LAPIS SEMICONDUCTOR

Dr.U8ICE

User's manual

Program Development support system for nx-U8/100 Core LSI

This manual contains important information pertaining to the safe use of the above product. Before using the product, read these safety notes thoroughly and then keep this manual handy for immediate reference.

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Table of Contents

Preface

1. Product Inquiries

Thank you for purchasing the Dr.U8ICE. Please direct any comments or questions that you may have about this product to your nearest LAPIS Semiconductor representative.

2. Using this Product Safely and Properly

This User's Guide uses various labels and icons that serve as your guides to operating this product safely and properly so as to prevent death, personal injury, and property damage. The following table lists these labels and their definitions.

Labels

Warning	1. This label indicates precautions that, if ignored or otherwise not completely followed, could lead to death or serious personal injury.
Caution	1. This label indicates precautions that, if ignored or otherwise not completely followed, could lead to personal injury or property damage.

Icons

A triangular icon draws your attention to the presence of a hazard. The illustration inside the triangular frame indicates the nature of the hazard—in this example, an electrical shock hazard.

A circular icon with a solid background illustrates an action to be performed. The illustration inside this circle indicates this action—in this example, unplugging the power cord.

A circular icon with a crossbar indicates a prohibition. The illustration inside this circle indicates the prohibited action—in this example, disassembly.

2.1 Important Safety Notes

Please read this page before using the product.

⚠ Warning	
Use only the specified voltage. Using the wrong voltage risks fire and electrical shock.	
At the first signs of smoke, an unusual smell, or other problems, unplug the emulator and disconnect all external power cords. Continued use risks fire and electrical shock.	
Do not use the product in an environment exposing it to moisture or high humidity. Such exposure risks fire and electrical shock.	
Do not pile objects on top of the product. Such pressure risks fire and electrical shock.	
At the first signs of breakdown, immediately stop using the product, unplug the emulator, and disconnect all external power cords. Continued use risks fire and electrical shock.	

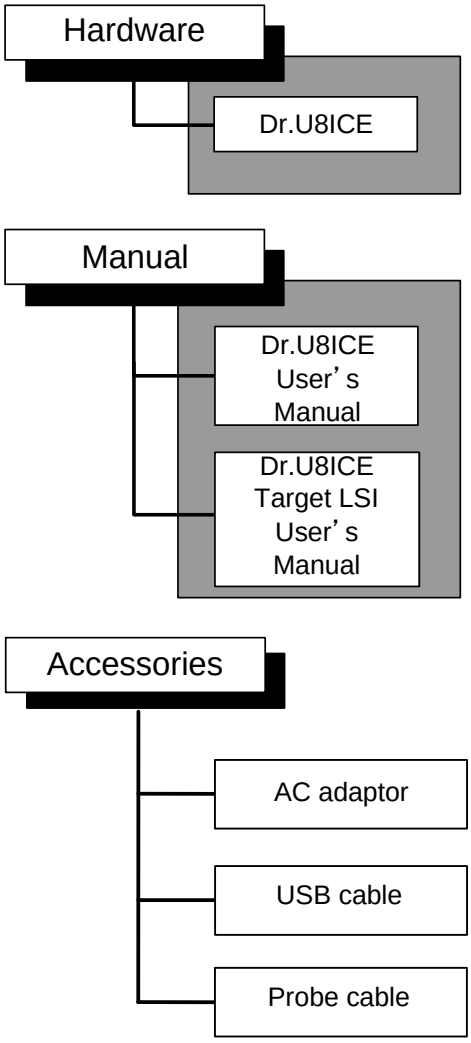
⚠ Caution	
Do not use this product on an unstable or inclined base as it can fall or overturn, producing injury.	
Do not use this product in an environment exposing it to excessive vibration, strong magnetic fields, or corrosive gases. Such factors can loosen or even disconnect cable connectors, producing a breakdown.	
Do not use this product in an environment exposing it to temperatures outside the specified range, direct sunlight, or excessive dust. Such factors risk fire and breakdown.	
Use only the cables and other accessories provided. Using non-compatible parts risks fire and breakdown.	
Do not use the cables and other accessories provided with other systems. Such improper usage risks fire.	

Please read this page before using the product.

⚠ Caution	
Do not exceed the rated input voltage for the user cable VDD pin. Doing so risks fire and breakdown.	
Always observe the specified order for turning equipment on and off. Using the incorrect order risks fire and breakdown.	
Always cut the power to the emulator before altering connections. Connection or disconnection with the power on risks fire and breakdown.	
Always cut the power to the emulator and the user application system before altering connections between the two. Connection or disconnection with the power on risks fire and breakdown.	

3. Package components

The package contains the components listed below.



This is a main componet of Dr.U8ICE.

Manual that describes the Dr.U8ICE common unit.
（This manual）

Manual which has indicated a different portion (the structure and notes of a user cable) for every model of micro controller supported by Dr.U8ICE.

Power supply of Dr.U8ICE.

Cable used to connect the Dr.U8ICE to a host computer.

Cable used to connect the probe connector of Dr.U8ICE.

