PHILIPS

User Manual for the Universal Register Debugger (URD)

CSH - DEV / SW

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4 History

Version	When	Description	Who
0.1	04-Mar-99	Initial version, headlines only.	CE
0.2	01-Apr-99	Updated headers after review	CE
0.3	13-Sep-99	First version	CE
1.0	21-Sep-99	Updated after review	CE
1.1	13-Dec-00	Added chapter 10 and error descriptions B28, B29, B30	PN

Table 1: History of this document

5 General

5.1 Document identification

Title	:	User Manual for the Universal Register Debugger (URD)
Subtitle	:	
Abbreviation	:	URD_USR
Date	:	13-Dec-00
Contact	:	Philips Semiconductors
		CSH - DEV / SW
		+49 / 40 5613 - 3270

5.2 Purpose

This document is intended for engineers using of the URD for hardware debugging on a PC platform. After reading this document they should be able to use the URD to access their target devices and adapt the URD to their needs.

5.3 Scope

This document describes the usage of the URD for accessing registers of a target device via an available communication channel (e.g. I2C, UART). Furthermore accessing memory regions in general is addressed (e.g. ROMs). Providing the necessary descriptions files of the hardware is detailed in the URD language reference [URD_LR].

Adaptation of the URD to new communication channels is detailed in the driver development section.

In addition installation and support are described.

5.4 Definitions, acronyms and abbreviations

API	Application Programming Interface
SW	Software
DEV	Product development department
CSH	Consumer systems Hamburg
DLL	Dynamic Link Library
FAE	Field application engineer
I2C	Inter IC connection
IC	Integrated Circuit
MS	Microsoft
OS	Operating System
ROM	Read Only Memory
UART	Universal Asynchronous Receiver Transmitter
URD	Universal Register Debugger

WIN16	16bit MS Windows environment (e.g. Windows 3.1)	WIN32	32bit MS Windows environment (e.g. Windows 95/98)

5.5 Reference documents

[URD_LR]	"Universal Register Debugger, Language Reference", Draft, Version 0.7, 13-Dec-2000
[URD_RN]	"Universal Register Debugger, Release Notes", Accepted, Version 3.10

6 Introduction

This user manual describes the handling of the Universal Register Debugger (URD) to access registers of a target device, which is connected to the host, on which the URD application is running. In particular, this manual describes:

- getting started with the URD application (chapter 7)
- understanding the underlying software architecture and hardware communication structure (chapter 8)
- reading and writing of registers and memory areas of a target device (chapter 10)
- storing and reloading current register settings of a target device (chapter 10)
- using simple macros for a sequence of register accesses (chapter 10)
- using URD basic macros for small programs (branches, loops, functions calls) (chapter 12)
- developing drivers to connect the URD application to the target device through a communication bus (chapter 13)

A general understanding of the handling of MS Windows OSs is required and assumed available.

The URD language and its use are described in the language reference manual [URD_LR]. The components of the URD application are described in the release note [URD_RN].

7 Getting Started

7.1 Hardware Requirements

The following minimum hardware is required to run the URD:

- Pentium 90 CPU
- 16Mbyte main memory
- 20Mbyte hard disk memory space
- CDROM drive, 2x or network connection, depending on the medium for installation of the URD

Depending on the communication channel between host and target, additional hardware is needed (e.g. an I2C transceiver or a JTAG probe)

7.2 Installation

The URD application will be installed by starting the selfextracting file URD.EXE. This invokes first an installation wizard, which copies all necessary file to a temporary file location for set-up. Afterwards a set-up wizard is invoked, which guides through the rest of the installation procedure. During installation, a choice needs to be made between the 16-bit and 32-bit version of the URD. Only by choosing the 32-bit version enhanced features like sliders or the URD basic engine are available (see also chapter 15.1). Further, several components of the URD package can be selected, like the application itself, user documentation, sample and driver files. In addition URD device description files of existing Philips ICs can be installed by starting URDFILES.EXE and following the set-up wizard instructions.

A detailed description of the contents of the URD application and URD files is available in the release notes [URD_RN].

7.3 Support

Support, updates and further information can be obtained via the following channels:

- In general the field application engineers (FAEs) of Philips supports usage of the URD. In addition Philips can be contacted via email at:

  pcptechsupport@hamburg.sc.philips.com

- Inside Philips information can be obtained in addition via

  http://pww-cs:8000/Software/URD/.

7.4 Sample files

Currently the following sample files are provided within an URD installation:

- A sample file showing details of the URD language
- A sample device description file ADD32
- A sample DLL showing the usage of the API without the need of a physical target
- A sample macro description file directly usable from the URD
- A sample macro description file called during macro execution indirectly

Further bus specific DLLs and device specific device description files have been developed. The actually available files are listed in the release notes [URD_RN].

8 Architecture

To debug a target with the URD two major components are needed: the URD environment to run the URD application and the target to be investigated. Communication between both components is carried out via a dedicated physical communication channel.

In terms of hardware this involves a PC to run the URD, one of the communication channels of the PC and a target device. The target device may be located inside the PC on a plug-in card or outside the PC as a separate piece of hardware. Examples of PC communication channels are the PCI bus, a serial port or a parallel port. Further channels may be established by using converters, e.g. a line printer to I2C converter to hook up the URD to an external I2C bus.

The URD environment consists of two major components: an application core and a set of support files. The application core provides the basic URD functionality and the support files customise the URD to access and manipulate the target device (Figure 1).

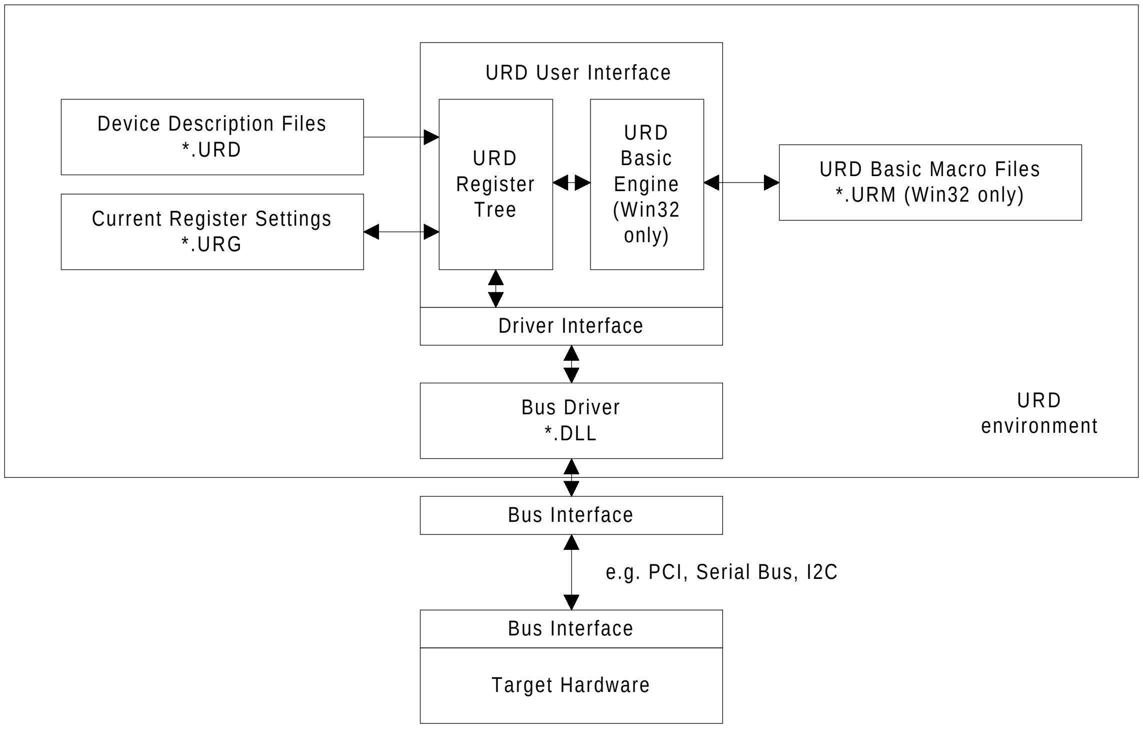


Figure 1: URD Software Architecture and Hardware Communication

The URD application core in general consists of the following two user relevant parts:

- User interface:
  The user interface shows a graphical representation of the target hardware and allows access to the registers of the target in the URD register tree.

- Driver interface:
  The driver interface is a generic interface to hook up various bus drivers to the URD environment for communication with the target hardware.

In a Win32 environment the user interface is extended by the following part:

- URD basic engine:
  The URD basic engine executes the URD basic macros to manipulate the target hardware.

The set of support files may consist of the following files:

- Device description file ('*.URD', mandatory):
  The device description file describes the registers of the target hardware. It forms the basis for the graphical representation of the target hardware in the user interface.

- Current Register Settings ('*.URG', optional):
  Next to one device description file sets of current register values can be stored in current register settings. These files are only usable together with the corresponding device description file.

- URD basic macro description file ('*.URM', optional, Win32 only):
  Sequences of register accesses can be described with URD basic macros and stored in a

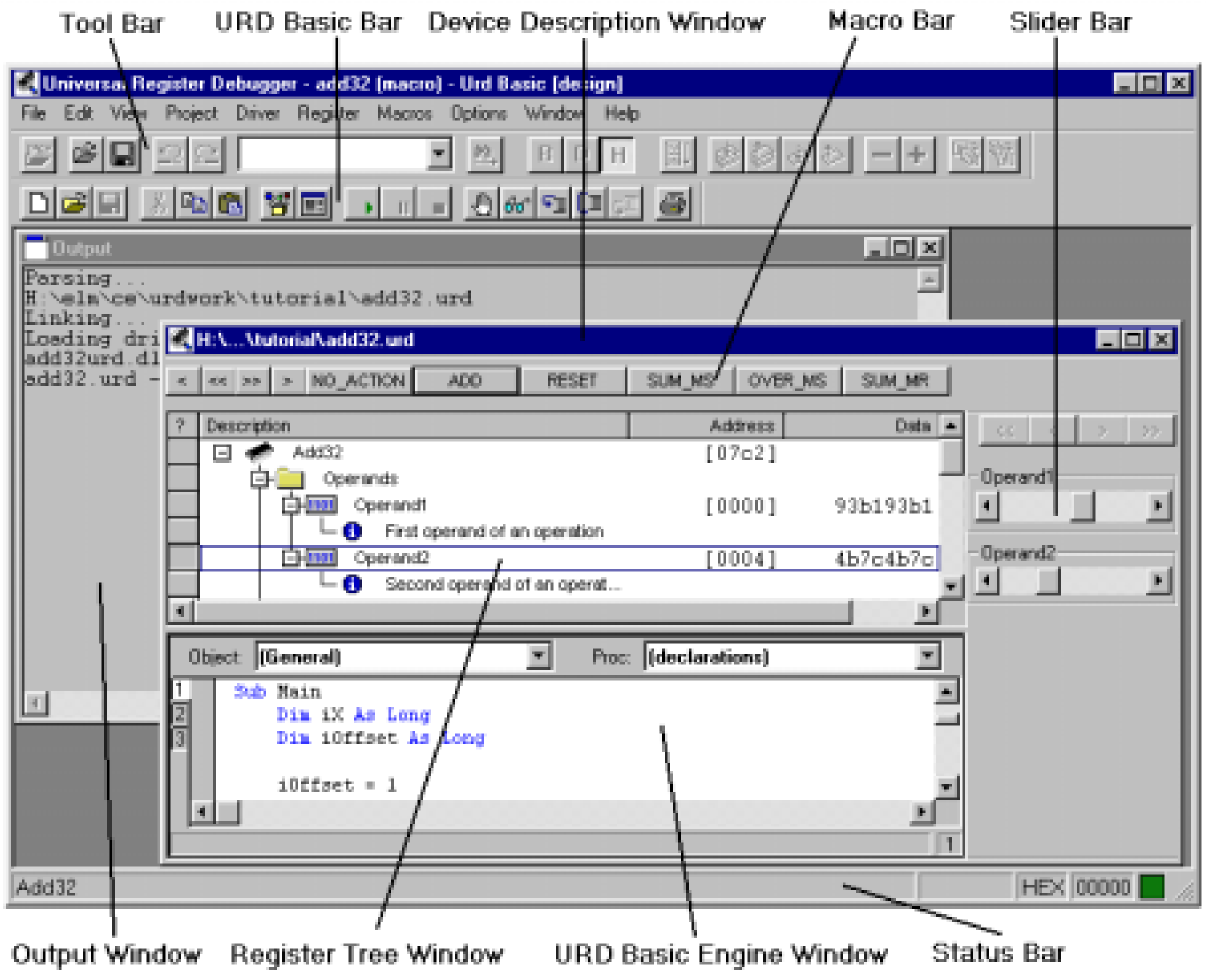
URD basic macro description file. These files are only usable together with the corresponding device description file.

