LEonard

User Manual





Software Version 22.11.1.1

**LEonard Software by Lecky Engineering, LLC**

|  |  |  |
| --- | --- | --- |
| **Document Version** | **Date** | **Major Additions** |
| 21.11.4.0 | 11/04/2021 | Initial user interface and device management system, Java interpreter |
| 22.04.1.0 | 04/01/2022 | Universal Robot interface and grinding system, LEScript support |
| 22.08.1.0 | 08/15/2022 | LMI Gocator interface and demonstration |
| 22.11.1.0 | 11/14/2022 | Python support, screen sizing and display management |
| 22.11.1.1 | 11/25/2022 | Documentation fixes, small code cleanup and reorganization |

**CONTENTS**

[Overview 5](#_Toc119334733)

[The LEonard Screen 6](#_Toc119334734)

[An Introduction to LEonard Devices 7](#_Toc119334735)

[The LEonardStatement and LEonardMessage 9](#_Toc119334736)

[All About LEonard Programming 11](#_Toc119334737)

[Theory of Operation 11](#_Toc119334738)

[Hello, World! 13](#_Toc119334739)

[LEScript 13](#_Toc119334740)

[Java 14](#_Toc119334741)

[Python 14](#_Toc119334742)

[The Main Leonard Tabs 16](#_Toc119334743)

[Run Tab 17](#_Toc119334744)

[Code Tab 19](#_Toc119334745)

[Code | Positions 19](#_Toc119334746)

[Code | Variables 20](#_Toc119334747)

[Code | Java 21](#_Toc119334748)

[Code | Python 22](#_Toc119334749)

[Code | Manual 23](#_Toc119334750)

[Setup Tab 24](#_Toc119334751)

[Setup | Devices 25](#_Toc119334752)

[Setup | Displays 28](#_Toc119334753)

[Setup | Tools 29](#_Toc119334754)

[Setup | Robot 31](#_Toc119334755)

[Setup | General 33](#_Toc119334756)

[Setup | License 33](#_Toc119334757)

[Logs Tab 34](#_Toc119334758)

[LEonard Statements 36](#_Toc119334759)

[LElib Standard Library, All Languages 36](#_Toc119334760)

[Variables and Data Structures 36](#_Toc119334761)

[Copying Variables Between LEonard and Java/Python 36](#_Toc119334762)

[string le\_read\_var(var\_name) 36](#_Toc119334763)

[le\_write\_var(string var\_name, string value) 36](#_Toc119334764)

[le\_write\_sysvar(string var\_name, string value) 36](#_Toc119334765)

[Limited LEScript Variable Handling 37](#_Toc119334766)

[import\_variables(filename) 37](#_Toc119334767)

[clear() 37](#_Toc119334768)

[LEScript Assignment 37](#_Toc119334769)

[LElib.console: Console Control Functions 37](#_Toc119334770)

[le\_print(string message) 37](#_Toc119334771)

[le\_show\_console(bool show?) 37](#_Toc119334772)

[le\_clear\_console() 37](#_Toc119334773)

[le\_prompt(string message) 38](#_Toc119334774)

[LElib.log: Logging Functions 38](#_Toc119334775)

[le\_log\_info(string message) 38](#_Toc119334776)

[le\_log\_error(string message) 38](#_Toc119334777)

[LElib.flow: Flow Control Functions 38](#_Toc119334778)

[comments 38](#_Toc119334779)

[label\_name: 38](#_Toc119334780)

[jump(string labelName) 39](#_Toc119334781)

[jumpif(bool condition, string labelName) 39](#_Toc119334782)

[call(string labelName) 39](#_Toc119334783)

[callif(bool condition, string labelName) 39](#_Toc119334784)

[ret() 39](#_Toc119334785)

[jump\_gt\_zero(string varName, string label) 39](#_Toc119334786)

[end() 39](#_Toc119334787)

[assert(bool condition) 39](#_Toc119334788)

[sleep(double timeout\_s) 39](#_Toc119334789)

[LElib.device: Device Control Functions 40](#_Toc119334790)

[device\_connect(string device\_name) 40](#_Toc119334791)

[device\_connect\_all() 40](#_Toc119334792)

[device\_disconnect(string device\_name) 40](#_Toc119334793)

[device\_disconnect\_all() 40](#_Toc119334794)

# 

# Overview

Welcome! LEonard is a work cell control program that maintains communication with all the devices in your industrial work cell and allows you to orchestrate their coordinated operation using simple scripting- just like a good orchestra conductor.

LEonard allows you to write work cell control Sequences in LEScript, Java, or Python. You can also use Java and Python to create complex programs and subroutines that the LEonard Sequence calls, so LEonard doesn’t trap you in someone else’s framework. The use of Java and Python opens the potential to use millions of lines of pre-existing code, as well as providing you with all the features of these rich programming environments.

LEonard is designed to talk to a variety of devices and allow you to coordinate all of them through a single script. LEonard’s tested and validated devices include:

* Robots
  + Universal Robots
* Vision Systems
  + LMI Gocator
  + MVTec HALCON
  + Teledyne Sherlock
  + Cognex Insight
* ID Readers
  + Keyence
  + Cognex Dataman
  + Zebra FS40
* PLC Interfaces (In test)
  + SIPC
  + MODBUS
* External Devices
  + TCP Connections
  + Serial Data

Really, anything you can talk to with Java or Python is a candidate for adding in yourself! Lecky Engineering adds custom device interfaces at customer request. These are usually very simple code extensions to develop, often identical to or very similar to something we already have.

Ask us!

# The LEonard Screen

Why does it look like this?

A picture containing timeline

Description automatically generated

Figure Typical LEonard Main Screen

LEonard is industrial control software and is designed to work well on standard 10” industrial touch screen tablets. Buttons are large and easy to read and special file open and save dialogs, as well as numeric entry, are handled in a touchscreen-friendly way.