Fig1-1 Package components of Dr.U8ICE

Chapter1 Overview

1. Overview

1.1 Overview of Dr.U8ICE

Dr.U8ICE is the in circuit emulator prepared in order to develop the program of LSI which used nx-U8/100 Core made from a Lapis semiconductor.
The example of program development composition which uses Dr.U8ICE is shown in Fig. 1-1.
Dr.U8ICE connects with the host computer which installed integration development environment IDEU8, realizes highly efficient debugging of the real-time monitor of a data RAM and a LCD terminal state, real-time trace, etc., and supports program development of a designer powerfully.

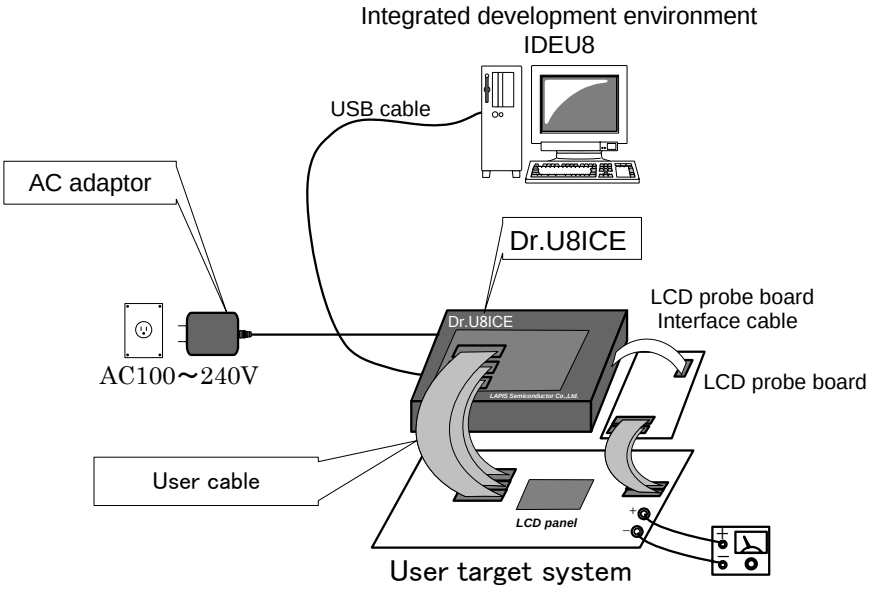


Fig1-1 The example of program development composition which uses Dr.U8ICE

■Note-1■

Depending on the model of Dr.U8ICE, the electrical property of the port inside Dr.U8ICE may differ from LSI.

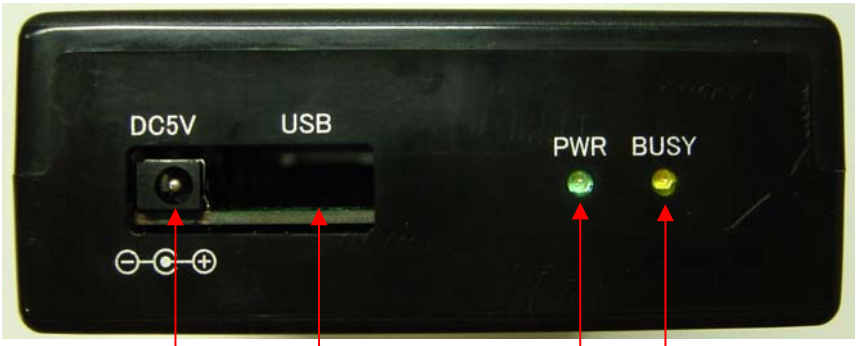
1.2 Appearance of Dr.U8ICE

Top view

(2) Extended connector

(1) User connector board connector

Left side view



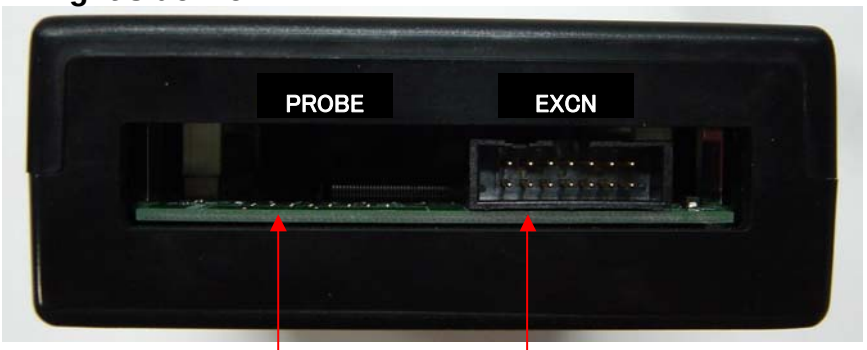
(4) USB connector

(6) Execution LED

(3) DC power connector

(5) POWER LED

Right side view



(8) External apparatus connection connector

(7) External probe connector

Fig1-2 Appearance of Dr.U8ICE

[Explanation of each part]

(1) User connector board connector ［UF_CN1, UF_CN2］
A user connector board is connected.
Direct attachment of the user cable for connecting with a user target system is carried out at the user connector board.