- Bus driver ('*.DLL', mandatory):
  The bus driver forms the connection to the selected communication channel between the URD and the target hardware. The driver converts the function calls of the URD to physical hardware accesses via the chosen bus interface of the PC, the involved bus system and the bus interface of the target to the target hardware.

To adapt the URD to target hardware at least a device description file and a suited bus driver needs to be provided. Development of a device description file is described in the URD language reference [URD_LR]. Bus driver development is described in chapter 13.

9 User Interface

A running URD application, which has a device description file successfully opened, consists of a set of windows and bars as shown in Figure 2.


Tool Bar
URD Basic Bar
Device Description Window
Macro Bar
Slider Bar
Universal Register Debugger - add32 (macro) - Urd Basic [design]
File Edit View Project Driver Register Macros Options Window Help
Output
H:\...\tutorial\add32.urd
NO_ACTION ADD RESET SUM_MS OVER_MS SUM_MR
Operand1
Operand2
Object: (General)
Proc: (declarations)
Add32
HEX 00000
Output Window
Register Tree Window
URD Basic Engine Window
Status Bar

```
Parsing...
H:\elm\ce\urdwork\tutorial\add32.urd
Linking...
Loading dri
add32urd.dl
add32.urd -
```

Description	Address	Data
Add32	[07c2]	
Operands		
Operand1	[0000]	93b193b1
First operand of an operation		
Operand2	[0004]	4b7c4b7c
Second operand of an operat...		

```
Sub Main
    Dim iX As Long
    Dim iOffset As Long

    iOffset = 1
```

Figure 2: User interface of the Universal Register Debugger (URD)

The most important window is the **device description window**. It covers all information available over the target device structure, the current status of the target device and several elements for access of the target registers.

All information about the structure of the target device are covered in a register tree, which is accessible via the **register tree window**. Details of how the register tree is build and the target device needs to be described are given in the URD language reference manual (URD_LR).

The following elements are in the device description window available for register access: the macro bar, the slider bar and the URD basic engine window.

- The **macro bar** allows execution of a linear sequence of register accesses. This bar is available automatically only, if at least one macro is part of the loaded device description file. Further details are given in chapter 11.4.
- The **slider bar** allows dynamic change of the contents of the related registers. This bar is available automatically only, if at least one slider is part of the loaded device description file. Details can be found in chapter 11.2.
- The **URD basic engine window** is the interface to the URD basic engine integrated in the URD. This window together with an introduction to the integrated basic engine is given in chapter 13.

The **tool bar** provides buttons for frequently used action for file handling and register access. The usage of the buttons is part of the descriptions of chapter 10.

The **URD basic bar** supports frequently used action for the usage of the integrated URD basic engine. Details are described in chapter 12.

The **output window** is the communication interface from the URD application to the user. It provides status information during loading of a device description file and about errors occurred. The contents of the output window is described in chapter 11.1. Error codes are explained in chapter 14.

The **status bar** provides current information about the URD application. Details are given with the descriptions of chapter 10.

Help information about functionality of the URD application is available in form of tooltips. The Help menu entry provides information about the URD application in an About URD box.

To customise the appearance of the user interface, the mentioned bars can be hidden or shown using the corresponding entries of the View menu (Figure 3).

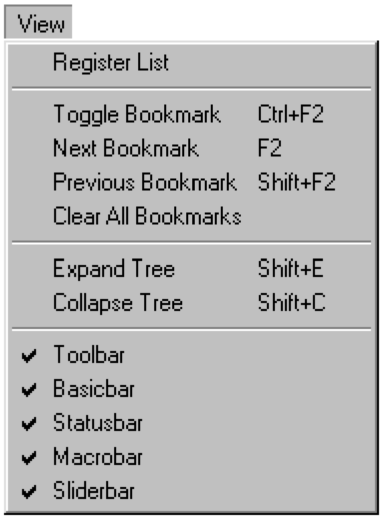


Figure 3: The View menu

10 Bookmarks and “Find”-Function

To make the dealing with urd-files more comfortable, there are two functions integrated

- Bookmarks
- “Find”- function

10.1 Bookmarks

Setting bookmarks eases the way to find important positions of the “Register Tree”.

They can be set in several ways:

- using the Toggle Bookmark entry from the View menu
- using the shortcut Crtl+F2
- clicking on the left button bar in the “Register Tree Window”

Switching between the bookmarks can be executed by

- using the previous or next Bookmark entry from the View menu
- using the shortcuts Shift+F2 or F2

10.2 “Find”-function

The “Find”-function allows the user to look for strings in the register tree. Note that there is no way to look for an address.

- To find a string, its name can be written in the “find”- field in the tool bar and pressing either the Find String button (), or the return key.
- Another way is either to use the shortcut Alt+F3, or to use the Find entry in the View menu. In both cases a dialog appears (Figure 4), where it is possible to specify the strings, the search direction and to choose, if the results should be bookmarked.

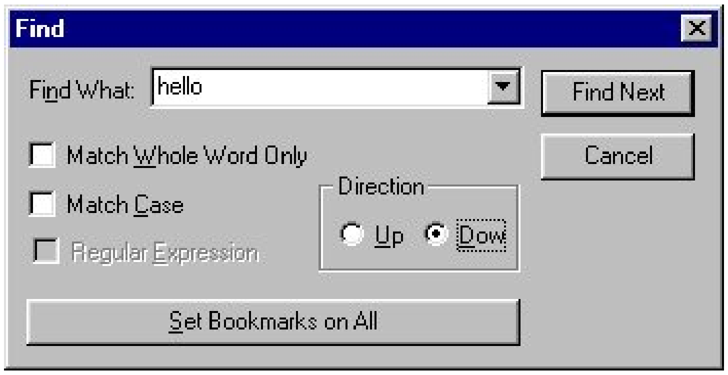


Figure 4: The Find Dialog

11 Accessing a hardware device

When the URD application has been installed and the target device has been described, access to the hardware can start carrying out various tasks:

- Accessing a device description file.
- Registers of the target device could be accessed and manipulated
- A linear sequence of register accesses can be carried out using simple macros.
- A more complex sequence of register access including e.g. branches or loops can be carried out using URD basic macros.
- A set of dedicated register values describing the status of the target at a certain moment could be handled using register description files.
- Whole memory regions like an embedded RAM could be written and read.

All these tasks, except the usage of URD basic macros, are described in detail in the following chapters. URD basic macros are described in chapter 12.

11.1 Accessing a device description file

Accessing a hardware device needs a description of the target in form of a device description file. This is needed as a file named '<file name>.URD'. Preparation of a device description file is detailed in the language reference manual [URD_LR].

Accessing a device description file could be either loading a file from the file system or choosing a loaded one.

Loading a file could be carried out by:

- using the Open entry from the File menu (Figure 5)
- using the shortcut Crtl+O
- using an entry of the least recently used (LRU) list of the File menu (Figure 5)
- drag and drop from one or files of the file system

Choosing a loaded device description file could be done by selecting the corresponding device description window or selecting an entry of the windows list of the windows menu (Figure 5).

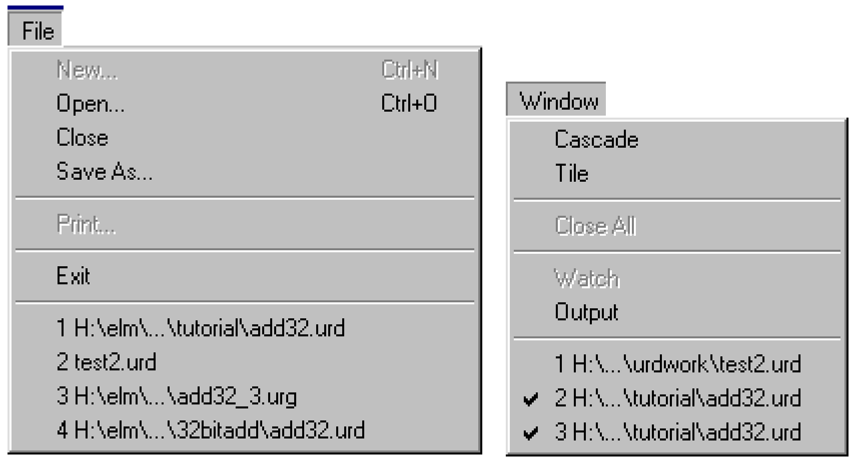
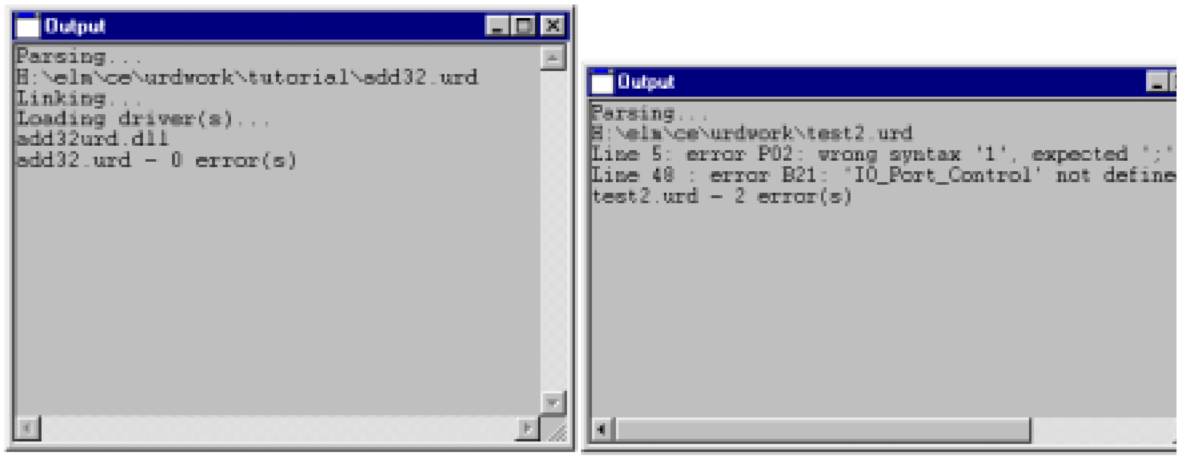

File
New... Ctrl+N
Open... Ctrl+O
Close
Save As...
Print...
Exit
1 H:\elm\...\tutorial\add32.urd
2 test2.urd
3 H:\elm\...\add32_3.urg
4 H:\elm\...\32bitadd\add32.urd
Window
Cascade
Tile
Close All
Watch
Output
1 H:\...\urdwork\test2.urd
✓ 2 H:\...\tutorial\add32.urd
✓ 3 H:\...\tutorial\add32.urd

Figure 5: Menus for device description file access

Loading a device description file, the contents of the file will be parsed, linked and loaded together with the appropriate driver into the main window of the URD. All actions carried out during the load operation will be logged to the output window. Assuming a successful load operation, the contents of the device description file will be shown in the device window (Figure 6).

Any error occurring during the load operation of a device description file is logged to the Output window (Figure 6).



```
Parsing...
H:\elm\ce\urdwork\tutorial\add32.urd
Linking...
Loading driver(s)...
add32urd.dll
add32.urd - 0 error(s)
```

```
Parsing...
H:\elm\ce\urdwork\test2.urd
Line 5: error P02: wrong syntax '1', expected ';'
Line 48 : error B21: 'IO_Port_Control' not define
test2.urd - 2 error(s)
```

Figure 6: Possible output window contents after loading a device description file

In this log each error found is shown with an explanation and is preceded by a line number indicating the location of the error in the device description file. For a complete list of all errors together with information for error correction, please refer to chapter 14.

11.2 Accessing device registers

Basic ways of accessing device registers are reading and writing.

