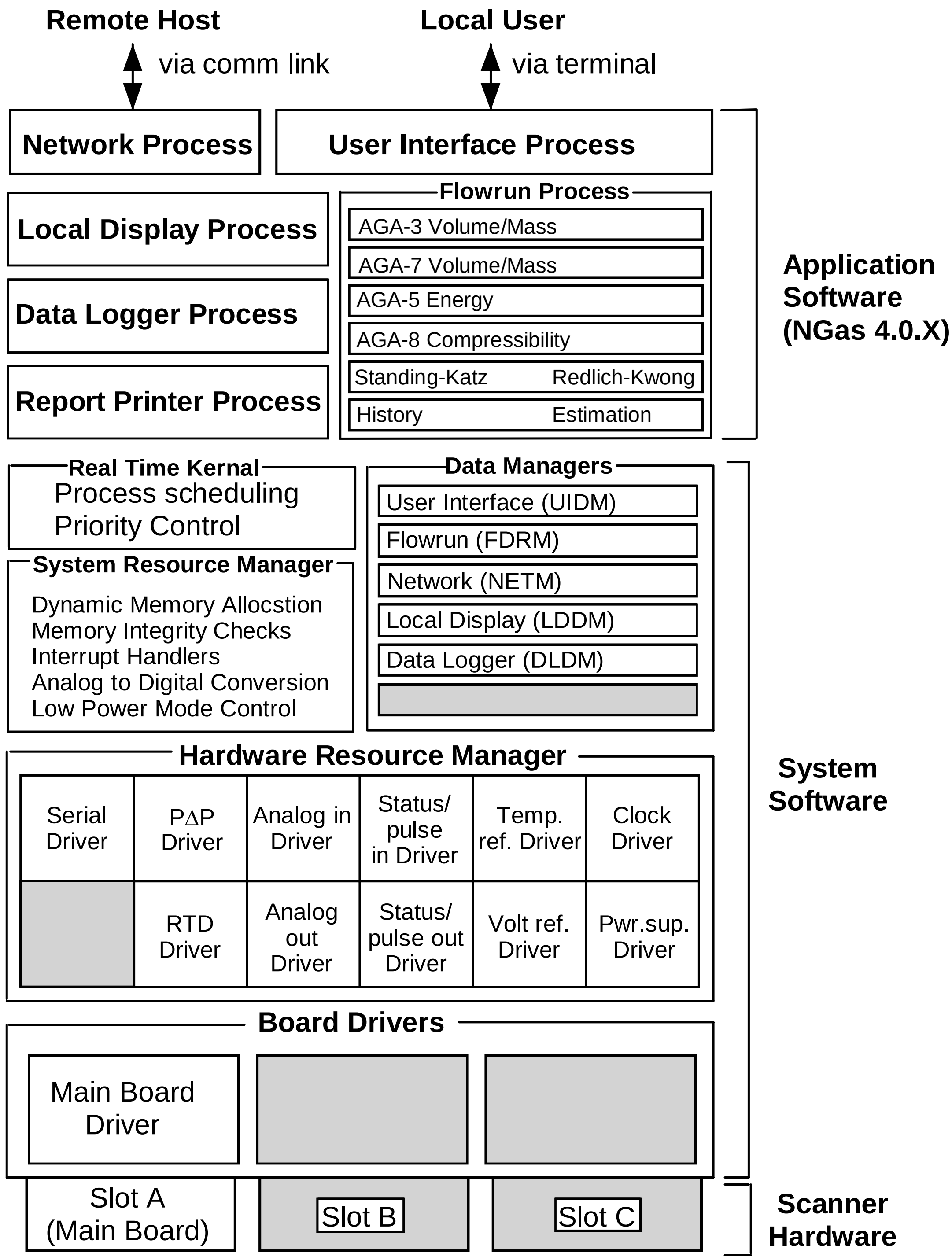
The Scanner employs a multi-tasking operating system. Programs are implemented as multiple processes that are time-sliced by the process scheduler (which is itself a process). Among other things, processes may suspend themselves (or other processes), invoke other processes, or be invoked by hardware interrupts. Several processes are usually active at any given time. Each process is prioritized, some, such as the power-fail, are given very high priority. In its internal mechanisms, the Scanner Operating System more closely resembles OS/2 or UNIX rather than MS-DOS.

The Scanner software is modular on several levels. The main advantage of modular software is enhanced reliability and lower development time. Well-designed modules do not interact with each other in unexpected ways, and can be rearranged in a "building block" fashion, or replaced with other modules. The diagram on the following page shows how the various modules and sub-modules relate to each other, to the user, and to the Scanner hardware.

Most of the Scanner software is written in "C," with some use of assembly language for critical portions, such as the operating system kernel and hardware interface.

Calculations are performed in IEEE-Format Floating-Point, using three levels of numeric precision for different purposes. This is in conformance with the practices recommended by the IEEE standard. In general, parameter data (e.g., user-entered values) are stored in double precision (64-bit) format. Round-off errors are minimized by employing extended precision (80-bit) in the calculations. Historical data is stored in single precision (32-bit), which affords the most compact representation. For further details, consult IEEE Std 754-1985 "IEEE Standard for Binary Floating-Point Arithmetic."

All data stored in the Scanner is secured with a check sum. Check sums are implemented on all nonvolatile data blocks as part of the system memory allocator. A background process periodically checks all data blocks and records any errors in the event log.

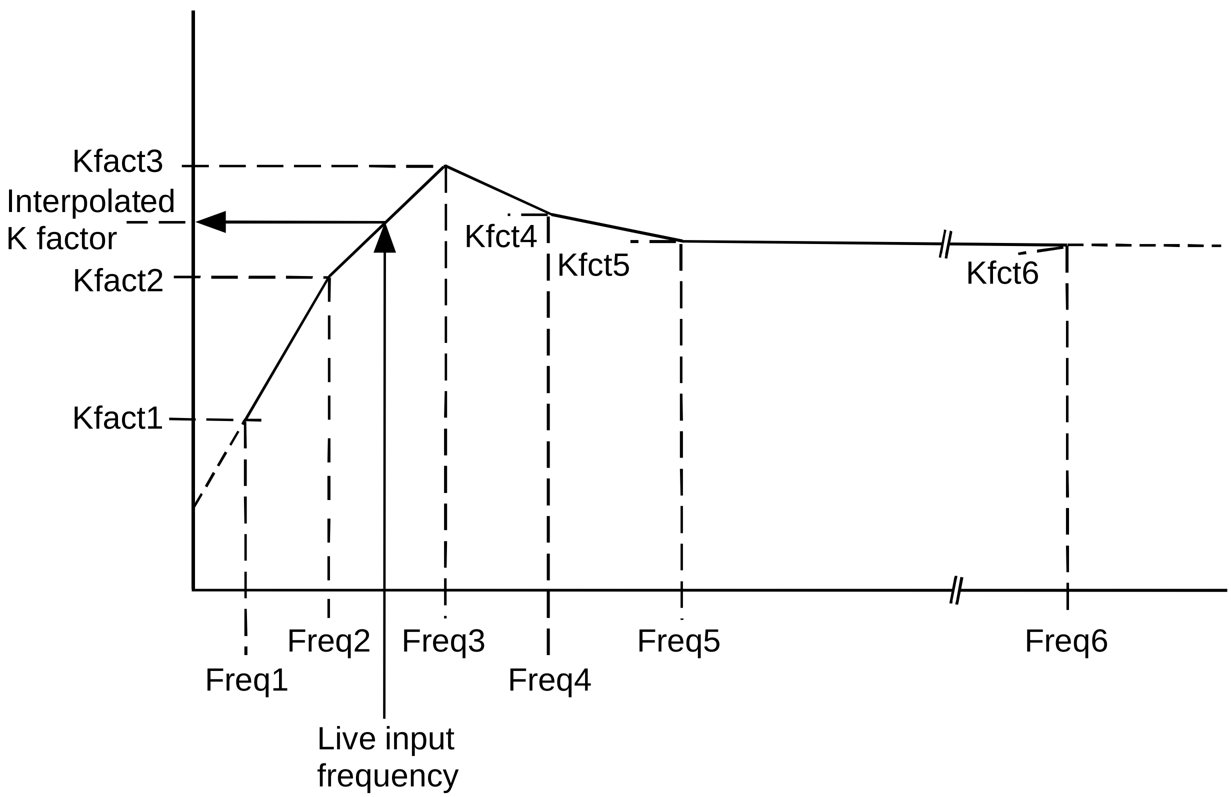

Remote Host
via comm link
Local User
via terminal
Network Process
User Interface Process
Local Display Process
Data Logger Process
Report Printer Process
Flowrun Process
AGA-3 Volume/Mass
AGA-7 Volume/Mass
AGA-5 Energy
AGA-8 Compressibility
Standing-Katz
Redlich-Kwong
History
Estimation
Application Software (NGas 4.0.X)
Real Time Kernal
Process scheduling
Priority Control
System Resource Manager
Dynamic Memory Allocstion
Memory Integrity Checks
Interrupt Handlers
Analog to Digital Conversion
Low Power Mode Control
Data Managers
User Interface (UIDM)
Flowrun (FDRM)
Network (NETM)
Local Display (LDDM)
Data Logger (DLDM)
Hardware Resource Manager
Serial Driver
P∆P Driver
Analog in Driver
Status/ pulse in Driver
Temp. ref. Driver
Clock Driver
RTD Driver
Analog out Driver
Status/ pulse out Driver
Volt ref. Driver
Pwr.sup. Driver
System Software
Board Drivers
Main Board Driver
Slot A (Main Board)
Slot B
Slot C
Scanner Hardware

Techniques

K-Factor Interpolation

The frequency input calibration or table is made up of several K-factors and the corresponding frequency. The software linearly interpolates between points in the table to calculate the K-factor for the input frequency. The following graph shows a K-factor vs. frequency plot for a typical turbine meter.

Note that extrapolation of the first two points (1 and 2) is done to zero frequency; the extrapolation of the last two points (5 and 6) is projected towards a higher frequency.



The following is an example calculation:

Freq2 = 1000	Kfct2 = 345
Freq3 = 1234	Kfct3 = 392

If the input frequency is 1082 Hz, the interpolated K-factor will be 361.47.

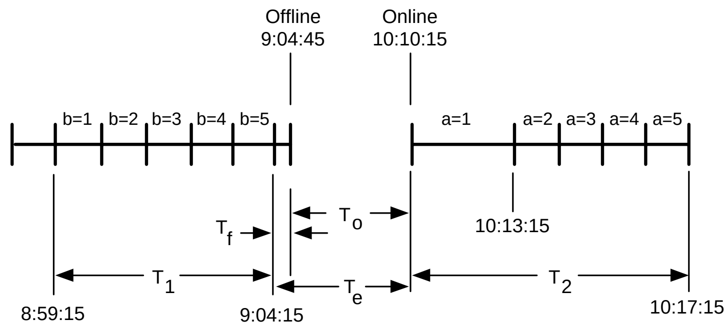
Automatic Estimation

The following occurrences cause a flowrun or system to go offline and an estimation to be performed, if the estimation routine is enabled (see **Est_Enable** in flowrun Configuration Rules - **page 156** (NGas), **page 194** (IGas), and **page 216** (NFlo).

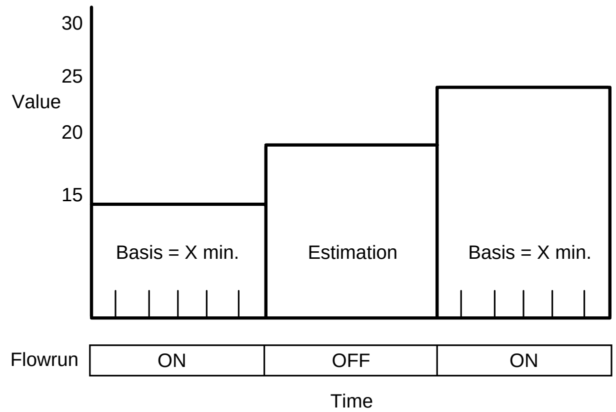
Orifice Plate Change (Only from `Main Menu`)
Gas Data Change (Only from `Main Menu`)
Calibration (Only from `Main Menu`)
Power Failure (if power failure affects sensors)

Prior to the flowrun or system going offline, the flow computer records the history data (averages and accumulation history) from the last hour boundary to the last completed calculation. The flow computer also maintains average history data, based on an operator-entered period (default is 5 minutes). After the flowrun or system comes back online, the flow computer calculates the average history data, based on the same operator entered period. Estimated values for the time the flowrun or system was offline are calculated based on the average history data before and after the flowrun or system was offline. The time stamp for the period of estimation is marked with an (`E`).

At the next hour boundary, the flow computer records the history data since the estimation was done. Records before and after an estimation contain data from a partial hour and are marked by a (`P`) following the time stamp. Daily histories, which contain estimated values, are marked by an (`E`) following the time stamp. The meter run must be back online for a period greater than the number of minutes on which the estimation is based for the estimation to be completed. Flow estimation cannot be performed until "Z" factors have been calculated.



Or more simply illustrated:



Basis default: 5 minutes
Flowrun OFF; -Plate Change
-Gas Composition Change
-Power Failure

History Report (hourly)

96-02-28 09:00:00	Accumulations V, E & M, averages DP, P, T, FE, SG, HV.
96-02-28 09:04:14P	Accumulations V, E & M, averages DP, P, T, FE, SG, HV. (9:00 to 9:04) b=2 through b=5.
96-02-28 10:13:32E	Accumulations V, E & M, (see example calculation) Ve + V2. Averages DP, P, T, FE, SG, HV, T2.
96-02-28 11:00:00P	Accumulations V, E & M, averages DP, P, T, FE, SG, HV (10:13:32 to 11:00:00).
96-02-28 12:00:00	Accumulations V, E, & M, averages DP, P, T, FE, SG, HV.

History Report (daily)

96-02-28 8:00:00E	Accumulations V, E & M.

> ***Note***:
> An **E** is added to the time to indicate that the values are estimated.
> A **P** is added to the time to indicate that the values are for a partial hour.

Estimation Variables

User-Entered Variables:

T_b = The number of minutes to base estimation on. User entered $2 \le T_b \le 30$) as `Estimation...Basis.` T_1 and T_2 represent before and after outage intervals respectively, $T_b = T_1$. T_2 is a longer interval than T_b because an initialization time (a=1) is required to calculate Fpv after the flowrun is turned online.

t = Flowrun calculation time in seconds, for volume and energy, using average DP, P, T, FE, SG, HV. User entered as `Timing...Calc Delay.`

Fixed Constants:

B = The maximum number of calculation buffers = 7 (Fixed).

Calculated Values:

T_f = The time between the last calculation and the meter run outage (0.5 minute in the preceding example).

T_o = The meter run outage time. For the example in the preceding diagrams T_o = 65.5 minutes.

T_e = The estimation interval starts on the last complete calculation interval and ends after the meter run and flow computer are back online.

For the example in the diagram T_e = 66 minutes (1.1 hours); $T_e = T_f + T_o$

N = The number of calculations performed in the estimation interval.

$$N = \frac{T_b}{t} * 60$$

b = The number of calculation buffers in use for interval Tb.

```
if (N<B)        then b=N
if (N>B)        then b=B
```

n = The number of calculations stored per calculation buffer.

$$n = \frac{N}{b}$$ (n is truncated to the nearest integer)

Q_j = The flow, energy, or mass rate for each "t" calculation interval (includes supercompressibility calculation).

Q_n = The average flow, energy, or mass rate for n calculations (If n=1, Q_n=Q_j).

$$Q_n = \frac{\sum_{j=1}^{n} Q_j}{n}$$

Q_1 = The average flow, energy, or mass rate for N calculations or b calculation buffers before outage.

$$Q_1 = \frac{\sum_{n=1}^{b} Q_n}{b}$$

In the example in the diagrams, assume the five values of Q_n for period T1 are 10, 5, 10, 5, 10. Therefore Q_1= 8 m3/hr.

Q_2 = The average flow, energy, or mass rate for N calculations or b calculation buffers, after outage. Q_2 is calculated in the same manner as Q_1

$$Q_2 = \frac{\sum_{n=1}^{b} Qn}{b}$$

In the example in the diagram, assume the five values of Q_n for period T_2 are 10, 15, 10, 15, 10. Therefore Q_2= 12 m3/hr.

Ve = The estimated volume.

$$V_e = \frac{Q_1 + Q_2}{2}\left(T_e\right)$$

For the example in the diagram:

$$V_e = \frac{8+12}{2}(1.1) = 11m^3$$

Energy and mass estimates would be calculated using the same method.

Flowrun Data Flow

The “Flowrun Data Flow” diagrams show the overall data flow in the flowrun process. On the left, each live input is read and converted to engineering units. The internal data flow of this conversion and calibration are shown in the “ATOD Conversion and Calibration” diagram. Once converted, the live inputs are passed on to the *Flowrun Averaging Routine*. The internal workings of this routine are shown in the “Flowrun Averaging (AGA-3)” and “Flowrun Averaging (AGA-7)” diagrams.

The Scanner employs two averaging techniques for all live inputs - full-time averaging and flow-time averaging. Full-time averaging accepts all live input samples no matter what the current flowing conditions are. Flow-time averaging only accepts a live input sample it the run is flowing.

Flow-time averaging provides accurate averaging of live data for flowruns (with fluctuating flowing conditions) since live samples are only included in the average when flow is present. For AGA-3 flowruns, flow is present if the differential pressure is above the cut-off value. For AGA-7 flowruns, flow is present if new pulses are received before the live inputs are sampled.

When a calculation is required, the flow-time averages for SP, T, SG, and Hv are used as well as the full-time averages for DP (FREQ) and FE. Every hour, the full time averages maintained for DP (FREQ), FE, SP, T, SG (optional), and Hv (optional) are placed in the hourly history buffer. On a daily basis, the accumulated totals for volume and energy are placed in the DAILY HISTORY buffer. All history data is stored as single-precision, 4-byte, floating point numbers in the default storage units for the value.

Frequency measurement is accomplished by using a running average of the pulse accumulations for a known interval. Five frequency count buffers, each containing two seconds of pulses, are maintained by the software. These buffers are read every 2 seconds, with the most current data replacing the oldest buffer. When a frequency is required, each buffer is summed and converted to a frequency using the equation:

$$\text{Frequency} = \frac{\sum_{i=1}^{5\ \text{buffers}} \text{buffer}_i}{2\ \text{sec} * 5\ \text{buffers}}$$

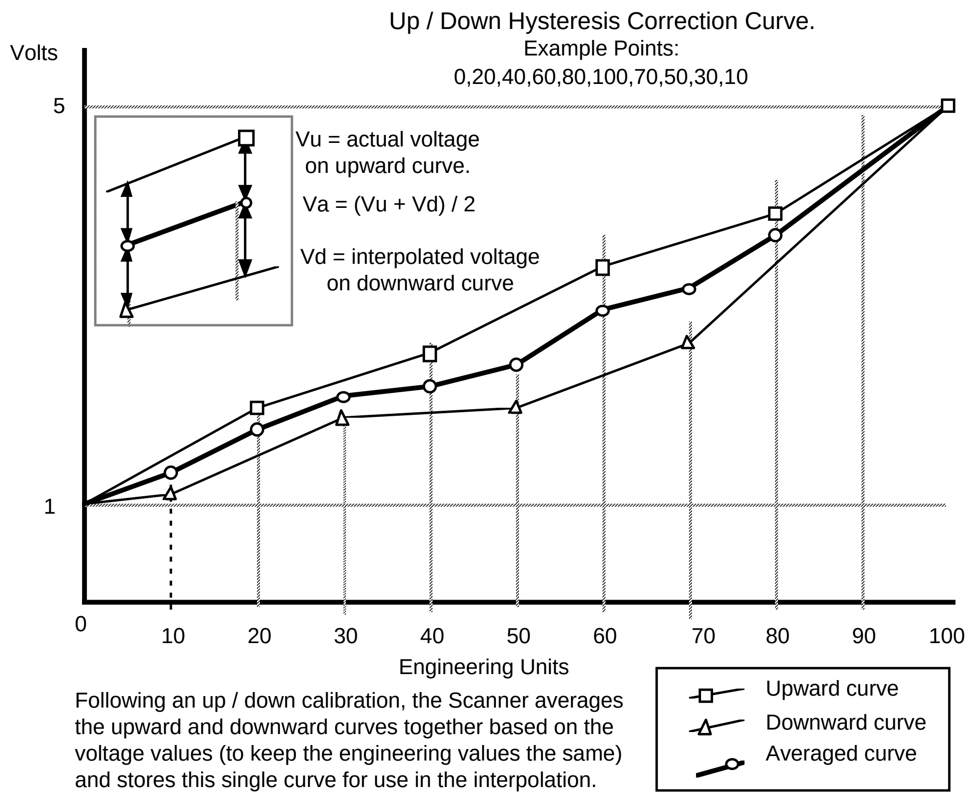
Pulse count to engineering value conversion (using the K-factor interpolation) is accomplished anytime the flowrun reads from the pulse input pulse buffer. If no pulses are counted in the calculation delay period, then “no flow” (no flow time) is logged. To benefit from the K-factor interpolation, the user should have a thorough knowledge of the pulse frequency. It is important that the flowrun reads this buffer at regular intervals, especially in cases where the pulse frequency varies.

The Scanner AGA-7 flowrun reads the pulse accumulation buffer and totals it at the same sample rate that it reads analog input channels. The flowrun maintains an internal sum and uses it when required to do an AGA-7 calculation. K-factor conversion errors are minimized when the sample rate keeps up with varying frequency conditions.

Analog Calibration

Up/Down Calibration

When analog and RTD inputs are configured for up/down or down/up calibrations, the average of the up and down calibration is used to linearize the transmitter and correct for hysteresis.



Example of up/down calibration:

Up-Scale VOLTAGE	Calibration Eng. Value	Down-Scale VOLTAGE	Calibration Eng. Value
1.00	0.00	5.05	100.00
1.80	20.00	3.75	70.00
2.60	40.00	3.10	50.00
3.40	60.00	2.30	30.00
4.20	80.00	1.40	10.00

After the calibration is performed, both calibration tables are combined into a table of voltage values. The engineering values are obtained by averaging the voltages of the up and down curves to form a new curve.

For the example, the new table is as follows:

Calibration Point (IN. WC)	Up-Scale VOLTAGE	Down-Scale VOLTAGE	Averaged VOLTAGE
0.0	1.00	1.045*	1.0225
10.0	1.40*	1.40	1.4000
20.0	1.80	1.843*	1.8215
30.0	2.20*	2.30	2.2500
40.0	2.60	2.641*	2.6205
50.0	3.00*	3.10	3.0500
60.0	3.40	3.439*	3.4195
70.0	3.80*	3.75	3.7750
80.0	4.20	4.237*	4.2185
100.0	5.00*	5.05	5.0250

*-These values were interpolated from the other curve

High Pressure Zero Adjustment

The calibration routine for differential pressure transmitters prompts the user to zero the differential pressure transmitter at "operating" conditions and then at atmospheric conditions to determine the High- Pressure Zero Adjustment, `Hpz`.

E.g. For a transmitter input with the following conditions:

Zero at calibration pressure (atmospheric): 1.000 Vdc

Zero at operating pressure: 0.998 Vdc

The "High-Pressure Zero Adjustment" is equal to +0.002 Vdc.

Chapter 10: NGas 4.X.X Configuration & Calculations

About Flowrun Configuration

NGas 4.X.X is based on industry standards for gas flow measurement, including AGA-3 and AGA-8 (1994). The program supports several gas compressibility methods, including AGA-8, (primary, GCN and HCN methods), Standing-Katz, Redlich-Kwong (with Wichert-Aziz correction for sour gases), and manual entry (single entry or matrix interpolation).

All calculations are performed in SI units, with automatic conversion to other units when it is required. NGas 4.X.X uses flow equations in their simplest form and bases all calculations on mass flow. Volume or energy flow is calculated from mass flow, even for turbine meters. This consistent treatment simplifies the calculations, and allows flowruns to be handled the same way regardless of what primary device is used.