(2) Extended connector ［IF_CN1, IF_CN2］
IO module extension board is connected if needed.
The required signal is connected to this connector between IO module and the Core module.

(3) DC power connector［DC5V］
An attached AC/DC adaptor is connected.

(4) USB connector［USB］
An attached USB cable is connected.

(5) POWER LED［PWR］
The LED is switched on in green if the power supply is supplied to Dr.U8ICE.

(6) Execution LED［BUSY］
The LED is switched on in yellow during the following periods.
- A period after turning on the power supply of Dr.U8ICE until a debugger starts
- During a real-time emulation period
- The correspondence model conversion period of Dr.U8ICE

(7) External probe connector［PROBE］
An attached probe cable is connected.

(8) External apparatus connection connector［EXCN］
LCD probe board is connected.

Chapter2 Functions

1. Functional Specification

1.1 Dr.U8ICE Specification

Table1-1 Dr.U8ICE specification (1/2)

Function	specification	note
Operating voltage	_	The voltage range of operation is 1.65V to 5.5V.
HOST interface	USB connector	For HOST PC connection USB2.0, Mini-B
External interface	External probe connector	2ch for an external break input 6ch for an external trace input
	External apparatus Connection connector	For LCD probe board connection
User interface	User connector board connector	for user cable board mounting
	LED	One for a POWER display One for an execution display
Extended interface	Extended connector	For IO module extension Peripheral bus signal connection
Memory	Program memory	256Kword ([32Kx16bit] x8) segment 0 to segment 7
	Data memory	512KByte ([64Kx8bit] x8) segment 0 to segment 7
Emulation function	Real-time emulation	
	Step emulation	step-in / step-out / step-over
Break function	PC match break	1ch
	Break point break	Unrestricted
	RAM match break	2ch
	Power down break	At the time of HALT/STOP instruction execution.
	External break	2ch
	ROM N area access break	
	RAM N area access break	
	Force break	

Table1-1 Dr.U8ICE specification (2/2)

Function	specification	note
Tracing function	The number of traces	A maximum of 262143 times
	Trace information	Execution address, RAM address, RAM data, PSW, External probe data
	Trace trigger	freerun, RAM data match, PC match (Stop by trace full is possible.)
Read & Write function	Memories	Program / Data
	SFR	
	Register	
The function which can be performed in an emulation	Real-time RAM monitor	The contents of all the data RAM area in 1 segment are displayed (A maximum of 16 K bytes).
	A real-time watch	Eight arbitrary (32bit x 8) places can be specified out of a symbol with the DATA attribute of a data RAM address / SFR / assembly language source level.
	Real-time LCD monitor	By acquiring the information on a LCD terminal, the state of LCD is displayed in realtime.
	Execution time measurement	The execution time from an emulation start to end is displayed in real time.
Execution time measurement function	Measurement unit	100us
	Maximum measurement time	119 hours
	Measurement conditions	It clears zero times for every emulation start.
Execution cycles measurement function	Counter	32-bit counter
	Count clock	CPU clock
	Count conditions	Free-run count
Probe cable function	Break signal input	2ch(EXT.BRK 0-1)
	Trace input	6ch(PROBE 0-5)

1.2 Dr.U8ICE Operating Condition

Operating condition	[Input voltage]	:	DC5V / 2A Be sure to use an attached AC/DC adaptor.
	[Temperature]	:	5 To 40 Degree C
	[Humidity]	:	30 to 80% (don't dew)

2. Functions

2.1 Emulation functions

Two , a real-time emulation and a step emulation, are prepared for the emulation function of Dr.U8ICE.

2.1.1 Real-time Emulation Function

A real-time emulation is the mode which executes a command continuously.

Refer to the 2.2nd clause for the details of the break which interrupts execution of the program in real-time emulation mode.

2.1.2 Step Emulation Function

The three following modes are prepared for the step emulation function.

(1) Step-in emulation function

The program code which a program counter points out is executed by one instruction.

(2) Step-out emulation function

After executing the instruction in the last position of the current program counter, it returns to the call instruction of the function.

(3) Step over emulation function

From a brunch and link instruction to a return instruction is executed at the time of a brunch and link instruction.

■ **Note-1** ■

If the command which shifts to HALT/STOP mode is executed by step-in and step-out emulation, each mode will be canceled compulsorily after shifting to each mode.

When the command which shifts to HALT/STOP mode is executed by a step over emulation, compulsive release in each mode is not performed.

■ **Note-2** ■

Please keep in mind that operation of CPU, such as HTBC and a serial port, and an asynchronous microcomputer function differs from a real-time emulation since a step emulation stops execution for every instruction.

2.2 Break Function

Break function is a function which interrupts execution of a real-time emulation.

There are the following in break conditions.

- PC match break
- Break point break
- RAM match break
- Power down break
- External break
- ROM N area access break
- RAM N area access break
- Forcible break

2.2.1 PC Match Break

If the specified address (PC) is performed by the specified number of times, a break will occur.

Just before executing the instruction of the specified address, a break occurs.

The number of times of the path count which can be specified is to 1 to 65536 times, and the address (PC) which can be specified is one address.