LEonard can also be used comfortably on larger monitors. The screen, all the dialogs, and even the font sizes automatically scale as you use different screen sizes or resize the application window.

LEonard provides a standard database of various fixed screen sizes and behaviors, and you can add your own.

More information on LEonard displays is provided in the [Setup | Displays](#_Setup_|_Displays) section of the manual

# An Introduction to LEonard Devices

LEonard maintains a list of devices that it communicates with. Devices are managed under the **Setup** | **Devices** tab.

Graphical user interface, table

Description automatically generated

Figure LEonard Setup | Devices Screen

Each device has many setup parameters that control how LEonard accesses and communicates with the device.

The device parameters are explained in more detail in [Setup | Devices](#_Setup_|_Devices). It is sufficient to know the following:

1. The list of connected devices is stored in a device file. You can have many of these, but most users will need only one.
2. Each device has a unique ID number and a unique name.
3. Devices can be enabled or disabled… this affects which devices get connected by the **Connect All** button.
4. There are several types of devices:
   1. TcpServer
   2. TcpClient
   3. Serial
   4. Null
   5. Specialty
      1. Universal Robot Dashboard: UrDashboard
      2. Universal Robot Command: UrCommand
      3. LMI Gocator Interface: UrGocator
5. Each device sets up a **CallBack** function, which is code to handle messages from the device whenever they arrive.

The general CallBack is most common and is one of LEonard’s key features and tricks!

More information on the specifics of the Devices features of LEonard are available in [Setup | Devices](#_Setup_|_Devices).

# The LEonardStatement and LEonardMessage

Making LEonard send some particular message to some particular device doesn’t take much fancy code. You just shoot the characters out some communication port and send some desired terminator.

The fancy part comes in dealing with what comes back. LEonard allows a CallBack function to be attached to any device, and most devices will be setup with the standard general CallBack.

The general CallBack knows how to interpret what it receives, whenever it receives it. This means that external devices can send messages to LEonard whenever they want.

The received messages need to be what is called a **LEonardMessage**… a series of **LEonardStatements** separated by some separation character.

When a **LEonardStatement** is analyzed, it is expected to be any one of the following. These are checked in sequence and the first match is handled and the other options untested.

1. filename.js Execute an entire Java file (wow!)
2. filename.py Execute an entire Python file (wow!)
3. LE:script Execute any LEScript statement
4. JE:script Execute any Java statement
5. PE:script Execute any Python statement
6. SET var\_name value Set var\_name = value all languages
7. GET var\_name. Return the current value of variable var\_name
8. var\_name = value Stores value into var\_name for all languages

That last one is simple and crucial: remote devices that can send results with var\_name= in front of each one are instantly integrated into LEonard. This covers most barcode readers, vision systems, and even robots.

As you can see, external devices can ask LEonard to do very complicated or special things. This is what makes it possible to use LEonard to automate so many work cell scenarios.

So, the **LEonardMessage** is simply one or more of these **LEonardStatements** glued together with some sort of character separator, which is # by default.

Single: LEonardMessage<TERM>

Double: LEonardMessage<SEP>LEonardMessage<TERM>

More: LEonardMessage<SEP>LEonardMessage<SEP> … <TERM>

Why do this? The advantage of a multiple statement message is that all the received messages will be executed by LEonard in rapid sequence as a unit. This helps avoid certain kinds of machine race conditions.

*What if I don’t want this powerful receive capability on certain devices?*

To use LEonardStatements, the general CallBack must be selected by the device. Not using a CallBack is the easiest way to prevent devices from asking LEonard to do fancy things when that’s not needed or appropriate.

# All About LEonard Sequence Programming

## Theory of Operation

Graphical user interface

Description automatically generated with medium confidence

**The Sequence**

Figure Where is the Main Sequence?

LEonard orchestrates the interoperation of many devices using a **Sequence**, a simple program script that can be written in LEScript, Java, Python, or a combination of all three.

All three languages are provided to make things easier for you. Use what you like.

LEonard executes the main **Sequence** *one line at a time*. This permits monitoring, error recovery, and single stepping.

This may seem odd to those with a formal Computer Science background, but for reasons of safety and error-recovery, each line of a work cell Sequence needs to be handled all on its own.

This also allows single stepping through work cell operations, critical during debug and testing.

Line execution rate is slow, perhaps 10 lines per second. But work cell lines are asking robots and vision systems to do things that typically take many seconds so this doesn’t matter.

Wait! What if I want to read the same barcode reader 10 times and return the highest confidence reading?

Just do it in Java or Python. Those languages run at full speed, you can build a function, and then you can just call it from your Sequence.

Large functions that are safe and which don’t make robots fly around can be built into Java or Python procedures that you load at the start of the LEonard Sequence. This way, you can go fast when you need to if the error conditions don’t create unsafe machine situations. Use your judgement. LEonard won’t get in your way or second-guess you.

Now, since LEonard executes Java and Python line-at-a-time in the main Sequence window, creating functions and classes in Java or Python must be done in a separate stand-alone file and loaded in your main program. LEonard provides Java and Python sandboxes for writing and testing standalone code in the **Code | Java** and **Code | Python** tabs.

## Hello, World!

How do we printf(“Hello, World!\n”); in a LEonard Sequence?

Well, first, about printing. LEonard provides a unified print console for debugging. Show or hide the console with the F12 key.