Reading can be

- reading a single register, which is selected in the register tree, using the Read Register button ( ) or the Read Register entry of the Register menu

- reading all registers using the Read Now button (), the Read Now entry of the Register menu or the Ctrl+R shortcut

Writing can be executed statically or dynamically. Static writing is covered by:

- directly editing the register value in the register tree. This is a non preserving way of editing.
- directly editing the register value with preserving of the previous contents. Therefore the header field of the data column has to be selected and the field of the selected register value has to be entered by pressing the return button.
- rewriting a single register, which is selected in the register tree, with the current register value using the Write Register button () or the Write Register entry in the Register menu.
- incrementing the value of a single, selected register using the Increase Value button (), the '+' key on the numerical keyboard or the Increase Value entry of the Edit menu. A single keystroke to the '+' key of the numerical keyboard increases the current register value by one. Leaving the key pressed continuously increases the value of the selected register.
- decrementing the value of a single, selected register using the Decrease Value button (), the '-' key on the numerical keyboard or the Decrease Value entry of the Edit menu. A single keystroke to the '-' key of the numerical keyboard decreases the current register value by one. Leaving the key pressed continuously decreases the value of the selected register.
- writing all registers with the current register values using the Write Now button (), the Write Now entry of the Register menu or the Ctrl+W shortcut
- writing all registers with default values using the Write Default button (), the Write Default entry of the Register menu or the Ctrl+D shortcut

The Edit menu and Register menus are shown in Figure 7.

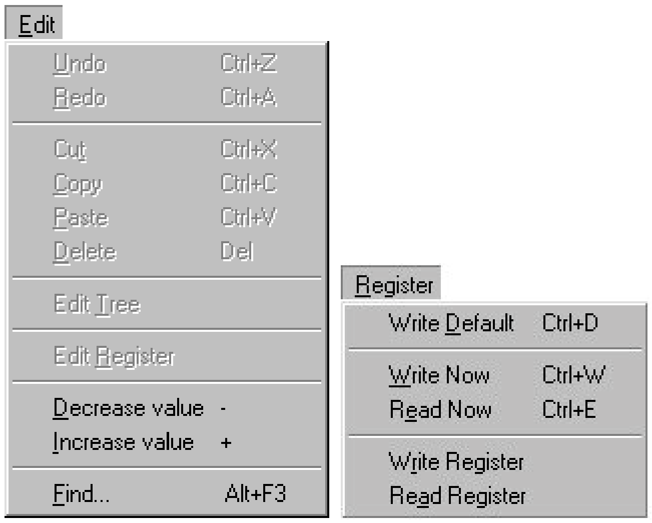


Figure 7: Register access menus

Dynamic writing is carried out using sliders of the slider bar. Sliders are available in Win32 systems only.

A slider belongs to a dedicated register or group of bits and is part of the device description (Figure 8).

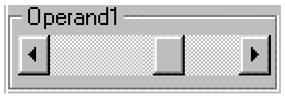


Figure 8: Slider of a register

The slider can be used in several ways:

- Using the left mouse button pressed down on the slider button, the contents of the register linked to the slider can be changed quickly over the whole available range of the register contents.
- Clicking with the left mouse button into the slider range area changes the current register contents by 1/16 of the whole range.
- Using the arrows at the ends of the slider by clicking with the left mouse button increments or decrements the register value.
- Leaving the left mouse button pressed down on the arrows continuously changes the value of the register contents.

In the slider bar at maximum four sliders are shown in parallel. They are ordered in the sequence of description in the device description file. To move forward or backward to the next available slider the single arrows of the slider bar can be used (<, >). Using the double arrows (<<, >>) moving covers four sliders at a time.

In addition the radix of the numerical representation of the register values can be changed. Options are binary, decimal or hexadecimal. To switch between the different number systems either the concerning buttons from the toolbar or the Set Base submenu from the Options menu of the URD can be used (Figure 9).

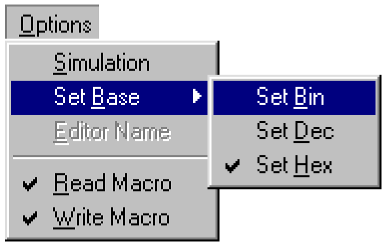


Figure 9: Setting the basis for the numerical register value representation

At the toolbar **B** is used to switch to a binary representation, **D** for a decimal representation and **H** for a hexadecimal representation of the register values. In the submenu the corresponding entries are Set Bin, Set Dec and Set Hex.

The status of the URD application during reading and writing is shown in the status bar (Figure 10).

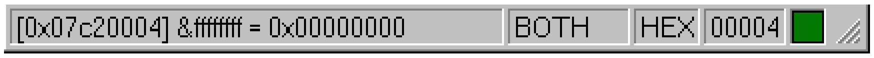

[0x07c20004] &ffffffff = 0x00000000 | BOTH | HEX | 00004 | 🟩

Figure 10: Status bar giving information over register accesses

In the first four windows of the status bar the following information are given over the selected register:

- register description
- access mode (read, write, both, status)
- numerical basis of the register value
- actual register value

The status of the current register access is shown in the fifth window using colours:

- Dark green: no register access ongoing
- Light green: register access ongoing
- Blinking dark and light red: register access simulation

Further the first window of the status bar is used to show description of other elements of the user interface while they are selected.

11.3 Handling dedicated target device configurations

Current register settings could be stored in a file as a snapshot of a certain device configuration. To store the register settings, the Save Register entry of the File menu is used (Figure 11).

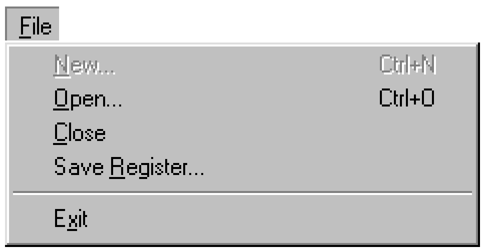


Figure 11: Storing current register settings of a target device

The stored file type is '*.URG'. A comment can be added in the Comment Field of the used file dialog box.

Reloading current register settings into a loaded device description file is used to bring the target device into a predefined state or mode. This is carried out by loading the device description file first and then using the Open entry of the File menu or the Ctrl+O shortcut (Figure 5).

For read only registers in the device, a Read Now access need to be executed to fill the "X..X" value entries in the register tree to restore all current register settings.

11.4 Using variables and simple macros

Variables can be used to have virtual registers for intermediate storage of values available. The contents of a register or another variable can be assigned to a variable. Accessing variables need the use of simple macros.

Simple macros are a means to execute a sequence of register or variable accesses. The accesses are constraint to the assignment of a numeric constant, a register contents or a variable contents to another writable register or variable contents. Further special sleep functionality allows wait states between the execution of register accesses.

The implementation of variables and simple macros in a device description file is detailed in [URD_LR].

Execution of a macro, which is accessible via the macro bar of a device description file, can be carried out by pressing the corresponding macro button or by selecting the corresponding macro from the Macro menu of the URD application. At maximum six macro buttons are shown in parallel. They are ordered in the sequence of description in the device description file. To scroll to further macros, the arrow buttons needs to be used. Scrolling forward and backward by one macro (<, >) or by six macros (<<, >>) is supported by the URD.

Furthermore macros can be executed prior to or directly after a register access. They are called pre-macros or post-macros. Depending on whether they are executed together with a read or write access to a register they are called in addition read macros or write macros. This is useful, when e.g. a reset of an IRQ status register is needed every time the signal condition, on which an interrupt will be generated, will be changed. Read and write macros are not accessible via buttons or the macro menu, if not especially allowed. Read and write macros can be enabled or disabled using the corresponding entries of the Options menu (Figure 9).

11.5 Accessing memory regions

In a memory mapped computer system any memory is accessed via its address. Because the URD is an application which reads and writes data from given addresses, memory regions can be accessed as well. The memory part, which should be accessed, needs to be divided into parts of equal or less than 32 bit and described in a device description file. This then contains a list of addresses and the organisation form of the data which should be accessed. Hence memory regions of a system could be accessed by the URD application in the same manner as registers.

12 The URD Basic Engine (Win32 only)

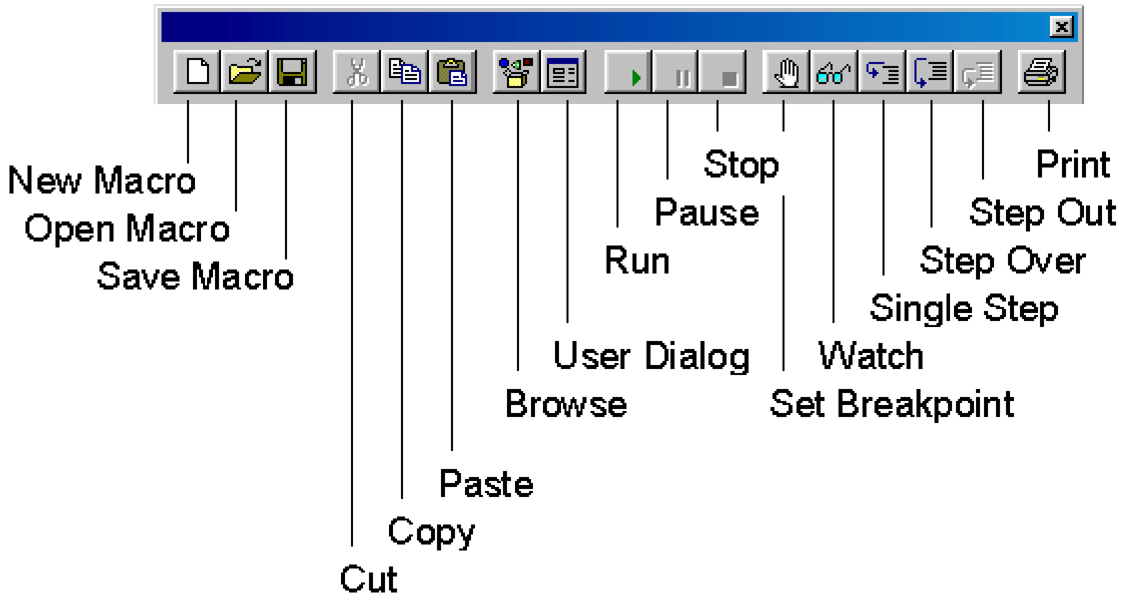
To access the target device in a dynamic way as a software program runs on a PC the URD provides the URD basic engine in a Win32 environment. The URD basic engine is an integral part of the URD and is based on a subset of MS Visual Basic. It provides an integrated develop environment (IDE) to develop, execute and debug the URD basic macros. In addition to the subset of Visual Basic, URD specific commands are provided to access registers of the target hardware.

12.1 Introduction to the URD basic engine

The URD basic language is a powerful enhancement to the standard URD described functionality so far. It enables you to automate your task. In the following chapters the usage and some of the basic commands are described to help you writing your own URD basic macros.

12.1.1 The URD basic toolbar

The following figure shows all buttons of the URD basic toolbar with there short description. They will be explained in detail in the table below.



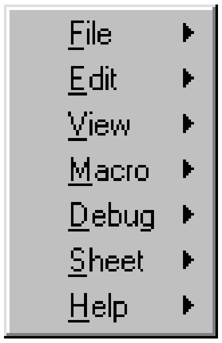
Command	Description	Button
New Macro	Creates a new empty macro in the URD basic editor.	🗋

	Note: The editor can handle up to 9 files at a time. If you try to open more, an error message will be displayed, and no macro will be opened. You have to close one of the already opened macros to create a new one.	
Open Macro	Opens an existing URD basic macro into the editor.	
Save Macro	Saves a new or changed macro. This button will be 'grayed' until the current macro in the editor has been changed. If it is a newly created macro, a ' Save As' dialog will be shown, where you can select the name and folder for the macro. If the macro already has a name the changed macro will be saved to the file without further prompting.	
Cut	Removes the selection from the active document and places it on the Clipboard. Note: This command is available only if you have selected some text in the URD basic editor.	
Copy	Copies the selection to the Clipboard. Note: This command is available only if you have selected some text in the URD basic editor.	
Paste	Inserts the contents of the Clipboard at the insertion point, and replaces any selection. Note: This command is available only if you have cut or copied an object, text, or contents of a cell.	
Browse	The Object Browser shows information about all the special data types that are available. Please refer to online help for more detailed information.	
User Dialog	To graphically edit a UserDialog place the current selection in a UserDialog block and click on . Please refer to online help for more detailed information.	
Run	Starts the actual selected URD basic macro in the editor. Before starting the macro, it is checked for errors, which will be displayed in the status line below the editor window.	
Pause	Pauses a running URD basic macro. The actual line will be highlighted. You can restart the macro from the current line with or use , or to debug your code.	
Stop	Stops the currently running macro.	
Set breakpoint	Sets or unsets a breakpoint to the line with the current selection. (Available only, when the macro is stopped or paused)	

Watch	Shows the actual value of the selected variable in the Immediate window.	
Step Into / Single Step	Executes one line of code. If the current line of code is a call to a subroutine or function, this command will step into the called subroutine or function and will stop at the next line of executable code in this subroutine or function.	
Step Over	This will execute one line of code. If the current line is a call to a subroutine or function, the whole subroutine or function will be executed, and the execution stops again on the next line in the current subroutine or function.	
Step Out	This will step out of a subroutine or function and will stop after the calling line of the current subroutine or function.	
Print	This will print the actual URD basic macro on a printer. You will be prompted which printer you want to use.	