When the address specified as PC which starts program execution is the same, in the execution which is the 1st time, without a break occurring, it is 2nd just before execution and a break occurs.

■ **Note-1** ■

A break is not generated even if it sets it as the address accessed by data transfer command, and the 2nd (odd number address is included) word of a 2-word command and the address of a table domain (a vector table, a data table).

2.2.2 Break Point Break

If the specified address is fetched, a break occurs.

The number of the address which can be specified does not have restriction.

Just before executing the instruction of the specified address, a break occurs.

When the address specified as PC which starts program execution is the same, in the execution which is the 1st time, without a break occurring, it is 2nd just before execution and a break occurs.

■Note-1■

Please be sure to set a break point as the head address of an executive instruction.

It does not take a break, even if it sets it as the address accessed by data transfer command, and the 2nd (odd number address is included) word of a 2-word command and the address of a table domain (a vector table, a data table).

2.2.3 RAM Match Break

If the data specified to the specified RAM address is written in or it reads, a break will occur.

Detailed conditions are described below.

A maximum of two RAM addresses can be specified.

A RAM address and data can set up the following conditions, respectively.

- The mask of a RAM address
- The access method (Read, Write, Rewd & Write)
- Read / Write data
- The mask of a Read / Write data
- Access unit (Byte, Word)
- Formation conditions (Equal, Not Equal)
- Path count value (1-65536)
- Combination of two RAM address condition (AND, OR)

■Note-1■

When an access unit is Word, path count specification cannot be performed.

2.2.4 Power down Break

If HALT mode or STOP mode is canceled by generating of an interrupt request after target LSI shifts to HALT mode or STOP mode, a break will occur.

2.2.5 External Break

If a signal is inputted into two external break input terminals (EXT.BRK0 and EXT.BRK1) of a probe cable, a break will occur.

The signal inputted into an external break terminal can choose either a rising edge/falling edge.

The voltage level tolerance level of an incoming signal is 0V-5.5V.

The level beyond 1.65V of incoming signal voltage is judged to be H level.

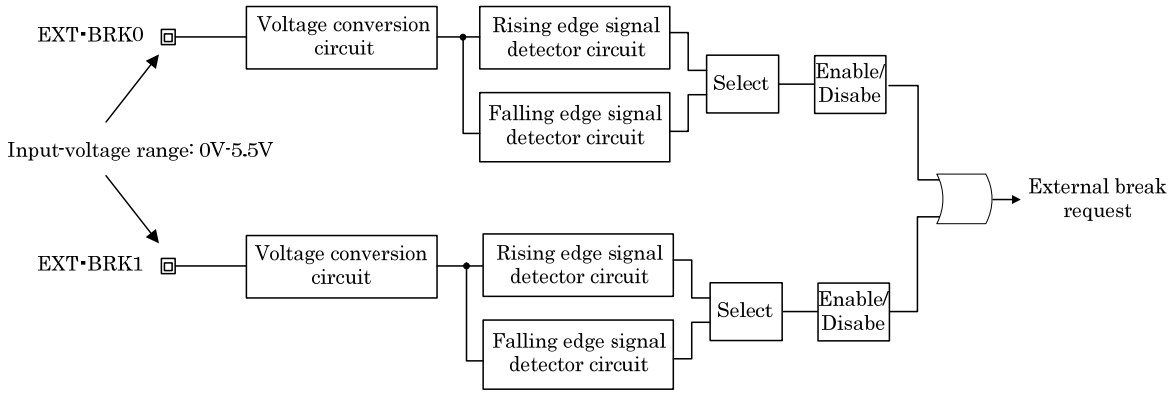


Fig2-1 External break circuit composition

2.2.6 ROM N area Access Break

Fetch of the address of the area where the program memory of target LSI does not exist will generate a break.

2.2.7 RAM N area Access Break

If reading-or-writing operation of data is performed to the area where the Data memory of target LSI does not exist, a break will occur.

2.3 Trace function

States, such as an execution address and PSW, are stored in the trace memory prepared for trace in an emulation.

Dr.U8ICE has trace memory for 262143 steps. If the data stored exceeds 262143 steps, data in trace memory is overwritten from the oldest data.