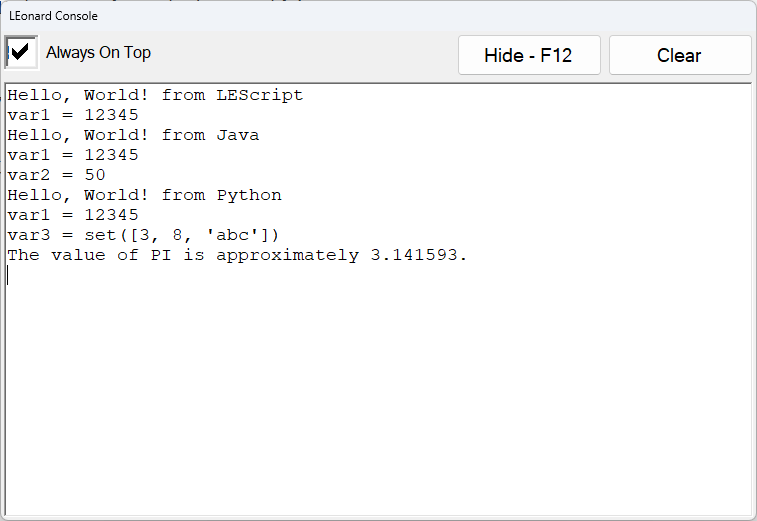


Figure LEonard Console Window

Pressing F12 repeatedly shows and hides the console. It is always receiving and buffering print data. All print data goes to the log files, too, in case you ever need to look for that. (You can also use le\_log\_error(message) and le\_log\_info(message) to send things to the log files. More on that in the [Logs](#_Logs_Tab) tab!)

The Sequence command le\_show\_console(True | False) will also show or hide the console and works in any language.

To send data to the print console, use le\_print(message) from any language.

OK, now we can try that Hello, World!

## LEScript

LEScript is a simple scripting language created by Lecky Engineering that allows “programming-free” interaction with devices. Most typical work cells can be programmed in LEScript. If you need to compute values or get into deeper calculations or manage data structures, think about using Java or Python.

# Hello, World! In LEScript

using\_lescript() # Redundant since LEScript is default

le\_print(Hello, World!)

value = 13.25

le\_print(value = {value})

Console Output:

Hello, World!

value = 13.25

## Java

LEonard provides a Java interface with full ECMA 5.1 compliance based on ***Jint***.

**Java Specifications:**

Jint Version: 2.11.58

Author: Sebastian Ros

License: <https://raw.githubusercontent.com/sebastienros/jint/master/LICENSE.txt>

Date Published: 11/27/2017

Project URL: <https://github.com/sebastienros/jint>

There are several ways that Java execution can be triggered in LEonard.

1. In a LEonard Sequence, commands are interpreted as LEScript until using\_java() is encountered. Subsequent lines will be executed using Jint.
2. The Sequence function exec\_java(filename) will run a Java .js file as specified.
3. An external device that is using the general CallBack can return a Java request.
   1. Filename.js The specified file will be executed by Jint
   2. JE:javascript The specified Java commands will be executed by LEonard
4. The test area in the **Code | Java** tab. This provides a “sandbox” where Java programs can be created, edited, saved, and retrieved.

# Hello, World! In Java

using\_java()

le\_print('Hello, World!')

value = 13.25 \* 8.1

le\_print('value = ' + value)

Console Output:

Hello, World!

value = 107.32499999999999

## Python

LEonard provides the open-source Iron Python implementation originally developed by Microsoft. This supports Python 2.7 environment and includes the entire standard library. Iron Python support for Python 3 is still in Beta and will be made available upon request if we feel it gets more stable! The Python standard library for 2.7 is quite complete. Import away!

**Python Specifications:**

Iron Python Version: 2.7.12

Author: Iron Python contributors, Microsoft

License: <https://licenses.nuget.org/Apache-2.0>

Date Published: 1/21/2022

Project URL: <https://ironpython.net/>

There are several ways that Python execution can be triggered in LEonard.

1. In the LEonard Sequence, commands are interpreted as LEScript until using\_python() is encountered. Subsequent lines will be executed in Python.
2. The Sequence function exec\_python(filename)will run a Python .py file as specified.
3. An external device that is using the general CallBack can return a Python request:
   1. Send Filename.py The specified file will be loaded and executed in Python.
   2. Send PE:pythonscript The specified Python commands will be executed in Python.
4. The test area in the **Code** | **Python** tab. This provides a “sandbox” where Python programs can be created, edited, saved, and retrieved.

# Hello, World! In Python

using\_python()

le\_print('Hello, World!')

value = 13.25 \* 8.1

le\_print(str(value))

import math

var3 = {8, 'abc', 3}

le\_print('var3 = ' + str(var3))

le\_print('The value of PI is approximately {0:.6f}.'.format(math.pi))

Console Output:

Hello, World!

107.325

var3 = set([3, 8, 'abc'])

The value of PI is approximately 3.141593.

# The Main Leonard Tabs

Now you’ve got a feel for the overall approach to LEonard.

Let’s go through each tab in the interface and describe what features are available.

In the main LEonard screen, there are four main operation tabs: **Run**, **Code**, **Setup**, and **Logs**. These tabs are described below.

Many functions can be manually activated with buttons or automatically activated with program commands. The convention in this manual is the used boldface for buttons and Tabs and Courier Font for program commands, as in **This Is a Button** and this\_is\_a\_code\_function(param1).

The four main tabs will be described below. Here are some quick links if you want to jump!

[Run Tab](#_Run)

[Code Tab](#_Program_Tab)

[Setup Tab](#_Setup_Tab)

[Logs Tab](#_Log_Tab)

## Run Tab

The **Run** tab is where the bulk of program execution will typically be observed.

Different annunciators that show status and control buttons appear on the Run Tab depending on what kinds of devices you are connected to.

For example, the raw LEonard screen looks like this, only showing the main program and providing access to Start, Stop, etc.

