

Low level C-programming and microprocessor
architecture

Welcome

VGA = Video Grafics Array

Graphical User Interface – GUI
Engineering job

Version	Date	Responsible	Description
0.0	2011	LL & Mia	Preliminary version
1.0	201510	LL	Changed HW to BeMicro



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Standard VGA

Video Graphics Array (VGA) was first marketed in 1987 by IBM. Since then it has been a well established standard, used in many applications.

Standard VGA graphics modes are

640×480 - 16 colors
640×350 - 16 colors
320×200 - 16 colors
320×200 - 256 colors

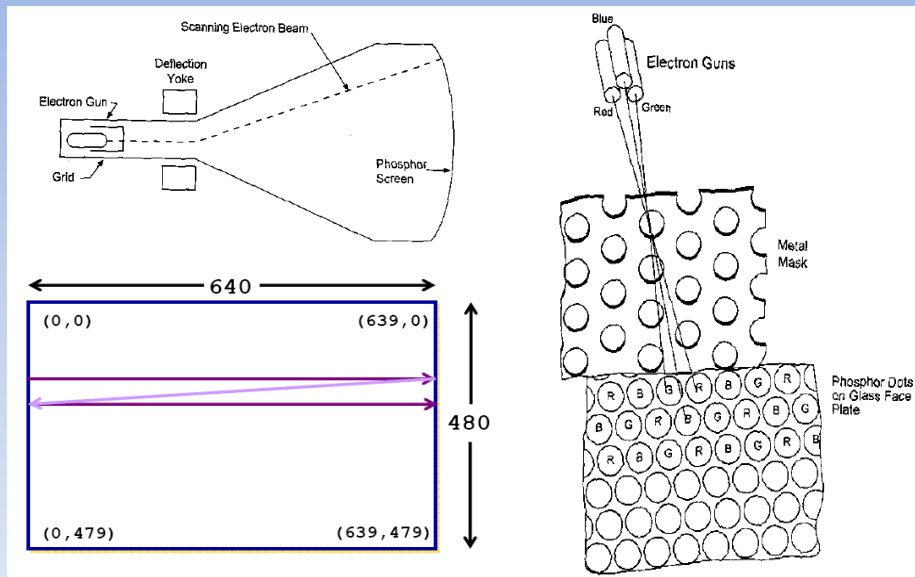
320×200 - 8 colors (TEIS standard!)



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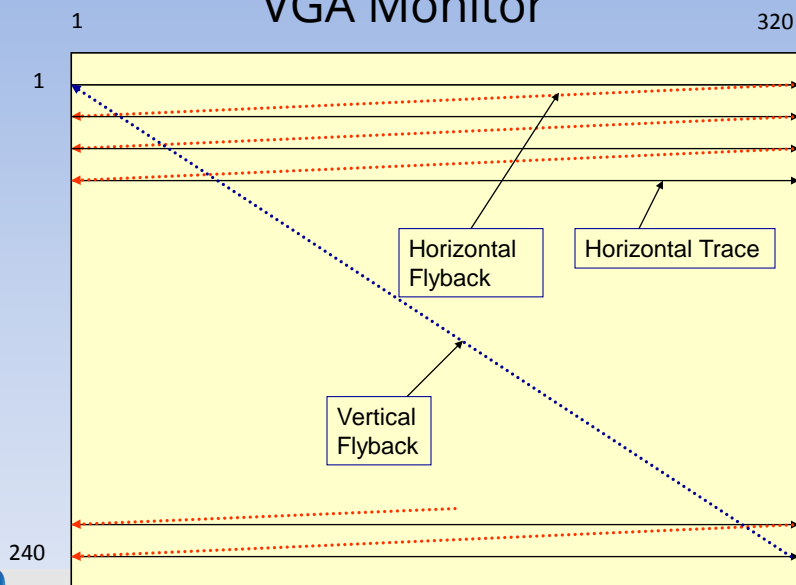
History



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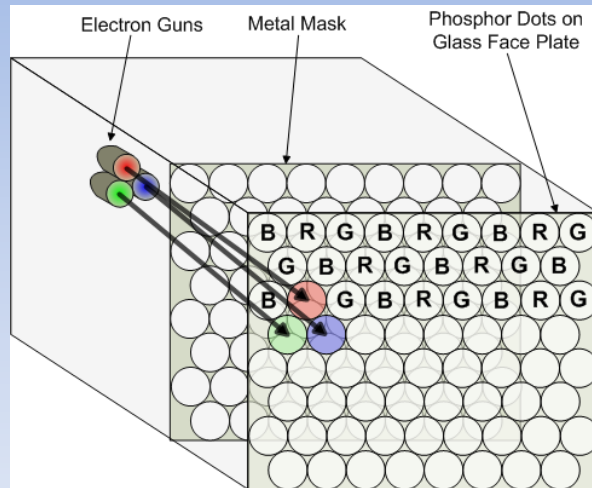
VGA Monitor