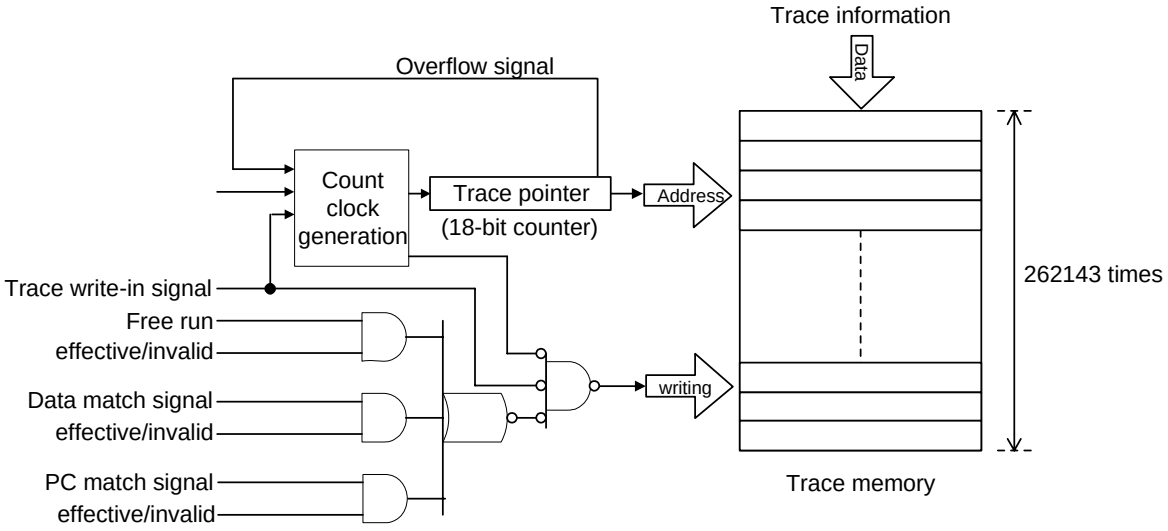


Figure 2-2 Composition of a trace control circuit

The following information is stored in a trace memory.

- PC

  It is a value of the program counter containing CSR, and is a head address of an executive instruction.

- PSW

  It is a value of PSW.

- RAM Address

  It is a value of the data RAM address containing DSR when the read/write instruction to a data RAM is performed

- RAM Data

  It is value of the data RAM containing DSR when a read/write instruction is executed.

- Probe

  It is a value of PROBE0-PROBE5 of a probe cable.

The number of trace memory to be used (counted) varies with instructions. For example, the word, double-word and quad-word transfer instructions use 2, 4 and 8 counts of trace memory, respectively. Also, when using the read modify write instruction

(a single instruction that reads and writes data, such as the SB instruction),
a total of two counts of trace memory (one count for read cycle and one count for write cycle) are used.

■Note-1■

The trace data in the trace window of the DTU8 debugger is displayed from the oldest data.
(The data displayed at the bottom is the latest data.)

2.3.1 Start of Trace

In order to start trace, there are the three following methods.

- Free-run trace

  It is always traced during the real-time emulation.

- RAM matched race

  Trace is started after formation of the specified RAM match conditions.

  The following setup is possible for RAM match conditions to a RAM address (only one address).

  - RAM address
  - The mask of a RAM address
  - The RAM access method (reading, writing, reading & writing)
  - The mask of RAM data
  - RAM data
  - Access saize (Byte, Word)
  - Formation conditions (Equal, Not Equal)
  - Path count value (1-65536)

    When an access unit is Word, a path count value cannot be set up (1 fixation).

- PC matched race

  Trace is started after formation of specified PC match conditions.

  Specification of a 16-bit path count is possible for PC match conditions to PC (only one address).

  While trace conditions are satisfied, it is traced by both in step emulation and real-time emulation.

An interruption shift cycle is displayed as "Interrupt cycle".

2.3.2 End of Trace

In order to stop trace, there are the two following methods.

- When a trace pointer overflows and the stop of trace by trace pointer overflow is effective.
- When trace start conditions are re-set up (RAM match trace / PC match trace)

■Note-1■

Change in the program status word (PSW) is traced with a delay of one instruction.

2.4 Read / Write Function

It is a Reading and writing function of Program memory, Data memory and SFR.

2.5 Execution Time Measurement Function

It is a measurement function of emulation time.

- The minimum measurement unit is 100 microseconds.
- The maximum time which can be measured is about 119 hours.
  If this maximum time is exceeded, measurement will be again started from 0.
- Start measurement from 0 for every emulation start.

2.6 Execution cycle Measurement Function

It is a measurement function of emulation cycle.

- The count clock of a cycle counter turns into a CPU clock.
- It is possible to set arbitrary values to a cycle counter.
- The number of the maximum cycles which can be measured is 4294967295, and if this value is exceeded, it will start measurement from 0 again.

2.7 Function Which Can be Performed in Emulation

2.7.1 Real-time RAM monitor function

It is a function which monitors the contents of the data RAM in real time in emulation.

The object of a real-time RAM monitor is a data RAM area in 1 segment, and can be displayed a maximum of 16 K bytes.

2.7.2 Real-time watch Function

It is a function which displays during the emulation the contents of the RAM data corresponding to the RAM address registered before the emulation start.

The RAM address which can be registered is shown below.

- The address assigned to the memory which can be used as a data RAM
- SFR
- A symbol with the DATA attribute of an assembly language source level
- C variable assigned to the memory which can be used as a data RAM

A maximum of eight RAM addresses can be registered in the data size of 8 bits, 16 bits, or 32 bits. These eight addresses can be specified in the range of segments 0-7, respectively.

■Note-1■

The display during a real-time emulation shows the write data when a write instruction is executed. However, when a break occurs, the real-time display function directly reads and displays the data of the specified address. Therefore, be aware that for the SFR values that have different meanings between data written and data read, such as WDTCON, data read rather than data written is displayed when a break occurs.