12.1.2 The URD Basic menu

You can open the URD Basic menu by clicking into the URD basic editor window with the right mouse button. The menu is shown in the following figure. All commands are described in the following paragraphs.



12.1.2.1 *File* Menu

Item	Description	Hot Key
New	Create a new macro.	
New Module	Create a new macro module (code, object or class).	
Open...	Load an existing macro/module from disk.	
Close	Close the current macro/module.	
Save	Save the current macro/module to disk.	
Save As...	Save the current macro/module to disk as a particular file.	

Save All	Save all the macros/modules to disk.	
Print	Print the current macro/module.	
Print Setup...	Select the default printer.	

12.1.2.2 *Edit* Menu

Item	**Description**	**Hot Key**
Undo	Undo the last edit.	Ctrl+Z
Redo	Redo the last undo.	Ctrl+Y
Cut	Move the selected text to the Clipboard.	Ctrl+X
Copy	Copy the selected text to the Clipboard.	Ctrl+C
Paste	Paste the Clipboard text over the selected text.	Ctrl+V
Delete	Delete the selected text.	Del
Select All	Select all of the text.	
Indent	Move selected lines right.	Tab
Outdent	Move selected lines left.	Shift+Tab
Tab As Spaces	Toggle the insert tab as spaces mode on/off.	
Find...	Find a string.	Ctrl+F
Replace...	Replace a string with another.	Ctrl+R
Again	Repeat last find or replace.	F3
UserDialog...	Edit a UserDialog. (see UserDialog Editor)	
References	Edit the macro/module's references.	
Properties	Edit the module's properties.	

12.1.2.3 *View* Menu

Item	**Description**	**Hot Key**
Macro	Activate the macro editing window.	Ctrl+A
Immediate	Show the immediate output window.	Ctrl+E
Watch	Show the watch expressions window.	Ctrl+W
Stack	Show the call stack window.	Ctrl+T
Loaded	Show the loaded macros/modules window.	Ctrl+L
Toolbar	Toggle the toolbar on/off.	
Status Bar	Toggle the status bar on/off.	

Edit Buttons	Toggle the edit buttons on/off.	
Always Split	Toggle the split on/off.	
Font...	Set the display font.	
Tab Width	Set the tab width.	
Object/Proc	Select the Object/Proc list display mode.	

12.1.2.4 *Macro* Menu

Item	**Description**	**Hot Key**
Run	Run the macro to completion. (If the macro is not active, start it.)	F5
Pause	Stop the macro/module. Execution can be continued.	Esc
End	Terminate the macro/module. Execution cannot be continued.	
Design Mode	Toggle the macro design mode.	

12.1.2.5 *Debug* Menu

Item	**Description**	**Hot Key**
Step Into	Execute the current line. If the current line is a subroutine or function call, stop on the first line of that subroutine or function. (If the macro is not active, start it.)	F8
Step Over	Execute to the next line. If the current line is a subroutine or function call, execute that subroutine of function completely.	Shift+F8
Step Out	Step out of the current subroutine or function call.	Ctrl+F8
Step to Cursor	Execute until the line the cursor is on is the current line. (If the macro is not active, start it.)	F7
Toggle Break	Toggle the break point on the current line.	F9
Clear All Breaks	Clear all break points.	Shift+Ctrl+F9
Quick Watch	Show the value of the expression under of the cursor in the immediate window.	Shift+F9
Add Watch	Add the expression under of the cursor in the watch window.	Ctrl+F9
Browse	Show the methods of the expression under of the cursor. (see Object Browser)	
Set Next	Set the next statement to be executed. Only statements in the current subroutine/function can be selected.	

Show Next	Show the next statement to be executed.	

12.1.2.6 *Sheet* Menu

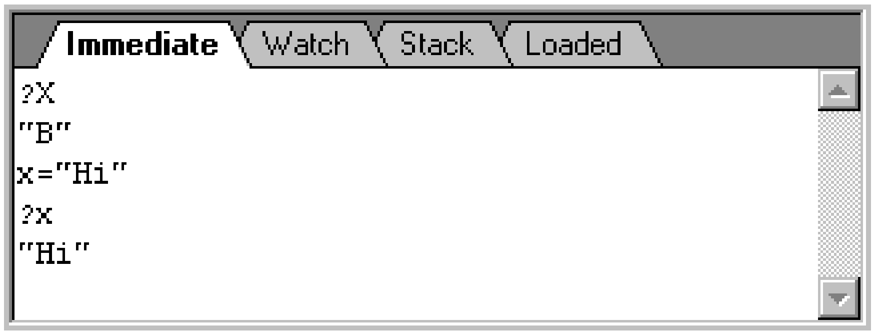
Item	**Description**	**Hot Key**
Open Uses	Open all the '#Uses modules for the current macro/module.	
Close All	Close all the macros/modules.	
1...9	Show this macro/module.	Ctrl+1...Ctrl+9

12.1.2.7 *Help* Menu

Item	**Description**	**Hot Key**
Editor Help	Show the table of contents for Sax Basic Editor.	
Language Help	Show the table of contents for the Sax Basic language.	Shift+F1
Topic Search	Show Sax Basic language help for the keyword under the cursor.	F1
About Sax Basic	Sax Basic Editor's about box.	

12.1.3 The URD basic windows

12.1.3.1 Immediate Window

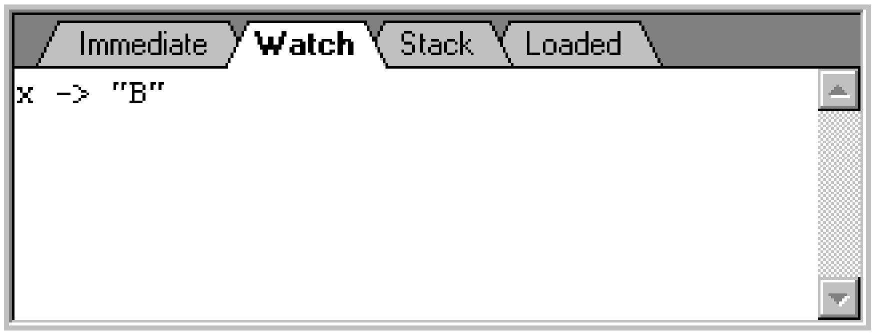


```
?X
"B"
x="Hi"
?x
"Hi"
```

Evaluate an expression, assign a variable or call a subroutine.

- Type '?expr' <Enter> to show the value of 'expr'.
- Type 'var = expr' <Enter> to change the value of 'var'.
- Type 'Set var = expr' <Enter> to change the reference of 'var'.
- Type 'subname args' <Enter> to call a subroutine or built-in instruction.
- Type 'Trace' <Enter> to toggle trace mode. Trace mode prints each statement in the immediate window when a macro/module is running.

12.1.3.2 Watch Window

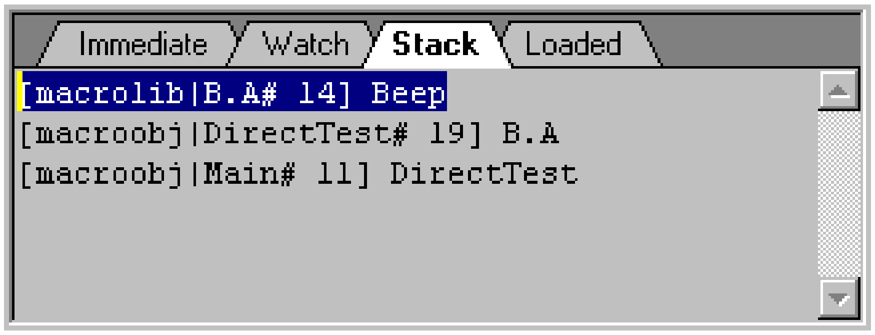


```
x -> "B"
```

List the variables, functions and expressions that are calculated and displayed.

- Each time execution pauses the value of each line in the window is updated.
- The expression to the left of '->' may be edited.
- Pressing Enter updates all the values immediately.
- Pressing Ctrl+Y deletes the line.

12.1.3.3 Stack Window



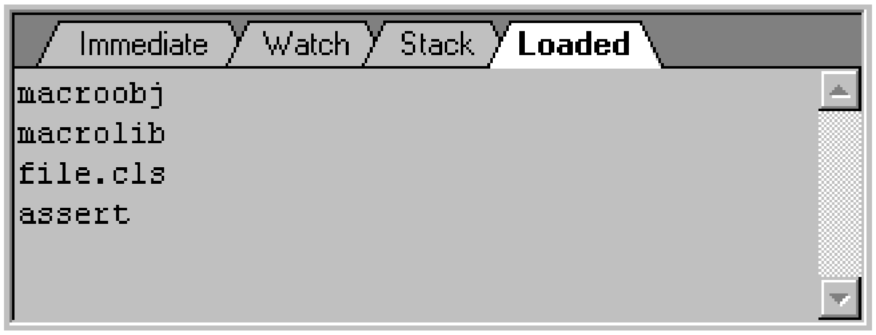
```
[macrolib|B.A# 14] Beep
[macroobj|DirectTest# 19] B.A
[macroobj|Main# 11] DirectTest
```

List the lines, which called the current statement.

The first line is the current statement. The second line is the one that called the first. And so on.

- Clicking on a line brings that macro/module into a sheet and highlights the line in the edit window.

12.1.3.4 Loaded Window

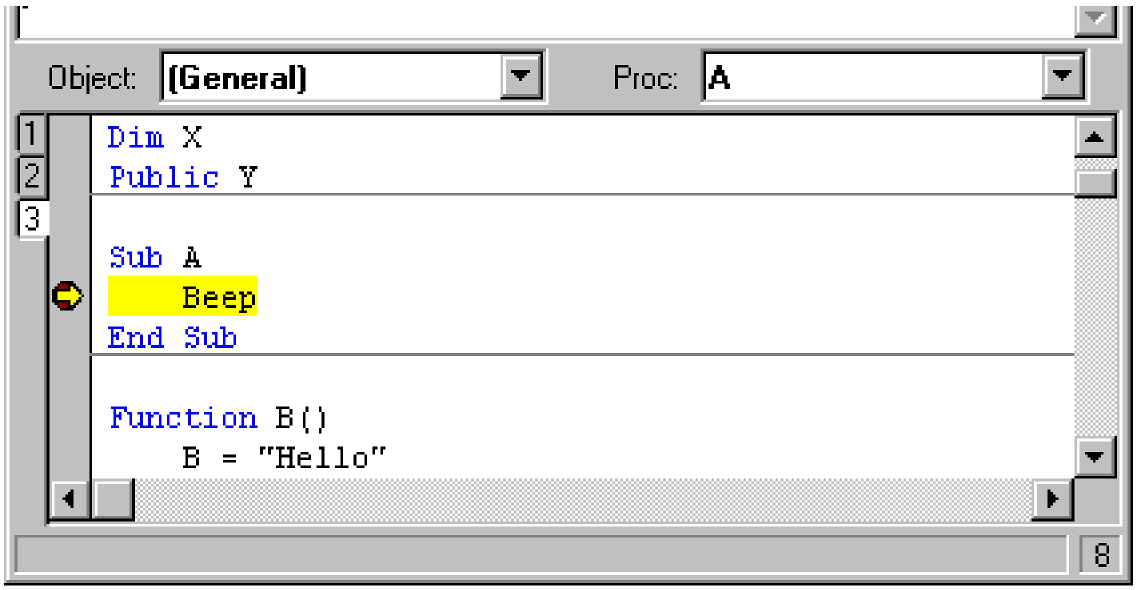


```
macroobj
macrolib
file.cls
assert
```

List all the currently active macros and loaded modules.

- These macros/modules are locked and can only be viewed (not edited).
- Clicking on a line brings that macro/module into a sheet and activates the sheet.