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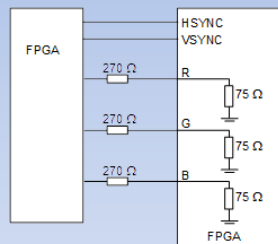
VGA signal production



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VGA interface



	Red	Green	Blue	Color
0	0	0	0	Black
1	0	0	1	Blue
2	0	1	0	Green
3	0	1	1	Cyan
4	1	0	0	Red
5	1	0	1	Magenta
6	1	1	0	Yellow
7	1	1	1	White

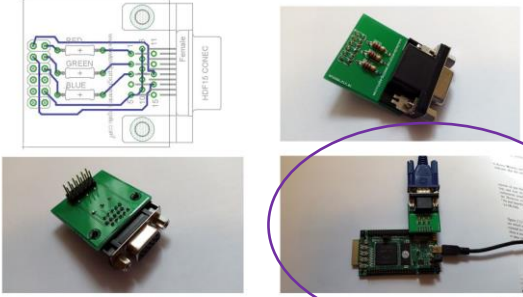
<http://www.xess.com/blog/a-simple-vga-interface-for-the-xula-fpga-board/>



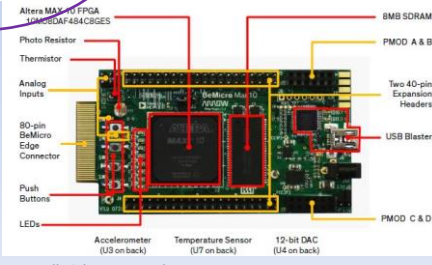
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FPGA board



The top section shows three images: a schematic of the HST15 connector, a small green PCB component, and a larger green PCB component with a blue connector. A purple circle highlights the larger component, with a blue arrow pointing to the detailed component diagram below.



The detailed component diagram labels the following parts:

- Altera MAX 10 FPGA (10M10BAF484C8GES)
- Photo Resistor
- Thermistor
- Analog Inputs
- 80-pin BeMicro Edge Connector
- Push Buttons
- LEDs
- 8MB SDRAM
- PMOD A & B
- Two 40-pin Expansion Headers
- USB Blaster
- PMOD C & D
- Accelerometer (U3 on back)
- Temperature Sensor (U7 on back)
- 12-bit DAC (U4 on back)

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Pmod

Pmod™: Registered trademark of Diligent Inc.

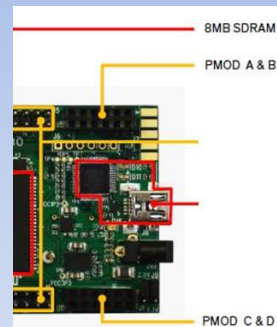
Pin	Signal	Direction
1	IO1	In/Out
2	IO2	In/Out
3	IO3	In/Out
4	IO4	In/Out
5	GND	
6	VCC	

- 1 ☐
- 2 ☐
- 3 ☐
- 4 ☐
- 5 ☐
- 6 ☐



The image shows a screenshot of the Pmod product catalog with the following items:

- PmodGPS** - GPS module with antenna, 10-pin BeMicro edge connector, and 4-pin header. \$49.00
- PmodGPS - GPS Receiver** - Similar to PmodGPS but with a different antenna. \$49.00
- PmodOLED - Organic LED Graphic Display** - 128x64 pixel, 1.3" display. \$27.99
- PmodWiFi - IEEE 802.11b WiFi Interface** - IEEE 802.11b/g/n WiFi module. \$52.00



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VHDL VGA control the screen

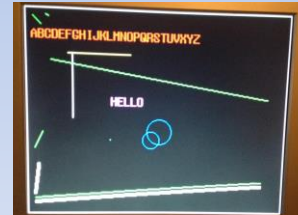
	Red	Green	Blue	Color
0	0	0	0	Black
1	0	0	1	Blue
2	0	1	0	Green
3	0	1	1	Cyan
4	1	0	0	Red
5	1	0	1	Magenta
6	1	1	0	Yellow
7	1	1	1	White