The flowrun configuration is set in the Scanner when the field device is first set up. Configurations are not normally changed but they can be altered in ScanWin LITE. The configuration specifies what is being calculated with which method. The parameters are the second level of information used to set up a Scanner and include gas composition values and physical specifications of the meter. Many of these parameters can be edited in ScanWin. For each flowrun, a configuration record is collected from the Scanner and this configuration controls the calculation routines used in ScanWin LITE.

You can specify up to twelve configuration categories. Options within each category are specified when the field device is configured and you cannot change these options in ScanWin LITE.

Flowrun Configuration Rules

Flowruns created using NGas 2.x and NGas 3.x will have some variations.

Variable Tag	Description	Units / Allowed Values
Run_name	Flowrun name	A user-assigned name for the flowrun. This may contain as many as 10 characters.
Run_Type	Flowrun type	**Gas -** is normally used for natural gas, but can also be used for any other industrial gas such as hydrogen or ammonia. **Monitor** – Refer to **Chapter 13: Monitor Flowrun Configuration** for details.
Method	Volume, Mass, Energy Calculations	**Volume Only**, **Mass Only**, **Volume & Mass**, **Volume & Energy**, **Mass & Energy**, and **Volume, Mass & Energy** establishes what combination of volume, mass and energy will be totaled by a gas flowrun.
Pri_Device	Orifice or turbine	**Differential Producer** is a term for meters that base their measurement on a pressure drop that they induce in the pipe. The most common is the orifice meter. Others include pitot tubes and numerous proprietary devices such as inverted venturi (V-Cone and Wedge Meter). **Linear Volume Meter** includes all true mass flowmeters that produce a pulsed output signal, in which each unscaled electrical pulse represents a discrete volume of fluid. This includes turbine meters, vortex-shedding meters, and positive displacement (PD) meters. **Linear Mass Meter** includes all true mass flowmeters that produce a pulsed output signal, in which each unscaled electrical pulse represents a discrete mass of fluid. Meters of this class are generally based on measurement of coriolis forces. These are usually liquid meters, but some gas coriolis meters are now being manufactured.
Dev_Type	Device type	If you are setting up an *orifice* run, the choices are: **Orifice meter**, **Pitot tube**, **Inverted Venturi, Entered Cd&Y** If it is a *turbine* run, the choices are: **Standard**, **Level B**, **Ultrasonic**
Tap_Type	Orifice pressure tap type	Flange taps
Tap_loc	Orifice tap location	**Upstream** or **Downstream** specifies the position of the static pressure tap with respect to the orifice. If the P and ΔP inputs will come from a Barton DPE™ unit, select upstream taps.
DP_mode	Orifice DP stack/check mode	The options include **Single**, **Dual Stacked**, **Triple Stacked** or **Dual Checking**. DP stacking extends the rangeability of differential producer runs by placing two or three differential pressure transmitters in parallel. The transmitters typically have full-scale ranges in 10:1 ratios. When configured this way, the flowrun automatically selects whichever transmitter is in range, and uses that signal for the flow calculation; out-of-range transmitters are ignored. The firmware program can accommodate DP inputs stacked up to three deep, which provides (in theory), about a 30 or 40-to-one flow rate rangeability from a single meter run. Dual checking mode is intended for critical applications. Two P transmitters are required; the primary and secondary must agree, otherwise an alarm is output.
Dens_srce	Density source	The normal choice is **Calculated**. Other choices include **All User Entered** or **Analog Densitometer** (includes any device, which can provide a density input in the form of a 4-20 mA signal proportional to the actual density at flowing conditions).

Variable Tag	Description	Units / Allowed Values
Gas_Data	Gas data type	This requires that the composition of the gas be fully specified, by entering the mole fractions of each of 21 component gases. Input can be from either manual entry or live from an installed gas chromatograph. **Manual** selects the Z matrix method. **Mole Fractions** extends the normal slate of hydrocarbon gases to include additional gas components. Choosing mole fractions limits you to either the Redlich-Kwong or Standing-Katz Z-factor methods (NGas3.x & 4.x). **GCN** (Gravity, %CO2, %N2), **HCN** (Heating Value, %CO2, %N2) and **GHN** (Gravity, Heating Value, %N2) are associated with a simplified gas quality input used by the "AGA-8 Gross" and "SGERG" methods. They specify various combinations of gravity (i.e. Real Gas Relative Density), gross volumetric heating value and percentages of inerts, which must be added to the calculation. (***Note*** that NGas 2.x also includes **GMCN** (Gravity, %C1, %CO2, %N2) and **GHCN** (Gravity, Heating Value, %CO2, %N2)). For **Pc**, **Tc**, Pc is the critical pressure (kPa [a] or other absolute units). Pc and Tc are thermodynamic constants for a given gas. This option selects a modified Redlich-Kwong calculation, which is suitable for most pure non-hydrocarbon gases, e.g. pure carbon dioxide, pure ammonia, steam or other industrial gases. The Pc and Tc for the gas(es) in question must be calculated and entered into the Scanner.
Z_method	Z method in use	Options depend on what is chosen in Gas Data Type (above): When Gas Data Type is *Manual*, **Matrix** is available. When Gas Data Type is *Mole Fractions*, **Standing-Katz, AGA8(92) GCN, AGA8(92) GHC, SGERG GHN** and **AGA8(92) Detailed** are options. When Gas Data Type is *Extended Mole Fractions***, Standing-Katz** and **Redlich-Kwong** are the options. When the Gas Data Type is *GCN*, the only option is **AGA8(92) GCN.** When the Gas Data Type is *GHC*, the only option is **AGA8(92) GHC.** When the Gas Data Type is *GHN*, the only option is **SGERG GHN**. When Gas Data Type is *Pc, Tc***, Redlich-Kwong** is the only option. **Redlich-Kwong** is the simplest and fastest equation of state provided in NGas. The version used in NGas includes Wichert-Aziz correction, making it suitable for sour natural gas. Redlich-Kwong is most accurate at relatively low pressures (to about 3.5 MPa or 500 psi). It is not recommended for use on custody transfer applications. **Standing-Katz** is another efficient algorithm based on the Standing-Katz graphical method. It includes Wichert-Aziz correction, making it suitable for sour natural gas. It is accurate for pressures up to about 17 MPa or 2500 psi. The options (collectively referred to as the **Gross Methods** (AGA8(92) GCN, AGA8(92) GHC, and SGERG GHN) require only three parameters to characterize the gas. Knowledge of the gravity, heating value, mole percent carbon dioxide and mole percent nitrogen (in various combinations) is all that's needed, rather than the complete list of 21 components. The Gross methods can also be selected after choosing "mole fractions" input, in which case the gravity, heating value, %CO2 and %N2 are automatically computed from the gas analysis. This allows the Gross methods to be used with live input from gas chromatographs. The AGA8 Gross methods are recommended for general natural gas measurement. They are efficient, well suited to low power applications, and nearly as accurate as the AGA-8 Detailed method. The major restriction is the pressure/temperature range and the limits on the gas composition. The range limits are well suited to pipeline-quality natural gas, but may not be suitable for production gas. Note that the temperature, pressure and composition limits must be observed otherwise serious measurement errors may result. AGA Report No. 8 contains a prominent warning that the gross methods should not be used outside the specified limits

Variable Tag	Description	Units / Allowed Values
		The “Gross” methods were originally developed by the European research organization G.E.R.G. (Group Europeen de Recherches Gaziers), and subsequently adopted by the American Gas Association to become a part of the AGA-8. The Standard GERG virial equation (SGERG) includes additional methods that were not adopted by A.G.A. Two of these have been included in NGas; The SGERG GHN and HCN methods are fully consistent with the other “Gross” methods. **AGA8 (92) Detailed** is the most accurate method for finding the compressibility of natural gas. It is also by far the most complex. The calculation is inherently slow, compared to most other methods. Since it requires the processor to be active for several consecutive seconds whenever Z is to be updated, the detailed method is a poor choice for low power applications. For example, in situations where the Scanner runs off batteries and solar panels). You should reserve this calculation for custody transfer meters where accuracy is of paramount importance and an adequate power supply is available. The Detailed Method also requires that a large number of intermediate variables be retained in memory. The amount of RAM installed in the Scanner is generally what determines the number of flowruns that can use this calculation. The **Matrix** is the method of last resort. It extends the utility of NGas to cover gases whose behavior cannot be predicted by any of the empirical methods described above. To use this method, you must fill the matrix with Z factors, which have been determined in advance at various temperatures and pressures. NGas determines the Z-factor by linear interpolation from the matrix. The major disadvantage of this method is that any given matrix is valid only for a single gas composition; a new matrix must be determined any time the gas composition changes significantly. The “Single Z” option is useful in situations where you need to input Z directly (perhaps in order to verify other calculations).
Z_size	Z matrix size	Options are **Single**, **3x3 Matrix**, and **5x5 Matrix**. Note that this Tag appears only when the ***Z method in use*** is **Matrix**. The Single option is useful in situations where you need to input Z directly (perhaps in order to verify other calculations).
Gr_mode	Gravity mode.	The options are **Calculated**, **Entered**, **Live (logged), Calculated and Logged,** and **Entered and Logged**. NGas can calculate the real gas relative density from the mole fractions, or the gravity can be entered. When entered, it must be ensured that the gravity is correct and consistent with the mole fractions. Otherwise, a measurement error will result. This problem does not occur when the gas gravity is calculated. Live input allows gas gravity to be obtained from any device which can provide it in the form of a 4-20 mA signal proportional to the real gas relative density at the reference conditions.

Variable Tag	***Description***	***Units / Allowed Values***
Hv_mode	Heating value mode	When Gas Data is *Mole Fractions*, options are • **Calculated Hvb (Calculated Hm)** • **Entered Hv (Calculated Hm),** • **Live Hv (Logged Hvb and Calculated Hm)** • **Entered Hm (Hv Calculated)** • **Calculated Hvb (Logged Hvb and Calculated Hm)** • **Entered Hvb (Logged Hvb and Calculated Hm)** • **Entered Hm (Logged Hvb and Calculated Hvb).** NGas can calculate the heating value from the mole fractions or it can be user-entered. Live input allows the heating value to be obtained from any device that can provide it in the form of a 4-20 mA signal. Note that when the heating value is user-entered, it ***must be*** correct and consistent with the mole fractions, otherwise a measurement error will occur. This problem will not occur when the gas heating value is calculated.
GC_mode	Gas component mode	Options are **Entered** or **From GC**.
GC_logging	Gas component logging on/off	The options are **User Change Log**, **Hourly Log**, **Daily Log**, and **Hourly and Daily**. This option determines whether updates in the gas composition will appear in the history log for this flowrun, as well as the location of the updates. ***Gas component logging increases the size of the history log***.
Peak_logging	Qb/Press peak logging	The options are **Off**, **Press**, **Qb**, and **Press & Qb**. If selected, the maximum or peak values will be recorded in the history log for the logging interval.
Hrly_Hist_size	"Hourly" History log size	This user-entered value determines the total length of the history logs, i.e. how many days' data will be retained in NVRAM. A log length of 1 to 15 days is appropriate for networked Scanners that are downloaded frequently. 35 days is normal for Scanners that are manually downloaded on a weekly schedule. 60 days may be the prudent choice for units in remote locations. The default unit is **days**. A value of 0 disables this feature. ***Note that there must be enough free NVRAM to accommodate the log.***
Daily_Hist_size	Daily History log size	
Hist_intvl	"Hourly" History log interval	This user-entered value determines how frequently data is recorded during the day. **60 minutes** is the default time. The minimum interval is 5 minutes. ***Note that the shorter the interval, the greater is the NVRAM memory requirement.***
Direction	Flowing direction	These options, **Forward**, **Unspecified**, **Reverse**, and **Status In** are associated with bi-directional meter runs. When equipped with the appropriate input expansion board, the Scanner can use phase discrimination to automatically determine the flow direction through a bi-directional turbine meter. Alternately, a status input may be connected to a valve position switch to inform the Scanner of flow direction. When the status input is asserted, a **Forward** flowrun will totalize while a **Reverse** flowrun (connected to the same status input) will be inhibited.
Q_Calc	Calculation delay	This is the time delay between calculation starts. It does not include the actual calculation time. The default is 60 seconds. To get the faster calculation time, set this value to a lower number.
Z_Calc	Z factor counter	This value (default 5) is a multiple of the calculation delay. This setting causes the compressibility factor to be calculated every fifth flow calculation.
Avg_Freq	Averaging delay	This value is the time delay (in seconds) between averaging starts and does not include the actual averaging time. (Applicable to versions **4.0 and below**.)
Avg_Delay	Averaging delay	This value is the time delay (in seconds) between averaging starts and does not include the actual averaging time. (Applicable to versions **4.1 and above**.)

Variable Tag	***Description***	***Units / Allowed Values***
Avg_Style	Averaging style	The options are **Flowtime**, **Fulltime**, and **0 Flowtime**. Flowtime only averages inputs when there is flow. If there is no flow for the history logging interval (typically 1 hour), Fulltime averages will be logged. Fulltime is always averaged. 0 Flowtime inserts zero values in the history log when there is no flow during the entire logging period.
Est_PC	Estimate during plate changes	This option enables (***green check mark***) or disables (***red X***) the estimation process during routine plate change operations.
Est_Enable	Estimation on/off	This option enables automatic estimation to take place during any period that the flowrun goes offline. ***On*** is indicated with a **green check mark** and ***off*** with a **red X**.
Est_Basis	Estimation basis	This value represents the time (in minutes), before and after a flowrun stoppage, that the values are averaged and used for automatic estimation. The default is 5 minutes.
Flow_check	Flow check limit	This value (percentage) is used to check the flow rate difference before and after a flowrun estimation. It is used to warn of a significant difference in flow rate in case an incorrect plate size is entered during a plate change routine.
Stn_A	Station A assignment	This option enables (***green check mark***) or disables (***red X***) the inclusion of the flowrun totals to Station A.
Stn_B	Station B assignment	This option enables (**green check mark**) or disables (**red X**) the inclusion of the flowrun totals to Station B.

Flowrun Parameters

Normalized Analysis

Normalizing is an operation that forces the gas analysis to add up to 100 percent. This is necessary to avoid mathematical errors in the gas properties calculations. The method that NGas uses to determine the percentage of each component in the gas slate is the same as that used to solve this problem: "You have three oranges, seven apples, nine pears, and two lemons. What is the percentage of each?" As long as the sum of the user-entered gas analyses is exactly 100 percent, the analysis, which appears in ScanWin in flow snapshots and in other reports, will be exactly as entered. Otherwise, the percentage of each component will be shifted slightly to reflect its true proportion.

Base Temperature and Pressure

Since all fluids expand and contract in response to temperature and pressure, fluid quantities expressed as volumes must always have the conditions of temperature and pressure specified. These are referred to as base conditions, symbolized as "Tb" (base temperature) and "Pb" (base pressure). In natural gas measurement, a variety of base conditions is used. Base conditions for custody transfer are specified by contract between buyer and seller. Some commonly used base conditions are:

(United States)	60 F, 14.73 psi
(Canada, UK, Australia)	15 C, 101.325 kPa
(Most of Europe)	0 C, 101.325 kPa (also known as "normal" conditions)

Pipe and Throat Diameters, Temperature Coefficients and Measurement Reference Temperatures

Flow measurement by means of differential producers (which includes orifice meters, flow nozzles, venturis, averaging pitot tubes, and similar devices) is based on knowledge of the exact diameters of the pipe and the meter throat. Since these measurements change with temperature, it is necessary to adjust for thermal expansion in these parts of the meter. "Dr" is the inside diameter of the meter tube measured at a particular temperature "TDref"; similarly, "dr" is the diameter of the throat as measured at the temperature "Tdref".

Different materials have different expansion characteristics. NGas includes the temperature coefficients of commonly used meter construction materials. If the meter is made of some other material, its coefficient(s) of thermal expansion can be entered numerically.

If the meter is an orifice meter, both the diameter and the reference temperature should be stamped on the orifice plate. For other types of differential meters, the information should appear on a data plate, or in documents provided by the manufacturer.

When the selected meter is a V-Cone®, "dr" represents the cone diameter. If the meter is an averaging Pitot tube (Annubar® or similar), "dr" represents the diameter of the strut. For the Taylor Wedge meter, "dr" represents the height of the channel below the wedge. The variable "Dr" (with a capital D) always represents the pipe diameter.

Discharge Coefficient

The discharge coefficient of the V-Cone® meter is provided by the manufacturer. It is typically around 0.84.

Isentropic Exponent

The isentropic exponent is a physical property of a gas. The values to use are:

Natural gases $k = 1.3$
Air, steam $k = 1.4$

For other industrial gases, consult a standard reference such as the *Chemical Engineer's Handbook*.

It is normal practice in flow measurement to use nominal values such as those given above, since the flow calculation is insensitive to the value of k (i.e., there is hardly any effect to the result even when k deviates by 10% or more from its true value).

Viscosity

The viscosity of a fluid is defined as its resistance to deformation. Flow measurement by means of differential producers requires knowledge of the viscosity of the fluid.

When a gas flowrun is configured to use "Gas data = Mole fractions", NGas calculates the gas's viscosity from the composition. If "Gas data" is something other than mole fractions, the viscosity must be entered by the user. The nominal viscosities of some common industrial gases are given below. Gas flowruns are not very sensitive to viscosity, so use of a nominal value provides reasonable accuracy.

Gases	***Nominal viscosity at 15 C (60 F), centipoise***
air	0.0179
natural gas	0.0107
hydrogen	0.0087
argon	0.0220
ammonia (gas)	0.0105
water (vapor)	0.0095

Meter Factors

Normally, differential producers are uncalibrated devices. Equations for predicting a meter's discharge coefficient were originally derived from a large number of experiments performed on meters of similar type. It is usually impractical to calibrate a gas flowmeter that is operating at high pressure. In those few cases where calibration is possible, a means must be provided for adjusting the meter's indicated flow rate to match its actual (calibrated) flow rate. The means provided by NGas is the meter factor table.

Meter factors are normally close to 1.0. A meter factor of 1.05 adjusts the flow upward by five percent. E.g. an indicated flow of 12.345 would be corrected to 12.962; if the meter factor were 0.95, the flow of 12.345 would be corrected downwards to 11.727.

Each meter factor is associated with a Reynolds Number that is determined during calibration.

The Reynolds Numbers must be entered into the table in ascending order, with Re1 having the smallest value and Re9 having the largest value; $Re1 < Re2 < Re3$, etc.

When all entries in the meter factor table are zero, no correction is applied to the flow. If you do not wish to use the meter factor table, simply leave it blank.

Calculated Values

Flow Extension (Differential Producers)

The flow extension is recorded in the history logs, and can be used to recalculate flows from the log entries.

Discharge Coefficient (Differential Producers)

The discharge coefficient is calculated differently for each type of differential producer, usually as a function of Reynolds Number and Beta.

Typical values:

Orifice meters	0.6
Flow nozzles	0.95 to 0.99

Reynolds Number (Differential Producers)

The Reynolds Number "Re" is defined as the ratio of inertial forces to viscous forces. It is a dimensionless, and usually rather large, number. Flow measurement by means of differential producers is made possible by the principle of Reynolds Number Similarity.

Typical values

Re=4000	high viscosity liquid at low flow rate
Re=100000 to 1000000	typical for a gas

Expansion Factor (Differential Producers, Gas Flow)

When gas passes through the meter throat its pressure drops and it expands. This action is reflected in the differential pressure measurement.

The gas expansion factor "Y" is very close to unity under most conditions. The Y factor correction increases as the differential pressure becomes a larger fraction of the static pressure; i.e. Y is most significant in low-pressure metering.

Typical values:

Y = 0.995	(typical pipeline pressure)

Since liquids are incompressible, the expansion factor for liquid flowruns always equals 1.0

Compressibility (Gas Flowruns)

The compressibility of a gas is the amount by which its behavior deviates from the Ideal Gas Law. It is a dimensionless number, symbolized by a "Z", and is the result of a complex calculation based on temperature, pressure and quality of the gas. Note that differential pressure is not involved. NGas computes two Z factors; Zf the compressibility at flowing conditions, and Zb, the compressibility at base conditions.

Typical values:

Zb	0.998	(always close to 1.0; usually 0.99 something)
Zf	0.8 to 1.05	(under typical conditions)
Zf	0.5 to 1.5	(under extreme conditions)

Molar Density (Gas Flowruns)

Molar density is closely related to compressibility. It is the density of the gas expressed in kilogram-moles per cubic meter, or equivalent units. As with compressibility, two molar densities are computed: Mdf (flowing conditions) and Mdb (base conditions).

Typical values:

Mdb	0.04	(typical natural gas)
Mdf	2.3	(typical natural gas at 700 psi)
Mdf	19.3	(typical natural gas at extreme pressure)

Mass Density (All Flowruns)

Mass density is normally symbolized with the Greek letter “θ”. It is the density of the fluid in kilograms per cubic meter or equivalent units.

Typical values:

RHOb	0.7	(typical natural gas)
RHOf	40.6	(typical natural gas at 700 psi)
RHOf	340	(natural gas at extreme pressure)

NGas 4.X.X Flowrun Variables

Variable Tag	Description	Storage Units	Attributes
Alpha D	Pipe Thermal Expansion Coefficient	mm/mm°C	Param
Alpha d	Throat Thermal Expansion Coefficient	mm/mm°C	Param
Beta	Diameter Ratio	-	Calc
Btot	Total Volume (Base Conditions)	M3	Total
Ca1	Annubar Coefficient 1	-	Param
Ca2	Annubar Coefficient 2	-	Param
Cd	Discharge Coefficient	-	Param/Calc
D	Pipe Inside Diameter	m	Calc
d	Throat Diameter	m	Calc
DiffP	Current Differential Pressure	Pa	Calc/Avg
DPh-l	Stacked DP high to low switchpoint	Pa	Param
DPh-m	Stacked DP high to mid switchpoint	Pa	Param
DPhi	High Stacked Differential Pressure	Pa	Live
DPl-h	Stacked DP low to high switchpoint	Pa	Param
DPl-m	Stacked DP low to mid switchpoint	Pa	Param
DPlow	Low Stacked Differential Pressure	Pa	Live
DPlv	Single Live Differential Pressure	Pa	Live
DPlast	Last read Differential Pressure	Pa	Calc
DPm-h	Stacked DP mid to high switchpoint	Pa	Param
DPm-l	Stacked DP mid to low switchpoint	Pa	Param
DPmid	Mid Stacked Differential Pressure	Pa	Live
DPpri	Primary Live Differential Pressure	Pa	Live
DPsec	Secondary Live Differential Pressure	Pa	Live
DPkPr	Peak Pressure (daily)	Pag	Calc
DPkQb	Peak Volume Flow Rate (daily)	M3/sec	Calc
Dr	Uncorrected Pipe Inside Diameter	m	Param
dr	Uncorrected Throat Diameter	m	Param
Etot	Total Energy	Joules	Total
Ev	Velocity of Approach factor	-	Calc
Fextn	Flow Extension (=sqrt(DP * RHOf))	-	Calc/Avg
Freq	Input frequency	Hz	Calc/Avg
Gr	Real Gas Relative Density	kg/M3	Par/Live/Calc
Hm	Heating value, mass basis	Joules/kg	Par/Calc
Hv	Heating value, volume basis, ref. conditions	Joules/M3	Calc
Hvb	Heating value, volume basis, base conditions	Joules/M3	Par/Live/Calc
HPkPr	Peak Pressure (hourly)	Pag	Calc
HPkQb	Peak Volume Flow Rate (hourly)	M3/sec	Calc
k	Isentropic Exponent	-	Param
Ka	Annubar Flow Coefficient	-	Calc
Mdb	Molar density, base conditions	-	Calc
Mdf	Molar density, flowing conditions	-	Calc
Mdref	Molar density, reference conditions	-	Calc
MF1	Meter factor 1	-	Param

Variable Tag	Description	Storage Units	Attributes
MF2	Meter factor 2	-	Param
MF3	Meter factor 3	-	Param
MF4	Meter factor 4	-	Param
MF5	Meter factor 5	-	Param
MF6	Meter factor 6	-	Param
MF7	Meter factor 7	-	Param
MF8	Meter factor 8	-	Param
MF9	Meter factor 9	-	Param
MFact	Meter factor (interpolated)	-	Calc
MFsum	Mole Fraction Sum	-	Calc/Live[10]
Mr	Molar mass	-	Calc
Mtot	Total Mass	kg	Total
MtotB	This Months Total Volume	M3	Total
MTotE	This Months Total Energy	Joules	Total
MTotM	This Months Total Mass	kg	Total
Mu	Absolute Viscosity	kg/Msec	Param/Calc
P1	Matrix pressure point 1	Paa	Param
P2	Matrix pressure point 2	Paa	Param
P3	Matrix pressure point 3	Paa	Param
P4	Matrix pressure point 4	Paa	Param
P5	Matrix pressure point 5	Paa	Param
Patm	Local Atmospheric Pressure	Paa	Param
Pbase	Contract Base Pressure	Paa	Param
Pc	Pseudocritical Pressure	Paa	Param/Calc
Pf	Absolute Pressure	Paa	Calc/Avg
PfZf	Absolute Pressure for Zf	Paa	Calc
Press	Gauge Pressure	Pag	Live
PtotB	Previous Months Total Volume	M3	Total
PTotE	Previous Months Total Energy	Joules	Total
PTotM	Previous Months Total Mass	kg	Total
Qb	Volume Flow Rate	M3/sec	Calc
Qe	Energy Flow Rate	Joules/sec	Calc
Qf	Uncorrected Pulse Rate	M3/sec	Live
Qfavg	Average Uncorrected Pulse Rate	M3/sec	Calc
Qftot	Uncorrected Pulse Total	M3	Total
Qf1	Ultrasonic Meter factor Qf 1	M3/sec	Param
Qf2	Ultrasonic Meter factor Qf 2	M3/sec	Param
Qf3	Ultrasonic Meter factor Qf 3	M3/sec	Param
Qf4	Ultrasonic Meter factor Qf 4	M3/sec	Param
Qf5	Ultrasonic Meter factor Qf 5	M3/sec	Param
Qf6	Ultrasonic Meter factor Qf 6	M3/sec	Param
Qf7	Ultrasonic Meter factor Qf 7	M3/sec	Param
Qf8	Ultrasonic Meter factor Qf 8	M3/sec	Param

[10] Live assignment supported only for GC peripheral devices, which assigns all gas components to GC.