■Note-2■

Change in the SFR whose content changes without depending on a write instruction, such as the timer, cannot be displayed during a real-time emulation using this real-time display function.

2.7.3 Real-time LCD Monitor function

It is a function which monitors the terminal state (COM/SEG) of LCD in real time on the screen of PC during program execution.

The terminal state of LCD is taken into Dr.U8ICE via external apparatus (LCD probe board), and is displayed on PC screen in the display image of the LCD panel.

2.8 Voltage Function Preselection Capability

The Dr.U8ICE operates on the supply power supply level from a user cable (UVDD_IN), as shown in Fig. 2-3.

The range of the power supply level on which the Dr.U8ICE can operate is 1.65V - 5.5V.

When the supply power supply level from UVDD_IN is lower than 1.65V, 3.3V inside Dr.U8ICE is supplied as voltage of Dr.U8ICE of operation.

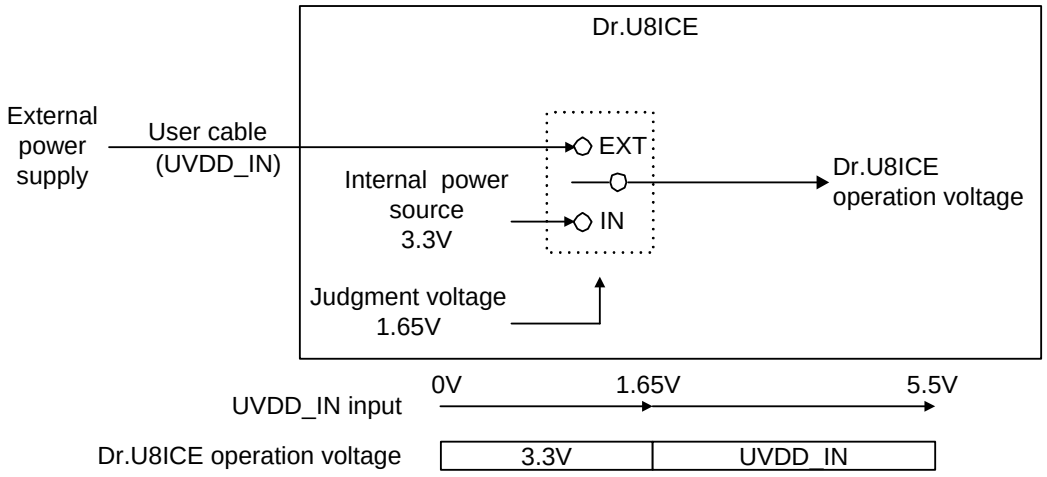


Fig 2-3 Dr.U8ICE operation voltage

Cautions Since Dr.U8ICE may be damaged when the voltage besides a standard is inputted, please input the voltage within a standard.

Cautions If a power supply is inputted by methods other than specification, Dr.U8ICE will break down or it will become a cause of a fire.

2.9 LED Display Function

There are following two kinds of LED in Dr.U8ICE.

Silk name	Color	Status
PWR	Green	Power supply
BUSY	Yellow	Execution

(1) ［PWR］

The light will be switched on if a power supply is supplied to Dr.U8ICE.

(2) ［BUSY］

The light is switched on in yellow in the following state.

- A period after turning on the power supply of Dr.U8ICE until a debugger starts
- Real-time emulation period
-The model conversion period of Dr.U8ICE

Chaptor 3　Starting

1. Starting of Dr.U8ICE

1.1 Connection of Dr.U8ICE and Accessories

As shown in the following figure, please connect accessories and peripheral equipment with Dr.U8ICE.

(Connection of the accessories and peripheral equipment which are not used is unnecessary.)

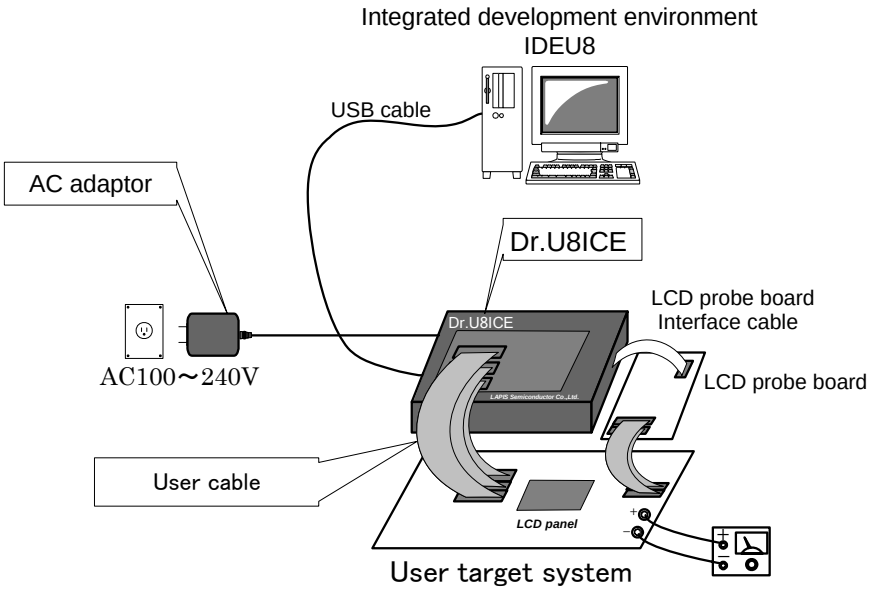


Figure 3-1 Connection of Dr.U8ICE and peripheral equipment

Cautions Cables and accessories should use appended goods at any cost.
If different things are used, it may become a cause of a fire or failure.