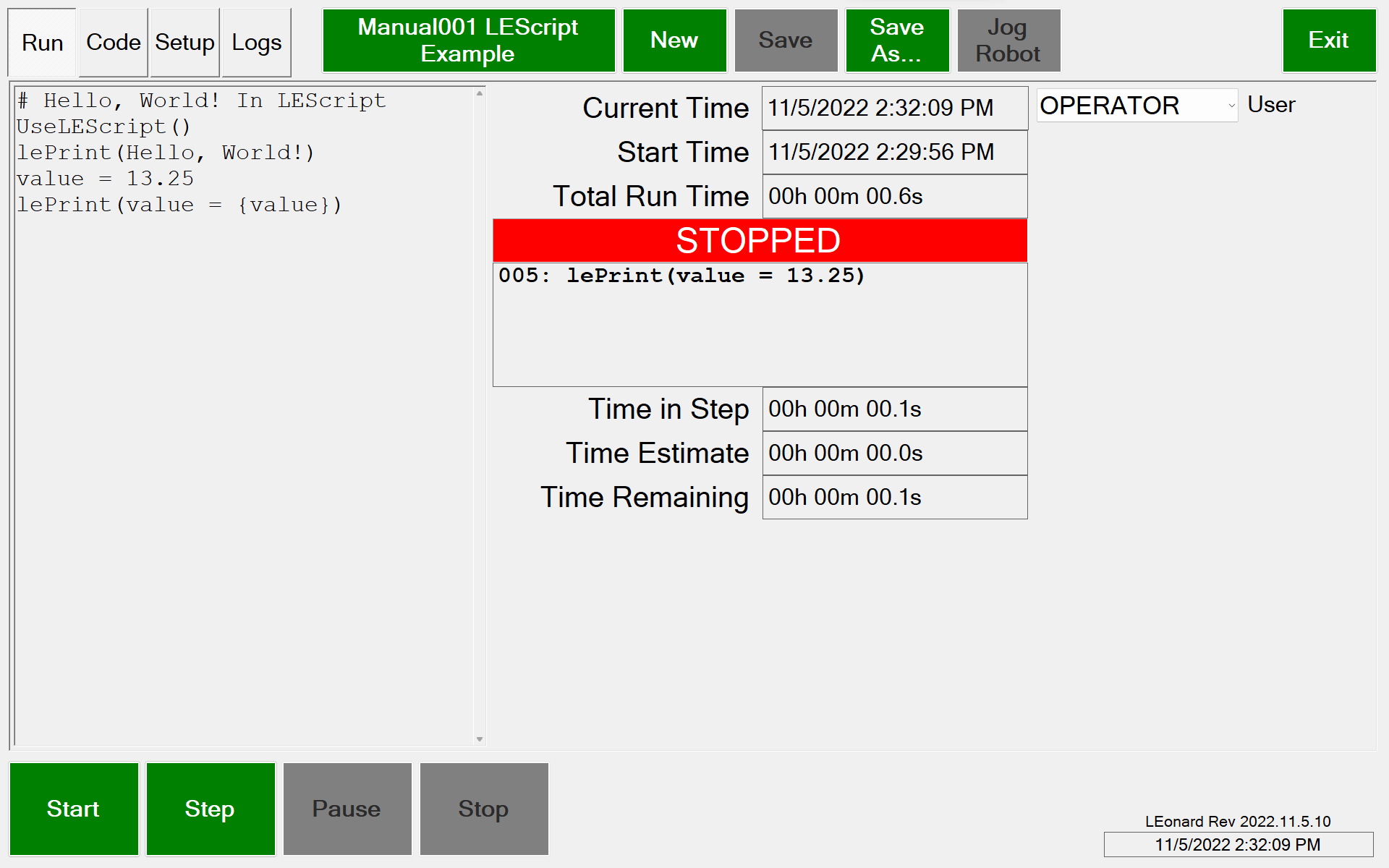


Figure LEonard Run Screen with No Options Installed

A program is loaded using the **Program Name** button up next to the **Logs** tab.

Program file operations in addition to **Load** are **New, Save, Save As.**

To prevent unintentional setup changes or Sequence edits, LEonard provides three **User Modes**.

The user mode is selected using the **User** field in the upper-right corner of the **Run** tab.

1. **Operator** mode only permits loading and running existing Sequences from the **Run** tab. There is no access to the **Code** or **Setup** tabs.
2. **Editor** mode allows access to the **Code** tab to permit editing, but **Setup** is suppressed.
3. **Engineering** mode provides full access to all functions including **Setup**.

Entering Operator or Engineering mode requires a fixed password. By default, these are 9 and 99, respectively.

## Code Tab

The **Code Tab** has five sub tabs: **Positions**, for teaching and manually moving to fixed positions, **Variables**, for monitoring or changing LEonard variables, **Java**, for writing and testing Java programs, **Python**, for writing and testing Python programs, and **Manual,** to provide access to documentation. The current software version is always displayed in the lower right of the screen.

### Code | Positions

Below is the **Program Tab** when the Positions Subtab is selected.

Graphical user interface

Description automatically generated with medium confidence

Figure Code | Positions Tab

Positions can be saved manually (**Set Position**) or from the Sequence with *save\_position(name)*.

You can manually move to Positions in Joint (**Joint Move To Position**) or Linear (**Linear Move To Pose**) paths. These can also be executed from a recipe with *move\_linear(position)* or *move\_joint(position).*

Jogging is used here for setting or updating named positions or just for moving the robot. This uses the standard Jog screen.

**Big Edit** opens up a full-screen editor to make editing complex recipes easier.

### Code | Variables

Below is the **Program Tab** when the **Variables Subtab** is selected.

Graphical user interface

Description automatically generated

Figure Code | Variables Tab

This tab shows all the local variables maintained in LEonard for internal, system, and user purposes. They can be edited here as well.

System variables will not be erased by the **Clear** button, or by the Sequence le\_clear\_variables()command.

The **TimeStamp** shows when the variable was last written.

**IsNew** indicates whether the variable has ever been examined by the program since the last write.

The variables may be saved or reloaded from Recipes/Variables.xml with the **Save** and **Reload** buttons. Variables are automatically saved on program exit and reloaded when the program starts.

### Code | Java

For testing out simple Java programs, the Code | Java tab allows loading, saving, and running Java code using the same Jint Java interpreter and environment used in Sequence execution.

Any code ideas you have can be tried out here prior to building them into an actual Sequence.