Variable Tag	Description	Storage Units	Attributes
Qf9	Ultrasonic Meter factor Qf 9	M3/sec	Param
Qm	Mass Flow Rate	kg/sec	Calc/Live
Re1	Meter factor Reynolds Number 1	-	Param
Re2	Meter factor Reynolds Number 2	-	Param
Re3	Meter factor Reynolds Number 3	-	Param
Re4	Meter factor Reynolds Number 4	-	Param
Re5	Meter factor Reynolds Number 5	-	Param
Re6	Meter factor Reynolds Number 6	-	Param
Re7	Meter factor Reynolds Number 7	-	Param
Re8	Meter factor Reynolds Number 8	-	Param
Re9	Meter factor Reynolds Number 9	-	Param
ReD	Reynolds Number (D)	-	Calc
RHOb	Fluid Density at Base Conditions	kg/M3	Calc
RHOf	Fluid Density	kg/M3	Calc
RHOrf	Fluid Density at Reference Conditions	kg/M3	Calc
SPlast	Last read Pressure	Pag	Calc
T1	Matrix temperature point 1	K	Param
T2	Matrix temperature point 2	K	Param
T3	Matrix temperature point 3	K	Param
T4	Matrix temperature point 4	K	Param
T5	Matrix temperature point 5	K	Param
Tbase	Contract Base Temperature	K	Param
Tc	Pseudocritical Temperature	K	Param/Calc
TDmea	Pipe Measurement Temperature	K	Param
Tdmea	Throat Measurement Temperature	K	Param
Temp	Live Temperature	K	Live
Tf	Flowing Temperature	K	Calc/Avg
Tlast	Last read Temperature	K	Calc
TtotB	Today's Total Volume	M3	Total
TTotE	Today's Total Energy	Joules	Total
TTotM	Today's Total Mass	kg	Total
Tzf	Temperature for Zf	K	Calc
UMF1	Ultrasonic Meter factor 1	-	Param
UMF2	Ultrasonic Meter factor 2	-	Param
UMF3	Ultrasonic Meter factor 3	-	Param
UMF4	Ultrasonic Meter factor 4	-	Param
UMF5	Ultrasonic Meter factor 5	-	Param
UMF6	Ultrasonic Meter factor 6	-	Param
UMF7	Ultrasonic Meter factor 7	-	Param
UMF8	Ultrasonic Meter factor 8	-	Param
UMF9	Ultrasonic Meter factor 9	-	Param
UMFact	Ultrasonic Meter factor (interpolated)	-	Calc
xAr	Mole Fraction Argon	-	Param
xC1	Mole Fraction Methane	-	Param
xC2H4	Mole Fraction Ethene	-	Param
xC2	Mole Fraction Ethane	-	Param

Variable Tag	Description	Storage Units	Attributes
xC3	Mole Fraction Propane	-	Param
xC3H6	Mole Fraction Propene	-	Param
xC4H8	Mole Fraction Butene	-	Param
xC5H10	Mole Fraction Pentene-1	-	Param
xCO	Mole Fraction Carbon Monoxide	-	Param
xCO2	Mole Fraction Carbon Dioxide	-	Param
xH2	Mole Fraction Hydrogen	-	Param
xH2O	Mole Fraction Water	-	Param
xH2S	Mole Fraction Hydrogen Sulfide	-	Param
xHe	Mole Fraction Helium	-	Param
xiC4	Mole Fraction Iso-Butane	-	Param
xiC5	Mole Fraction Iso-Pentane	-	Param
xN2	Mole Fraction Nitrogen	-	Param
xnC10	Mole Fraction Normal Decane	-	Param
xnC4	Mole Fraction Normal Butane	-	Param
xnC5	Mole Fraction Normal Pentane	-	Param
xnC6	Mole Fraction Normal Hexane	-	Param
xnC7	Mole Fraction Normal Heptane	-	Param
xnC8	Mole Fraction Normal Octane	-	Param
xnC9	Mole Fraction Normal Nonane	-	Param
xO2	Mole Fraction Oxygen	-	Param
Y	Expansion Factor	-	Param/Calc
YtotB	Yesterdays Total Volume	M3	Total
YTotE	Yesterdays Total Energy	Joules	Total
YTotM	Yesterdays Total Mass	kg	Total
Z11	Z factor @ Pressure1 / Temperature 1	-	Param
Z12	Z factor @ Pressure1 / Temperature 2	-	Param
Z13	Z factor @ Pressure1 / Temperature 3	-	Param
Z14	Z factor @ Pressure1 / Temperature 4	-	Param
Z15	Z factor @ Pressure1 / Temperature 5	-	Param
Z21	Z factor @ Pressure2 / Temperature 1	-	Param
Z22	Z factor @ Pressure2 / Temperature 2	-	Param
Z23	Z factor @ Pressure2 / Temperature 3	-	Param
Z24	Z factor @ Pressure2 / Temperature 4	-	Param
Z25	Z factor @ Pressure2 / Temperature 5	-	Param
Z31	Z factor @ Pressure3 / Temperature 1	-	Param
Z32	Z factor @ Pressure3 / Temperature 2	-	Param
Z33	Z factor @ Pressure3 / Temperature 3	-	Param
Z34	Z factor @ Pressure3 / Temperature 4	-	Param
Z35	Z factor @ Pressure3 / Temperature 5	-	Param
Z41	Z factor @ Pressure4 / Temperature 1	-	Param
Z42	Z factor @ Pressure4 / Temperature 2	-	Param
Z43	Z factor @ Pressure4 / Temperature 3	-	Param
Z44	Z factor @ Pressure4 / Temperature 4	-	Param
Z45	Z factor @ Pressure4 / Temperature 5	-	Param

Variable Tag	Description	Storage Units	Attributes
Z51	Z factor @ Pressure5 / Temperature 1	-	Param
Z52	Z factor @ Pressure5 / Temperature 2	-	Param
Z53	Z factor @ Pressure5 / Temperature 3	-	Param
Z54	Z factor @ Pressure5 / Temperature 4	-	Param
Z55	Z factor @ Pressure5 / Temperature 5	-	Param
Zb	Compressibility at Base Conditions	-	Param/Calc
Zf	Compressibility at Flowing Conditions	-	Param/Calc
Zref	Compressibility at Ref. Conditions	-	Param/Calc

NGas Calculations

Units of Measurement

All calculations in NGas/IGas 4.x.x are performed in **SI** units.

Measurement	*Units*	*Conversion*	*Other Units*
Pressure	Pascal (Pa)	=0.001	Kilo Pascal (kPa)
		=0.0001450377	psi
		=0.000001	Mega Pa (MPa)
		=0.0040186	Inch WC (IWC)
		=0.000334883	Feet WC (FWC)
		=0.000296134	Inch Hg (IHg)
		=0.01	Millibar (mBar)
		=0.00001	Bar
Temperature	K (Kelvin)	=1.8	Rankine (R)
Length	Meter (m)	=39.370079	Inch (in)
		=100.0	cm
		=1000.0	mm
		=3.28084	feet (ft)
		=1.093613	yard (y)
Volume	Meter cu (m^3)	=1000.0	liter (L)
		=35.314667	Cu foot (CF)
		=1E-3	Thsd m^3 (E3M3)
		=1E-6	Miln m^3 (E6M3)
		=.035315	Thsd ft^3 (MCF)
		=35.3147 E-6	Miln ft^3 (MMCF)
		=219.969248	Imp Gal (ImpG)
		=264.172052	US Gal (USG)
		=6.289811	Barrel (BBL)
Mass	Kilogram (kg)	=1000.0	gram (g)
		=2.204623	Pound mass (LBm)
Energy	Joule (J)	=0.000001	Megajoule (MJ)
		=0.001	KJoule (kJ)
		=0.000947816988	Btu (BTU)
		=1E-9	GJoule (GJ)
		=947.816988E-9	Thsd Btu (MBTU)
		=947.816988E-12	Miln Btu (MMBTU)
		=2.777778E-7	Kilowatt Hours (kWh)
		=0.00023884932	Kilocalories (kCal)
Time	Second (s)	=1.6543439E-6	week (w)
		=1.157407E-5	day (d)
		=2.777778E-4	hour (h)
		=0.01666667	min (m)

Gas Properties

Properties of hydrocarbon gases and other components of natural gas:

Component	Symbol	Tc °K	Pc MPa (a)	Mr	µ cp	Hm MJ/kg
Nitrogen	N2	126.21	3.398	28.0134	0.01735	0
Cbn dioxide	CO2	304.11	7.374	44.010	0.01439	0
Hyd. sulf.	H2S	373.37	8.963	34.08		16.502
Water	H2O	647.1	22.064	18.0153	0.01240	2.4664
Helium	He	5.18889	0.22683	4.0026	0.01927	0
Methane	C1	190.56	4.599	16.043	0.01078	55.575
Ethane	C2	305.41	4.880	30.070	0.00901	51.950
Propane	C3	369.77	4.240	44.097	0.00788	50.368
n-butane	nC4	425.1	3.784	58.123	0.00724	49.546
isobutane	iC4	407.82	3.640	58.123	0.00723	49.388
n-pentane	nC5	469.65	3.365	72.150		49.045
isopentane	iC5	460.35	3.381	72.150		48.949
n-hexane	nC6	506.4	3.030	86.177		48.716
heptane	nC7	539.2	2.740	100.204		48.473
octane	nC8	568.4	2.490	114.231		48.288
nonane	nC9	594.7	2.280	128.258		48.152
decane	nC10	617.7	2.100	142.285		48.037
Oxygen	O2	154.59	5.043	31.9988	0.02006	0
Cbn. monox.	CO	132.9222	3.49909	28.010	0.01439	10.1004
Hydrogen	H2	32.97778	1.29273	2.0159	0.00871	141.94
Argon	Ar	150.8611	4.89804	39.948	0.02201	0

Properties of assorted industrial gases:

Component	Symbol	Tc °K	Pc Mpa	Viscosity cp
Ammonia	NH3	405.5	11.29	0.00982
Air		132.45	3.77	0.01827
Steam	H2O	647.14	22.13	0.01240
Helium	He	5.189	0.227	0.01927
Argon	Ar	150.86	4.898	0.02201
Neon	Ne	44.45	2.62	0.03111
Chlorine	Cl	417.15	7.71	0.01327
Fluorine	F	118.15	2.53	
Sulphur dioxide	SO2	430.35	7.87	0.01242
Acetylene	C2H2	309.15	6.28	0.00935
Ethylene	C2H4	282.85	5.12	0.01008
Nitric oxide	NO	179.15	6.59	0.01876
Nitrous oxide	N2O	309.65	7.27	0.01488

Reference Standards

This section specifies the equations, limitations and assumptions relating to the NGas 3.X and 4.X program. Throughout this section, references are made to various published gas measurement standards. The following is a list of the industry gas measurement standards publications:

Manual of Petroleum Measurement Standards
Chapter 14 - Natural Gas Fluids Measurement
Section 3 - Concentric, Square-edged Orifice Meters
Part 1 - General Equations and Uncertainty Guidelines
Part 3 - Natural Gas Applications
Part 4 - [implementation]
American Petroleum Institute, 1990
Note: Synonymous with A.G.A. Report No. 3, Parts 1 through 4

"Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases", American Gas Association Transmission Measurement Committee Report No. 8
Starling, K.E. and Savidge, J.L. eds
Second printing (version 1.2), July 1994
AGA Catalog Number XQ9212
Note: Synonymous with American Petroleum Institute MPMS Chapter 14.2

Table of Physical Constants of Paraffin Hydrocarbons and Other Components of Natural Gas
GPA Standard 2145-93
Gas Producer's Association, Tulsa OK.

Computer calculation of natural gas compressibility factors using the Standing and Katz correlation
P.M. Dranchuk, R.A. Purvis, and D.B. Robinson
Institute of Petroleum, Technical Series No. 1, IP 74-008, 1974

Compressibility Factor of Sour Natural Gases
Edward Wichert and Khalid Aziz
Canadian Journal of Chemical Engineering, Vol. 49, April 1971

On the Thermodynamics of Solutions
An Equation of State. Fugacities of Gaseous Solutions.
Otto Redlich and J.N.S Kwong
Oct 25, 1948
Presented at the Symposium on Thermodynamics and Molecular Structure of Solutions; the 114th meeting of the American Chemical Society, Portland, Oregon

Standard GERG Virial Equation for Field Use
Technical monograph GERG TM5 1991
M. Jeaschke and A.E.Humphreys
Groupe Européen de Recherches Gaziérs
Verlag des Vereins Deutscher Ingenieure
Düseldorf, 1991
ISBN 3-18-146606-9

Flow Measurement Engineering Handbook
Richard W. Miller
McGraw-Hill, 1989 (Second edition)

Reference Conditions

The reference conditions for all gas property data are:

THref	Heating value reference temperature	288.15 °K/15°C
TDref	Mmolar density reference temperature	288.15 °K/15°C
TGref	Relative density reference temperature	288.15 °K/15°C
PDref	Molar density reference pressure	101.325 kPa
PGref	Relative density reference pressure	101.325 kPa

These values are used internally in the NGas/IGas 4.X software, and do not appear on any of the pages. However, the user should ensure that the values entered for the real gas relative density (`Gr`) and gross volumetric heating value (`HV`) are based on the above reference conditions. If `Gr` or `HV` are based on different reference conditions, they should be corrected for best accuracy. Methods for changing the reference conditions are given in AGA Report No 8, appendix C. (This should not be necessary. The above reference conditions are standard for gas measurement in North America).

Other reference conditions are:

`Tbase`	Contract base temperature	user-entered
`Pbase`	Contract base pressure	user-entered
`TrefD`	Meter tube reference temperature	user-entered
`Trefd`	Orifice plate reference temperature	user-entered
`Patm`	Average atmospheric pressure	user-entered

`Tbase` and `Pbase` are used only in volumetric measurement. They are the base temperature and pressure specified in the contract between buyer and seller of the gas.

Metals expand and contract with changes in temperature. TrefD and Trefd are used by NGas/IGas 4.X.X to account for changes in the meter bore and orifice plate. AGA Report No 3, Part 2 gives the full procedure for "miking" the meter and orifice plate.

Note: The current AGA-3 standard requires the reference temperature and the bore diameter to be marked on the orifice plate.

`Patm` is the average barometric pressure at the meter site.

For a detailed explanation of these and other reference conditions, see AGA Report No 8 (1994), appendix C2.

Rates and Totals Calculations

Mass Flow

The final flow calculation used in NGas 4.X.X departs slightly from the standard formulation. The flow extension *Fextn* (see **page 175**) is introduced as a separate variable whose value is recorded in the flowrun's history log. The Meter Factor *MF* is discussed later in this chapter. The incremental mass is obtained by integrating the instantaneous mass flow rate over the time interval of the calculation.

$$m = \int Qm\,dt$$

or

$$m = v\,\rho f \qquad \textbf{(if pulse input)}$$

where

Qm = mass flow (from diff producer, linear volume meter, or mass meter)

m = incremental mass added to Mtot

dt = time elapsed since the preceding calculation

v = incremental volume

ρf = RHOf = mass density at flowing conditions

Volume Flow

Volume flow at base conditions:

$$Qb = \frac{Qm}{\rho b}$$

$$V = \frac{m}{\rho b}$$

where

qm = mass flow (from diff producer, volume pulse meter, or mass meter)

Qb = volume flow rate at contract base conditions

V = incremental volume at contract base conditions added to Btot

ρb = RHOb = mass density at contract base conditions

Energy Flow

$$Qe = Qm\,Hm$$

$$E = m\,Hm$$

where

Qm = mass flow (from diff producer, volume pulse meter, or mass meter)

Qe = energy flow rate

Hm = mass basis heating value (Gross or Superior heating value)[11]

E = incremental energy added to Etot

Differential Pressure Producers

All differential pressure producers use the equation

$$m = \int Qm\,dt$$

Common Equations

1. Meter tube diameter (D):

   $$D = Dr\left[1 + \alpha_2\left(Tf - Tr\right)\right]$$

   Where

   Dr = meter tube diameter at reference temperature Tr

   $\alpha 2$ = AlphaD = coefficient of linear expansion of orifice plate material

   Tf = temperature of flowing gas

   Tr = reference temperature

2. Flow extension (Fextn):

   $$Fextn = \sqrt{\rho f \Delta P}$$

   Where

   ρf = RHOf = mass density at flowing conditions, kg/m^3

   ΔP = DiffP = differential pressure

3. Meter factor (MF):

   $$MF_x = \left[\left(\frac{\mathrm{Re}_x - \mathrm{Re}_n}{\mathrm{Re}_{n+1} - \mathrm{Re}_n}\right)\left(MF_{n+1} - MF_n\right)\right] + MF_n$$

   Where

   Re = Reynolds number

[11] Effect of "spectator" water is not taken into consideration.

Orifice Meter

Mass flow rate using an orifice meter (qm):

$$Qm = N_1 Cd\, E v Y d^2\, Fextn\, MF$$

- $N_1 = \left(\frac{\pi}{4}\right)\sqrt{2}$ **(for MKS units)**
- Discharge coefficient for flange taps (Cd):

$$Cd(FT) = C_i(FT) + 0.000511\left[\frac{10^6 \beta}{\mathrm{Re}_D}\right]^{0.7} + (0.0210 + 0.0049A)\beta^4 C$$

$$C_i(FT) = C_i(CT) + TapTerm$$

$$C_i(CT) = 0.5961 + 0.0291\beta^2 - 0.2290\beta^8 + 0.003(1-\beta)M_1$$

$$TapTerm = Upstrm + Dnstrm$$

$$Upstrm = -\left[0.0433 + 0.0712e^{-8.5L_1} - 0.1145e^{-6.0L_1}\right]\left(1 - 0.23A\right)B$$

$$Dnstrm = -0.0116\left[M_2 - M_2^{1.3}\right]\beta^{1.1}\left(1 - 0.14A\right)$$

$$B = \frac{\beta^4}{1-\beta^4}$$

$$M_1 = \max\left(2.8 - \frac{D}{N_4}, 0.0\right)$$

$$M_2 = \frac{2L_2}{1-\beta}$$

$$A = \left[\frac{19000\beta}{\mathrm{Re}_D}\right]^{0.8}$$

$$C = \left[\frac{10^6 \beta}{\mathrm{Re}_D}\right]^{0.35}$$

Beta ratio:

$$\beta = \frac{d}{D}$$

Orifice bore:

$$d = dr\left[1 + \alpha_1\left(Tf - Tr\right)\right]$$

where

dr = orifice bore at reference temperature Tr

Reynolds Number:

$$\mathrm{Re}_D = \frac{N_2 Qm}{\mu D}$$

where

$N_2 = \frac{4}{\pi}$ **(for MKS units)**

μ = Mu = viscosity

- Velocity of approach factor (Ev):

$$Ev = \frac{1}{\sqrt{1-\beta^4}}$$

$$\beta = \frac{d}{D}$$

- Expansion factor (Y):

$$Y = 1 - \left(0.41 + 0.35\beta^4\right)\left(\frac{x_1}{k}\right)$$

(Isentropic exponent (k) is a user-entered value)

$$x_1 = \frac{\Delta P}{N_3 P_{f1}}$$

where

$N_3 = 1.0$ **(for MKS units)**

Static pressure, when measured at the upstream tap:

$$P_f = P_{gage} + P_{atm}$$

where P_{gage} = Press = gauge pressure

Static pressure, when measured at the downstream tap:

$$P_f = P_{gage} + P_{atm} + \Delta P$$

where P_{gage}, P_{atm}, and ΔP are in the same units (kPa)

- Refer to **Common Equation for NGas Calculations (page 175)** for flow extension (Fextn) and meter factor (MF).

Averaging Pitot Tube (Annubar®)

Mass flow rate using a pitot tube (qm):

$$Qm = N\,K\,D^2\,Y\,Fextn\,MF$$

- Flow coefficient (K):

$$K = \frac{1 - Ca_2\beta}{\sqrt{1 + Ca_1(1 - Ca_2\beta)^2}}$$

where the values of Ca_1 and Ca_2 are dependent on the model being used:

	Ca_1	Ca_2
Model 10 (coefficients need to be checked with Annubar	1.20107	1.38155
Others (models 15/16, 25/26, 35/36, 45/46)	1.34966	0.8468

Beta ratio:

$$\beta = \sqrt{\frac{4d}{\pi D}}$$

where

d = throat diameter (strut width)

D = internal pipe diameter

d is dependent on the model:

Model	d (in inches)
10	0.183
15/16	0.3576
25/26	0.8460
35/36	1.230
45/46	1.980

- Refer to **Common Equation for NGas Calculations (page 175)** for pipe diameter (D).
- Expansion factor (Y):

$$Y = 1 - \left[0.31424(1 - \beta)^2 - 0.09484\right]\frac{\Delta p}{kP_f}$$

where

k = user-entered isentropic exponent

- Refer to **Common Equation for NGas Calculations (page 175)** for flow extension (Fextn) and meter factor (MF).

Inverted Venturi (Vcone)

Mass flow rate using the Vcone (qm):

$$Qm = Cd\,Ev\,K\,Y(\beta D)^2\,Fextn\,MF$$

- Discharge coefficient (Cd) is a user-entered value;
- Velocity of approach factor (Ev):

$$Ev = \frac{1}{\sqrt{1-\beta^4}}$$

$$\beta = \frac{\sqrt{D^2 - d^2}}{D}$$

$$d = dr\left[1 + \alpha_3 (Tf - Tr)\right]$$

where

dr = throat diameter at temperature Tr

Tr = reference temperature

Tf = temperature of flowing gas

- Flow coefficient (K): $K = \frac{\pi}{4}\sqrt{2}$ **(for MKS units)**
- Expansion factor (Y):

Tube meter equation: $\varepsilon = 1 + \left(-\left[0.649 + 0.696\beta^4\right]\right)\frac{\Delta P}{k\,Pf}$

where if

$k = 1.3$

$\beta = 0.65$

$\Delta P = 10$

$Pf = 300$

$\varepsilon = 0.980173324358974$

Wafer meter equation: $\varepsilon = 1 + \left(-\left[0.755 + 6.787\beta^8\right]\right)\frac{\Delta P}{kPf}$

where if

$k = 1.3$

$\beta = 0.45$

$\Delta P = 20$

$Pf = 5000$

$\varepsilon = 0.997641807921223$

- Refer to **Common Equation for NGas Calculations (page 175)** for meter bore (D), flow extension (Fextn) and meter factor (MF).