12.1.3.5 Edit Area

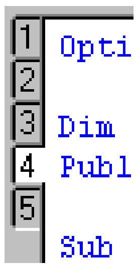


```
Dim X
Public Y

Sub A
    Beep
End Sub

Function B()
    B = "Hello"
```

The current macro/module are edited/viewed in this area.

- Macros/Modules that are not currently loaded may be edited.
- Changes to a line are automatically capitalized and highlighted when a different line is selected.
- Break points may be toggled on/off. A dot at the front of the line indicates a break point.

12.1.3.6 Sheet Tabs

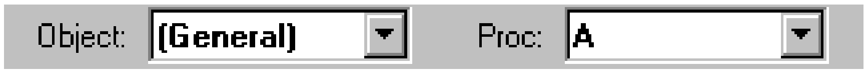


```
Opti

Dim
Publ

Sub
```

Each sheet has a tab.

- Clicking once on a tab makes that sheet the current sheet.
- Double-clicking closes that sheet.

12.1.3.7 Object and Proc List



The object list shows all the objects for the current module.

- The "(general)" object groups all of the procedures which are not part of any specific object.
- The proc list shows all the procedures for the current object.
- Selecting a procedure that is not bold inserts the proper procedure definition for that procedure.

12.2 URD specific commands

Next to the standard basic commands there are some special commands which are used to accesses the registers defined in the URD file. A short description is given in the following table. A detailed description is given in the subsequent chapters:

Command	*Description*	**Button**
ReadAll	Read all registers from the device into the tree	
WriteAll	Write all actual values from the tree to the device	
WriteDefault	Write the default values from the URD file into the tree and to the device	
ReadReg	Read the content of one register of the device into the tree	
WriteReg	Write a value to one register of the device (this will also update the value in the tree)	
DebugOut	Writes a string to the output window of the URD	
Inc	Increments a variable	
Dec	Decrements a variable	
Magic	Several useful functions	

12.2.1 ReadAll

Syntax	`ReadAll`	
Description	Read all register values from the actual device. Same functionality, as the Read Now button in the URD toolbar	
Parameter	None	
Return	None	
Example	`Call ReadAll`	

12.2.2 WriteAll

Syntax	`WriteAll`	
Description	Write all actual register values from the tree to the device. Same functionality, as the Write Now button in the URD toolbar	
Parameter	None	

Return	None	
Example	`Call WriteAll`	

12.2.3 WriteDefault

Syntax	`WriteDefault`	
Description	Writes all default register values to the device. Same functionality, as the Write Default button in the URD toolbar	
Parameter	None	
Return	None	
Example	`Call WriteDefault`	

12.2.4 ReadReg

Syntax	ReadReg(lRegister As Long) As Long	
Description	Reads a value from a register. If not successful an error message is written to the URD output window. In this case 0 is returned	
Parameter	lRegister As Long	One of the constants defined in *register.urm (this is automatically generated while loading the URD file)
Return	The value read from the given register. The tree will be updated to the new value also. In case of an error 0 will be returned.	

Example	`'#uses "*register.urm"`
	`Dim lMode As Long`
	`lMode = ReadReg(MODE)`	

Comment	To access the registers defined in the tree it is necessary to have a reference to the automatically generated register constants list. This must be done with: `'#uses "*register.urm"` Please see also #uses in the online documentation of the basic engine.	

12.2.5 WriteReg

Syntax	WriteReg(lRegister As Long, lValue as Long) As Boolean	
Description	Writes a value to a register.	
Parameter	lRegister As Long	One of the constants defined in *register.urm (this is automatically generated while loading the URD file)
	lValue As Long	The value to be written to the register. If the value is to big to fit in the register, only the

		least significant bits that will fit will be written. The tree will be updated to the new value too.
Return	TRUE (1)	If successful
	FALSE (0)	If not successful

Example	`'#uses "*register.urm"`
	`Dim lReturn as Boolean`
	`lReturn = WriteReg(MODE, 3)`
	`If lReturn = True then`
	`   DebugOut “Write Successful”`
	`Else`
	`   DebugOut “Write Unsuccessful”`
	`End If`	

Comment	To access the registers defined in the tree it is necessary to have a reference to the automatically generated register constants list. This must be done with: `'#uses "*register.urm"` Please see also #uses in the online documentation of the basic engine.	

12.2.6 DebugOut

Syntax	DebugOut (sString As String) As Boolean	
Description	Writes a string to the URD output window	
Parameter	sString As String	String to be written to the URD output window
Return	TRUE (1)	If successful
	FALSE (0)	If not successful

Example	`Dim lReturn as Boolean`
	`lReturn = DebugOut(“Hello URD World”)`
	`If lReturn = True then`
	`   Debug.Print “Write Successful”`
	`Else`
	`   Debug.Print “Write Unsuccessful”`
	`End If`	

Comment	You can also use the call to Debug.Print to write to the Immediate pane of the URD basic development environment.	

12.2.7 Inc

Syntax	Inc (lValue As Variant) As Variant	
Description	Increments the value given in lValue	
Parameter	lValue As Variant	Value to be incremented
Return	lValue + 1	

Example	`Dim k As Single`
	`Do Until k >= 10`
	`     DebugOut Inc(k)`
	`Loop`

Comment	lValue can be an Integer, Long or Single

12.2.8 Dec

Syntax	Dec (lValue As Variant) As Variant	
Description	Decrements the value given in lValue	
Parameter	lValue As Variant	Value to be decremented
Return	lValue - 1	

Example	`Dim k As Single`
	`Do Until k <= 0`
	`     DebugOut Dec(k)`
	`Loop`	

Comment	lValue can be an Integer, Long or Single	

12.2.9 Magic

Syntax	Magic(lFunc as Long) As Long	
Description	Performs the following actions depending on the parameter lFunc	
Parameter	lFunc as Long	1: Redraws the entire desktop 2: Minimizes the URD window 3: Restores the URD window 4: Calls the PeekMessage service to check for a WM_KEYDOWN message
Return	Depending on lFunc the following values are returned	
	`lFunc = 1`	If the window was previously visible, the return value is True. If the window was previously hidden, the return value is False
	`lFunc = 2`	`True`
	`lFunc = 3`	`True`
	`lFunc = 4`	Returns the value of the pressed key or zero, if no key is pressed

Example	`‘ Wait for a key press`
	`Dim lRet As Long`
	`Do While lRet = 0`
	`     lRet = Magic(4)`
	`Loop`
	`Debug.Print lRet`	

Comment		

12.2.10 LeftShift

Syntax	LeftShift(lValue As Variant, Optional lShifts As Long = 1) As Variant	
Description	Shifts the bits in lValue to the left.	
Parameter	lValue As Variant	Value to be left-shifted
	lShifts As Long	Number of positions to shift. Optional, if lShifts is not specified, the bits are shifted for one position.
Return	lValue shifted	lValue will be changed too

Example	`Dim lValue As Long`
	`lValue = 1`
	`Debug.Print LeftShift(lValue, 3) ‘ gives 8`
	`Debug.Print LeftShift(lValue)    ‘ gives 16`	

Comment	lValue can be an Integer, Long or Single	

12.2.11 RightShift

Syntax	RightShift (lValue As Variant, Optional lShifts As Long = 1) As Variant	
Description	Shifts the bits in lValue to the right.	
Parameter	lValue As Variant	Value to be right-shifted
	lShifts As Long	Number of positions to shift. Optional, if lShifts is not specified, the bits are shifted for one position.
Return	lValue shifted	lValue will be changed too

Example	`Dim lValue As Long`
	`lValue = 16`
	`Debug.Print RightShift(lValue, 3) ‘ gives 2`
	`Debug.Print RightShift(lValue)    ‘ gives 1`	

Comment	lValue can be an Integer, Long or Single	

12.3 Short Introduction to the URD basic language

12.3.1 Variables

Variables temporarily store values during the execution of a URD macro. Variables must have a name and a data type. For variable names the following applies:

- they must begin with a letter
- they must not exceed 255 characters
- they must be unique within the same scope

- they can’t contain a period (.)
- they can’t contain a type declaration character (@, #, %, !, $)

Variables are declared in URD basic with the Dim keyword.

```
Dim varname [As type][, varname 2 [As type]] …
```

The various possible types for variables and the range are given in the following table:

Type	**Range**
Boolean	True or False
Byte	0 to 255
Currency	15 digits before and 4 digits after the period
Date	Date value from 01.01.0100 to 31.12.9999 Time value from 0:00:00 to 23:59:59
Double	$\pm 4.9 \cdot 10^{-324}$ to $1.8 \cdot 10^{+308}$
Integer	-32768 to 32767
Long	-2147483648 to 2147483647
Single	$\pm 1.4 \cdot 10^{-45}$ to $3.4 \cdot 10^{+38}$
String	fixed length: 1 to ~65400 characters variable length: 0 to $\sim 2 \cdot 10^{+9}$ characters
Variant	This is a universal data type, which can store values of all other data types. URD Basic knows about the data type in a variant and treats the value accordingly. Conversions are made automatically.

12.3.1.1 Implicit Declaration

You don't have to declare a variable before using it. For example, you could write a function where you don't need to declare TempVal before using it:

```
Function SafeSqr(num)
   TempVal = Abs(num)
   SafeSqr = Sqr(TempVal)
End Function
```

URD Basic automatically creates a variable with that name, which you can use as if you had explicitly declared it. While this is convenient, it can lead to subtle errors in your code if you misspell a variable name. For example, suppose that this was the function you wrote:

```
Function SafeSqr(num)
   TempVal = Abs(num)
   SafeSqr = Sqr(TemVal)
End Function
```

At first glance, this looks the same. But because the TempVal variable was misspelled on the next-to-last line, this function will always return zero. When URD Basic encounters a new name, it can't determine whether you actually meant to implicitly declare a new variable or you just misspelled an existing variable name, so it creates a new variable with that name.

12.3.1.2 Explicit Declaration

To avoid the problem of misnaming variables, you can stipulate that URD Basic always warn you whenever it encounters a name not declared explicitly as a variable.

12.3.1.3 To explicitly declare variables

Place this statement in the Declarations section of a module:

```
Option Explicit
```

Had this statement been in effect for the form or standard module containing the SafeSqr function, URD Basic would have recognized TempVal and TemVal as undeclared variables and generated errors for both of them. You could then explicitly declare TempVal:

```
Function SafeSqr(num)
   Dim TempVal
   TempVal = Abs(num)
   SafeSqr = Sqr(TemVal)
End Function
```

Now you'd understand the problem immediately because URD Basic would display an error message for the incorrectly spelled TemVal. Because the Option Explicit statement helps you catch these kinds of errors, it's a good idea to use it with all your code.

12.3.2 Arrays

If you have programmed in other languages, you're probably familiar with the concept of arrays. Arrays allow you to refer to a series of variables by the same name and to use a number (an index) to tell them apart. This helps you create smaller and simpler code in many situations, because you can set up loops that deal efficiently with any number of cases by using the index number. Arrays have both upper and lower bounds, and the elements of the array are contiguous within those bounds. Because URD Basic allocates space for each index number, avoid declaring an array larger than necessary.

All the elements in an array have the same data type. Of course, when the data type is Variant, the individual elements may contain different kinds of data (objects, strings, numbers, and so on). You can declare an array of any of the fundamental data types, including user-defined types.

In URD Basic there are two types of arrays: a *fixed-size array* which always remains the same size, and a *dynamic array* whose size can change at run-time. Dynamic arrays are discussed in more detail later in this chapter.

12.3.2.1 Declaring Fixed-Size Arrays

When declaring an array, follow the array name by the upper bound in parentheses. The upper bound cannot exceed the range of a Long data type (-2,147,483,648 to 2,147,483,647). For example, these array declarations can appear in the Declarations section of a module:

```
Dim Counters(14) As Integer         ' 15 elements.
Dim Sums(20) As Double             ' 21 elements.
```

To create a public array, you simply use Public in place of Dim:

```
Public Counters(14) As Integer
Public Sums(20) As Double
```

The same declarations within a procedure use Dim:

```
Dim Counters(14) As Integer
Dim Sums(20) As Double
```

The first declaration creates an array with 15 elements, with index numbers running from 0 to 14. The second creates an array with 21 elements, with index numbers running from 0 to 20. The default lower bound is 0.