Graphical user interface, text

Description automatically generated

Figure Code | Java Test Area

The buttons **New**, **Load**, **Save**, and **Save As…** operate as expected in creating, saving, and loading Java .js files.

The **Run** button will execute the Java program displayed immediately, even if LEonard is in the middle of running a Sequence. This is a powerful (maybe too powerful) debug and testing tool.

The bottom-left panel is a copy of any messages sent to le\_print by Java. The right bottom-right panel shows a list of all Java variables.

### Code | Python

For testing out simple Python programs, the Code | Python tab allows loading, saving, and running Python code using the same Iron Python interpreter and environment used in Sequence execution.

Any code ideas you have can be tried out here prior to building them into an actual Sequence.

Graphical user interface, application, table, Word

Description automatically generated

Figure Code | Python Test Area

The buttons **New**, **Load**, **Save**, and **Save As…** operate as expected in creating, saving, and loading Java .py files.

The **Run** button will execute the Python program displayed immediately, even if LEonard is in the middle of running a Sequence. This is a powerful (maybe too powerful) debug and testing tool.

The bottom-left panel is a copy of any messages sent to le\_print by Python. The right bottom-right panel is currently unused.

### Code | Manual

Below is the **Program Tab** when the **Manual Subtab** is selected.

Graphical user interface

Description automatically generated

Figure Code | Manual Tab

This tab provides access to all of the LEonard manuals as PDF files. They are automatically opened in Chrome by the buttons.

There are also desktop shortcuts and Start Menu icons created for all the manuals in the installation process.

## Setup Tab

The **Setup Tab** has six sub tabs: **Devices**, **Displays**, **Tools**, **Robots**, **General**, and **License**.

Graphical user interface, table

Description automatically generated

### Setup | Devices

The LEonard Device list is a datafile created in the LEonardRoot/Config directory. You can have several device files and load different ones for different testing or operational situations. One or more Devices files can be created and managed in the **Setup | Devices** tab, shown below.

Table

Description automatically generated

Figure LEonard Setup | Devices tab

The **Reload**, **Load**, **Save**, **Save As..** and **Clear** buttons behave as expected. **Clear** also offers an opportunity to create a set of default devices spanning the set of common LEonard devices.

Press **Use This File At Startup** to copy the name of the current file into the **Startup File** field. This will cause that file to be loaded when LEonard starts. If you also select **Auto Connect On Load**, LEonard will attempt to connect to all of the enabled devices in the file at startup.

LEonard devices have the following parameters:

|  |  |  |
| --- | --- | --- |
| Field Name | Type | Description |
| ID | Integer | A unique ID assigned to the device |
| Name | String | A name to help you remember what the device does |
| Enabled | Boolean | Specifies whether the device should be automatically connected by the Connect All button.  Devices are also automatically connected when the device file is loaded if **Auto Connect On Load** is enabled in **Setup | General** |
| Connected | Boolean | A boolean value |
| DeviceType | String | One of several classes of devices, discussed below |
| Address | String | Either IP:Port or COMn |
| MessageTag | String | A string to be prepended to log messages to help identify messages from a particular device |
| CallBack | String | A CallBack function, described below. |
| TxPrefix <PREFIX> | String | A prefix of characters to be sent before each transmission. May include <CR> <LF>, and <CRLF> |
| TxSuffix <SUFFIX> | String | Characters sent at the end of each transmission. May include <CR> <LF>, and <CRLF> |
| RxTerminator <TERM> | String | Characters to be waited for to signify end of received message. May include <CR> <LF>, and <CRLF> |
| RxSeparator <SEP> | String | LEonard will parse (and execute atomically) multiple commands using command<SEP>command<TERM> |
| OnConnectExec | String | When the external device connects, any LEonardMessage specified here will be executed. |
| OnDisconnectExec | String | When LEonard initiates a disconnect, any LEonardMessage specified here will be executed. |
| RuntimeAutostart | Boolean | If true, Runtime Program will be started before connection is attempted. This can be used to start a background server needed by the device for operation. |
| RuntimeWorkingDirectory | String | The Runtime Program will be executed from this directory |
| RuntimeFilename | String | Specifies the filename of the Runtime Program |
| RuntimeArguments | String | Specifies arguments for the Runtime Program |
| SetupWorkingDirectory | String | Some devices have a Setup Program used to configure them. These can be specified here for directory, filename, and arguments |
| SetupFilename | String | Filename of the Setup Program |
| SetupArguments | String | Arguments for the Setup Program |
| SpeedSendButtons | String | If you’d like to be able to send simple commands for testing to the device, they may be entered here as command1|command2|command3|… A button will be created for each string between vertical bars! |
| JobFile | String | If a device needs to load a specific program to run it can be specified here. This is currently used by UrDashboard and Gocator to start the specified programs at connect time. |
| Model | String | If a device returns a model number, it will be entered here |
| Serial | String | If a device returns a serial number, it will be entered here |
| Version | String | If a device returns a software version number, it will be entered here |

**Device Types**

LEonard device types must be one of the following items:

1. TcpServer Set up a TCP Server on Address:Port and wait for a connection.
2. TcpClient Immediately connect to a device on Address:Port.
3. Serial Connect to a device with Address = COMn using serial protocol over either a hard serial or a USB serial connection
4. UrDashboard Setup a TCP Client connection to a Universal Robot dashboard server.
5. UrCommand Setup a TCP Server for a Universal Robot PolyScope program to attach to
6. Gocator Setup a TCP Client appropriate for handling commands with an LMI Gocator.
7. Null Connect to nothing… but perhaps use the other features of a device!

**Connect/Disconnect Execution**

Just after a device connects or just before it is disconnected, LEonard can perform an operation.

These operations are encoded in the **OnConnectExec** and **OnDisconnectExec** fields in the device.

Any **LEonardMessage** can be specified. Recall a multi-statement LEonard message can be encoded as:

LEonardMessage = LEonardStatement<SEP>LEonardStatement

### Setup | Displays

LEonard maintains a database of standard display sizes in the **Setup | Displays** tab, shown below.