Linear Volume Meter

NGas 4.X.X uses a somewhat unconventional calculation for turbine metering. Gross volume is converted immediately to mass.

The mass flow is computed (qm):

$$Qm = qf\,\rho f$$

$$m = v\,\rho f$$

where

Qm = mass flow rate

qf = gross (uncorrected) volumetric flow rate (pulse or analog input)

m = incremental mass added to Mtot

ρf = RHOf = mass density at flowing conditions

v = incremental volume

For **pulse input**:

The gross volumetric flow is first computed from the frequency and the K-factor:

$$qf = \frac{3600\,f}{K}$$

$$v = \frac{p}{K} \times MF$$

where

qf = gross (uncorrected) volumetric flow rate

f = frequency (Hertz)

K = meter K-factor (also see K-factor interpolation)

p = incremental pulse count (since previous channel scan)

v = incremental (uncorrected) volume added to Qftot

MF = user-entered meter factor value (dimensionless)

For **analog input**:

$$m = \int qm\,dt$$

Note: The gross volume is determined from the pulse count accumulated in the hardware register. A separate hardware register measures the period used to determine the signal frequency. This helps ensure that, although the Scanner cannot compute a flow rate based on a frequency that is below its minimum threshold, the accumulated volume (mass, energy) will always be correct. An analogy of this process is the speedometer on a car. The speedometer on most cars does not register speeds below 10 or 15 miles per hour. If the vehicle is barely moving, the driver has no way of knowing how fast the car is travelling. However, the odometer is geared directly to the wheel, so the ***mileage*** registered will always be correct.

Composite Gas Properties

When the "`Mole Fraction Analysis`" option is specified, NGas 4.X.X determines various physical gas properties by calculation from the user-specified gas composition, and a table of constants stored in ROM. The physical constants are obtained primarily from GPA-2145 (SI tables); properties or components not covered by the GPA standard are taken from AGA-3 part 3.

The sum of mole fractions (as entered by the user or input from a gas chromatograph) is forced to equal one exactly (normalized).

Note: In all equations of this form, the list of gas components begins at N2 and ends at Ar. The first table in the **Gas Properties (page 171)** section lists the components in standard order, along with the physical constants for each component.

For each component `i`, the normalized mole fraction `x` is:

$$x_i = \frac{xentered_i}{MFsum}$$

Pseudocritical temperature:

$$Tc = \sum_{i=N_2}^{Ar} x_i Tc_i$$

Pseudocritical pressure:

$$Pc = \sum_{i=N_2}^{Ar} x_i Pc_i$$

Viscosity:

$$Mu = \sum_{i=N_2}^{Ar} x_i \mu_i$$

Mass basis heating value:

$$Hm = \frac{\sum_{i=N_2}^{Ar} x_i Mr_i Hm_i}{\sum_{i=N_2}^{Ar} x_i Mr_i}$$

Molar mass (molecular weight):

$$Mr = \sum_{i=N_2}^{Ar} x_i Mr_i$$

Real gas relative density (gas gravity):

$$Gr = \frac{MrMd_{ref}}{\rho_{air}}$$

When gravity is input instead of mole fractions:

$$Mr = \frac{Gr\rho_{air}}{Md_{ref}}$$

Density of air:

$$B_{air} = -0.12527 + 5.91\times10^{-4} T_b - 6.62\times10^{-7} T_b^{\,2}$$

$$\rho_{air} = \frac{Mr_{air}}{\left(\dfrac{RT_{Gref}}{P_{Gref}}\right) + B_{air}}$$

where:

Mr_{air} = 28.96256

T_b = contract base temperature

Density of the gas at reference conditions TD_{ref}, Pd_{ref}

$$\rho_{ref} = Md_{ref} M_r$$

When the volumetric basis heating value is required (as input to the AGA-8 Gross GHC method, for example), it is calculated from Hm by:

$$HV = Hm\rho_{ref}$$

$$Hm = \frac{HV}{\rho_{ref}}$$

The mass density at reference conditions:

$$\rho_{ref} = Md_{ref} M_r$$

where Md_{ref} is the molar density at reference conditions T_{Gref} and P_{Gref}, calculated via the selected Z-factor method.

Mass density at contract base conditions:

$$\rho_b = Md_b\, M_r.$$

where Md_b is the molar density at contract base conditions `Tbase` and `Pbase` calculated through the selected Z-factor method.

Mass density at flowing conditions:

$$\rho_f = Md_f M_r$$

where Md_f is the molar density at flowing conditions `Tf` and `Pf`, calculated via the selected Z-factor method.

Compressibility

AGA-8 Detailed Method

The following variables are computed when the gas composition is updated:

$$U^5 = \left[\sum_{i=1}^{n} x_i E_i^{\frac{5}{2}}\right]^2 + 2\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j \left(U_{ij}^5 - 1\right)\left(E_i E_j\right)^{\frac{5}{2}}$$

$$K^5 = \left[\sum_{i=1}^{n} x_i K_i^{\frac{5}{2}}\right]^2 + 2\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j \left(K_{ij}^5 - 1\right)\left(K_i K\right)^{\frac{5}{2}}$$

$$C_n^* = a_n\left(G + 1 - g_n\right)^{g_n}\left(Q^2 + 1 - q_n\right)^{q_n}\left(F^2 + 1 - f_n\right)^{f_n} U^{u_n}$$

where:

$$G = \left[\sum_{i=1}^{n} x_i G_i\right] + \sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j \left(G_{ij}^* - 1\right)\left(G_i + G\right)$$

$$Q = \sum_{i=1}^{N} x_i Q$$

$$F = \sum_{i=1}^{N} x_i^2 F_i$$

$$U^5 = \left[\sum_{i=1}^{n} x_i E_i^{\frac{5}{2}}\right]^2 + 2\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j \left(U_{ij}^5 - 1\right)\left(E_i E_j\right)^{\frac{5}{2}}$$

$$B_{nij}^* = \left(G_{ij} + 1 - g_n\right)^{g_n}\left(Q_i Q_j + 1 - q_n\right)^{q_n}\left(F_i^{\frac{1}{2}} F_j^{\frac{1}{2}} + 1 - f_n\right)^{f_n}\left(S_i S_j + 1 - s_n\right)^{s_n}\left(W_i W_j + 1 - w_n\right)^{w_n}$$

where:

$$G_{ij} = \frac{G_{ij}^*\left(G_i + G_j\right)}{2}$$

For the numerical values of a_n, b_n, c_n, k_n, u_n, g_n, q_n, f_n, s_n, w_n see AGA-8 table 4.

For the numerical values of E, K, G, Q, F, S, W see AGA-8 Table 5.

For the numerical values of E_{ij}, U_{ij}, K_{ij}, G^*_{ij} see AGA-8 Table 6.

Virial coefficient B is computed whenever the pressure or temperature is updated:

$$B = \sum_{n=1}^{18} a_n T^{-u_n} \sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j E_{ij}^{u_n}\left(K_i K_j\right)^{\frac{3}{2}} B_{nij}^*$$

where

$$E_{ij} = E_{ij}^*\left(E_i E_j\right)^{\frac{1}{2}}$$

The molar density, M_d, is a nonlinear function of pressure. Thus, numerical methods are used to solve the following equation for M_d:

$$P = M_d RT \left\{ 1 + BM_d - D\sum_{n=13}^{18} C_n^* T^{-u_n} + \sum_{n=13}^{58} C_n^* T^{-u_n} \left(b_n - c_n k_n D^{k_n} \right) D^{b_n} \exp\left(-c_n D^{k_n} \right) \right\}$$

Once the molar density is known, the compressibility factor Z is determined from:

$$Z = 1 + BM_d - D\sum_{n=13}^{18} C_n^* T^{-u_n} + \sum_{n=13}^{58} C_n^* T^{-u_n} \left(b_n - c_n k_n D^{k_n} \right) D^{b_n} \exp\left(-c_n D^{k_n} \right)$$

Calculation time for the AGA-8 "Detailed" method is governed by the number of non-zero components in the gas. The following formula provides a reasonable estimate of the calculation time:

$$t = k \times u \times \frac{m!}{(m-2)!}$$

where

t = time to recalculate, seconds

k = system timing constant (CPU, clock speed, math coprocessor, etc.)

k ≈ ## for Scanner 1110/1120

k ≈## for Scanner 1110/1120 with math coprocessor

k ≈ ## for Scanner 1130

k ≈ ## for Scanner 1131

k ≈## for Scanner 1131 with math coprocessor

k ≈## for Scanner 1140

m = number of gas components

u = update constant

u ≈ ## for gas composition update

u ≈ ## for pressure or temperature updates

AGA-8 Gross Methods

The AGA-8 Gross GCN and GHC methods, and the SGERG GHN methods are based on the following equations:

$$B_{mix} = \sum_{i-CO_2}^{CH} \sum_{j=CO_2}^{CH} B_{ij} x_i x_j$$

$$C_{mix} = \sum_{i=CO_2}^{CH} \sum_{j=CO_2}^{CH} \sum_{k=CO_2}^{CH} C_{ijk} x_i x_j x_k$$

where:

Component ID = CO_2, N_2, CH.

N_2 is the mole fraction of nitrogen.

CO_2 is the mole fraction of carbon dioxide.

CH is the mole fraction of the (fictitious) "equivalent hydrocarbon".

$$B_{ij} = b_0 + b_1 T + b_2 T^2$$

$$C_{ijk} = c_0 + c_1 T + c_2 T^2$$

For the numeric values of b_0, b_1, and b_2, see AGA-8 Table 7:

$$B_{CH-CH} = B_0 + BH_{CH} + B_2\, H_{CH}^2$$

$$C_{CH-CH-CH} = C_0 + C_1 H_{CH} + C_2 H_{CH}^2$$

$$B_i = b_{i0} + b_{i1} T + b_{i2} T^2, i = 0,1,2$$

$$C_i = c_{i0} + c_{i1} T + c_{i2} T^2, i = 0,1,2$$

For the numeric values of b_{i0}, b_{i1}, b_{i2}, c_{i0}, c_{i1}, and c_{i2}, see AGA-8 Table 8.

The interaction second virial coefficient terms for N_2, CO_2 and CH are calculated:

$$B_{N_2-CH} = \left(0.72 + 1.875 \times 10^{-5} (320 - T)^2\right) \frac{\left(B_{N_2-N_2} + B_{CH-CH}\right)}{2}$$

$$B_{CO_2-CH} - 0.865 \sqrt{B_{CO_2-CO_2} B_{CH-CH}}$$

The interaction third virial coefficient terms for N_2, CO_2 and CH are calculated:

$$C_{N_2-CH-CH} = \left(0.92 + 0.0013 (T - 270)\right) \sqrt[3]{C_{CH-CH-CH}^2 \, C_{N_2-N_2-N_2}^2}$$

$$C_{N_2-N_2-CH} = \left(0.92 + 0.0013 (T - 270)\right) \sqrt[3]{C_{CH-CH-CH}^2 \, C_{N_2-N_2-N_2}^2}$$

$$C_{CO_2-CH-CH} = 0.92 \sqrt[3]{C_{CH-CH-CH}^2 \, C_{CO_2-CO_2-CO_2}^2}$$

$$C_{CO_2-CO_2-CH} = 0.92 \sqrt[3]{C_{CH-CH-CH}^2 \, C_{CO_2-CO_2-CO_2}^2}$$

$$C_{N_2-CO_2-CH} = 1.10 \sqrt[3]{C_{CH-CH-CH} C_{N_2-N_2-N_2} C_{CO_2-CO_2-CO_2}}$$

Numerical methods are used to solve the following equation for the molar density d:

$$P = dRT\left(1 + B_{mix} d + C_{mix} d^2\right)$$

And finally,

$$Z = 1 + B_{mix} d + C_{mix} d^2$$

Range of Validity of the AGA-8 Methods

The AGA-8 Detailed method provides the best accuracy when its inputs fall within the **Normal Range** given below. The method is useable for the limits indicated under the "expanded range" with reduced accuracy (see AGA Report No. 8 for details).

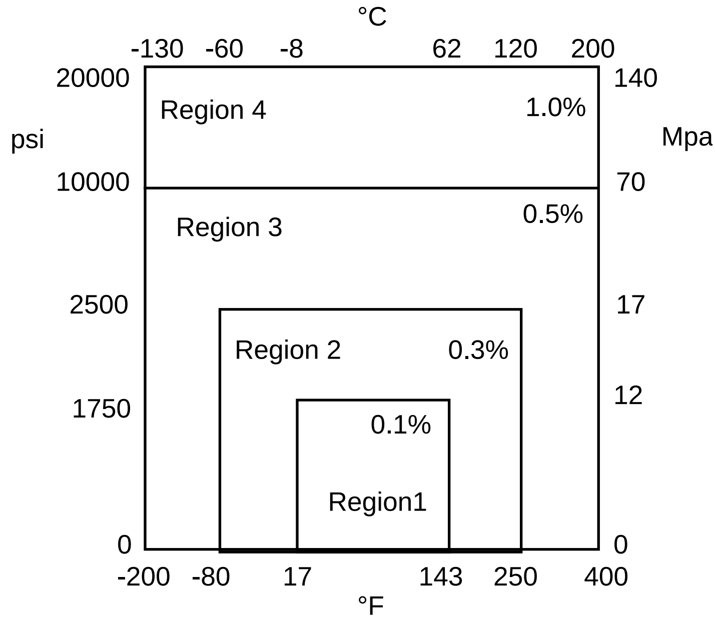
The AGA-8 Gross methods (GCN, GHC) and the SGERG GHN methods should be used only on dry, sweet gases having characteristics that fall within the **Normal Range** given below:

Quantity	***Normal range***	***Expanded range***
Relative density	0.554 to 0.87	0.07 to 1.52
Gross heating value	477 to 1150 BTU/cf	0 to 1800 BTU/cf
Gross heating value	18.7 to 45.1 MJ/m^3	0 to 66.6 MJ/m^3
Mole % Methane	45.0 to 100.0	0 to 100.0
Mole % Nitrogen	0 to 50.5	0 to 100.0
Mole % Carbon Dioxide	0 to 30.0	0 to 100.0
Mole % Ethane	0 to 10.0	0 to 100.0
Mole % Propane	0 to 4.0	0 to 12.0
Mole % Butanes	0 to 1.0	0 to 6.0
Mole % Pentanes	0 to 0.3	0 to 4.0
Mole % Hexanes Plus	0 to 0.2	0 to dew point
Mole % Helium	0 to 0.2	0 to 3.0
Mole % Hydrogen	0 to 10.0	0 to 100.0
Mole % Carbon monoxide	0 to 3.0	0 to 3.0
Mole % Argon	0	0 to 1.0
Mole % Oxygen	0	0 to 21.0
Mole % Water	0 to 0.05	0 to dew point
Mole % Hydrogen Sulphide	0 to 0.02	0 to 100.0

From AGA Report No. 8 (92), Table 1

The Detailed Method is valid within the pressure/temperature range indicated by **Regions 1 to 4** in the figure below (accuracies as indicated).

The AGA-8 Gross methods (GCN, GHC) and the SGERG GHN methods are valid only within the temperature and pressure limits of **Region 1.** *AGA Report No. clearly warns that the equation was not designed for use outside of these limits.*



From AGA Report No. 8 (92), Figure 1

Standing-Katz

Using information from an original paper by Messrs, Standing and Katz describe a graphical method for obtaining the Z factors of hydrocarbon mixtures over a broad range of temperature and pressure conditions. The Standing-Katz curves have been adapted for computer calculation by various investigators. One of the best is the method developed by Dranchuk, Purvis and Robinson. The method is based on the Benedict-Webb-Rubin equation of state, fitted to the Standing-Katz curves.

NGas/IGas solve "Z" as a function of reduced temperature and pressure, using Newton-Rapheson iteration, as follows:

$$Z = \frac{0.27\,\mathrm{Pr}}{\rho Tr}$$

Molar density is from:

$$M_d = \frac{P}{ZRT}$$

Iteration for pseudoreduced density ρ :

$$\rho_{i+1} = \rho_i - \frac{f(\rho)}{f'(\rho)}$$

$$f(\rho) = A\rho^6 + B\rho^3 + C\rho^2 + D\rho + E\rho^3\left(1 + F\rho^2\right)\exp\left(-F\rho^2\right) - G$$

$$f'(\rho) = 6A\rho^5 + 3B\rho^2 + 2C\rho + D + E\rho^2\left[3 + F\rho^2\left(3 - 2F\rho^2\right)\right]\exp\left(-F\rho^2\right)$$

where:

$A = 0.06423$

$B = 0.5353\ Tr - 0.6123$

$$C = 0.3151Tr - 1.0467 - \frac{0.5783}{Tr^2}$$

$D = Tr$

$$E = \frac{0.6845}{Tr^2}$$

$F = 0.6845$

$G = 0.27\ Pr$

$$\mathrm{Pr} = \frac{P}{Pc}$$

$$Tr = \frac{T}{Tc}$$

where:

P	= absolute pressure, pounds per square inch.
Pc	= pseudocritical pressure of the gas mixture, pounds per square inch absolute.
T	= absolute temperature, °Rankine
Tc	= pseudocritical temperature of the gas mixture, °Rankine

The Wichert-Aziz correction to the Standing-Katz calculation is automatically applied whenever the percentage of $H_2S + CO_2$ is greater than 0% and less than 80%.

$$Cwa = 120\left\{(xCO_2 + xH_2S)^{0.9} - (xCO_2 + xH_2S)^{1.6}\right\} + 15\left\{\sqrt{xH_2S} - xH_2S^4\right\}$$

$$Tc' = Tc - Cwa$$

$$Pc' = \frac{Pc(Tc - Cwa)}{Tc + xH_2S(1 - xH_2S)Cwa}$$

where:

xCO_2	= $\%CO_2/100$
xH_2S	= $\%H_2S/100$
Cwa	= Wichert-Aziz correction factor
Tc	= critical temperature, °R
Pc	= critical pressure, PSIA
Tc'	= corrected critical temperature, °R
Pc'	= corrected critical pressure, PSIA

If $\%CO_2$ and $\%H_2S$ are both equal to zero, then:

Cwa	= 0
Tc'	= Tc
Pc'	= Pc

Range of validity: $0 = (\%CO_2 + \%H_2S) < 80$

The Standing-Katz method has a broad range of validity for hydrocarbon gas mixtures. The limits are:

$1.05 = Tr < 3.0$

$0 < Pr < 30$

Under some conditions, the range of validity of the calculation could be exceeded. If there is any doubt, the user should confirm that the Standing Katz method will produce valid results for the anticipated operating conditions. This confirmation can be performed as follows:

- Determine Pc and Tc from an analysis of the gas (the easiest way to do this is to key the data into the Scanner and let it perform the calculation). Use an analysis that shows the highest percentage of heavy components.
- From T and Tc, calculate Tr for the min, and max. anticipated operating temperature.
- From P and Pc, calculate Pr for the min. and max. operating pressure.
- Verify that Tr and Pr are within the ranges noted above. If they are not, the Standing Katz method should not be used.

Redlich-Kwong & Wichert-Aziz

The "standard" Redlich-Kwong algorithm was intended for use on hydrocarbon gases. It is relatively simple and quite accurate in comparison to other much more complex methods. It is readily modified for improved accuracy. One such modification is the Wichert-Aziz correction, which extends the utility of the Redlich-Kwong method to cover sour hydrocarbon gases.

The equation of state is solved for the compressibility factor by Newton-Rapheson iteration:

$$Z = \frac{1}{1-h} - \frac{A^2}{B} \times \frac{h}{1+h}$$

where:

$$A^2 = \frac{a}{R^2 T^{2.5}}$$

$$B = \frac{b}{RT}$$

$$h = \frac{BP}{Z}$$

The Redlich-Kwong mixing rule is:

$$a_m = \sum_{i=N_2}^{Ar} \sum_{j=N_2}^{Ar} y_i y_j a_{ij}$$

$$b_m = \sum_{i=N_2}^{Ar} y_i b_i$$

$$a_{ij} = \sqrt{a_i a_j}$$

where:

$$a = \frac{0.4278 Tc^{2.5} R^2}{Pc}$$

$$b = \frac{0.0867 RTc}{Pc}$$

where:

R	= universal gas constant = 0.08207 K*atm
Tc	= critical temperature of the i'th component (°R)
Pc	= critical pressure of the i'th component (psia)

The Wichert-Aziz correction adjusts the pseudocritical temperature and pressure:

$$\varepsilon = 27\left(\left(xCO_2 + xH_2S\right) - \left(xCO_2 + xH_2S\right)^2\right) + 7.5\left(\sqrt{xH_2S} - xH_2S^2\right)$$

$$T_{ci}^{*} = T_{ci} - \varepsilon$$

$$P_{ci}^{*} = P_{ci}\frac{T_{ci}^{*}}{T_{ci}}$$

When 0 < P < 2500 psia, temperature is adjusted as follows:

$$T^{*} = T + 3.5\left(\frac{P}{400} - 0.000001P^{2}\right)$$

Molar density is computed from:

$$M_{d} = \frac{P}{ZRT}$$

where:

P	= pressure, pounds per square inch absolute
Pc	= pseudocritical pressure of the gas mixture, pounds per square inch absolute
T	= temperature, °Rankine
Tc	= pseudocritical temperature of the gas mixture, °Rankine

Redlich Kwong (Modified)

The modified Redlich-Kwong algorithm works well for most pure gases (e.g. pure nitrogen, carbon dioxide, hydrogen, etc.) over normal ranges of temperature and pressure. Inclusion of Redlich-Kwong extends the utility of NGas/IGas 4.X.X to non-hydrocarbon gases.

The equation of state is solved for the compressibility factor by Newton-Rapheson iteration.

$$Z_{i+1} = Z_{i} - \frac{f(Z)}{f'(Z)}$$

$$f(Z) = 1 + A - Z - \frac{AB}{A+Z} + \frac{A^{2}B}{AZ + Z^{2}}$$

$$f'(Z) = \frac{A * B}{(A+Z)^{2}} - \frac{A^{2}B(2Z + A)}{(Z^{2} + AZ)^{2}} - 1$$

where:

$$A = \frac{0.0867\,\mathrm{Pr}}{Tr}$$

$$B = \frac{4.934}{\sqrt{Tr^{3}}}$$

$$\mathrm{Pr} = \frac{P}{Pc}$$

$$Tr = \frac{T}{Tc}$$

Molar density is computed from:

$$M_{d} = \frac{P}{ZRT}$$

where:

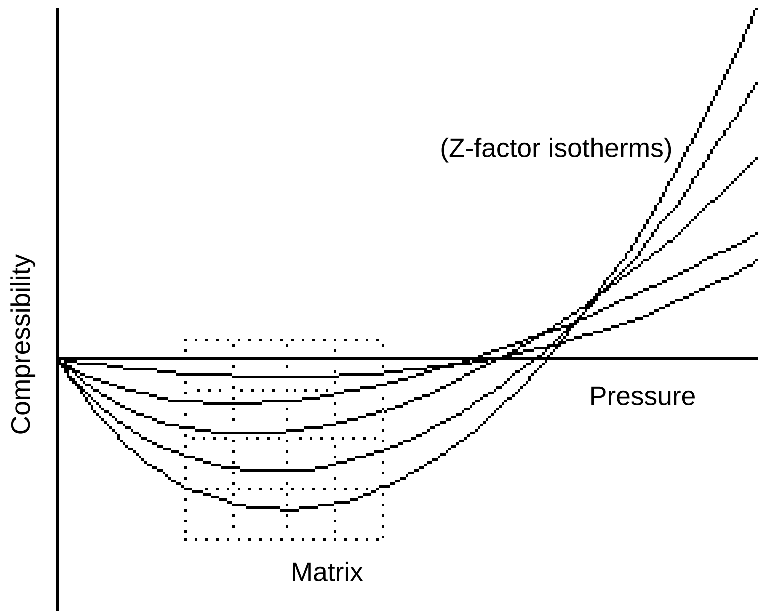
P	= pressure, pounds per square inch absolute
Pc	= pseudocritical pressure of the gas mixture, pounds per square inch absolute

T = temperature, °Rankine

Tc = pseudocritical temperature of the gas mixture, °Rankine

Matrix

The matrix provides a "window" into the compressibility graph of the particular gas:



The Scanner interpolates the compressibility from the user-entered matrix using the live temperature and pressure.