To specify a lower bound, provide it explicitly (as a Long data type) using the To keyword:

```
Dim Counters(1 To 15) As Integer
Dim Sums(100 To 120) As String
```

In the preceding declarations, the index numbers of `Counters` range from 1 to 15, and the index numbers of `Sums` range from 100 to 120.

12.3.2.2 Multidimensional Arrays

Sometimes you need to keep track of related information in an array. For example, to keep track of each pixel on your computer screen, you need to refer to its X and Y coordinates. This can be done using a multidimensional array to store the values.

With URD Basic, you can declare arrays of multiple dimensions. For example, the following statement declares a two-dimensional 10-by-10 array within a procedure:

```
Static MatrixA(9, 9) As Double
```

Either or both dimensions can be declared with explicit lower bounds:

```
Static MatrixA(1 To 10, 1 To 10) As Double
```

You can extend this to more than two dimensions. For example:

```
Dim MultiD(3, 1 To 10, 1 To 15)
```

This declaration creates an array that has three dimensions with sizes 4 by 10 by 15. The total number of elements is the product of these three dimensions, or 600.

Note When you start adding dimensions to an array, the total storage needed by the array increases dramatically, so use multidimensional arrays with care. Be especially careful with Variant arrays, because they are larger than other data types.

12.3.2.3 Using Loops to Manipulate Arrays

You can efficiently process a multidimensional array by using nested For loops. For example, these statements initialize every element in MatrixA to a value based on its location in the array:

```
Dim I As Integer, J As Integer
Static MatrixA(1 To 10, 1 To 10) As Double
For I = 1 To 10
   For J = 1 To 10
      MatrixA(I, J) = I * 10 + J
   Next J
Next I
```

For information about loops, see "Loop Structures" later in this chapter.

12.3.3 Subroutines and Functions

12.3.3.1 Subroutines

A Sub procedure is a block of code that is executed in response to an event. By breaking the code in a module into Sub procedures, it becomes much easier to find or modify the code in your application.

The syntax for a Sub procedure is:

```
[Private|Public] Sub procedurename (arguments)
     statements
End Sub
```

Each time the procedure is called, the *statements* between Sub and End Sub are executed. Sub procedures can be placed in modules. Sub procedures are by default Public in all modules, which means they can be called from anywhere in the application. To be able to use a Sub procedure in another file, then the one with the calling function, the reference to the other file must be made by using the '#uses keyword. (See online help for details)

The *arguments* for a procedure are like variable declarations, declaring values that are passed in from the calling procedure.

A procedure tells the application how to perform a specific task. Once a procedure is defined, it must be specifically invoked by the application.

Why create general procedures? One reason is that several different event procedures might need the same actions performed. A good programming strategy is to put common statements in a separate procedure application call it. This eliminates the need to duplicate code and also makes the application easier to maintain.

12.3.3.2 Calling Sub Procedures

A Sub procedure differs from a Function procedure in that a Sub procedure cannot be called by using its name within an expression. A call to a Sub is a stand-alone statement. Also, a Sub does not return a value in its name as does a function. However, like a Function, a Sub can modify the values of any variables passed to it.

There are two ways to call a Sub procedure:

```
' Both of these statements call a Sub named MyProc.
Call MyProc (FirstArgument, SecondArgument)
MyProc FirstArgument, SecondArgument
```

Note that when you use the Call syntax, arguments must be enclosed in parentheses. If you omit the Call keyword, you must also omit the parentheses around the arguments.

12.3.3.3 Functions

URD Basic includes built-in, or intrinsic functions, like Sqr, Cos or Chr. In addition, you can use the Function statement to write your own Function procedures.

The syntax for a Function procedure is:

```
[Private|Public] Function procname (arguments) [As type]
   statements
End Function
```

Like a Sub procedure, a Function procedure is a separate procedure that can take arguments, perform a series of statements, and change the value of its arguments. Unlike a Sub procedure, a Function procedure can return a value to the calling procedure. There are three differences between Sub and Function procedures:

- Generally, you call a function by including the function procedure name and arguments on the right side of a larger statement or expression (*returnvalue = function()*).
- Function procedures have data types, just as variables do. This determines the type of the return value. (In the absence of an As clause, the type is the default Variant type.)
- You return a value by assigning it to the *procname* itself. When the Function procedure returns a value, this value can then become part of a larger expression.

For example, you could write a function that calculates the third side, or hypotenuse, of a right triangle, given the values for the other two sides:

```
Function Hypotenuse (A As Integer, B As Integer) As String
   Hypotenuse = Sqr(A ^ 2 + B ^ 2)
End Function
```

12.3.3.4 Calling Function Procedures

Usually, you call a function procedure you've written yourself the same way you call an intrinsic URD Basic function like Abs; that is, by using its name in an expression:

```
' All of the following statements would call a function
' named ToDec.
Print 10 * ToDec
X = ToDec
If ToDec = 10 Then Debug.Print "Out of Range"
X = AnotherFunction(10 * ToDec)
```

It's also possible to call a function just like you would call a Sub procedure. The following statements both call the same function:

```
Call Year(Now)
Year Now
```

When you call a function this way, URD Basic throws away the return value.

12.3.4 Flow Control

Control structures allow you to control the flow of your program's execution. If left unchecked by control-flow statements, a program's logic will flow through statements from left to right, and top to bottom. While some very simple programs can be written with only this unidirectional flow, and while some flow can be controlled by using operators to regulate precedence of operations, most of the power and utility of any programming language comes from its ability to change statement order with structures and loops.

12.3.4.1 Decision Structures

URD Basic procedures can test conditions and then, depending on the results of that test, perform different operations. The decision structures that URD Basic supports include:

- If...Then
- If...Then...Else
- Select Case

12.3.4.2 If...Then

Use an If...Then structure to execute one or more statements conditionally. You can use either a single-line syntax or a multiple-line *block* syntax:

```
If condition Then statement

If condition Then
   statements
End If
```

The *condition* is usually a comparison, but it can be any expression that evaluates to a numeric value. URD Basic interprets this value as True or False; a zero numeric value is False, and any nonzero numeric value is considered True. If *condition* is True, URD Basic executes all the *statements* following the Then keyword. You can use either single-line or multiple-line syntax to execute just one statement conditionally (these two examples are equivalent):

```
If anyDate < Now Then anyDate = Now

If anyDate < Now Then
   anyDate = Now
End If
```

Notice that the single-line form of If...Then does not use an End If statement. If you want to execute more than one line of code when *condition* is True, you must use the multiple-line block If...Then...End If syntax.

```
If anyDate < Now Then
   anyDate = Now
   Timer1.Enabled = False      ' Disable timer control.
End If
```

12.3.4.3 If...Then...Else

Use an If...Then...Else block to define several blocks of statements, one of which will execute:

```
If condition1 Then
   [statementblock-1]
[ElseIf condition2 Then
   [statementblock-2]] ...
[Else
   [statementblock-n]]
End If
```

URD Basic first tests *condition1*. If it's False, URD Basic proceeds to test *condition2*, and so on, until it finds a True condition. When it finds a True condition, URD Basic executes the corresponding statement block and then executes the code following the End If. As an option, you can include an Else statement block, which URD Basic executes if none of the conditions are True.

If...Then…ElseIf is really just a special case of If...Then...Else. Notice that you can have any number of ElseIf clauses, or none at all. You can include an Else clause regardless of whether you have ElseIf clauses.

For example, your application could perform different actions depending on the parameter Index, which is passed to the subroutine:

```
Private Sub foo (Index As Integer)
   If Index = 0 Then           ' Cut command.
      CopyActiveControl        ' Call general procedures.
      ClearActiveControl
   ElseIf Index = 1 Then      ' Copy command.
      CopyActiveControl
   ElseIf Index = 2 Then      ' Clear command.
      ClearActiveControl
   Else                        ' Paste command.
      PasteActiveControl
   End If
End Sub
```

Notice that you can always add more ElseIf parts to your If...Then structure. However, this syntax can get tedious to write when each ElseIf compares the same expression to a different value. For this situation, you can use a Select Case decision structure.

12.3.4.4 Select Case

URD Basic provides the Select Case structure as an alternative to If...Then...Else for selectively executing one block of statements from among multiple blocks of statements. A Select Case statement provides capability similar to the If...Then...Else statement, but it makes code more readable when there are several choices.

A Select Case structure works with a single test expression that is evaluated once, at the top of the structure. URD Basic then compares the result of this expression with the values for each Case in the structure. If there is a match, it executes the block of statements associated with that Case:

```
Select Case testexpression
   [Case expressionlist1
      [statementblock-1]]
   [Case expressionlist2
      [statementblock-2]]
.
.
.
   [Case Else
      [statementblock-n]]
End Select
```

Each *expressionlist* is a list of one or more values. If there is more than one value in a single list, the values are separated by commas. Each *statementblock* contains zero or more statements. If more than one Case matches the test expression, only the statement block associated with the first matching Case will execute. URD Basic executes statements in the Case Else clause (which is optional) if none of the values in the expression lists matches the test expression.

For example, suppose you added another command to the Edit menu in the If...Then...Else example. You could add another ElseIf clause, or you could write the function with Select Case:

```
Private Sub foo (Index As Integer)
   Select Case Index
      Case 0                  ' Cut command.
         CopyActiveControl      ' Call general procedures.
         ClearActiveControl
      Case 1                  ' Copy command.
         CopyActiveControl
      Case 2                  ' Clear command.
         ClearActiveControl
      Case 3                  ' Paste command.
         PasteActiveControl
      Case Else
         DoSomeThing         ' Do something.
   End Select
End Sub
```

Notice that the Select Case structure evaluates an expression once at the top of the structure. In contrast, the If...Then...Else structure can evaluate a different expression for each ElseIf statement. You can replace an If...Then...Else structure with a Select Case structure only if the If statement and each ElseIf statement evaluates the same expression.

12.3.4.5 Loop Structures

Loop structures allow you to execute one or more lines of code repetitively. The loop structures that Visual Basic supports include:

- Do...Loop
- For...Next

12.3.4.6 Do...Loop

Use a Do loop to execute a block of statements an indefinite number of times. There are several variations of the Do...Loop statement, but each evaluates a numeric condition to determine whether to continue execution. As with If...Then, the *condition* must be a value or expression that evaluates to False (zero) or to True (nonzero).

In the following Do...Loop, the *statements* execute as long as the *condition* is True:

```
Do While condition
   statements
Loop
```

When URD Basic executes this Do loop, it first tests *condition*. If *condition* is False (zero), it skips past all the statements. If it's True (nonzero), URD Basic executes the statements and then goes back to the Do While statement and tests the condition again.

Consequently, the loop can execute any number of times, as long as *condition* is nonzero or True. The statements never execute if *condition* is initially False. For example, this procedure counts the occurrences of a target string within another string by looping as long as the target string is found:

```
Function CountStrings (longstring, target)
   Dim position, count
   position = 1
   Do While InStr(position, longstring, target)
      position = InStr(position, longstring, target) + 1
      count = count + 1
   Loop
   CountStrings = count
End Function
```

If the target string doesn't occur in the other string, then InStr returns 0, and the loop doesn't execute.

Another variation of the Do...Loop statement executes the statements first and then tests *condition* after each execution. This variation guarantees at least one execution of *statements*:

```
Do
   statements
Loop While condition
```

Two other variations are analogous to the previous two, except that they loop as long as *condition* is False rather than True.

Loop zero or more times	**Loop at least once**

`Do Until condition`	`Do`
`statements`	`statements`
`Loop`	`Loop Until condition`

12.3.4.7 For...Next

Do loops work well when you don't know how many times you need to execute the statements in the loop. When you know you must execute the statements a specific number of times, however, a For…Next loop is a better choice. Unlike a Do loop, a For loop uses a variable called a counter that increases or decreases in value during each repetition of the loop. The syntax is:

```
For counter = start To end [Step increment]
   statements
Next [counter]
```

The arguments *counter*, *start*, *end*, and *increment* are all numeric.

Note The *increment* argument can be either positive or negative. If *increment* is positive, *start* must be less than or equal to *end* or the statements in the loop will not execute. If *increment* is negative, *start* must be greater than or equal to *end* for the body of the loop to execute. If Step isn't set, then *increment* defaults to 1.

In executing the For loop, URD Basic:

1. Sets *counter* equal to *start*.
2. Tests to see if *counter* is greater than *end*. If so, URD Basic exits the loop.
3. (If *increment* is negative, URD Basic tests to see if *counter* is less than *end*.)
4. Executes the *statements*.
5. Increments *counter* by 1 or by *increment*, if it's specified.
6. Repeats steps 2 through 4.