Graphical user interface, table

Description automatically generated

Figure LEonard Setup | Displays Screen

All LEonard windows and dialogs are designed to be resizable. Fonts get larger or smaller as necessary. However, you arrange the dialog to use it, that is how it will appear the next time you see it.

You can create your own display setting, complete with Width, Height, whether the window is fixed size or resizable, whether it should expand to full screen, and an optional additional Font Scale parameter. The **FontScale** is applied to the main windows and all LEonard dialogs.

The display database is automatically saved by LEonard, but you can reload the old one if you’ve made a mistake. Clearing the displays will also offer an option to restore these defaults.

Whatever display is selected when LEonard exits will be restored at application startup.

### Setup | Tools

Tools are defined in the **Setup | Tool** tab, shown below.

Graphical user interface, application

Description automatically generated

Figure Setup | Tools Tab

Each tool entry contains the following information. These are saved in the Tools.xml file in LEonardRoot/Config and are loaded and saved automatically.

1. **Tool TCP:** This is a copy of what we would teach for the tool on the UR including x, y, z offset and rx, ry, rz orientation. Teaching these is best done on the UR and then the values simply copied to the entry in LEonard
2. **Mass and Center of Gravity:** Set these as you would on the UR. Accurate settings improves behavior when in freedrive mode.
3. **ToolOnOuts, ToolOffOuts:** This is a list of up to 4 digital IOs that need to be turned on or off to enable the tool. This is only done during a grind in **Touch ON Grind ON** mode. Examples: “1,1,3,1” implies that output 1 should be set to 1 and output 3 should be set to 1. “3,1” implies that output 3 should be set to 1
4. **CoolantOnOuts, CoolantOffOuts:** Similarly, these are digital output commands to be executed when grinding in **TouchOn Grind ON** mode.
5. **MountPosition:** This is a position recommended for installing/removing this tool. The system will use joint moves to approach the position with **Joint Move To Mount** or *move\_tool\_mount()*. This must be a position that has been defined in the **Positions Table**.
6. **HomePosition:** This is a position recommended for homefor this tool. The system will use joint moves to approach the position with **Joint Move To Home** or *move\_tool\_home()*. This must be a position that has been defined in the **Positions Table**.
7. **Tool Test,** **Tool Off** and **Cool Test,** **Cool Off**: These allow manually verifying the outputs for the currently selected tool.
8. **Set Footswitch Pressed Input:** This is defaulted to 7,1 meaning that input 7 goes high when the footswitch is pressed.
9. **Set Door Closed Input:** This is defaulted to 1,1 meaning that input 1 goes high when the door is closed.

### Setup | Robot

Robot and grinding general settings are maintained in the Setup | Robots page, shown below.

A screenshot of a computer

Description automatically generated with medium confidence

Figure Setup | Robots Tab

First, there are settings governing grind operations. These are saved in the Variables.xml file in LEonardRoot/Config and are sent to the robot whenever the software starts. New values are saved automatically.

**Grind Trial Speed:** When not in **Touch On Grind On** mode, the grind patterns are limited to one cycle and are performed at this speed.

**Grind Acceleration:** Linear acceleration used during grinding

**Grind Max Blend Radius:** Maximum blend radius used during grinding. Recommended 2 mm

**Grind Touch Speed:** Speed robot advances toward part for touch off. Recommended 5-10 mm/s

**Grind Touch Retract:** Distance robot retracts from part after touch off.

**Grind Force Dwell Time:** How long robot waits after turning force-on to allow time for tool to settle against part

**Grind Max Wait Time:** Maximum time system will wait for the next grind command if a grind command ends with 1 (stay in contact with part)

**Grind Jog Speed:** Linear speed used for all grinding motions that are not in contact with the part other than the actual simulated grind which runs at **Grind Trial Speed.**

**Grind Jog Accel:** Linear acceleration used for all grinding motions that are not in contact with the part.

**Grind Point Frequency:** Used as a minimum frequency for points generated for circles and spirals.

**Force Damping:** May be useful for force mode tuning in the future. Calls the URScript function force\_mode\_set\_damping() with a value between 0 and 1. The default is 0 and that is the only value that has been tested.

**Force Gain Scaling:** May be useful for force mode tuning in the future. Calls the URScript function force\_mode\_set\_gain\_scaling() with a value between 0 and 2. The default is 1.0 and that is the only value that has been tested.

Second, there are generally self-explanatory settings for default speeds and accelerations used in basic jogging and non-grinding motion. These are also saved in Variables.xml. New values are saved automatically. **Restore Defaults** sets all to standard values used in all testing.

### Setup | General

Any system-wide setup is stored in **Setup | General**.

Currently, only the LEonardRoot directory is stored here and that is currently defaulted to C:\Users\Public\LEonard. This is a good place for LEonard files since any user will be able to access them there.

### Setup | License

LEonard shows its licensing information in **Setup | License**. LEonard uses an encrypted license file that includes information about the CPU, Windows Version it is licensed on, and options that are included in the installation.

Text

Description automatically generatedLicenses can be perpetual or have a time limit for trial purposes.

Figure LEonard Setup | License Viewer

A given license file will only work on one CPU and one installation of Windows. Contact Lecky Engineering if you have other needs. We’re very flexible.

Current options are:

* Java
* Python
* Universal Robots Support Package
* Grinding Package for Universal Robots
* LMI Gocator Support

Contact Lecky Engineering to enable features and troubleshoot licensing issues on your system.

## Logs Tab

The Log Tab provides five windows where log messages are displayed. The level of detail in the messages is controlled by the Log Level setting:

* Error: only error messages are shown
* Warn: Error messages and Warnings are shown
* Info: All of the above, plus informational messages about execution. Default setting
* Debug: All of the above plus additional information that may be useful for debugging
* Trace: All of the above plus extremely verbose execution tracing

The **All Log Messages** box gets 100% of the generated messages. These messages are also written to log files in the LEonardRoot/Logs directory, where up to forty 25MB files are archived. Information older than this 2GB total is automatically and silently deleted over time.