The pressure and temperature points need not be evenly distributed. The interpolation formula will work correctly both inside and outside the bounds of the matrix; it can interpolate and extrapolate the compressibility factor. NGas and IGas 4.X.X can handle an “n x n” matrix, where n is user-selectable: 1, 3 or 5. When n=1, the resulting 1x1 "matrix" means simply that a single user-entered constant is used for Z at all times, regardless of temperature and pressure. This is a useful option in situations where the user purposely does not want to calculate the compressibility in real time, or wishes to use the computer on non-critical low-pressure flowruns, where accuracy is not important enough to justify complex methods (or even temperature and pressure transmitters).

Meter Factor

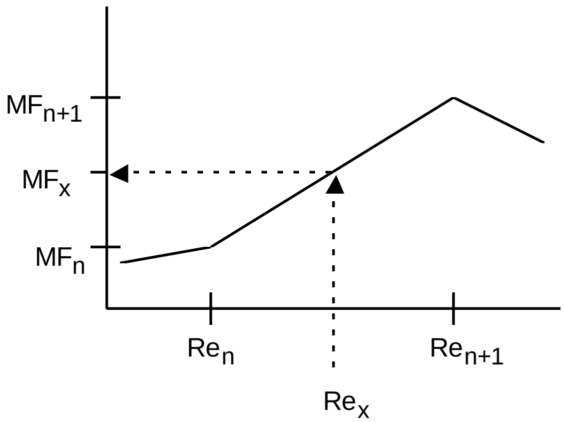
Meter factors have been a standard part of liquid metering for many years but their application to natural gas orifice metering is rather new. It is described in AGA-3, section 1.9 ("In-Situ Calibration"). The NGas/IGas 4.X.X orifice calculation includes a meter factor, "MF," to accommodate this requirement. NGas/IGas 4.X.X accepts up to nine meter factors, which are tabulated against the Reynolds Number; the final meter factor is found by linear interpolation.

The meter factor is optional. If the user does not wish to activate it, simply leave everything in the meter factor table at the original values; this forces the interpolation to output a meter factor of 1.

The interpolation formula is:

$$MF_x = \left[\left(\frac{\mathrm{Re}_x - \mathrm{Re}_n}{\mathrm{Re}_{n+1} - \mathrm{Re}_n} \right) \left(MF_{n+1} - MF_n \right) \right] + MF_n$$

Graphically:



The general method for determining meter factors through "In-Situ Calibration" is summarized below (see also AGA-3 part 1, section 1.9).

> ***Note***: This is merely a brief description; a full calibration procedure would depend on the specific equipment used, and would require close attention to many details not covered here.

The main requirement is a master meter (such as a turbine meter, or a sonic flow nozzle) that has been characterized at a flow laboratory. Place the master meter in series with the orifice meter, so that the normal flow profile through the orifice meter is not disturbed. Record the flow rates indicated by both meters by varying the flow to obtain several different Reynolds Numbers. The flow must remain steady during each calibration run. Several runs should be taken at each Reynolds Number and the results averaged.

Chapter 11: IGas 4.X.X Configuration & Calculations

About Flowrun Configuration

IGas is a firmware package for Scanner 1130, 1140, and 1131 flow computers. It conforms to ISO and related flow measurement standards that were current as of 1999, for measurement of natural gas and other industrial gases by means of a variety of flow elements. IGas provides mass flow, volume and energy measurement. It includes a curve of Reynolds Number vs. Meter Factor, which accommodates calibrated primary flow elements, and a similar curve of gross volumetric flowrate vs. K factor, which may be used with turbine meters or equivalent devices calibrated at multiple flowrates. The firmware is configured using a personal computer (PC) with ScanWin software.

IGas supports a variety of primary elements including orifice meters, ISO nozzles, Long Radius nozzles, classical Venturi meters, turbine and other linear pulse-output volumetric devices, and coriolis meters. Secondary devices include pressure, temperature, and differential pressure analog transmitters, RTDs, analog or frequency-type densitometers, and gas chromatographs.

The flowrun configuration is set in the Scanner when the field device is first set up. Configurations normally do not change, but can be altered in ScanWin LITE. The configuration specifies what is being calculated and the method by which the calculation will be performed. The parameters are the second level of information used to set up a Scanner and include flowrun parameters and physical specifications of the meter. Many of these parameters can be edited in ScanWin. You can specify up to 12 configuration categories. Options within each category are specified when the field device is configured and you cannot change these options in ScanWin LITE.

Flowrun Configuration Setup Options

Variable Tag	Description	Units / Allowed Values
Run_name Run_Type Method Pri_Device	Refer to the NGas **Flowrun Configuration Rules (page 156)** for details about setting these options.	
Dev_Type	Device type	If you are setting up a *Differential Producer* run, the choices are: **Orifice (ISO-98)**, **ISA 1932 nozzle**, **Venturi**, **Long radius nozzle, Venturi nozzle** and **Orifice (ISO-91)** If you are setting up a *turbine* or *mass pulse* run, the choices are: **Standard, Level B** and **Ultrasonic**
Tap_Type	Orifice pressure tap type	**Flange taps**, **Corner taps** and **D and D/2 taps** are the options.
Tap_loc DP_mode Dens_srce	Refer to the NGas **Flowrun Configuration Rules (page 156)** for details about setting these options.	
Gas_Data	Gas data type	**Mole Fractions** requires that the composition of the gas be fully specified, by entering the mole fractions of each of 21 component gases. Input can be from either manual entry or live from an installed gas chromatograph. **Manual** selects the Z matrix method. **Extended Mole Fractions** extends the normal slate of hydrocarbon gases to include additional gas components. Choosing mole fractions limits you to either the Redlich-Kwong or Standing-Katz Z-factor methods. **GCN** (Gravity, %CO2, %N2), **HCN** (Heating Value, %CO2, %N2), **GHC** (Gravity, heating value, %CO2) and **GHN** (Gravity, Heating Value, %N2) are associated with a simplified gas quality input used by the "SGERG" method. They specify various combinations of gravity (i.e. Real Gas Relative Density), gross volumetric heating value and percentages of inerts, which must be added to the calculation. For **Pc**,**Tc**, Pc is the critical pressure (kPa [a] or other absolute units). Pc and Tc are thermodynamic constants for a given gas. This option selects a modified Redlich-Kwong calculation, which is suitable for most pure non-hydrocarbon gases, e.g. pure carbon dioxide, pure ammonia, steam or other industrial gases. The Pc and Tc for the gas(es) in question must be calculated and entered into the Scanner.
Z_method	Z method in use	Options depend on what is chosen in Gas Data (above): When Gas Data is *Manual*, **Matrix** is available. When Gas Data is *Mole Fractions*, **Standing-Katz, Redlich-Kwong 1, SGERG-88 GCN, SGERG-88 GHC, SGERG GHN** and **AGA-8 92 DC** are options. When Gas Data is *Extended Mole Fractions*, **Standing-Katz** and **Redlich-Kwong (S)** are the options. When the Gas Data is *GCN*, the only option is **SGERG-88 GCN.** When the Gas Data is *GHC*, the only option is **SGERG-88 GHC.** When the Gas Data is *GHN*, the only option is **SGERG-88 GHN**. When Gas Data is *Pc, Tc*, **Redlich-Kwong (M)** is the only option. **Redlich-Kwong** is the simplest and fastest equation of state provided in IGas. The version used includes Wichert-Aziz correction, making it suitable for sour natural gas. Redlich-Kwong is most accurate at relatively low pressures (to about 3.5 MPa or 500 psi). It is not recommended for use on custody transfer applications. **Standing-Katz** is another efficient algorithm based on the Standing-Katz graphical

Variable Tag	Description	Units / Allowed Values
		method. It includes Wichert-Aziz correction, making it suitable for sour natural gas. It is accurate for pressures up to about 17 MPa or 2500 psi. The options, collectively referred to as the SGERG-88 method (SGERG-88 GCN, SGERG-88 GHC, and SGERG GHN) require only three parameters to characterize the gas. Knowledge of the gravity, heating value, mole percent carbon dioxide and mole percent nitrogen (in various combinations) is all that's needed, rather than the complete list of 21 components. The SGERG-88 method can also be selected after choosing "mole fractions" input, in which case the gravity, heating value, %CO2 and %N2 are automatically computed from the gas analysis. This allows the SGERG-88 method to be used with live input from gas chromatographs. The SGERG-88 method is recommended for general natural gas measurement. It is efficient, well-suited to low-power applications, and nearly as accurate as the AGA8-92 DC method. The major restriction is the pressure/temperature range and the limits on the gas composition. The range limits are well suited to pipeline-quality natural gas, but they may not be suitable for production gas. Note that the temperature, pressure and composition limits must be observed otherwise serious measurement errors may result. ISO 1221302 contains a prominent warning that the SGERG-88 methods should not be used outside the specified limits. **AGA8 (92) DC** is the most accurate method for finding the compression factor of natural gas. It is also by far the most complex. The calculation is inherently slow compared to most other methods. Since it requires the processor to be active for several consecutive seconds whenever Z is to be updated, the detailed method is a poor choice for low-power applications (e.g., in situations where the Scanner runs off batteries and solar panels). You should reserve this calculation for custody transfer meters where accuracy is of paramount importance and an adequate power supply is available. The Detailed Method also requires that a large number of intermediate variables be retained in memory. The amount of RAM installed in the Scanner is generally what determines the number of flowruns that can use this calculation. The **Matrix** is the method of last resort. It extends the utility of IGas to cover gases whose behavior cannot be predicted by any of the empirical methods described above. To use this method, you must fill the matrix with Z factors, which have been determined in advance at various temperatures and pressures. IGas determines the Z-factor by linear interpolation from the matrix. The major disadvantage of this method is that any given matrix is valid only for a single gas composition; a new matrix must be determined any time the gas composition changes significantly. The "Single Z" option is useful in situations where you need to input Z directly (perhaps in order to verify other calculations).
Z_size	Refer to the NGas **Flowrun Configuration Rules (page 156)** for details about setting these options.	
Gr_mode		
Hv_mode		
GC_mode		
GC_logging		
Peak_logging		
HrlyHist_size		
DailyHist_size		
Hist_intvl		
Direction		
Q_Calc		
Z_Calc		
Avg_Freq	Refer to the NGas **Flowrun Configuration Rules (page 156)** for details about setting these options.	

Variable Tag	Description	Units / Allowed Values
Avg_Delay		
Avg_Style		
Est_PC		
Est_Enable		
Est_Basis		
Flow_check		
Ref_Cond	Reference Conditions	The options are (see values below) • **USA** • **France, Japan** • **Canada, UK, Australia** • **Europe**
Stn_A	Refer to the NGas **Flowrun Configuration Rules (page 156)** for details about setting these options.	
Stn_B		

Reference Condition values are:

	HvCF	RdCF	Thref (℃)	Tdref/Tgref (℃)	Pdref/Pgref kPa
USA	1.0539	1.0002	15.5	15.5	101.559
France, Japan	0.9974	1.0	0	0	101.325
Canada, UK, Australia	1.0543	1.0002	15	15	101.325
Europe	1.0	1.0	25	0	101.325

NOTE:

When the **Configuration Lock Switch** is **ON**,

1. The following parameters may be modified:
   - Heating value
   - Density
   - Gas composition
   - Flowrun status (stopped, running)
   - Gas component reference string
   - Time and date
   - Accessories
2. The following components are **LOCKED** and cannot be modified:
   - System
   - Flowrun setup, including:
     - Pulse output from a total
     - Flowrun configuration values and status values
     - Flowrun parameters
   - Hardware for flowrun input and calibration
   - Station totals
   - Superboot switch
   - The ability to assign flowrun items to outputs and alarms and set alarm levels
   - Communications

Flowrun Parameters

Refer to the NGas **Flowrun Parameters (page 161)** section for details about the following items:
(a) ***Normalized Analysis***, (b) ***Base Temperature and Pressure***, (c) ***Pipe and Throat Diameters, Temperature Coefficients and Measurement Reference Temperatures***, (d) ***Isentropic Exponent***, (e) ***Viscosity*** and (f) ***Meter Factors***.

Discharge Coefficient

For classical venturi meters, the discharge coefficient is user-entered. Values recommended by ISO-5167 are:

machined inlet	0.995
rough-cast inlet	0.984
welded steel	0.985

Calculated Values

For more information about the following parameters, refer to the NGas **Calculated Values (page 163)**:
(a) ***Flow Extension (differential producers)***, (b) ***Discharge Coefficient (differential producers)***, (c) ***Reynolds Number (differential producers)*** and (d) ***Expansion Factor (differential producers, gas flow)***.

Compression Factor (Gas Flowruns)

The compression factor of a gas is the amount by which its behavior deviates from the Ideal Gas Law. It is a dimensionless number, symbolized "Z", which is the result of a complex calculation based on temperature, pressure, and quality of the gas (note that differential pressure does not enter it). IGas computes three Z factors: Zf, the compression factor at flowing conditions; Zb, the compression factor at base conditions and Zn, the compression factor at normal conditions. Typical values:

Zb, Zn	0.998	(always close to 1.0; usually 0.99…)
Zf	0.8 to 1.05	(under typical conditions)
Zf	0.5 to 1.5	(under extreme conditions)

Molar Density (Gas Flowruns)

Molar density is closely related to compression factor. It is the density of the gas expressed in kilogram-moles per cubic meter, or equivalent units. As with compression factor, three molar densities are computed: Mdf (flowing conditions, Mdb (base conditions) and Mdn (normal conditions). Typical values are:

Mdn, Mdb	0.04	(typical natural gas)
Mdf	2.3	(typical natural gas at 700 psi)
Mdf	19.3	(typical natural gas at extreme pressure)

Mass Density (All Flowruns)

Mass density is normally symbolized with the Greek letter "θ". It is the density of the fluid in kilograms per cubic meter (or equivalent units). Typical values are:

RHOb, RHOn	0.7	(typical natural gas)
RHOf	40.6	(typical natural gas at 700 psi)
RHOf	340	(natural gas at extreme pressure)

IGas 4.X.X Flowrun Variables

Variable Tag	Description	Storage Units	Attributes
AlphaD	Pipe Thermal Expansion Coefficient	mm/mm°C	Param
Alphad	Throat Thermal Expansion Coefficient	mm/mm°C	Param
Beta	Diameter Ratio	-	Calc
Btot	Total Volume (Base Conditions)	M3	Total
C	Discharge Coefficient	-	Param/Calc
D	Pipe Inside Diameter	m	Calc
d	Throat Diameter	m	Calc
dp	Current Differential Pressure	Pa	Calc/Avg
DPh-l	Stacked DP high to low switchpoint	Pa	Param
DPh-m	Stacked DP high to mid switchpoint	Pa	Param
DPhi	High Stacked Differential Pressure	Pa	Live
DPl-h	Stacked DP low to high switchpoint	Pa	Param
DPl-m	Stacked DP low to mid switchpoint	Pa	Param
DPlow	Low Stacked Differential Pressure	Pa	Live
DPlv	Single Live Differential Pressure	Pa	Live
DPlast	Last read Differential Pressure	Pa	Calc
DPm-h	Stacked DP mid to high switchpoint	Pa	Param
DPm-l	Stacked DP mid to low switchpoint	Pa	Param
DPmid	Mid Stacked Differential Pressure	Pa	Live
DPpri	Primary Live Differential Pressure	Pa	Live
DPsec	Secondary Live Differential Pressure	Pa	Live
DPkPr	Peak Pressure (daily)	Pag	Calc
DPkQb	Peak Volume Flow Rate (daily)	M3/sec	Calc
Dr	Uncorrected Pipe Inside Diameter	m	Param
dr	Uncorrected Throat Diameter	m	Param
Etot	Total Energy	Joules	Total
Ev	Velocity of Approach factor	-	Calc
Fextn	Flow Extension (=sqrt(DP * RHOf))	-	Calc/Avg
Freq	Input frequency	Hz	Calc/Avg
rd	Relative Density at ref. Conditions	kg/M3	Par/Live/Calc
rdn	Relative Density at normal conditions	kg/M3	Calc
Hmh	Mass calorific value at ref. Conditions	J/kg	Par/Calc
Hs	Gross calorific value at normal conditions	J/M3	Calc
HN25	Molar calorific value at 25 C	J / mol	Calc
HNh	Molar calorific value at ref. Conditions	J / mol	Calc
HV	Gross calorific value at ref. Conditions	Joules/M3	Par/Live/Calc
HvCF	Heating value reference correction	-	Param
HPkPr	Peak Pressure (hourly)	Pag	Calc
HPkQb	Peak Volume Flow Rate (hourly)	M3/sec	Calc
k	Isentropic Exponent	-	Param
Mdb	Molar density, base conditions	-	Calc
Mdf	Molar density, flowing conditions	-	Calc

Variable Tag	Description	Storage Units	Attributes
Mdg	Molar density, gravity ref. conditions	-	Calc
Mdh	Molar density, HV ref. conditions	-	Calc
Mdn	Molar density, normal conditions	-	Calc
MF1	Meter factor at Re1	-	Param
MF2	Meter factor at Re2	-	Param
MF3	Meter factor at Re3	-	Param
MF4	Meter factor at Re4	-	Param
MF5	Meter factor at Re5	-	Param
MF6	Meter factor at Re6	-	Param
MF7	Meter factor at Re7	-	Param
MF8	Meter factor at Re8	-	Param
MF9	Meter factor at Re9	-	Param
MFact	Meter factor (interpolated)	-	Calc
MFsum	Mole Fraction Sum	-	Calc/Live[12]
Mr	Molar mass	-	Calc
Mtot	Total Mass	kg	Total
MtotB	This Months Total Volume	M3	Total
MTotE	This Months Total Energy	Joules	Total
MTotM	This Months Total Mass	kg	Total
MtotN	This Months Total Normal Volume	M3	Total
Mu	Absolute Viscosity	kg/Msec	Param/Calc
Ntot	Total Volume (Normal Conditions)	M3	Total
P1	Matrix pressure point 1	Paa	Param
P2	Matrix pressure point 2	Paa	Param
P3	Matrix pressure point 3	Paa	Param
P4	Matrix pressure point 4	Paa	Param
P5	Matrix pressure point 5	Paa	Param
pa	Local Atmospheric Pressure	Paa	Param
pb	Contract Base Pressure	Paa	Param
Pc	Pseudocritical Pressure	Paa	Param/Calc
PDref	Pressure Density Reference	Paa	Param
PGref	Pressure Gravity Reference	Paa	Param
p	Absolute Pressure	Paa	Calc/Avg
PfZf	Absolute Pressure for Zf	Paa	Calc
pg	Gauge Pressure	Pag	Live
pglast	Last read Pressure	Pag	Calc
PtotB	Previous Months Total Volume	M3	Total
PTotE	Previous Months Total Energy	Joules	Total
PTotM	Previous Months Total Mass	kg	Total
PtotN	Previous Months Normal Total Volume	M3	Total
Qb	Volume Flow Rate	M3/sec	Calc
Qe	Energy Flow Rate	Joules/sec	Calc
Qf	Uncorrected Pulse Rate	M3/sec	Live
Qfavg	Average Uncorrected Pulse Rate	M3/sec	Calc

[12] Live assignment supported only for GC peripheral devices, which assigns all gas components to GC.

Variable Tag	Description	Storage Units	Attributes
Qftot	Uncorrected Pulse Total	M3	Total
Qf1	Ultrasonic Meter Factor Qf 1	M3/sec	Param
Qf2	Ultrasonic Meter Factor Qf 2	M3/sec	Param
Qf3	Ultrasonic Meter Factor Qf 3	M3/sec	Param
Qf4	Ultrasonic Meter Factor Qf 4	M3/sec	Param
Qf5	Ultrasonic Meter Factor Qf 5	M3/sec	Param
Qf6	Ultrasonic Meter Factor Qf 6	M3/sec	Param
Qf7	Ultrasonic Meter Factor Qf 7	M3/sec	Param
Qf8	Ultrasonic Meter Factor Qf 8	M3/sec	Param
Qf9	Ultrasonic Meter Factor Qf 9	M3/sec	Param
Qm	Mass Flow Rate	kg/sec	Calc/Live
Qn	Normal Volume Flow Rate	M3/sec	Calc
rdCF	Heating value reference correction	-	Param
Re1	Reynolds Number 1	-	Param
Re2	Reynolds Number 2	-	Param
Re3	Reynolds Number 3	-	Param
Re4	Reynolds Number 4	-	Param
Re5	Reynolds Number 5	-	Param
Re6	Reynolds Number 6	-	Param
Re7	Reynolds Number 7	-	Param
Re8	Reynolds Number 8	-	Param
Re9	Reynolds Number 9	-	Param
ReD	Reynolds Number (D)	-	Calc
RHOb	Fluid Density at Base Conditions	kg/M3	Calc
RHOf	Fluid Density	kg/M3	Calc/Live
RHOn	Fluid Density at Normal Conditions	kg/M3	Calc
T1	Matrix temperature point 1	K	Param
T2	Matrix temperature point 2	K	Param
T3	Matrix temperature point 3	K	Param
T4	Matrix temperature point 4	K	Param
T5	Matrix temperature point 5	K	Param
tb	Contract Base Temperature	K	Param
Tc	Pseudocritical Temperature	K	Param/Calc
TDmea	Pipe Measurement Temperature	K	Param
Tdmea	Throat Measurement Temperature	K	Param
Temp	Live Temperature	K	Live
t	Flowing Temperature	K	Calc/Avg
tlast	Last read Temperature	K	Calc
TDref	Temperature Density Reference	K	Param
TGref	Temperature Gravity Reference	K	Param
THref	Temperature Heating Value Reference	K	Param
TtotB	Today’s Total Volume	M3	Total
TTotE	Today’s Total Energy	Joules	Total
TTotM	Today’s Total Mass	kg	Total
TtotN	Today’s Total Normal Volume	M3	Total

Variable Tag	Description	Storage Units	Attributes
Tzf	Temperature for Zf	K	Calc
UMF1	Ultrasonic Meter Factor 1	-	Param
UMF2	Ultrasonic Meter Factor 2	-	Param
UMF3	Ultrasonic Meter Factor 3	-	Param
UMF4	Ultrasonic Meter Factor 4	-	Param
UMF5	Ultrasonic Meter Factor 5	-	Param
UMF6	Ultrasonic Meter Factor 6	-	Param
UMF7	Ultrasonic Meter Factor 7	-	Param
UMF8	Ultrasonic Meter Factor 8	-	Param
UMF9	Ultrasonic Meter Factor 9	-	Param
UMFact	Ultrasonic Meter Factor (interpolated)	-	Calc
XAr	Mole Fraction Argon	-	Param
xC1	Mole Fraction Methane	-	Param
xC2H4	Mole Fraction Ethene	-	Param
xC2	Mole Fraction Ethane	-	Param
xC3	Mole Fraction Propane	-	Param
xC3H6	Mole Fraction Propene	-	Param
xC4H8	Mole Fraction Butene	-	Param
xC5H10	Mole Fraction Pentene-1	-	Param
XCO	Mole Fraction Carbon Monoxide	-	Param
xCO2	Mole Fraction Carbon Dioxide	-	Param
xH2	Mole Fraction Hydrogen	-	Param
xH2O	Mole Fraction Water	-	Param
xH2S	Mole Fraction Hydrogen Sulfide	-	Param
XHe	Mole Fraction Helium	-	Param
xiC4	Mole Fraction Iso-Butane	-	Param
xiC5	Mole Fraction Iso-Pentane	-	Param
xN2	Mole Fraction Nitrogen	-	Param
xnC10	Mole Fraction Normal Decane	-	Param
xnC4	Mole Fraction Normal Butane	-	Param
xnC5	Mole Fraction Normal Pentane	-	Param
xnC6	Mole Fraction Normal Hexane	-	Param
xnC7	Mole Fraction Normal Heptane	-	Param
xnC8	Mole Fraction Normal Octane	-	Param
xnC9	Mole Fraction Normal Nonane	-	Param
xO2	Mole Fraction Oxygen	-	Param
Eps	Expansibility Factor	-	Param/Calc
YtotB	Yesterdays Total Volume	M3	Total
YtotE	Yesterdays Total Energy	Joules	Total
YtotM	Yesterdays Total Mass	kg	Total
YtotN	Yesterdays Total Normal Volume	M3	Total
Z11	Z factor @ Pressure1 / Temperature 1	-	Param
Z12	Z factor @ Pressure1 / Temperature 2	-	Param
Z13	Z factor @ Pressure1 / Temperature 3	-	Param
Z14	Z factor @ Pressure1 / Temperature 4	-	Param
Z15	Z factor @ Pressure1 / Temperature 5	-	Param

Variable Tag	Description	Storage Units	Attributes
Z21	Z factor @ Pressure2 / Temperature 1	-	Param
Z22	Z factor @ Pressure2 / Temperature 2	-	Param
Z23	Z factor @ Pressure2 / Temperature 3	-	Param
Z24	Z factor @ Pressure2 / Temperature 4	-	Param
Z25	Z factor @ Pressure2 / Temperature 5	-	Param
Z31	Z factor @ Pressure3 / Temperature 1	-	Param
Z32	Z factor @ Pressure3 / Temperature 2	-	Param
Z33	Z factor @ Pressure3 / Temperature 3	-	Param
Z34	Z factor @ Pressure3 / Temperature 4	-	Param
Z35	Z factor @ Pressure3 / Temperature 5	-	Param
Z41	Z factor @ Pressure4 / Temperature 1	-	Param
Z42	Z factor @ Pressure4 / Temperature 2	-	Param
Z43	Z factor @ Pressure4 / Temperature 3	-	Param
Z44	Z factor @ Pressure4 / Temperature 4	-	Param
Z45	Z factor @ Pressure4 / Temperature 5	-	Param
Z51	Z factor @ Pressure5 / Temperature 1	-	Param
Z52	Z factor @ Pressure5 / Temperature 2	-	Param
Z53	Z factor @ Pressure5 / Temperature 3	-	Param
Z54	Z factor @ Pressure5 / Temperature 4	-	Param
Z55	Z factor @ Pressure5 / Temperature 5	-	Param
Zb	Compressibility at Base Conditions	-	Param/Calc
Zf	Compressibility at Flowing Conditions	-	Param/Calc
Zn	Compressibility at Normal Conditions	-	Param/Calc

IGas Calculations

Units of Measurement

All calculations in IGas 4 are performed in pure MKS units. Refer to the NGas **Units of Measurement (page 170)** for information about this topic.