This code prints the numbers 0 to 10 on the Immediate window:

```
Private Sub foo()
   Dim I As Integer
   For i = 0 To 10
      DebugPrint i
   Next
End Sub
```

12.3.5 Accessing registers

All registers defined in the actual '.urd' file can be found as predefined constants in one of the sheets (Right after opening a '.urd' file it's the last sheet, but by adding new macros, the new macros will be appended at the end of the sheets). The sheet has the name '*register.urm', this is an automatically generated list of constants. The names of the constants are the same, as the register names in the '.urd' file. The values for these constants can change every time you open the '.urd' file. So please use the constants names in your code, and not the numbers.

You should never edit or close this macro.

To access the constants from the macros you want to write you need the line:

```
'#uses "*register.urm"
```

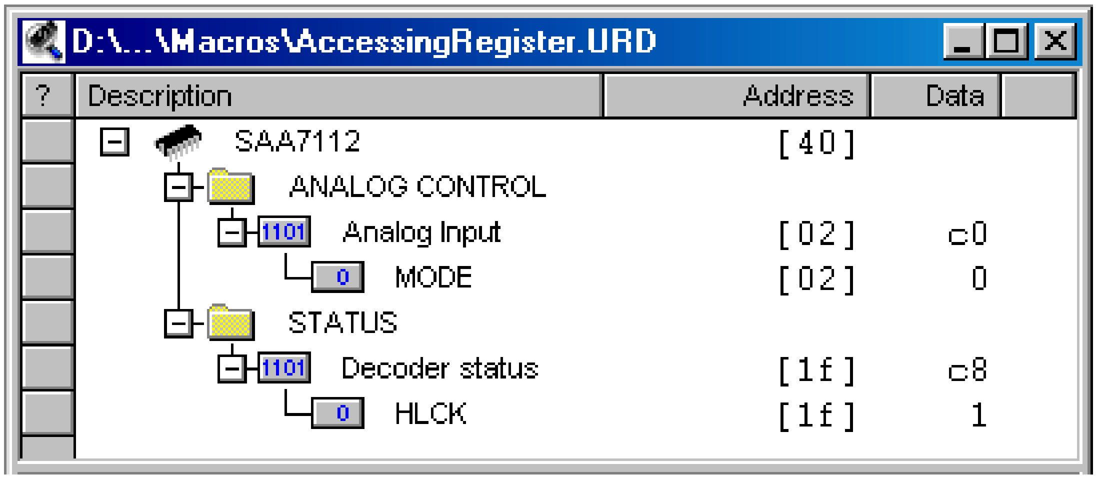
An example:

If you have the following URD file (taken from the SAA7112), which defines two byte items with underlying bit items:

#BeginRegisterList "i2curd46.dll"

```
  0: SAA7112 A2 D1                                    [0x40] << 1.1;
//==============================================================================
  2: "ANALOG CONTROL";
//==============================================================================

//------------------------------------------------------------------------------
  3:     Analog_Input                                 [0x02] & 0xff = 0xc5;
//------------------------------------------------------------------------------
             MODE                                     [0x02] & 0x0f SL;

//==============================================================================
  2: "STATUS";
//==============================================================================

//------------------------------------------------------------------------------
  3:     Decoder_status                               [0x1f] & 0xff = 0x00 R;
//------------------------------------------------------------------------------
             HLCK                                     [0x1f] & 0x40;

#EndRegisterList
```

The URD tree will look like this:



D:\...\Macros\AccessingRegister.URD

?	Description	Address	Data
	SAA7112	[40]	
	ANALOG CONTROL		
	Analog Input	[02]	c0
	MODE	[02]	0
	STATUS		
	Decoder status	[1f]	c8
	HLCK	[1f]	1

And '*register.urm' will be:

```
'DO NOT EDIT THIS CODE!
'Device : SAA7112

'Byte Items
Public Const Analog_Input As Integer = 0
Public Const Decoder_status As Integer = 2
'Bit Items
Public Const MODE As Integer = 1
Public Const HLCK As Integer = 3
```

To access the bit item MODE, you can use:

```
Dim lValue As Long
lValue = ReadReg(MODE)
WriteReg(MODE, &h3)
```

As the bit item HLCK is defined as readonly, you can’t write to it (but WriteReg will give you no error, if you still try to do so, but the value will not change). The values passed to WriteReg can be decimal (without a prefix) or in hexadecimal (use &h before the value). Reading this bit item can be done by:

```
Dim lValue As Long
lValue = ReadReg(MODE)
```

Do display the returned value (which is decimal) in hexadecimal use the URD basic function Hex or Hex$.

You can also access the byte item directly, so the commands:

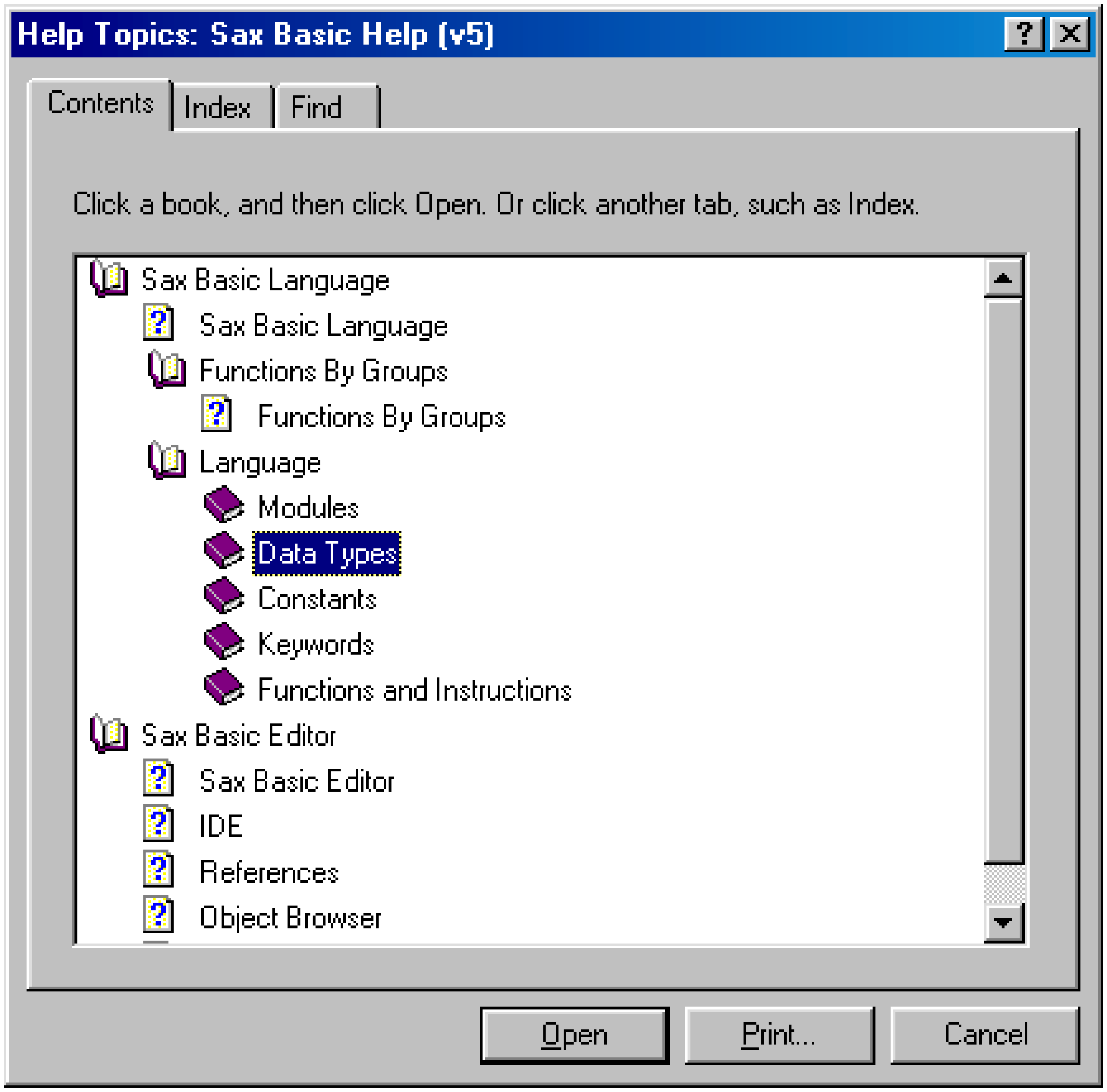
```
WriteReg(Analog_Input, &hC6)
```

will write the hexadecimal value $C6_{hex}$ to the register Analog_Input

12.4 Using Online help

The URD basic engine comes with context sensitive online help. If you place the current selection in a keyword and press F1, the online help will open and display the syntax and example for the keyword. If the keyword can not be found in the help, a index of all commands will be displayed. The URD basic editor must be selected prior to pressing F1 to open online help (So if the tree view is currently selected, when you press F1, nothing will happen).

You can also choose to view the hierarchical content of the help file by selecting the ‘Content’ tab in online help:



The online help describes all commands, keyword and functions, etc. of the language and the usage of the URD basic editor.

13 Driver Development

If access to the target hardware should be carried out via a communication channel for which no driver is available, a new driver could be developed. This results in a DLL, which can be used within an actually installed URD application. Information about the driver API and the usage of the newly developed driver are given in the following chapters.

General knowledge about development of a DLL using the MS IDE is assumed to be available here.

A sample DLL for a WIN32 environment is provided in the sample file collection. It consists of the two source code files add32urd.c and add32urd.h and the DLL file add32urd.dll. This DLL is to be used with the ADD32 device description file, which is as well part of the sample file collection.

13.1 API requirements description

The URD driver API consists of 6 functions:

- LibMain	Get access to an instance of the driver (WIN16 only)
- UrdOpen	Open and initialise the target device
- UrdClose	Close the target device and free used memory
- UrdSetReg	Set the contents of a register at a given address
- UrdGetReg	Get the contents of a register at a given address
- UrdGetStatus	Get status of Open, Close, GetReg and SetReg access to the driver

In general the URD will call UrdOpen after loading a device description file and UrdClose when closing the URD. Between these two function calls register accesses will be carried out using UrdSetReg and UrdGetReg. A register access is initiated by changes in the device description file. In case of an error, the status of the URD driver will be obtained automatically using UrdGetStatus.

In case of a driver development for a WIN16 environment, the function LibMain gets access to an instance of the device driver.

A programmers reference description of the URD API functions is given in the appendix in chapter 15.2.

13.2 Driver architecture

Two main architectures for an URD device driver can be realised: A complete new driver or an interface between the URD and an existing driver. For writing a new driver it is recommended to investigate whether a separation between a Windows kernel mode driver and an URD interface to this driver is feasible. If yes, the kernel mode driver can be reused for other applications in the Windows environment as well.

13.3 Using a new driver

To use a newly developed driver in an actually installed URD application the following steps has to be carried out:

- A newly developed driver has to be named '<driver name>.DLL'.
- The driver file has to be placed in the same directory as the 'URD16.EXE' or 'URD32.EXE' file.
- The driver has to be addressed in the first line of an URD device description file as follows: #BeginRegisterList '<driver name>.DLL'. Comment lines and empty lines are excluded from line counting here.

13.4 Driver modes

Concerning drivers, the URD application can run in two modes: in driver mode and in simulation mode.

In driver mode the driver named in the line #BeginRegisterList line of the device description file will be used to access the target hardware. The driver mode is the default mode while loading a new device description file.

In simulation mode the register accesses to the target hardware will not be executed and hence reactions of the target hardware to register accesses by the URD application cannot be expected.

On way to enter simulation mode is during loading of a new device description file. When either an unavailable driver (in the directory of the URD application file) or no driver is specified in the device description file, the application queries to switch to simulation mode. In case of a positive user response the URD application switches to simulation mode. In case of a negative response the application will be aborted.

A second way to enter simulation mode is to use the simulation entry in the Options menu (Figure 9). This menu entry allows toggling between simulation mode and driver mode, when the current device description file was loaded with a valid driver. Switching from simulation mode to driver mode, when no valid driver was loaded, leads to an error message in the output window.

To reset a loaded driver into the state, which it enters after loading, the Reset entry of the Driver menu can be used.