Graphical user interface

Description automatically generated with low confidence

Figure LEonard Logs Tab

In addition, some messages are copied for clarity to other boxes.

1. Any Warning or Error messages are duplicated in the Errors and Warnings box. Warnings are always displayed in Orange, and Errors in Red.
2. Any messages starting with the characters EXEC are duplicated in the “Exec: Messages Starting With EXEC” box. These messages are typically associated with Sequence line-by-line execution. Execution messages generated by LEScript contains “EXECL”. Java and Python execution messages start with “EXECJ” and “EXECP”, respectively.
3. Messages beginning with R. are duplicated in the “Robot: Messages starting with R.” box. All devices have a **MessageTag** setup in their **Devices** entry and these characters are always prepended to their messages. Placing all the robot-related messages into a device containing a tag that starts with R. causes those messages to be duplicated here. This can help see robot-related issues with your Sequence.
4. Similarly, there is an “Aux: Messages Starting With A.” box. Any messages beginning with A. are duplicated here, so assign a **MessageTag** starting with A. to any devices whose messages you’d like to see here.

Any of the boxes can be cleared by double-clicking on them. All boxes can be cleared with **Clear All.** All the messages are appended to the log files and are archived as described above.

# LEonard Statements

You know all there is to know about the LEonard user interface. Congratulations!

What’s left? All the possible Sequence statements and what they do.

This is the comprehensive list.

Certain options, such as Universal Robot or LMI Gocator support, enable other options which are documented in the **Using XXXX with LEonard** manual series.

## LElib Standard Library, All Languages

The LElib Library provides common functions across all three languages.

Where differences exist, they are be highlighted with the language matrix shown below.

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
| ? | ? | ? |

### Language Control

By default, all Sequences are interpreted as LEScript. You can change this with the using\_xxx() functions. The language that is currently being interpreted is always available in the system variable le\_language.

#### using\_lescript()

Future sequence lines will be interpreted as LEScript. The variable le\_language is set to LEScript in LEScript, Java, and Python.

#### using\_java()

Future sequence lines will be interpreted as Java. The variable le\_language is set to Java in LEScript, Java, and Python.

#### using\_python()

Future sequence lines will be interpreted as LEScript. The variable le\_language is set to Python in LEScript, Java, and Python.

#### exec\_java(string filename)

This command loads an entire Java script file and executes it in a fashion identical to the way the **Code | Java** test area does.

#### exec\_python(string filename)

This command loads an entire Python file and executes it in a fashion identical to the way the **Code | Python** test area does.

### Variables and Data Structures

This is the area where the three languages supported by LEonard differ the most!

For Java and Python, declaring and setting variables, using math, and creating class and structures works as expected in those languages.

Just remember that the Sequence executes line-by-line, so any multiline definitions need to be placed in a text file and either imported or loaded.

### LEScript Variable Handling

LEScript has a few specific variable handling functions which are described below:

#### le\_clear\_variables()

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
| X |  |  |

Deletes all variables except ones that are marked in the Code | Variables table as system variables.

Variables named robot\_\* and grind\_\* are automatically marked as system variables.

You can also use le\_write\_sysvar(name, value) from Java or Python, or le\_system\_variable(name, True|False), to set whether a variable is a system variable.

#### le\_import\_variables(filename)

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
| X |  |  |

Read a file and process any lines that contain variable\_name = value.

#### le\_system\_variable(var\_name, True|False)

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
| X |  |  |

Sets whether an existing variable is a system variable.

#### le\_random(int N, double low, double high)

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
| X |  |  |

LEScript doesn’t have direct access to the powerful random number facilities of Java or Python. We suggest you use them, but for a basic capability from native LEScript we have le\_random().

This function creates N variables between low and high and names them rnd1, rnd2, through rndN.

#### LEScript Assignment

LEScript supports updating variables using any of these basic operations. Variables can be inserted in any LEScript command using the syntax {var\_name}.

var\_name = 12.3 var\_name = {other\_var\_name}

var\_name++ var\_name--

var\_name -= 17.5 var\_name += 18

### Copying Variables Between LEonard and Java/Python

When a variable is written in LEScript or assigned a value in a LEonardMessage, it is written to the global variable list of all three languages.

Explicitly rereading a variable or writing a variable back to LEScript either as a system variable or a standard variable is support for both Java and Python.

System variables differ from normal variables in that they are not erased by the le\_clear\_variables() function. All variables are written to the data file LEonardRoot\Config\Variables.xml when LEonard closes, and so are persistent.

#### string le\_read\_var(var\_name)

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
|  | X | X |

Copies a variable from LEonard to Java or Python. All LEonard variables are stored as strings!

#### le\_write\_var(string var\_name, string value)

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
|  | X | X |

Copies a variable from Java or Python to LEonard. All LEonard variables are strings.

#### le\_write\_sysvar(string var\_name, string value)

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
|  | X | X |

Copies a variable from Java or Python to LEonard and marks it as a system variable. All LEonard variables are strings.

### LElib.console: Console Functions

#### le\_print(string message)

Prints message to the Console Window. For Java and Python, it is also sent to the console test areas in **Code | Java** or **Code | Python** as appropriate. The messages are also logged to the logfile as:

LEScript: LPR:message

Java: JPR:message

Python: PPR:message

#### le\_show\_console(bool show?)

Hides or shows the Console Window. The console is always open and accumulating any le\_print(…) messages from any language.

#### le\_clear\_console()

Clears all the text from the Console Window, just like the **Clear** button in the window itself.

### LElib.log: Logging Functions

#### le\_log\_info(string message)

Send the message to the logging system as Info. The message will appear in the **Logs** tab and in the logfile.