Gas Properties

Refer to the NGas **Gas Properties (page 171)** for information about the properties of hydrocarbon gases, other components of natural gas and assorted industrial gases.

Reference Standards

ISO 5167-1 (1992-12-15)
"Measurement of fluid flow by means of pressure differential devices"
Part 1: Orifice plates, nozzles, and Venturi tubes inserted in circular cross-section conduits running full"
International Organization for Standardization, 1992
Including amendment 1 (1998-04-01) for the R-G orifice equation.

W. Wagner & A. Kruse; "Properties of Water and Steam - The Industrial Standard IAPWS-IF97 for the Thermodynamic Properties and Supplementary Equations for Other Properties"; Springer-Verlag 1998; ISBN 3-540-64339-7

"Natural Gas - Calculation of compression factor"
ISO 12213-1 : Introduction and guidelines
ISO 12213-2 : Calculation using molar composition analysis
ISO 12213-3 : Calculation using physical properties
International Organization for Standardization, 1997

M. Jaeschke & A.E. Humphreys: "Standard GERG Virial Equation for Field Use"
GERG Technical monograph TM5, 1991
Groupe Europeen de Recherches Gaziers (GERG)
Verlag des Vereins Deutcher Ingenieure, DŸsseldorf, 1991; ISBN 3-18-146606-9

R. W. Miller; "Flow Measurement Engineering Handbook" (3rd edition); McGraw Hill 1996; ISBN 0-07-042366-0

A.G.A. "Manual for the Determination of Supercompressibility Factors for Natural Gas"; PAR Research Project NX-19; American Gas Association 1962

Reference Conditions

Refer to the NGas **Reference Conditions (page 173)** for details.

Composite Gas Properties

When the "`Mole Fraction Analysis`" option is specified, IGas 4.X.X determines various physical gas properties by calculation from the user-specified gas composition, and a table of constants stored in ROM. The physical constants are obtained primarily from GPA-2145 (SI tables); properties or components not covered by the GPA standard are taken from AGA-3 part 3.

The sum of the mole fractions (as entered by the user or input from a gas chromatograph), must equal one exactly (normalized).

Note: In all equations of this form, the list of gas components begins at N_2 and ends at Ar. The first table in the NGas **Gas Properties (page 171)** section lists the components in standard order, along with the physical constants for each component.

For each component `i`, the normalized mole fraction `x` is:

$$x_i = \frac{Xentered_i}{MFsum}$$

Pseudocritical temperature:

$$Tc = \sum_{i=N_2}^{Ar} x_i Tc_i$$

Pseudocritical pressure:

$$Pc = \sum_{i=N_2}^{Ar} x_i Pc_i$$

Viscosity:

$$Mu = \frac{\sum_{n=N_2}^{Ar} x_i \mu_i \sqrt{Mr_i}}{\sum_{n=N_2}^{Ar} x_i \sqrt{Mr_i}}$$

Mass basis heating value:

$$HN25 = \sum_{i=N_2}^{Ar} x_i HN_i$$

Molar mass (molecular weight):

$$Mr = \sum_{i=N_2}^{Ar} x_i Mr_i$$

Real gas relative density (gas gravity):

$$Gr = \frac{MrMd_{ref}}{\rho_{air}}$$

When gravity is input instead of mole fractions:

$$Mr = \frac{Gr\rho_{air}}{Md_{ref}}$$

Density of air:

$$B_{air} = -0.12527 + 5.91\times10^{-4}T_b - 6.62\times10^{-7}T_b^2$$

$$\rho_{air} = \frac{Mr_{air}}{\left(\frac{RT_{Gref}}{P_{Gref}}\right) + B_{air}}$$

Where:

Mr_{air} = 28.96256

T_b = contract base temperature

Density of the gas at reference conditions TD_{ref}, Pd_{ref}

$$\rho_{ref} = Md_{ref}M_r$$

The mass density at reference conditions:

$$\rho_{ref} = Md_{ref}M_r$$

Where Md_{ref} is the molar density at reference conditions TG_{ref} and PG_{ref}, calculated via the selected Z-factor method.

Mass density at contract base conditions:

$$\rho_b = Md_bM_r$$

Where Md_b is the molar density at contract base conditions Tbase and Pbase calculated through the selected Z-factor method.

Mass density at flowing conditions:

$$\rho_f = Md_fM_r$$

Where Md_f is the molar density at flowing conditions Tf and Pf, calculated via the selected Z-factor method.

Orifice Metering

Discharge coefficient for flange taps:

$$C = 0.5961 + 0.0261\beta^2 - 0.216\beta^8 + 0.000521\left[\frac{10^6\beta}{\mathrm{Re}_D}\right]^{0.7} + (0.0188 + 0.0063A)\beta^{3.5}\left[\frac{10^6}{\mathrm{Re}_D}\right]^{0.3}$$

$$+ \left(0.043 + 0.080e^{-10L_1} - 0.123e^{-7L_1}\right)(1 - 0.11A)\frac{\beta^4}{1-\beta^4} - 0.031\left(M'_2 - 0.8M'^{1.1}_2\right)\beta^{1.3}$$

In the case where D>71.12 mm (2.8 in), the following term should be added to the above equation:

$$+0.011(0.75-\beta)\left[2.8 - \frac{D}{25.4}\right]$$ (D is expressed in millimeters)

where

$\beta = d / D$ is the diameter ratio;

Re_d is the Reynolds number related to D;

$$A = \left[\frac{19000\beta}{\mathrm{Re}_D}\right]^{0.8};$$

$$M'2 = \frac{2L'_2}{1-\beta};$$

$L_1 = I_1 / D$ is the quotient of the distance of the upstream tapping from the upstream face of the plate and the pipe diameter.

$L'_2 = I'_2 / D$ is the quotient of the distance of the downstream tapping from the **downstream** face of the plate, and the pipe diameter. (*L'_2* denotes the reference of the downstream spacing from the **downstream** face, while *L_2* would denote the reference of the downstream spacing from the **upstream** face).

The values of L_1 and L'_2 to be used in this equation, when the spacings are in accordance with the requirements of 8.2.1.2, 8.2.1.3 or 8.2.2, are as follows:

for corner tappings:

$$L_1 = L'_2 = 0$$

for D and D/2 tappings:

$$L_1 = 1$$

$$L'_2 = 0.47$$

for flange tappings:

$$L_1 = L'_2 = \frac{25.4}{D}$$

where D is expressed in millimeters.

Long Radius nozzle:

$$C = 0.9965 - 0.00653\beta^{0.5}\left[\frac{10^6}{\mathrm{Re}_D}\right]^{0.5}$$

ISA 1932 Nozzle:

$$C = 0.99 - 0.226\beta^{4.1} - \left[0.00175\beta^2 - 0.0033\beta^{4.15}\right]\left[\frac{10^6}{\mathrm{Re}_D}\right]^{1.15}$$

Venturi Nozzle:

$$C = 0.9858 - 0.196\beta^{4.5}$$

Orifice bore, meter bore, beta ratio:

$$D = Dr\left[1 + \alpha 2\left(T_f - T_r\right)\right]$$

$$d = dr\left[1 + \alpha 1\left(T_f - T_r\right)\right]$$

$$\beta = \frac{d}{D}$$

where

dr = orifice bore at reference temperature T_r

Dr = meter tube diameter at reference temperature T_r

$\alpha 1$ = coefficient of linear expansion of meter tube material

$\alpha 2$ = coefficient of linear expansion of orifice plate material

Expansion Factor (orifice):

$$Y = 1 - \left(0.41 + 0.35\beta^4\right)\frac{x_1}{k}$$

$$x_1 = \frac{\Delta P}{N_3 P_{f1}}$$

$$\varepsilon = \sqrt{\frac{\left(1-\beta^4\right)\dfrac{k}{k-1}Tau^{\frac{2}{k}}\left(1 - Tau^{\frac{k-1}{k}}\right)}{\left(1-\beta^4 Tau^{\frac{2}{k}}\right)\left(1 - Tau\right)}}$$

where

$$Tau = \frac{P - dP}{P}$$

Static pressure, when measured at the upstream tap:

$$P_f = P_{gage} + P_{atm}$$

Static pressure, when measured at the downstream tap:

$$P_f = P_{gage} + P_{atm} + \Delta P$$

Where P_{gage}, P_{atm}, and ΔP are in the same units

Reynolds Number:

$$\mathrm{Re} = \frac{4 * qm}{\pi \mu D}$$

Velocity of Approach factor:

$$E_v = \frac{1}{\sqrt{1 - \beta^4}}$$

Mass Flow

The final orifice flow calculation used in IGas 4.X.X departs slightly from the standard formulation. The flow extension *Fext* is introduced as a separate variable whose value is recorded in the flowrun's history log. The Meter Factor *MF* is later discussed. The incremental mass is obtained by integrating the instantaneous mass flow rate over the time interval of the calculation.

$$q_m = N_1 C E_v Eps\, d^2\, Fext\, MF$$

$$m = \int q_m dt$$

Where:

$$Fext = \sqrt{\rho_f \Delta P}$$

ρf = RHOf = mass density at flowing conditions, kg/m^3

ΔP = differential pressure

m = incremental mass

dt = time elapsed since the preceding calculation

Linear Volume Meter

Refer to the NGas **Linear Volume Meter (page 180)** section for details.

Volume Flow

Refer to the NGas **Volume Flow** (**page 174**) section for details.

Energy Flow

Refer to the NGas **Volume Flow** (**page 175**) section for details

Compressibility

AGA8-92 DC Equation

The following variables are computed when the gas composition is updated:

$$U^5 = \left[\sum_{i=1}^{n} x_i E_i^{\frac{5}{2}}\right]^2 + 2\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j \left(U_{ij}^5 - 1\right)\left(E_i E_j\right)^{\frac{5}{2}}$$

$$K^5 = \left[\sum_{i=1}^{n} x_i K_i^{\frac{5}{2}}\right]^2 + 2\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j \left(K_{ij}^5 - 1\right)\left(K_i K\right)^{\frac{5}{2}}$$

$$C_n^* = a_n\left(G + 1 - g_n\right)^{g_n}\left(Q^2 + 1 - q_n\right)^{q_n}\left(F^2 + 1 - f_n\right)^{f_n} U^{u_n}$$

Where:

$$G = \left[\sum_{i=1}^{n} x_i G_i\right] + \sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j \left(G_{ij}^* - 1\right)\left(G_i + G\right)$$

$$Q = \sum_{i=1}^{N} x_i Q$$

$$F = \sum_{i=1}^{N} x_i^2 F_i$$

$$U^5 = \left[\sum_{i=1}^{n} x_i E_i^{\frac{5}{2}}\right]^2 + 2\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j \left(U_{ij}^5 - 1\right)\left(E_i E_j\right)^{\frac{5}{2}}$$

$$B_{nij}^* = \left(G_{ij} + 1 - g_n\right)^{g_n}\left(Q_i Q_j + 1 - q_n\right)^{q_n}\left(F_i^{\frac{1}{2}} F_j^{\frac{1}{2}} + 1 - f_n\right)^{f_n}\left(S_i S_j + 1 - s_n\right)^{s_n}\left(W_i W_j + 1 - w_n\right)^{w_n}$$

Where:

$$G_{ij} = \frac{G_{ij}^*\left(G_i + G_j\right)}{2}$$

For the numerical values of a_n, b_n, c_n, k_n, u_n, g_n, q_n, f_n, s_n, and w_n, see AGA-8 Table 4.

For the numerical values of E, K, G, Q, F, S, and W, see AGA-8 Table 5.

For the numerical values of E_{ij}, U_{ij}, K_{ij}, and G^*_{ij}, see AGA-8 Table 6.

Virial coefficient B is computed whenever the pressure or temperature is updated:

$$B = \sum_{n=1}^{18} a_n T^{-u_n} \sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j E_{ij}^{u_n}\left(K_i K_j\right)^{\frac{3}{2}} B_{nij}^*$$

Where

$$E_{ij} = E_{ij}^*\left(E_i E_j\right)^{\frac{1}{2}}$$

The molar density Md is a nonlinear function of pressure. Therefore, numerical methods are used to solve the following equation for Md:

$$P = M_d RT\left\{1 + BM_d - D\sum_{n=13}^{18} C_n^* T^{-u_n} + \sum_{n=13}^{58} C_n^* T^{-u_n}\left(b_n - c_n k_n D^{k_n}\right)D^{b_n}\exp\left(-c_n D^{k_n}\right)\right\}$$

Once the molar density is known, the compressibility factor Z is determined from

$$Z = 1 + BM_d - D\sum_{n=13}^{18} C_n^* T^{-u_n} + \sum_{n=13}^{58} C_n^* T^{-u_n}\left(b_n - c_n k_n D^{k_n}\right)D^{b_n}\exp\left(-c_n D^{k_n}\right)$$

Calculation time for the AGA8-92 DC method is governed by the number of non-zero components in the gas. The following formula provides a reasonable estimate of the calculation time:

$$t = k \times u \times \frac{m!}{(m-2)!}$$

where

t = time to recalculate, seconds

k = system timing constant (CPU, clock speed, math coprocessor, etc.)

k ≈ ## for Scanner 1110/1120

k ≈## for Scanner 1110/1120 with math coprocessor

k ≈ ## for Scanner 1130

k ≈ ## for Scanner 1131

k ≈## for Scanner 1131 with math coprocessor

k ≈## for Scanner 1140

m = number of gas components

u = update constant

u ≈ ## for gas composition update

u ≈ ## for pressure or temperature updates

SGERG-88 Equation

The AGA-8 Gross GCN and GHC methods, and the SGERG GHN methods are based on the following equations:

$$B_{mix} = \sum_{i=CO_2}^{CH} \sum_{j=CO_2}^{CH} B_{ij} x_i x_j$$

$$C_{mix} = \sum_{i=CO_2}^{CH} \sum_{j=CO_2}^{CH} \sum_{k=CO_2}^{CH} C_{ijk} x_i x_j x_k$$

Where:

Component ID = CO_2, N_2, CH.

N_2 is the mole fraction of nitrogen.

CO_2 is the mole fraction of carbon dioxide.

CH is the mole fraction of the (fictitious) "equivalent hydrocarbon".

$$B_{ij} = b_0 + b_1 T + b_2 T^2$$

$$C_{ijk} = c_0 + c_1 T + c_2 T^2$$

For the numeric values of b_0, b_1, and b_2, see AGA-8 Table 7:

$$B_{CH-CH} = B_0 + BH_{CH} + B_2 \, H_{CH}^2$$

$$C_{CH-CH-CH} = C_0 + C_1 H_{CH} + C_2 H_{CH}^2$$

$$B_i = b_{i0} + b_{i1} T + b_{i2} T^2, i = 0,1,2$$

$$C_i = c_{i0} + c_{i1} T + c_{i2} T^2, i = 0,1,2$$

For the numeric values of b_{i0}, b_{i1}, b_{i2}, c_{i0}, c_{i1}, and c_{i2}, see AGA-8 Table 8.

The interaction second virial coefficient terms for N_2, CO_2 and CH are calculated:

$$B_{N_2-CH} = \left(0.72 + 1.875 \times 10^{-5} (320 - T)^2\right) \frac{\left(B_{N_2-N_2} + B_{CH-CH}\right)}{2}$$

$$B_{CO_2-CH} - 0.865 \sqrt{B_{CO_2-CO_2} B_{CH-CH}}$$

The interaction third virial coefficient terms for N_2, CO_2 and CH are calculated:

$$C_{N_2-CH-CH} = \left(0.92 + 0.0013(T - 270)\right) \sqrt[3]{C_{CH-CH-CH}^2 \, C_{N_2-N_2-N_2}^2}$$

$$C_{N_2-N_2-CH} = \left(0.92 + 0.0013(T - 270)\right) \sqrt[3]{C_{CH-CH-CH}^2 \, C_{N_2-N_2-N_2}^2}$$

$$C_{CO_2-CH-CH} = 0.92 \sqrt[3]{C_{CH-CH-CH}^2 \, C_{CO_2-CO_2-CO_2}^2}$$

$$C_{CO_2-CO_2-CH} = 0.92 \sqrt[3]{C_{CH-CH-CH}^2 \, C_{CO_2-CO_2-CO_2}^2}$$

$$C_{N_2-CO_2-CH} = 1.10 \sqrt[3]{C_{CH-CH-CH} C_{N_2-N_2-N_2} C_{CO_2-CO_2-CO_2}}$$

Numerical methods are used to solve the following equation for the molar density d:

$$P = dRT\left(1 + B_{mix} d + C_{mix} d^2\right)$$

And finally,

$$Z = 1 + B_{mix} d + C_{mix} d^2$$

Range of Validity of the SGERG-88 Methods

The SGERG-88 method provides the best accuracy when its inputs fall within the **Normal Range** given below. The method is useable for the limits indicated under "expanded range", with reduced accuracy (see ISO 12213-2 for details).

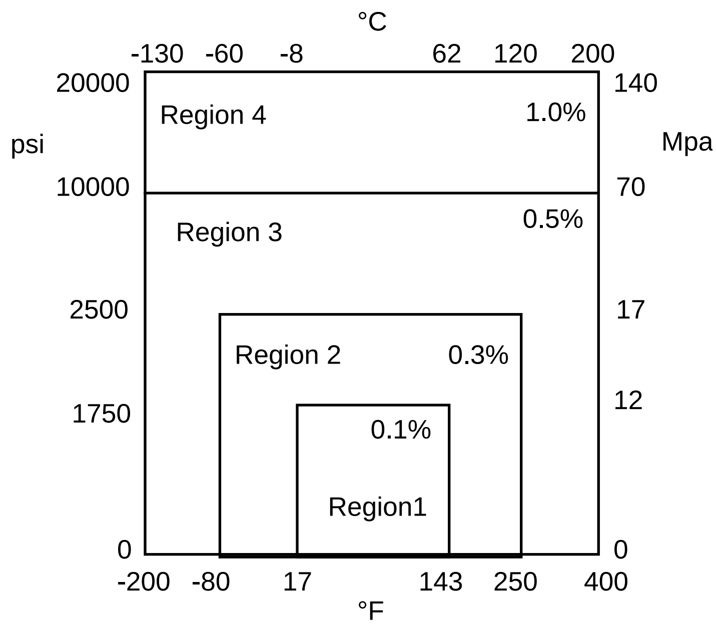
The SGERG-88 methods should be used only on dry, sweet gases having characteristics that fall within the **Normal Range** given below:

Quantity	Normal range	Expanded range
Relative density	0.554 to 0.87	0.07 to 1.52
Gross heating value	477 to 1150 BTU/cf	0 to 1800 BTU/cf
Gross heating value	18.7 to 45.1 MJ/m^3	0 to 66.6 MJ/m^3
Mole % Methane	45.0 to 100.0	0 to 100.0
Mole % Nitrogen	0 to 50.5	0 to 100.0
Mole % Carbon Dioxide	0 to 30.0	0 to 100.0
Mole % Ethane	0 to 10.0	0 to 100.0
Mole % Propane	0 to 4.0	0 to 12.0
Mole % Butanes	0 to 1.0	0 to 6.0
Mole % Pentanes	0 to 0.3	0 to 4.0
Mole % Hexanes Plus	0 to 0.2	0 to dew point
Mole % Helium	0 to 0.2	0 to 3.0
Mole % Hydrogen	0 to 10.0	0 to 100.0
Mole % Carbon monoxide	0 to 3.0	0 to 3.0
Mole % Argon	0	0 to 1.0
Mole % Oxygen	0	0 to 21.0
Mole % Water	0 to 0.05	0 to dew point
Mole % Hydrogen Sulphide	0 to 0.02	0 to 100.0

From ISO 12213-2, Table 1

The Detailed Method is valid within the pressure/temperature range indicated by **Regions 1 to 4** in the figure below (accuracies as indicated).

The SGERG-88 methods (GCN, GHC) and the SGERG GHN methods are valid only within the temperature and pressure limits of **Region 1.** *ISO 12213-2 clearly warns that the equation was not designed for use outside of these limits.*



From AGA Report No. 8 (92), Figure 1

Standing-Katz

Refer to the NGas **Standing-Katz** (**page 187**) section for details.

Redlich-Kwong & Wichert-Aziz

Refer to the NGas **Redlich-Kwong & Wichert-Aziz (page 189)** section for details.

Redlich Kwong (Modified)

Refer to the NGas **Redlich Kwong (Modified)** (**page 190**) section for details.

Matrix

Refer to the NGas **Matrix** (**page 191**) section for details.

Meter Factor

Refer to the NGas **Meter Factor (page 192)** section for details.

Chapter 12: NFlo 4.X.X Configuration & Calculations

About Flowrun Configuration

The flowrun configuration is set in the Scanner when the field device is first set up. Configurations are not normally changed but can be altered in ScanWin LITE. The configuration specifies what is being calculated with which method. The parameters are the second level of information used to set up a Scanner and include flowrun parameters and physical specifications of the meter. Most of these parameters can be edited in ScanWin LITE.

NFlo is a combined gas and liquid measurement program for the Barton Scanner 1100 series flow computers. It is based on the gas flow measurement standards current as of 1994, primarily the "new" AGA-3 and AGA-8. Liquid properties calculations are based on the API Manual of Petroleum Measurement Standards (MPMS) chapters 11.2.1, 11.2.2, 11.2.3 and API 2540. NFlo supports a variety of primary elements including orifice meters, turbines and other linear pulse-output volumetric devices, coriolis meters, averaging pitot tubes, and inverted venturis. Secondary devices include pressure, temperature, and differential pressure analog transmitters, RTDs, analog or frequency-type densitometers, and gas chromatographs.

All calculations are performed in SI units, with automatic conversion of other units performed by the Unit Manager as required. NFlo bases all calculations on mass flow; volume and energy flow are always calculated from mass flow. Even turbine metering is handled this way. This consistent treatment simplifies the calculations, and allows flowruns to be handled the same way regardless of what primary device is used.