1.2 Starting of Dr.U8ICE

Please start according to the following procedure.

Refer to Fig. 3-1 for connection of apparatus.

(1) Connect host PC with Dr.U8ICE with an attached USB cable.

(2) Connect a user target system with Dr.U8ICE by a user cable.

When using a LCD probe board, a LCD probe board interface cable is connected to the EXCN connector of DrU8ICE.

(3) Connect an AC adaptor with Dr.U8ICE and turn ON the power supply of Dr.U8ICE.

Dr.U8ICE "PWR" LED (green) and "BUSY" LED (yellow) light up.

(4) Turn ON the power supply of a user target system.

(5) Start DTU8 debugger.

Since the target setting dialog of a debugger is displayed, target ICE is set as "Dr.U8ICE", and a target chip chooses the LSI product name for debugging, and clicks the O.K. button.

(6) If DTU8 debugger starts normally, "BUSY"LED (yellow) of Dr.U8ICE will go out.

It is the completion of starting.

Chaptor4 Model conversion

1. Model Conversion

1.1 Notes at Time of Correspondence Model Conversion

To perform model conversion of Dr.U8ICE to corresponding LSI, the ICE configuration data file (extension ICD) corresponding to LSI is required.

The number of models of LSI which can respond by Dr.U8ICE has a difference depending on the model of Dr.U8ICE, and the number of ICD files also applies to it correspondingly.

Please refer to a Dr.U8ICE target LSI manual for the number of models of LSI which can respond by Dr.U8ICE.

1.2 Model Conversion Procedure

Please start according to the following procedure. Refer to Fig. 1-1 for connection of apparatus.

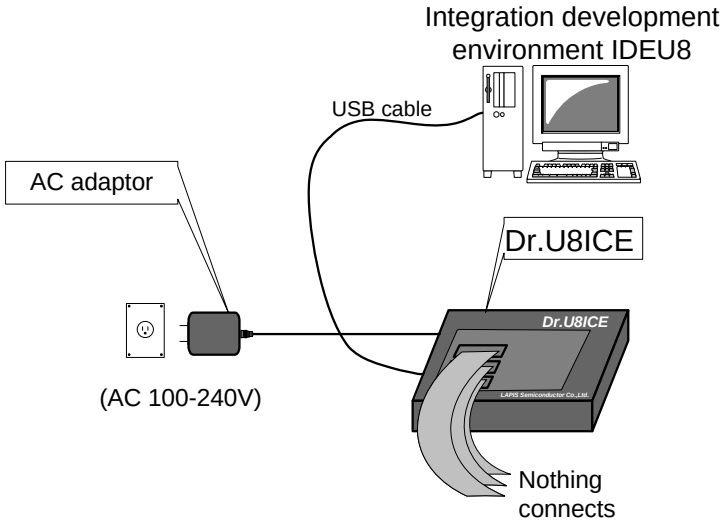


Figure 1-1 System configuration at the time of model conversion

Cautions

Please do not connect any apparatus to a user cable at the time of a model conversion setup.
It becomes causes, such as Dr.U8ICE breaking down or causing a fire.

The procedure of model conversion

(1) Copy the target setting file (ICD file) corresponding to the model of MCU to the same directory as the directory where the executable file (DTU8.exe) of the debugger is stored.
(An ICD file is offered from our company)
(2) Connect host PC with Dr.U8ICE with an attached USB cable.
(3) Connect an AC adaptor with Dr.U8ICE and turn ON the power supply of Dr.U8ICE.
Dr.U8ICE "PWR" LED (green) and "BUSY" LED (yellow) light up.
(4) Start DTU8 debugger.
Setting target setting dialog as "Dr.U8ICE", a target chip chooses the LSI product name of the model set up now.
(5) If DTU8 debugger starts normally, "BUSY"LED (yellow) of Dr.U8ICE will go out.
(6) If a debugger starts normally, it will click on the reset icon (RES) which exists in the center of a tool bar of a debugger.
(7) Click [Change target device of ICE ...] of the help menu of DTU8.
(8) Since a "Load target setting file of ICE" dialog box opens on a debugger screen, if the ICD file copied by (1) is chosen and it clicks " Open", model conversion processing will be started.
(9) If model conversion processing carried out the normal end, after the message which reading of a target settting file ended will be outputted to the log window of a debugger, BUSY LED of Dr.U8ICE lights up for about 2 seconds.
(10) Please terminate the debugger.
(11) Please remove a USB cable after turning off the power supply of Dr.U8ICE.

It is the completion of model conversion.

Appendix

1. Probe Cable

1.1 Structure of Probe Cable

The structure of a probe cable is shown in the following figure.