#### le\_log\_error(string message)

Send the message to the logging system as Error. The message will appear in the **Logs** tab in red in the Error buffer and will also be sent to the logfile.

### LElib.flow: Flow Control Functions

Flow control in line-by-line execution is implemented differently than it is in the Java or Python standards.

LEonard follows a convention in which lines can be given label names and then jumped to or called. This is consistent with line-by-line execution and is why LEonard is different in the main execution window.

Java and Python functions created in text files operate the way Java and Python always do!

The following sections list each flow control command.

#### comments

LEScript comments in the Sequence are ignored as follows:

1. All blank lines are skipped
2. Characters after “#” on any line are ignored

Java and Python comments are defined as in the respective languages. Python statements ignore characters after “#” on any line and Java statements ignore any characters after “;” on any line.

#### le\_pause()

Causes execution to pause, just like pressing **Pause** on the Run tab.

#### le\_stop()

Causes execution to stop, just like pressing **Stop** on the Run tab.

#### le\_prompt(string message)

Puts up a dialog box containing message and pauses execution until the operator presses Continue or Abort.

#### label\_name:

Yes, this works in all three languages! This helps support line-by-line sequencing and flow control, which Java and Python cannot do.

This structure associates a name with a line in the Sequence. Label names are alphanumeric, case-sensitive, and may include the ‘\_’ character. Labels are found prior to execution and can be used as targets for jump, jumpif, call, and callif statements. LEScript provides the jump\_gt\_zero(variable, labelName) function since it does not presently have the ability to evaluate comparison conditions.

#### jump(string labelName)

Causes execution to pass to the line containing labelName:

#### jumpif(bool condition, string labelName)

Performs a jump to the line containing labelName: if condition is true.

#### call(string labelName)

Causes execution to pass to the line containing labelName: Use ret() to return from the call. Call maintains a return stack (which is cleared when execution begins!) and can nest.

#### callif(bool condition, string labelName)

Performs a call to the line containing labelName: if condition is true.

#### ret()

Return execution from a call(…) or callif(…) to the line after the one that initiated the call.

#### jump\_gt\_zero(string varName, string label)

Only available in LEScript since traditional Java and Python comparisons aren’t available there. Equivalent to jumpif(var\_name > 0, ‘label\_name’) in either Java or Python.

#### assert(bool condition)

Testing support function.

1. In LEScript: used as assert(varName, value). The function checks to see if var\_name == value and generates an error message if not.
2. In Python and Java, The function generates an error dialog if condition != True.

#### sleep(double timeout\_s)

Causes the Sequence to pause for timeout\_s seconds. All other operations continue, so this is better to use than the built-in sleep functions in Java or Python!

### LElib.device: Device Control Functions

#### le\_connect(string device\_name)

Performs the **Connect** function on the specified device. Equivalent to selecting the corresponding row in the **Setup | Devices** table and pressing **Connect**.

#### le\_disconnect(string device\_name)

Performs the **Disconnect** function on the specified device. Equivalent to selecting the corresponding row in the **Setup | Devices** table and pressing **Disconnect**.

#### le\_connect\_all()

Performs the **Connect** function on all devices in the **Setup | Devices** table that are enabled. Equivalent to pressing **Setup | Devices | Connect All**.

#### le\_disconnect\_all()

Performs the **Disconnect** function on all connected devices in the **Setup | Devices** table that are enabled. Equivalent to pressing **Setup | Devices | Connect All**.

#### le\_send(string device\_name, string message)

Sends the specified message to dev\_name including any terminators specified in the device entry. Device must be connected.

#### string le\_ask(string device\_name, string message, double timeout\_ms)

Sends the specified message to dev\_name including any terminators specified in the device entry. Device must be connected.

Waits up to timeout\_ms for a response and returns it as follows:

1. LEScript. Any response is stored in the variable le\_ask\_response. If no response is received or the device is not connected, sets the return value to Null.
2. Java and Python. The received string is returned by the function.

### LElib.infile: Using Input Files

Java and Python have extensive file I/O capabilities. This library is a simple set of functions that allow LEScript to read CSV files one line at a time. Deprecated.

|  |  |  |
| --- | --- | --- |
| LEScript | Java | Python |
| X |  |  |

#### infile\_open(string filename)

Opens up file LEonardRoot/Data/filename for reading. The file is assumed to be in CSV format. Headers are skipped.

#### infile\_close()

Closes any file that has been opened with infile\_open(…).

#### infile\_readline()

A line is read from the file opened with infile\_open(…). Fields found on the line are stored in variables named infile\_p0, infile\_p1, etc. The values can be automatically scaled using infile\_scale(…) below.

#### infile\_scale()

Causes any data subsequently read using infile\_readline() from specified columns of the input file to be scaled by a value. For example, the line below would cause columns 2, 3, and 4 of the input data to be multiplied by 0.0254, for example to convert from inches to meters.

infile\_scale(2,0.0254,3,0.0254,4,0.0254)

**INDEX**

LElib.console

le\_clear\_console() 39

le\_print 39

le\_show\_console 39

LElib.device

le\_ask 42

le\_connect 41

le\_connect\_all 41

le\_disconnect 41

le\_disconnect\_all 41

le\_send 42

LElib.flow

assert 41

call 40

callif 41

comments 40

jump 40

jump\_gt\_zero 41

jumpif: 40

label\_name: 40

le\_pause 40

le\_prompt 40

le\_stop 40

ret 41

sleep 41

LElib.infile

infile\_close 42

infile\_open 42

infile\_readline 42

infile\_scale 42

LElib.language

exec\_java 36

exec\_python 37

le\_language 36

using\_java 36

using\_lescript 36

using\_python 36

LElib.log

le\_log\_error 39

le\_log\_info 39

LElib.variables

import\_variables 38

le\_clear\_variables 37

le\_import\_variables 37

le\_random 37

le\_read\_var 38

le\_system\_variable 37

le\_write\_sysvar 38

le\_write\_var 38

LEScript Assignment 38

system variable 37