Liquid Flowrun Configuration Rules

Refer to **Chapter 10: NGas 4.X.X Configuration & Calculations** for creating Gas flowruns; for installing Monitor flowruns, refer to **Chapter 13: Monitor Flowrun Configuration**. The following table is specific to a Liquid flowrun.

Variable Tag	Description	Options / Allowed Values
Run_name	Flowrun name	A user-assigned name for the flowrun. This may contain as many as 10 characters.
Run_Type	Flowrun type	**Gas –** Refer to **Chapter 10: NGAS 4.X.X Configuration & Calculations** for details. **Monitor** – Refer to **Chapter 13: MONITOR Flowrun Configuration** for details. **Liquid** - is used for any hydrocarbon liquid, from crude oil to liquefied natural gas. NFlo also includes algorithms that handle almost any other industrial liquid.
Method	Volume, Mass, Energy Calculations	**Volume Only**, **Mass Only**, and **Volume & Mass** establishes what combination of volume, mass and energy will be totaled by a liquid flowrun.
Pri_Device	Orifice or turbine	**Differential Producer** is a term for meters whose measurement is based on a pressure drop that they induce in the pipe. The most common is the orifice meter. Others include pitot tubes and proprietary devices such as inverted venturi (V-cone and Wedge meter). **Linear Volume Meter** includes all true mass flowmeters that produce a pulsed output signal, in which each unscaled electrical pulse represents a discrete volume of fluid. This includes turbine meters, vortex-shedding meters, and positive displacement (PD) meters. **Linear Mass Meter** includes all true mass flowmeters that produce a pulsed output signal, in which each unscaled electrical pulse represents a discrete mass of fluid. Meters of this class are generally based on measurement of coriolis forces. These are usually liquid meters, but may include gas coriolis meters.
Dev_Type	Device type	If you are setting up an *orifice* run, the choices are: **Orifice meter**, **Pitot tube (Annubar®)**, **Inverted Venturi (V-Cone®), Wedge Meter** and **Entered Cd.** If you are setting up a *turbine* run, the choices are: **Standard**, **Level B** (future)
Tap_Type	Orifice pressure tap type	Flange taps
Tap_loc	Orifice tap location	**Upstream** or **Downstream** specifies the position of the static pressure tap with respect to the orifice. If the P and ΔP inputs will come from a Barton DPE™ unit, select upstream taps.
DP_mode	Orifice DP stack/check mode	The options include **Single**, **Dual Stacked**, **Triple Stacked** or **Dual Checking**. DP stacking extends the rangeability of differential produce runs by placing two or three differential pressure transmitters in parallel. The transmitters typically have full-scale ranges in 10:1 ratios. When configured this way, the flowrun automatically selects whichever transmitter is in range, and uses that signal for the flow calculation; out-of-range transmitters are ignored. The firmware program can accommodate DP inputs stacked up to three deep, which provides (in theory), about a 30:1 or 40:1 flow rate rangeability from a single meter run. Dual checking mode is intended for critical applications. Two DP transmitters are required; the primary and secondary must agree, otherwise an alarm is output.
HrlyHist_size	Hourly History log size	This user-entered value determines the total length of the history logs, i.e. how many days' data will be retained in NVRAM. A log length of 1 to 15 days is

Variable Tag	***Description***	***Options / Allowed Values***
DailyHist_size	Daily History log size	appropriate for networked Scanners, which will be downloaded frequently. A 35-day log is normal for Scanners that will be manually downloaded on a weekly schedule, and 60 days may be the prudent choice for units in remote locations. The default unit is **days**. A value of 0 disables this feature. *Note that there must be enough free NVRAM to accommodate the log.*
Peak_logging	Qb/Press peak logging	The options are **Off**, **Press**, **Qb**, and **Press & Qb**. If selected, the maximum or peak values will be recorded in history log for the logging interval.
Dens_srce	Density source	The normal choice is **Calculated**. Other choices include **Pulse Densitometer, All User Entered** or **Analog Densitometer** (includes any device that can provide a density input in the form of a 4-20 mA signal proportional to the actual density at flowing conditions).
Base_Temp	Base Temperature	**15°C** or **60°F** – Current API standards allow for only two base temperatures (unlike gas measurement where a great variety of base conditions is used).
Liquid_prop	Liquid Properties	The options are **Relative Density** or **Abs. Density & Temp.** A liquid flowrun needs to know the relative density of the fluid at base conditions. This can either be entered directly, or the computer can calculate it from the absolute density (normally expressed in kg/m^3) and the temperature at which that density was measured. The latter option is useful if the density must be measured on-site using a glass hydrometer; NFlo includes a correction for the thermal expansion of glass hydrometers.
Liquid_type	Liquid Type	The options are **Normal Hydrocarbon**, **LPG/LNG** and **Other Liquid**. Choose **Normal Hydrocarbon** or **LPG/LNG,** based on the table at the end of this section.[13] Select **Other Liquid** for anything that does not fall into the normal hydrocarbon or LPG category. Only temperature correction can be applied to "Other Liquid". To perform the correction, NFlo needs to be given the density of the liquid at three or more temperatures (up to 10). This information can usually be obtained from standard engineering references.
Flow_Dirn	Flowing Direction	Options are **Forward**, **Unspecified**, **Reverse** and **Status Input**. These options are associated with bi-directional meter runs. When equipped with the appropriate input expansion board, the Scanner can use phase discrimination to automatically determine the flow direction through a bi-directional turbine meter. Alternatively, a status input may be connected to a valve position switch to inform the Scanner of flow direction. When the status input is asserted, a "Forward" flowrun will totalize while a "Reverse" flowrun (connected to the same status input) will be inhibited.

[13] **Appropriate choices for different petroleum products**

Product	**Flowrun Configuration Choice**	**Liquid Parameter Choice**
Crude Oil	Normal Hydrocarbons	Crude/JP4
Lubricating Oil	Normal Hydrocarbons	Lube Oils
Jet fuel, Kerosene & Solvents	Normal Hydrocarbons	Jet Fuel/Kerosene
Diesel, Heating & Fuel Oils	Normal Hydrocarbons	FUEL Oils/Diesel
Gasolines and Napthenes	Normal Hydrocarbons	Gasoline/Naptha
Condensate (> 638 kg/M3)	Normal Hydrocarbons	Crude/JP4
LPG/LNG	LPG/LNG	----
NGL/Condensate(<637 kg/M3)	LPG/LNG	----

Variable Tag	Description	Options / Allowed Values
Hist_intvl	Hourly History log interval	This user-entered value determines how frequently data is recorded during the day. **60 minutes** is the default time. The minimum interval is 5 minutes. *Note that the shorter the interval, the greater the NVRAM memory requirement.*
Wedge_FC	Wedge Flow Coefficient	**** This line appears only if the Device Type is chosen as a Wedge Meter. **** The coefficient can be **Calculated** or **Entered**.
Avg_Delay	Averaging delay	This value is the time delay (in seconds) between averaging starts and does not include the actual averaging time. (Applicable to versions **4.1 and above**.)
PT_correct	Pressure & Temperature correction	**** This line appears only if the Density Source is a Pulse Densitometer. **** Options are **Barton equation**, **Solartron equation** and **None**. Densitometer inputs are normally corrected for the small shift that is due to the effects of temperature and pressure upon the mechanism of the densitometer. Select either the Barton or Solartron equation as appropriate. These correction equations require several coefficients, which can be found on the densitometer's calibration sheet. The third option "None" allows you to bypass the P/T correction and use only the three basic densitometer coefficients (normally called A0, A1, and A2).
Interp_pts	Number of interpolation points (Other Liquids)	**** This line appears only if the Liquid Type is "Other Liquid". **** NFlo creates a table of densities and temperatures in the flowrun. The size of the table is determined by the number of points chosen (3 to 10)
Avg_Style	Averaging style	The options are **Flowtime**, **Fulltime** and **0 Flowtime**. Flowtime only averages inputs when there is flow. If there is no flow for the history logging interval (typically 1 hour), Fulltime averages will be logged. Fulltime is always averaged. 0 Flowtime inserts zero values in the history log when there is no flow during the entire logging period.
Est_PC	Estimate during plate changes	This option enables (***green check mark***) or disables (***red X***) the estimation process during routine plate change operations.
Est_Enable	Estimation on/off	This option enables automatic estimation to take place during any period that the flowrun goes offline. ***On*** is indicated with a **green check mark** and ***off*** with a **red X**.
Est_Basis	Estimation basis	This value represents the time (in minutes), before and after a flowrun stoppage, that the values are averaged and used for automatic estimation. The default is 5 minutes.
Par_enable	Partial Records Enabled	This option allows partial records to be recorded. ***On*** is indicated with a **green check mark** and ***off*** with a **red X**.
Flow_check	Flow check limit	This value (percentage) is used to check the flowrate difference before and after a flowrun estimation. It is used to warn of a significant difference in flow rate in case an incorrect plate size is entered during a plate change routine.
DP_check	DP check limit	**** This selection appears only if an orifice run's DP stack/check mode has been selected as Dual Checking. **** This value is used to set the percentage difference allowed between two DP inputs in a DP checking configuration. If measurement devices are more than the percentage entered, a DP check alarms appears on the Alarms page and in the Event log. The Dpcheck limit is used to check all dual DP checking flowruns.

Flowrun Parameters

Pipe and Throat Diameters, Temperature Coefficients and Measurement Reference Temperatures

Flow measurement by means of differential producers (which includes orifice meters, flow nozzles, venturis, averaging pitot tubes, and similar devices), is based on knowledge of the exact diameters of the pipe and the meter throat. Since these measurements change with temperature, it is necessary to adjust for thermal expansion in these parts of the meter. "Dr" is the inside diameter of the meter tube measured at a particular temperature "TDref"; similarly, "dr" is the diameter of the throat as measured at the temperature "Tdref".

Different materials have different expansion characteristics. NFlo includes the temperature coefficients of commonly used meter construction materials. If the meter is made of some other material, its coefficient(s) of thermal expansion can be entered numerically.

If the meter is an orifice meter, both the diameter and the reference temperature should be stamped on the orifice plate. For other types of differential meters, the information should appear on a data plate, or in documents provided by the manufacturer.

When the selected meter is a V-Cone®, "dr" represents the cone diameter. If the meter is an averaging Pitot tube (Annubar® or similar), "dr" represents the diameter of the strut. For the Taylor Wedge meter, "dr" represents the height of the channel below the wedge. The variable "Dr" (with a capital D) always represents the pipe diameter.

Discharge Coefficient

The discharge coefficient of the V-Cone® meter is provided by the manufacturer. It is typically 0.84.

Properties of Hydrocarbon Liquids

The viscosity of a fluid is defined as its resistance to deformation. Flow measurement by means of differential producers requires knowledge of the fluid's viscosity.

Nominal Viscosity of Hydrocarbon Liquids at 15°C (60°F), centipoise: [14]

Liquid	Relative Density	Viscosity	Vapor Pressure
Crude oil	0.611 - 1.076	See table below	0
Gasoline	0.72	0.4	
Jet fuel	0.8	2.0 - 4.0	
Fuel oil			
Lube oil			
LPG/LNG			
Methane	0.3		28371.0
Ethane	0.374	0.056	3343.7
Propane	0.508	0.117	729.5
Butanes	0.584	0.181	182.4
Pentanes	0.631	0.233	72.95
Hexane	0.664	0.325	20.26
Heptane	0.688	0.325	5.87
Octane	0.707	0.586	1.87
Water	1.0 - 1.25 (brine)	1.0	

Approximate Viscosities of Crude Oils:

Pennsylvania Crude Oils		California Crude Oils	
Relative Density	Viscosity	Relative Density	Viscosity
0.842	15.0	0.917	50.0
0.834	12.0	0.904	20.0
0.829	6.2	0.891	8.60
0.810	3.5	0.874	4.90
0.797	2.4	0.860	3.00
0.785	1.7	0.844	1.96
0.773	1.2	0.818	1.40
0.760	0.84	0.805	1.01
0.746	0.68	0.782	0.80
0.728	0.54	0.761	0.64

[14] Data Book on Hydrocarbons, J. B. Maxwell, 1977

Meter Factors

Normally, Differential Producers are uncalibrated devices. Equations for predicting a meter's discharge coefficient were originally derived from a large number of experiments performed on meters of similar type. It is usually impractical to calibrate a gas flowmeter that is operating at high pressure. In those few cases where calibration is possible, a means must be provided for adjusting the meter's indicated flowrate to match its actual (calibrated) flow rate. The means provided by NFlo is the meter factor table.

Meter factors are normally close to 1.0. A meter factor of 1.05 adjusts the flow upward by five percent. E.g., an indicated flow of 12.345 would be corrected to 12.962; if the meter factor were 0.95, the flow of 12.345 would be corrected downwards to 11.727.

Each meter factor is associated with a Reynolds Number that is determined during calibration.

The Reynolds Numbers must be entered into the table in ascending order, with Re1 having the smallest value and Re9 having the largest value: Re1 < Re2 < Re3, etc.

When all entries in the meter factor table are zero, no correction is applied to the flow. If you do not wish to use the meter factor table, simply leave it blank.

Calculated Values

Flow Extension (Differential Producers)

The flow extension is recorded in the history logs, and can be used to recalculate flows from the log entries.

Discharge Coefficient (Differential Producers)

The discharge coefficient is calculated differently for each type of differential producer, usually as a function of Reynolds Number and Beta.

Typical values:

Orifice meters	0.6
Flow nozzles	0.95 to 0.99

Reynolds Number (Differential Producers)

The Reynolds Number "Re" is defined as the ratio of inertial forces to viscous forces. It is a dimensionless, and usually rather large, number. Flow measurement by means of differential producers is made possible by the principle of Reynolds Number Similarity.

Typical values

Re=4000	high viscosity liquid at low flow rate
Re=100000 to 1000000	typical for a gas

Expansion Factor (Differential Producers, Liquid Flow)

When a liquid passes through the meter throat, its pressure drops and it expands. This action is reflected in the differential pressure measurement.

The liquid expansion factor "Y" is very close to unity under most conditions. The Y factor correction increases as the differential pressure becomes a larger fraction of the static pressure; i.e., Y is most significant in low-pressure metering.

Since liquids are incompressible, the expansion factor for liquid flowruns always equals 1.0

Mass Density (All Flowruns)

Mass density is normally symbolized with the Greek letter "ρ". It is the density of the fluid in kilograms per cubic meter (or equivalent units).

RHOb - Density at base conditions

RHOf - Density at flowing conditions (flowing temperature and pressure)

Typical RHOf values:

800 – 900 kg/m^3	(typical hydrocarbons)
500 – 600 kg/m^3	(LPG/LNG)
1000 kg/m^3	(water)
1100 kg/m^3	(brine)

NFlo 4.X.X Flowrun Variables

Variable Tag	Description	Storage Units	Attributes
AlphaD	Pipe thermal expansion coefficient	mm/mm°C	Param
Alphad	Throat thermal expansion coefficient	mm/mm°C	Param
Beta	Diameter ratio	-	Calc
BSW	Base Solids and Water	%	Live
Btot	Total Volume (Base Conditions)	M3	Total
Ca1	Annubar Coefficient 1	-	Param
Ca2	Annubar Coefficient 2	-	Param
Cd	Discharge Coefficient	-	Param/Calc
Cpl	Liquid Press. Correction	-	Calc
Ctl	Liquid Temp. Correction	-	Calc
D	Pipe Inside Diameter	m	Calc
d	Throat Diameter	m	Calc
DiffP	Current Differential Pressure	Pa	Calc/Avg
Dm	Live liquid density	kg/M3	Live
DPh-l	Stacked DP high to low switchpoint	Pa	Param
DPh-m	Stacked DP high to mid switchpoint	Pa	Param
DPhi	High Stacked Differential Pressure	Pa	Live
DPl-h	Stacked DP low to high switchpoint	Pa	Param
DPl-m	Stacked DP low to mid switchpoint	Pa	Param
DPlow	Low Stacked Differential Pressure	Pa	Live
DPlv	Single Live Differential Pressure	Pa	Live
DPlast	Last read Differential Pressure	Pa	Calc
DPm-h	Stacked DP mid to high switchpoint	Pa	Param
DPm-l	Stacked DP mid to low switchpoint	Pa	Param
DPmid	Mid Stacked Differential Pressure	Pa	Live
DPpri	Primary Live Differential Pressure	Pa	Live
DPsec	Secondary Live Differential Pressure	Pa	Live
DPkPr	Peak Pressure (daily)	Pag	Calc
DPkQb	Peak Volume Flow Rate (daily)	M3/sec	Calc
Dp	Pres above Equil	Pa	Calc
Dr	Uncorrected Pipe Inside Diameter	m	Param
dr	Uncorrected Throat Diameter	m	Param/Calc
Etot	Total Energy	Joules	Total
Ev	Velocity of Approach factor	-	Calc
F	Liquid Compressibility	-	Calc
Fextn	Flow Extension (=sqrt(DP * RHOf))	-	Calc/Avg
Freq	Average frequency	Hz	Calc/Avg
Gb	Relative Density (liquid)	-	Param
Gr	Real Gas Relative Density	kg/M3	Par/Live/Calc
H/D	Wedge meter height/diameter ratio	-	Param

Variable Tag	Description	Storage Units	Attributes
HProd	Hydrocarbon Type[15]	-	Param
Hm	Heating value, mass basis	Joules/kg	Live/Calc
Hv	Heating value, volume basis, ref. conditions	Joules/M3	Calc
Hvb	Heating value, volume basis	Joules/M3	Par/Live/Calc
Hyd	Hydrometer used[15]	-	Param
HPkPr	Peak Pressure (hourly)	Pag	Calc
HPkQb	Peak Volume Flow Rate (hourly)	M3/sec	Calc
k	Isentropic Exponent	-	Param
K0	API 2540 K0 Coefficient	-	Calc
K1	API 2540 K1 Coefficient	-	Calc
K18	Density Temp Calib Coeff	-	Param
K19	Density Temp Calib Coeff	-	Param
K20A	Density Pres Calib Coeff	-	Param
K20B	Density Pres Calib Coeff	-	Param
K21A	Density Pres Calib Coeff	-	Param
K21B	Density Pres Calib Coeff	-	Param
Ka	Annubar Flow Coefficient	-	Calc
Kd2	Wedge meter flow coefficient	-	Param
Mdb	Molar density, base conditions	-	Calc
Mdf	Molar density, flowing conditions	-	Calc
Mdref	Molar density, reference conditions	-	Calc
MF1	Meter factor 1	-	Param
MF2	Meter factor 2	-	Param
MF3	Meter factor 3	-	Param
MF4	Meter factor 4	-	Param
MF5	Meter factor 5	-	Param
MF6	Meter factor 6	-	Param
MF7	Meter factor 7	-	Param
MF8	Meter factor 8	-	Param
MF9	Meter factor 9	-	Param
MFact	Meter factor (interpolated)	-	Calc
MFsum	Mole Fraction Sum	-	Calc/Live[16]
Mr	Molar mass	-	Calc
Mtot	Total Mass	kg	Total
MtotB	This Months Total Volume	M3	Total

[15]

Variable Tag	Description	Allowed Values
HProd	Hydrocarbon product type	0=Crude Oils/JP4, 1=Jet Fuel/Kerosene 2=Gasoline/Naphthenes, 3=Lube Oils, 4=Diesel/Fuel Oil
Hyd	Hydrometer used	0=Not used, 1=Used

[16] Live assignment supported only for GC peripheral devices, which assigns all gas components to GC.

Variable Tag	Description	Storage Units	Attributes
MTotE	This Months Total Energy	Joules	Total
MTotM	This Months Total Mass	kg	Total
Mu	Absolute Viscosity	kg/Msec	Param/Calc
P1	Matrix pressure point 1	Paa	Param
P2	Matrix pressure point 2	Paa	Param
P3	Matrix pressure point 3	Paa	Param
P4	Matrix pressure point 4	Paa	Param
P5	Matrix pressure point 5	Paa	Param
Patm	Local Atmospheric Pressure	Paa	Param
Pbase	Contract Base Pressure	Paa	Param
Pc	Pseudocritical Pressure	Paa	Param/Calc
Pe	Equil Vapour Pressure	Paa	Param
Pdns	Live Densitometer Pressure	Pag	Live
Pf	Absolute Pressure	Paa	Calc
Pfzf	Absolute Pressure for Zf	Paa	Calc
Press	Gauge Pressure	Pag	Live
PtotB	Previous Months Total Volume	M3	Total
PTotE	Previous Months Total Energy	Joules	Total
PTotM	Previous Months Total Mass	kg	Total
Qb	Volume Flow Rate	M3/sec	Calc
Qbnet	Total Volume (after BS&W)	M3	Total
Qe	Energy Flow Rate	Joules/sec	Calc
Qf	Uncorrected Pulse Rate	M3/sec	Live
Qfavg	Average Uncorrected Pulse Rate	M3	Calc
Qftot	Uncorrected Pulse Total	M3	Total
Qf1	Ultrasonic Meter factor Qf 1	M3/sec	Param
Qf2	Ultrasonic Meter factor Qf 2	M3/sec	Param
Qf3	Ultrasonic Meter factor Qf 3	M3/sec	Param
Qf4	Ultrasonic Meter factor Qf 4	M3/sec	Param
Qf5	Ultrasonic Meter factor Qf 5	M3/sec	Param
Qf6	Ultrasonic Meter factor Qf 6	M3/sec	Param
Qf7	Ultrasonic Meter factor Qf 7	M3/sec	Param
Qf8	Ultrasonic Meter factor Qf 8	M3/sec	Param
Qf9	Ultrasonic Meter factor Qf 9	M3/sec	Param
Qm	Mass Flow Rate	kg/sec	Calc/Live
Re1	Meter factor Reynolds Number 1	-	Param
Re2	Meter factor Reynolds Number 2	-	Param
Re3	Meter factor Reynolds Number 3	-	Param
Re4	Meter factor Reynolds Number 4	-	Param
Re5	Meter factor Reynolds Number 5	-	Param
Re6	Meter factor Reynolds Number 6	-	Param
Re7	Meter factor Reynolds Number 7	-	Param
Re8	Meter factor Reynolds Number 8	-	Param
Re9	Meter factor Reynolds Number 9	-	Param
ReD	Reynolds Number (D)	-	Calc
RHOb	Fluid Density at Base Conditions	kg/M3	Calc

Variable Tag	Description	Storage Units	Attributes
RHOf	Fluid Density	kg/M3	Calc/Live
RHOrf	Fluid Density at Reference Conditions	kg/M3	Calc
RHOr	Liquid Density at Reference Conditions	kg/M3	Param
RHOt	Temp Corrected Density	kg/M3	Calc
RHO1	Density 1	kg/M3	Param
RHO2	Density 2	kg/M3	Param
RHO3	Density 3	kg/M3	Param
RHO4	Density 4	kg/M3	Param
RHO5	Density 5	kg/M3	Param
RHO6	Density 6	kg/M3	Param
RHO7	Density 7	kg/M3	Param
RHO8	Density 8	kg/M3	Param
RHO9	Density 9	kg/M3	Param
RHO10	Density 10	kg/M3	Param
SPlast	Last read Pressure	Pag	Calc
Tl1	Temperature 1	K	Param
Tl2	Temperature 2	K	Param
Tl3	Temperature 3	K	Param
Tl4	Temperature 4	K	Param
Tl5	Temperature 5	K	Param
Tl6	Temperature 6	K	Param
Tl7	Temperature 7	K	Param
Tl8	Temperature 8	K	Param
Tl9	Temperature 9	K	Param
Tl10	Temperature 10	K	Param
Tdns	Live Densitometer Temp	K	Live
Tr	Reference Temp	K	Param
T1	Matrix temperature point 1	K	Param
T2	Matrix temperature point 2	K	Param
T3	Matrix temperature point 3	K	Param
T4	Matrix temperature point 4	K	Param
T5	Matrix temperature point 5	K	Param
Tbase	Contract Base Temperature	K	Param
Tc	Pseudocritical Temperature	K	Param/Calc
TDmea	Pipe Measurement Temperature	K	Param
Tdmea	Throat Measurement Temperature	K	Param
Temp	Live Temperature	K	Live
Tf	Flowing Temperature	K	Calc/Avg
Tlast	Last read Temperature	K	Calc
TtotB	Today’s Total Volume	M3	Total
TTotE	Today’s Total Energy	Joules	Total
TTotM	Today’s Total Mass	kg	Total
Tzf	Temperature for Zf	K	Calc
UMF1	Ultrasonic Meter factor 1	-	Param
UMF2	Ultrasonic Meter factor 2	-	Param