A probe cable is connected to the PROBE connector of Dr.U8ICE.。

Fig1-1 Structure of Probe Cable

1.2 Structure of PROBE Connector

The structure of the PROBE connector which connects a probe cable is shown in Fig. 1.2.

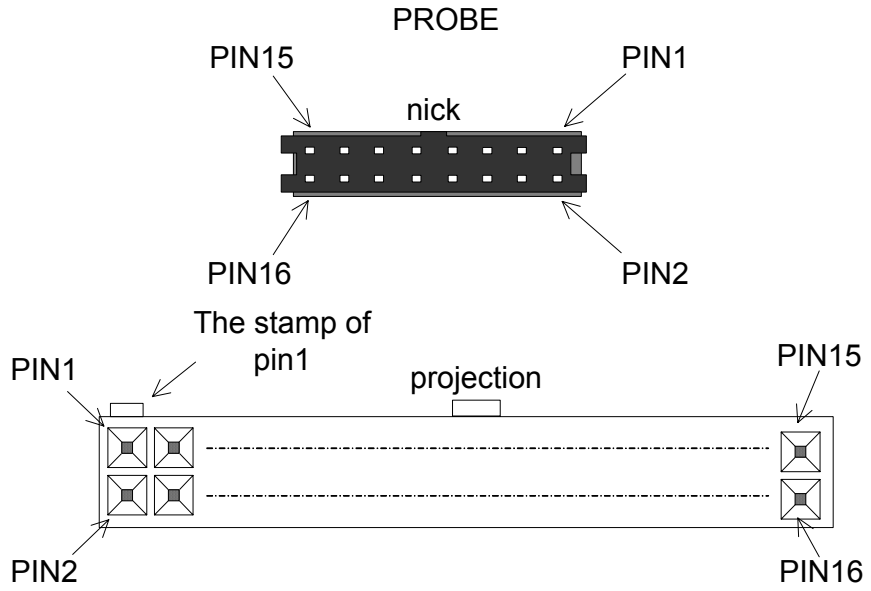


Fig1-2 PROBE connector pin assignment

1.3 Pin Arrangement of PROBE Connector

Table1-1 PROBE connector table

PIN No.	Cable color	Signal name	IO	PIN No.	Cable color	Signal name	IO
1	—	GND	—	9	—	GND	—
2	Black	PROBE0	I	10	Yellow	PROBE4	I
3	—	GND	—	11	—	GND	—
4	Brown	PROBE1	I	12	Green	PROBE5	I
5	—	GND	—	13	—	GND	—
6	Red	PROBE2	I	14	Blue	EXT.BRK0	I
7	—	GND	—	15	—	GND	—
8	Orange	PROBE3	I	16	Purple	EXT.BRK1	I

■Note1■

PROBE 0-5 is an input terminal for external trace.

EXT.BRK0 and EXT.BRK1 are the input terminals for an external break.

2. EXCN Connector

2.1 Structure of EXCN Connector

The structure of the EXCN connector which connects a LCD probe board is shown in the following figure.

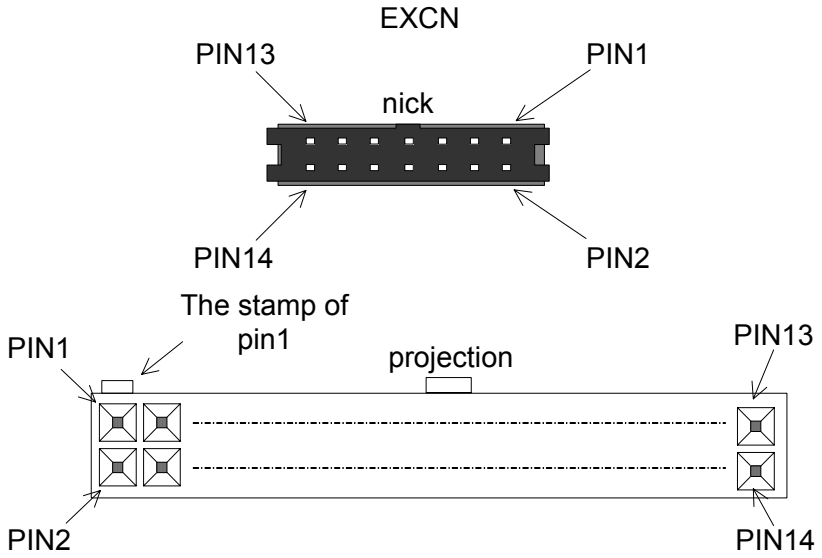


Figure2-1 EXCN connector pin assignment

2.2 Pin Arrangement of EXCN Connector

Table 2-1 EXCN connector table

PIN No.	Signal name	IO	内容
1	NC	－	open
2	GND	－	GND
3	NC	－	open
4	GND	－	GND
5	SCLK	I	Synchronous serial clock
6	GND	－	GND
7	SDATA	I/O	Synchronous serial-data in/out
8	GND	－	GND
9	NC	－	open
10	GND	－	GND
11	NC	－	Open
12	GND	－	GND
13	NC	－	open
14	NC	－	open