14 Error Codes and Trouble Shooting

While loading an URD device description file the following actions will be carried out:

- The driver description of the device description file will be used to check the driver to be loaded.
- The device description of the device description file will parsed line by line to check it syntactically.
- Next the semantics of the syntactically checked line will be checked against already checked contents of the device description file.
- Macro description will be linked into register descriptions to extend them with pre and post macro conditions.

Further hardware accesses will be monitored to check the correct function of the used driver.

All these activities may result in an error, which is represented by an error code. This section describes all error codes together with an explanation of possible error causes and hints for solving the problems detected. The error codes are grouped into parser error messages, builder error messages and driver error messages.

14.1 Parser error messages

Error P00: Unexpected end of file
This can be either a missing **last** "#EndRegisterList" or "#EndMacro" or "#EndBasic" statement, which of them ever is intended to be the last one. If one of the mentioned statements are missing before a starting "#BeginRegisterList", "#BeginMacro", "#BeginBasic", a P02 error will be generated.

Error P01: Open comment
At least one closing "*/" comment statement is possibly missing at the end of the device description file to complete an existing opening "/*" comment statement.

Error P02: Wrong syntax %l, expected %l
This is a general parsing error, stating which syntax element was found to be wrong and explaining which syntax element was expected. All error causes, which are not covered by other parser error codes, results in this error code.

Error P03: Hex constants must have at least one hex digit
If "0x" is used as a number format specifier, at least one hexadecimal digit (0..9, a..f) must follow to make it a number in binary format. If non hexadecimal digits follow, P02 will be generated.

Furthermore (sub) addresses of bytes and bits are required in hexadecimal format, e.g. Operand1 [0x00]. To identify the given address as hexadecimal "0x" must be used as prefix. This error code is generated, when only "0x" is used as sub address specifier and no address itself is provided.

Error P04: Dual constants must have at least one dual digit
If "0b" is used as a number format specifier, at least one dual digit (0,1) must follow to make it a number in dual format. If non dual digits follow, P02 will be generated.

Error P05: Newline in constant
Sets and descriptions in a device description file are included in quotation marks. This error occurs, when the closing quotation marks are not in the same line as the opening quotation marks.

Error P06: Number of characters exceeds line size
Maximum number of characters in a line is 200.

Error P07: Unknown token
The parser detected a language element in the device description file which is unknown. It must be replaced by a known language element according to the syntax as described in the language reference [URD_LR]. Known language elements used at wrong places lead to a P02 error code.

14.2 Builder error messages

Error B01: Address is not completely defined
The address width of a device is given in number of bytes by an address width specifier (e.g. A4). The contents of the bytes is detailed in a sub address specifier (e.g. [0x0000]). If a definition for one of the bytes of an address is missing this error code is reported. Possible solutions are an extension of the given address (e.g. from [0x0000] to [0x00000000]) or the usage of an appropriate address shift specifier and address length specifier (e.g. [0x0000] << 0.4).

Error B02: Address shift constant out of range
Maximum address width is defined as 8 bytes. Hence the range of possible address shift specifier values is 0 to 7 for a given sub address specifier. Any

other numerical integer value used as address shift specifier will cause this error code to be reported.

Error B03: Address length constant out of range
Maximum address width is defined as 8 bytes. Hence the range of possible address length specifier values is 1 to 8 for a given sub address specifier. Any other numerical integer value used as address length constant will cause this error code to be reported.

Error B04: Hierarchy label constant out of range
Hierarchy labels as part of a register declaration of a device can range from 1 to 9. Other hierarchy label values will cause this error code to be reported.

Error B05: No matching hierarchy label is found
The hierarchy label of an element in a device description file is checked against the label of the previous element. In this case the label of the previous element is missing, because it is optional and was not used here.

Error B06: Hierarchy label is already defined
The hierarchy label of an element in a device description file is checked against the label of the previous element. In this case a label is used, which is not increased as it should be due to the structure of the language.

Error B07: Address greater than defined address size
The sub address specifier is greater than the address width specifier of an address size specifier (e.g. byte address [0x00 00] is greater than "1" of the address size specifier A1).

Error B08: Sum of length, shift exceeds address size
The sum of an address length specifier and an address shift specifier of an address specifier exceeds the address width specifier of an address size specifier (e.g. [0x00] << 2.2 is greater than A3).

Error B09: Sum of length, shift overwrites previous address
A combination of address shift specifier and address length specifier of an address specifier overwrites a given address, e.g. from a device declaration (e.g. byte [0x01] << 2.1 overwrites A3 [0x00] << 2.1).

Error B10: Variable bit size out of range
The variable bit size exceeds the address size specifier of a device declaration (e.g. byte [0x00] << 0.4 exceeds A3).

Error B11: Address specifier greater than address length.
The sub address specifier is greater than the address length specifier of an address specifier (e.g. "[0x00 00]" of "[0x00 00] << 0.1" is greater than "0.1").

Error B12: Mask error
A mask specifier of one item (e.g. a bit direct specifier) specifies a bit at a position which is not specified in the mask specifier of a corresponding other item, e.g. a byte specifier (e.g. bit [0x00] & 0x11 and byte [0x00] & 0x18).

Error B13: Bit address error
The address specifier of a bit specifier specifies a different address than the address specifier of the corresponding byte specifier (e.g. bit [0x04] of byte [0x00]).

Error B14: Byte has different access type
Descriptions of bytes accessing the same address are overlaping in their access type (e.g. byte1 [0x00] B and byte2 [0x00] R).

Error B15: Different default values defined for same register
Different default values are given for a register due to errors in the masking of that register.

Error B16: %l: redefinition
The same register name is used more than once for different addresses.

Error B17: %l: redefinition; different types
The same name is used more than once for different types.

Error B18: Same address with different memory models
Data size specifier with different data distance specifiers are used at the same address.

Error B19: String too large
The maximum size of 30 characters for an identifier or 80 characters for a string-literal are exceeded.

Error B20: Concatenated data size error
The number of data bits specified in a joined register is greater than the maximum number of 32 (4 bytes).

Error B21: %l not defined in register part
A register was used, which was not defined before.

Error B22: memory model greater than defined data size
Data distance specifier of the data size specifier bigger than the maximum value of 8.

Error B23: data size constant out of range
The data length specifier of a data size specifier is greater than the maximum value of 4 (e.g. D6).

Error B24: memory size constant out of range
The data distance of a data size specifier is greater than the allowed maximum value of 4.

Error B25: address size constant out of range
Address width specifier of the address size specifier is out of range. Maximum value is eight.

Error B27: %l: unresolved macro
A macro name was used, which is not provided in the macro section.

Error B28: more than four bytes in the byte order
The number of bytes in the byteorder is greater than the maximum of datasize

Error B29: non allowed byte sequence
Bytes can be defined only once in the byteorder and they must be allowed (e.g. byte 4 isn’t accessible in a D3)

Error B30: datasize differs from number of bytes in byte order
The number of bytes in the byteorder has to be the same as the datasize

14.3 Driver error messages

Error D00:	Not valid driver. Do you want to switch in the simulation mode? The URD driver DLL as specified in the line #BeginRegisterList "<driver name>.dll" of the device description file is not found in the specified directory. The default directory is the directory, where the file 'URDxx.EXE' is located (see as well chapter 13.3).
Error D01:	cannot load the driver %l The URD driver file is not complete.
Error D02:	cannot find function %l The URD driver API functions are (partly) not available in the driver file.
Error D03:	cannot open the driver The OPEN function returns a FALSE value. This is most probably due to a hardware error.
Error D04:	cannot close the driver The CLOSE function returns a FALSE value. This is most probably due to a hardware error.
Error D05:	cannot write to address The WRITE function returns a FALSE value. This is most probably due to a hardware error.
Error D06:	cannot read from address The READ function returns a FALSE value. This is most probably due to a hardware error.
Error D07:	no valid data to write to address The WRITE function tries to write a value of "X…X" to the register. This is the current value of the register in the register tree.
Error D08:	cannot execute the command, driver is not loaded When starting the URD in simulation mode, the link to the driver file as described in the line #BeginRegisterList "<driver name>.dll" of the device description file will not be registered. Switching later back to use a driver instead of simulation mode without restarting the URD causes this error.

15 Appendix

15.1 Table of features of the URD per OS

The following table summarises the features of the URD depending on the OS used:

Feature	WIN31 16bit	WIN95/98 16bit	WIN95/98 32bit	WINNT4 32bit
Read/write single register	x	x	x	x
Read/write all registers	x	x	x	x
Access memory areas	x	x	x	x
Store actual register settings	x	x	x	x

Support development of new driver	x	x	x	x
Use slider to change register values			x	x
Use simple macros	x	x	x	x
Use basic macros			x	x

15.2 Programmers reference of the URD hardware driver API

The URD API consists of the following functions:

- LibMain	Get access to an instance of the driver (WIN16 only)
- UrdOpen	Open and initialise the target device
- UrdClose	Close the target device and free used memory
- UrdSetReg	Set the contents of a register at a given address
- UrdGetReg	Get the contents of a register at a given address
- UrdGetStatus	Get status of Open, Close, GetReg and SetReg access to the driver

In detail they are to be used as follows:

15.2.1 LibMain

Syntax

int CALLBACK LibMain (HINSTANCE *hModule***, WORD** *wDataSeg***, WORD** *wHeapSize***, LPSTR** *lpCmdLine* **)**

The main library function that is called when the library is first opened.

Return Value

The result of the operation of this function.

1	The operation was successful. No error occurred.
0	The operation was not successful. An error occurred.

Parameters

hModule
Handle of library instance.

wDataSeg
Library data segment.

wHeapSize
Default heap size.

lpCmdLine
Command-line arguments.

15.2.2 UrdOpen

Syntax

BOOL URDAPI_EXPORT UrdOpen (void)

For the first initialisation of the URD API this function is called. During this function all necessary initialisation has to be done.

Return Value

The result of the operation of this function.

TRUE	The operation was successful. No error occurred.
FALSE	The operation was not successful. An error occurred. Please use the **UrdGetStatus** function for more details of the error.

15.2.3 UrdClose

Syntax

BOOL URDAPI_EXPORT UrdClose (void)

After all data transfers has been done this function will be called to close the data transfer path and release all allocated resources.

Return Value

The result of the operation of this function.

TRUE	The operation was successful. No error occurred.
FALSE	The operation was not successful. An error occurred. Please use the **UrdGetStatus** function for more details of the error.

15.2.4 UrdSetReg

Syntax

BOOL URDAPI_EXPORT UrdSetReg (int *nAdrBytes***, int** *nDataBytes***, const LPBYTE** *pucAdr***, DWORD** *dwData* **)**

To send several data bytes to a specific location (address) this function will be called. Here occurs the data transfer.

Return Value

The result of the operation of this function.

TRUE	The operation was successful. No error occurred.
FALSE	The operation was not successful. An error occurred. Please use the **UrdGetStatus** function for more details of the error.

Parameters

nAdrBytes
Number of bytes in the device address.

nDataBytes
Number of bytes in the data (max. 4).

pucAdr
This pointer points to an array which holds the # of address bytes.

dwData
The data bytes are located in this parameter. The most significant byte contains the first data byte.

Comments

There are at most 4 data bytes (DWORD).

15.2.5 UrdGetReg

Syntax

BOOL URDAPI_EXPORT UrdGetReg(int *nAdrBytes***, int** *nDataBytes***, const LPBYTE** *pucAdr***, LPDWORD** *pdwData* **)**

To receive several data bytes from a specific location (address) this function will be called. Here occurs the data transfer.

Return Value

The result of the operation of this function.

TRUE	The operation was successful. No error occurred.
FALSE	The operation was not successful. An error occurred. Please use the **UrdGetStatus** function for more details of the error.

Parameters

nAdrBytes
Number of bytes in the device address.

nDataBytes
Number of bytes in the data (max. 4).

pucAdr
This pointer points to an array which holds the # of address bytes.

pdwData
The data bytes will be retrieved in this parameter. The most significant byte contains the first data by.

Comments

There are at most 4 data bytes (DWORD).

15.2.6 UrdGetStatus

Syntax

void URDAPI_EXPORT UrdGetStatus (LPSTR *pMessage* **)**

This function has to report the current error status. If no error has occurred after the last call of this function the return string has to be "No Error".

Parameters

pMessage
Pointer to a character array that will receive the error message. The buffer has to be at least 50 characters large.

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Not described:

- the project menu
- windows basics like file exit, window tile, …
- all details for a windows beginner