Variable Tag	Description	Storage Units	Attributes
UMF3	Ultrasonic Meter factor 3	-	Param
UMF4	Ultrasonic Meter factor 4	-	Param
UMF5	Ultrasonic Meter factor 5	-	Param
UMF6	Ultrasonic Meter factor 6	-	Param
UMF7	Ultrasonic Meter factor 7	-	Param
UMF8	Ultrasonic Meter factor 8	-	Param
UMF9	Ultrasonic Meter factor 9	-	Param
UMFact	Ultrasonic Meter factor (interpolated)	-	Calc
Vtype	V-Cone Install Type[17]	-	Param
xAr	Mole Fraction Argon	-	Param
xC1	Mole Fraction Methane	-	Param
xC2H4	Mole Fraction Ethene	-	Param
xC2	Mole Fraction Ethane	-	Param
xC3	Mole Fraction Propane	-	Param
xC3H6	Mole Fraction Propene	-	Param
xC4H8	Mole Fraction Butene	-	Param
xC5H10	Mole Fraction Pentene-1	-	Param
xCO	Mole Fraction Carbon Monoxide	-	Param
xCO2	Mole Fraction Carbon Dioxide	-	Param
xH2	Mole Fraction Hydrogen	-	Param
xH2O	Mole Fraction Water	-	Param
xH2S	Mole Fraction Hydrogen Sulfide	-	Param
XHe	Mole Fraction Helium	-	Param
XiC4	Mole Fraction Iso-Butane	-	Param
XiC5	Mole Fraction Iso-Pentane	-	Param
xN2	Mole Fraction Nitrogen	-	Param
XnC10	Mole Fraction Normal Decane	-	Param
XnC4	Mole Fraction Normal Butane	-	Param
XnC5	Mole Fraction Normal Pentane	-	Param
XnC6	Mole Fraction Normal Hexane	-	Param
XnC7	Mole Fraction Normal Heptane	-	Param
XnC8	Mole Fraction Normal Octane	-	Param
XnC9	Mole Fraction Normal Nonane	-	Param
xO2	Mole Fraction Oxygen	-	Param
Y	Expansion Factor	-	Param/Calc
YtotB	Yesterday's Total Volume	M3	Total
YTotE	Yesterday's Total Energy	Joules	Total
YTotM	Yesterday's Total Mass	kg	Total
Z11	Z factor @ Pressure1 / Temperature 1	-	Param

[17]

Variable Tag	Description	Allowed Values
Vtype	V-Cone Install Type	0=wafer 1=tube/spool

Variable Tag	Description	Storage Units	Attributes
Z12	Z factor @ Pressure1 / Temperature 2	-	Param
Z13	Z factor @ Pressure1 / Temperature 3	-	Param
Z14	Z factor @ Pressure1 / Temperature 4	-	Param
Z15	Z factor @ Pressure1 / Temperature 5	-	Param
Z21	Z factor @ Pressure2 / Temperature 1	-	Param
Z22	Z factor @ Pressure2 / Temperature 2	-	Param
Z23	Z factor @ Pressure2 / Temperature 3	-	Param
Z24	Z factor @ Pressure2 / Temperature 4	-	Param
Z25	Z factor @ Pressure2 / Temperature 5	-	Param
Z31	Z factor @ Pressure3 / Temperature 1	-	Param
Z32	Z factor @ Pressure3 / Temperature 2	-	Param
Z33	Z factor @ Pressure3 / Temperature 3	-	Param
Z34	Z factor @ Pressure3 / Temperature 4	-	Param
Z35	Z factor @ Pressure3 / Temperature 5	-	Param
Z41	Z factor @ Pressure4 / Temperature 1	-	Param
Z42	Z factor @ Pressure4 / Temperature 2	-	Param
Z43	Z factor @ Pressure4 / Temperature 3	-	Param
Z44	Z factor @ Pressure4 / Temperature 4	-	Param
Z45	Z factor @ Pressure4 / Temperature 5	-	Param
Z51	Z factor @ Pressure5 / Temperature 1	-	Param
Z52	Z factor @ Pressure5 / Temperature 2	-	Param
Z53	Z factor @ Pressure5 / Temperature 3	-	Param
Z54	Z factor @ Pressure5 / Temperature 4	-	Param
Z55	Z factor @ Pressure5 / Temperature 5	-	Param
Zb	Compressibility at Base Conditions	-	Param/Calc
Zf	Compressibility at Flowing Conditions	-	Param/Calc
Zref	Compressibility at Ref. Conditions	-	Param/Calc

Flowrun Calculations

The equations used in NFlo are given here for information only. The flow measurement standards listed in the **References (page 238)** section are the final authority on all calculations.

Due to the extreme complexity of many of the computations performed by NFlo (particularly the AGA-8 methods) manual calculation is often impractical. Software suitable for validating NFlo's output is available commercially as well as from the American Petroleum Institute or the American Gas Association.

Units of Measurement

All calculations in NFlo 4.X are performed in SI units. Refer to the NGas **Units of Measurement (page 170)** section for information about this topic.

Symbols

The following symbols are used in the calculations:

Symbol	Tag	Description	Storage Units
Y	Y	Expansion factor	–
Pf		Flowing pressure	Pa
qm	Qm	Mass flow rate	Kg/s
Qe	Qe	Energy flow rate at contract base T P	MJ/s
Qv		Volume flow rate at contract base T P	M3/s
qv		Volume flow rate at flowing T P	M3/s
Cpl	Cpl	Correction for Pressure on liquid	–
Ctl	Ctl	Correction for Temperature on Liquid	–
ΔP	DP	Pressure above equil. vapor press (Pf - Pe)	Pa
F	F	Liquid compressibility factor	–
Gb	Gb	Liquid relative density	–
ρf	RHOf	mass density at flowing T P	Kg/M3
ρb	RHOb	mass density at contract base T P	Kg/M3
Cd(FT)	Cd	discharge coefficient, flange taps	-
ReD	Re	Pipe Reynolds Number	–
B	Beta	Beta ratio	–
Dr	Dr	Meter tube ID @ reference T	m
D	D	Meter tube ID @ flowing T	m
a2	AlphaD	Coefficient of thermal expansion, pipe	mm/mm°C
N1		units constant : $\pi/4 * \sqrt{2} = 1.110720735$	
N2		units constant : $4/\pi = 1.27324$	
N3		units constant : 1.0	
N4		units constant : 0.0254	
dr	dr	Orifice ID @ reference T	m
d	d	Orifice ID at flowing T	m
a1	Alphad	Coefficient of thermal expansion, orifice	mm/mm°C
Tf	Tf	Flowing temperature	K
Pf	Pf	Flowing absolute pressure	Paa
ΔP	DiffP	Differential pressure	Pa

Standard T P is 288.15 °K, 101.325 kPa

Standard units are the units in which the calculation is performed. Conversions to/from user-specified units are handled automatically by the Unit Manager.

Orifice Metering

Discharge coefficient for flange taps

$$C_d(\mathrm{FT}) = C_i(\mathrm{FT}) + 0.000511\left[\frac{10^6\beta}{\mathrm{Re}_D}\right]^{0.7} + (0.0210 + 0.0049A)\beta^4 C$$

$$C_i(FT) = C_i(CT) + TapTerm$$

$$C_i(CT) = 0.5961 + 0.0291\beta^2 - 0.2290\beta^8 + 0.003(1-\beta)M_1$$

$$TapTerm = Upstrm + Dnstrm$$

$$Upstrm = -\left[0.0433 + 0.0712e^{-8.5L_1} - 0.1145e^{-6.0L_1}\right](1 - 0.23A)B$$

$$Dnstrm = -0.0116\left[M_2 - M_2^{1.3}\right]\beta^{1.1}(1 - 0.14A)$$

$$B = \frac{\beta^4}{1-\beta^4}$$

$$M_1 = \max\left(2.8 - \frac{D}{N_4}, 0.0\right)$$

$$M_2 = \frac{2L_2}{1-\beta}$$

$$A = \left[\frac{19{,}000\beta}{\mathrm{Re}_D}\right]^{0.8}$$

$$C = \left[\frac{10^6\beta}{\mathrm{Re}_D}\right]^{0.35}$$

Orifice bore, meter bore, beta ratio

$$D = Dr\left[1 + \alpha 2(T_f - T_r)\right]$$

$$d = dr\left[1 + \alpha 1(T_f - T_r)\right]$$

$$\beta = \frac{d}{D}$$

where

dr = orifice bore at reference temperature T_r

Dr = meter tube diameter at reference temperature T_r

α1 = coefficient of linear expansion of meter tube material

α2 = coefficient of linear expansion of orifice plate material

Expansion Factor

$$Y = 1 - \left(0.41 + 0.35\beta^4\right)\frac{x_1}{k}$$

$$x_1 = \frac{\Delta P}{N_3 P_{f1}}$$ (N$_3$ = 1 for liquids)

Static pressure, when measured at the upstream tap

$$P_f = P_{gage} + P_{atm}$$

Static pressure, when measured at the downstream tap

$$P_f = P_{gage} + P_{atm} + \Delta P$$

where P_{gage}, P_{atm}, and ΔP are in the same units

Reynolds Number

$$\mathrm{Re}_D = \frac{N_2 q_m}{\mu D}$$

where $N_2 = \pi/4$

Velocity of Approach factor

$$E_v = \frac{1}{\sqrt{1 - \beta^4}}$$

Mass Flow

The final orifice flow calculation used in NFlo departs from the standard formulation in two ways.

- The flow extension *Fext* is introduced as a separate variable whose value is recorded in the flowrun's history log.
- A Meter Factor *MF* is introduced. This is discussed in this document starting on **page 221**.

The incremental mass is obtained by integrating the instantaneous mass flow rate over the time interval of the calculation. The integration time base is provided by the Scanner's real-time clock.

$$q_m = N_1 C_d E_v Y d^2 Fext MF$$

where $N_1 = \pi/4 * \sqrt{2} = 1.110720735$

$$m = \int q_m dt$$

Where

$$Fext = \sqrt{\rho_f \Delta P}$$

Where:

ρf = RHOf = mass density at flowing conditions, kg/m^3

ΔP = differential pressure

m = incremental mass

dt = time elapsed since the preceding calculation

Volume Pulse Meter

NFlo uses a somewhat unconventional (though perfectly valid) calculation for turbine metering. Gross volume is converted immediately to mass using flowing density. The gross volumetric flow is first computed from the frequency and K-factor:

$$qv = \frac{3600 f}{K}$$

$$v = \frac{p}{K}$$

Where:

qv = instantaneous gross volumetric flow rate

f = frequency (Hertz)

K = meter K-factor (see also #### K-factor interpolation)

p = incremental pulse count (since previous channel scan)

v = incremental volume

The mass flow is computed:

$$qm = qv\rho f$$

$$m = v\rho f$$

Where:

qm = mass flow rate

qv = gross volumetric flow rate

m = incremental mass

ρf = mass density at flowing conditions

> ***Note***: The gross volume is determined from the pulse count accumulated in a hardware register. A separate hardware register performs period measurement used to determine the signal frequency. Although the Scanner cannot compute a flow rate based on a frequency that is below its minimum threshold, the accumulated volume (mass, energy) will always be correct. An analogy of this process is the speedometer on a car. The speedometer on most cars does not register speeds below 10 or 15 miles per hour. If the vehicle is barely creeping along, the driver has no way of knowing how fast it is moving. However, the odometer is geared directly to the wheel, so the ***mileage*** registered will always be correct.

Volume Flow

Volume flow at base conditions

$$Qb = \frac{qm}{\rho b}$$

$$Qbtot = \frac{m}{\rho b}$$

Where:

qm = mass flow (from diff producer, volume pulse meter, or mass meter)

Qb = volume flow rate at contract base conditions

Qbtot = incremental volume at contract base conditions

ρb = mass density at contract base conditions

Information about which liquid totals include BSW (Base Solids and Water)

1. % BSW is applied to corrected totals in the following manner.
   Qbnet = (1- (BSW/100))

2. The following volume totals include BSW adjustment:

Tag	Description
Qbnet	Total Volume (after BS&W)
MtotB	This Months Total Volume
PtotB	Previous Months Total Volume
TtotB	Today's Total Volume
YtotB	Yesterdays Total Volume

   Hourly and Daily history logs Total Volume also include BSW
   Station volume totals that are summed using the above totals also include BSW.

3. The following corrected volumes and rates do not include BSW:

Tag	Description
Btot	Total Volume (Base Condition)
Qb	Volume Flow Rate

Meter Factors (NFlo)

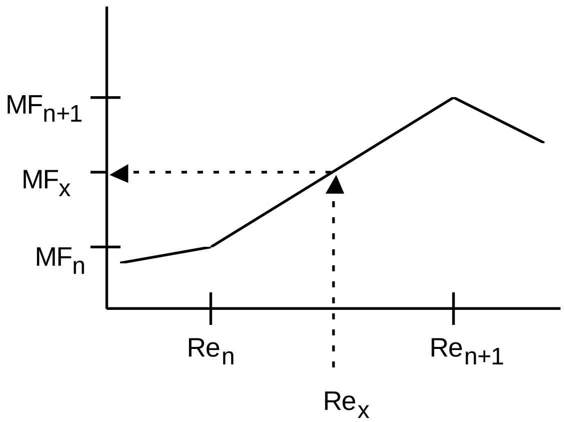
Meter factors have been a standard part of liquid metering for many years but their application to natural gas orifice metering is rather new, and is described in AGA-3, section 1.9 ("In-Situ Calibration"). NFlo calculations for differential producers include a meter factor term "MF" to accommodate this requirement. NFlo accepts up to nine meter factors that are tabulated against Reynolds Number; the final meter factor is found by linear interpolation.

The meter factor is optional. If you don't wish to activate it, simply leave everything in the meter factor table at the original values; this forces the interpolation to output a meter factor of one.

The interpolation formula is:

$$MF_x = \left[\left(\frac{\mathrm{Re}_x - \mathrm{Re}_n}{\mathrm{Re}_{n+1} - \mathrm{Re}_n}\right)(MF_{n+1} - MF_n)\right] + MF_n$$

Graphically:



The general method for determining meter factors via in-situ calibration is summarized below (see also AGA-3 part 1, section 1.9). Note that this is merely a brief description; a full calibration procedure would depend on the specific equipment used, and would require close attention to many details not covered here.

The main requirement is a master meter (such as a turbine meter, or a sonic flow nozzle) that has been characterized at a flow laboratory. Place the master meter in series with the orifice meter, such that the normal flow profile through the orifice meter is not disturbed. Record the flow rates indicated by both meters by varying the flow to obtain several different Reynolds Numbers. The flow must remain steady during each calibration run; several runs should be taken at each Reynolds Number and the results averaged.

Use the following formulas to determine the various calibration points.

The Reynolds Number at the test meter:

$$R_e = \frac{N_2 qm}{\mu D}$$

The meter factor for this Reynolds Number:

$$MF = \frac{qm_p}{qm} = \frac{qm_p}{qv\rho f}$$

where

qm_p= mass flow rate through the master meter

qm = mass flow rate registered by the orifice meter under test

qv = volume flowrate indicated by the orifice meter under test

ρf = mass density of the fluid at the test meter, under flowing conditions

μ = fluid viscosity at the flowing conditions of the test meter

D = meter tube diameter (test meter)

N2 = units constant

= 22,735.5 for qm in LBm/sec; μ in centipoise; D in inches

= 127,324 for qm in kg/sec; μ in centipoise; D in millimeters

Repeat to obtain up to nine *Re* vs. *MF* points and tabulate the results. A typical table might appear like the one below:

Point No.	Re	MF
1	500,000	0.9903
2	1,000,000	0.9921
3	1,500,000	0.9937
4	2,000,000	0.9984
5	2,500,000	1.0003
6	3,000,000	0.9992
7	3,500,000	0.9977
8	4,000,000	0.9919
9	4,500,000	0.9889

Note: The Reynolds Numbers must be entered into the Scanner's "MF" table in ascending order. Meter factor #1 will be used at all Reynolds Numbers below Re#1; Meter Factor #9 will be used at all Reynolds Numbers above Re#9.

Liquid Properties

Ctl for "normal" hydrocarbons - API 2540 table 53A, 53B, 54A, 54B

$$\rho_f = \rho_t Cpl$$

$$\rho_t = \rho_b Ctl$$

$$Ctl = \exp(-\alpha \times \Delta T(1 + (0.8 \times \alpha \times \Delta T)))$$

$$\alpha = \frac{K0}{\rho_b{}^2} + \frac{K1}{\rho_b}$$

Where

Product	K0	K1
Crude oil	613.9723	0
Gasoline	346.4228	0.4388
Jet fuel	594.5418	0
Fuel oil	186.9696	0.4862
Lube oil	259.2769	0.3411

$$Cpl = \frac{1}{1 - \Delta P \times F}$$

$$\Delta P = P_m - P_e$$

Ctl for LPGs and LNGs are obtained via table lookup from API 2540 volume XII, Table 34 "Reduction of Volume to 60°F against Specific Gravity 60/60°F for Liquefied Petroleum Gases". The table is too large to reproduce here; see the API standard.

F for "normal" hydrocarbons (638 < rho < 1074 kg/m^3) - MPMS 11.2.1M

$$F = \exp\left(A + B \times T + \frac{C}{\rho_b{}^2} + \frac{D \times T}{\rho_b{}^2} \right)$$

Compressibility factor F for light hydrocarbons, LPGs, LNGs (350 < rho < 637 kg/m^3)

$$F = \frac{1}{(A + \Delta P \times B)}$$

$$A \times 10^{-5} = C_1 T_r{}^2 + C_2 T_r{}^2 G^2 + C_3 T_r{}^2 G^4 + C_4 T_r{}^3 G^6 + C_5 + C_6 T_r{}^3 G^2 + C_7 T_r{}^3 G^4$$

$$+ C_8 T_r G^2 + C_9 T_r G + C_{10} T_r + C_{11} G$$

$$B \times 10^{-5} = C_{12} T_r{}^2 + C_{13} T_r G^2 + C_{14} G + C_{15} G^2$$

For the values of the constants C1 ... C13 see MPMS 11.2.2M

Solartron Densitometer

$$\rho = K_0 + K_1 T + K_2 T^2$$

$$\rho_t = \rho\left(1 + K_{18}\left(T_{dns} - 20.0\right)\right) + K_{19}\left(T_{dns} - 20.0\right)$$

$$\rho_{tp} = \rho_t\left(1 + K_{20}\left(P_{dns} - 1.0\right)\right) + K_{21}\left(P_{dns} - 1.0\right)$$

$$K_{20} = K_{20A} + K_{20B}\left(P_{dns} - 1.0\right)$$

$$K_{21} = K_{21A} + K_{21B}\left(P_{dns} - 1.0\right)$$

Uncorrected Densitometer

$$\rho_f = A_0 + A_1 T + A_2 T^2$$

where A_0, A_1 and A_2 are calibration constants for the densitometer and T is the densitometer period in msec.

References

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Section 3 - Concentric, Square-edged Orifice Meters
Part 1 - General Equations and Uncertainty Guidelines
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Richard W. Miller
McGraw-Hill, 1989 (Second edition)

Manual of Petroleum Measurement Standards
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Chapter 11.2.1M — Compressibility Factors for Hydrocarbons; 638–1074 Kilograms per Cubic Meter Range
Chapter 11.2.2M— Compressibility Factors for Hydrocarbons; 350–637 Kilograms per Cubic Meter Density (15°C) and –46°C to 60 °C Metering Temperature
Chapter 11.2.3M — Water Calibration of Volumetric Provers
Chapter 12 Section 2 — Calculation of Liquid Petroleum Quantities Measured by Turbine or Displacement Meters.

API 2540 - Petroleum Measurement Tables
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Volume X - Background, development, and Program Documentation
Volume XI/XII - Intraconversion between Volume Measures and Density Measures

Chapter 13: Monitor Flowrun Configuration

- **Flowrun Variables (p240)**

About Monitor Flowruns

The Monitor Flowrun is a special type of flowrun that performs no calculations whatever. Its purpose is to make simple inputs of any type "visible" to networks, combiners, data loggers and other accessories. In other words, it gives the user a simple volume pulse accumulator (Volume Flow Rate, Total Volume, Today's Total Volume, and Yesterday's Total Volume) plus three auxiliary inputs (Input 1, Input 2, and Input 3). Note that these three "Inpt" averaging values are special in that they can be used to log any type of analog-style input (Analog In, DPE, RTD, etc.). When assigning their live input assignment to the Scanner's analog inputs, the user must set the hardware category of the analog input **BEFORE** assigning the "Inpt" value. The monitor input will use this pre-defined category to set up the category and units of the "Inpt" values.

All inputs are logged in the history log and can be configured for various lengths and logging intervals.

Also, note that Monitor flowruns may **NOT** be used with station parameters.

Monitor Flowrun Configuration Rules

Variable Tag	*Description*	*Options / Allowed Values*
Run_name	Flowrun name	A user-assigned name for the flowrun. This may contain as many as 10 characters.
Run_Type	Flowrun type	**Gas –** Refer to **Chapter 10: NGAS 4.X.X Configuration & Calculations** or **Chapter 11: IGAS 4.X.X Configuration & Calculations** for details. **Monitor** – is a special type of flowrun that performs no calculations. **Liquid** – Refer to **Chapter 12: NFLO 4.X.X Configuration & Calculations** for details.
Unit_Cfg	Unit Configuration string	This may contain up to 15 characters.
Items_to_log	History log items	The options are • **Totals** • **Inputs** • **Totals, Inputs** • **Battery** • **Totals, Battery** • **Inputs, Battery** • **Totals, Inputs, Battery**
HrlyHist_size	"Hourly" History log size	This user-entered value determines the total length of the history logs, i.e. how many days' data will be retained in NVRAM. A log length of 1 to 15 days is appropriate for networked Scanners, which will be downloaded frequently. A 35-day log is normal for Scanners that will be manually downloaded on a weekly schedule and 60 days may be the prudent choice for units in remote locations. The default unit is **days**. A value of 0 disables this feature. ***Note that there must be enough free NVRAM to accommodate the log***.
Daily_Hist_size	"Daily" History log size	
Hist_intvl	"Hourly" History log interval	This user-entered value determines how frequently data is recorded during the day. **60 minutes** is the default time. The minimum interval is 5 minutes**. *Note that the shorter the interval, the greater the NVRAM memory requirement***.

Variable Tag	Description	Options / Allowed Values
Q_Calc	Calculation delay	This is the time delay between calculation starts. It does not include the actual calculation time. The default is 60 seconds. To get a faster calculation time, set this value to a lower number.
Avg_Delay	Averaging delay	This value is the time delay (in seconds) between averaging starts and does not include the actual averaging time.
Avg_Style	Averaging style	The options are **Flowtime**, **Fulltime** and **0 Flowtime**. Flowtime only averages inputs when there is flow. Fulltime is always averaged. 0 Flowtime inserts zero values in the history log when there is no flow during the entire logging period.
Est_Enable	Estimation on/off	This option enables automatic estimation to take place during any period that the flowrun goes offline. ***On*** is indicated with a **green** **check mark** and ***off*** with a **red** **X**.
Est_Basis	Estimation basis	This value represents the time (in minutes), before and after a flowrun stoppage, that the values are averaged and used for automatic estimation. The default is 5 minutes.
Par_enable	Partial Records Enabled	This option allows partial records to be recorded. ***On*** is indicated with a **green** **check mark** and ***off*** with a **red** **X**.

Monitor Flowrun Variables

Variable Tag	Description	Storage Units	Attributes
Inpt1	Input 1	*	Live
Inpt2	Input 2	*	Live
Inpt3	Input 3	*	Live
Qb	Volume Flow Rate	M3/sec	Live
Qbtot	Total Volume	M3	Total
TtotB	Today's Total Volume	M3	Total
YtotB	Yesterdays Total Volume	M3	Total

* Storage units are determined by the category of the hardware input assigned.

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