Screen

Pixel RAM
1 – 320 Pixels
1 -239 rows
 Ca 77000 rows
 with three bits

Address = $X + Y*320$;
 //X = 1 – 320 Y = 1-239

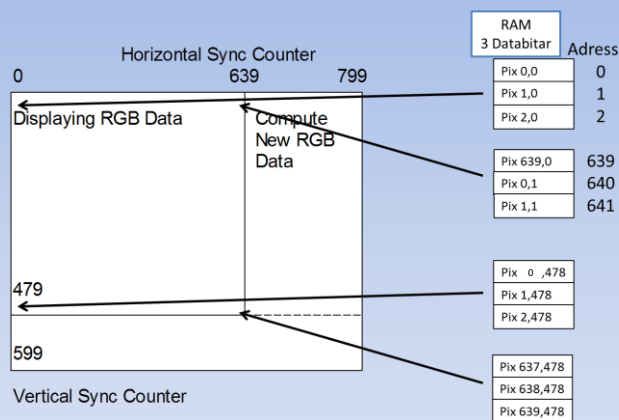
VGA-
contr
oller



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Pixel ram or graphic memory

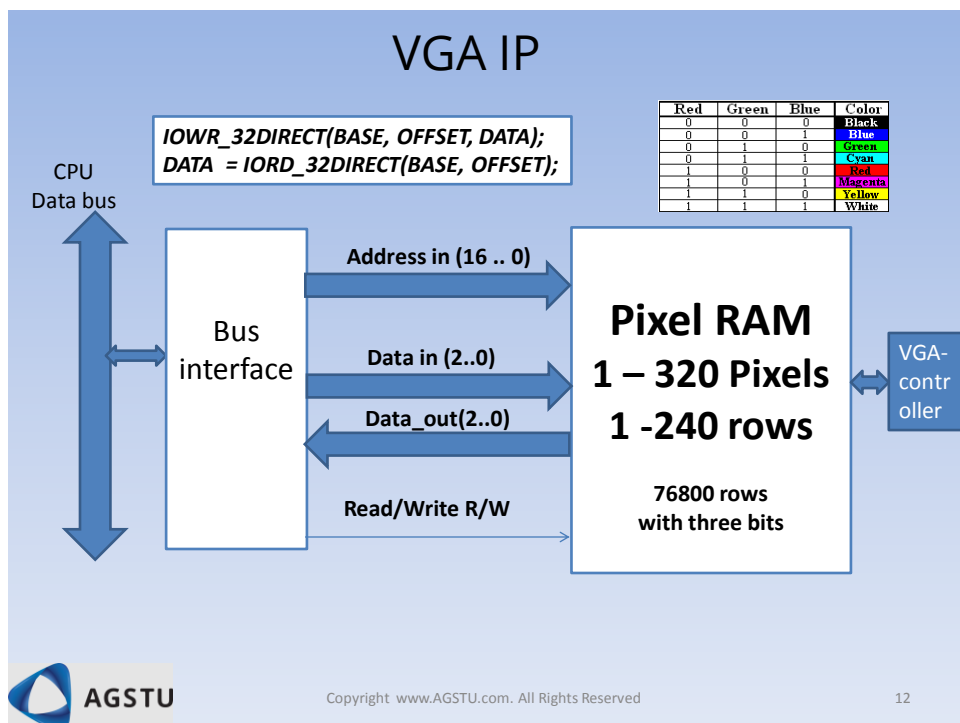
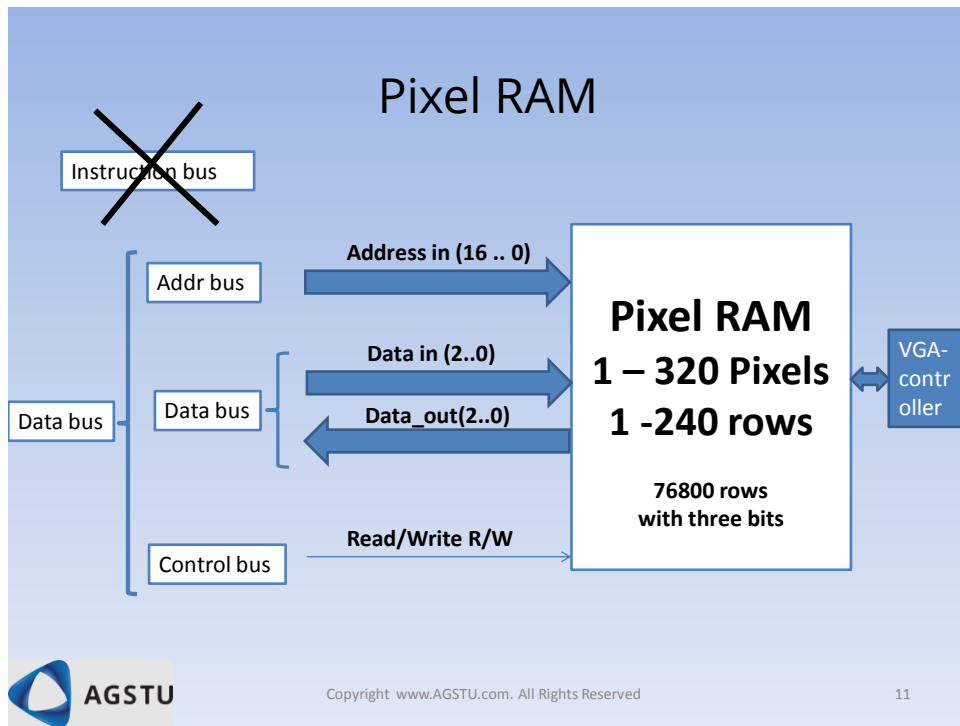


OBS: 320*240

Pixel RAM Address = $X + Y*320$;

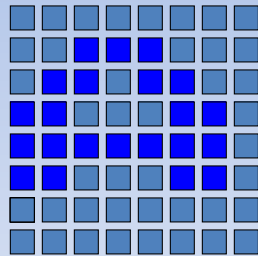
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A character-glyph example

- Here's a sample 8x8 character glyph ('A'):



```
alt_u8 font[3072] =
{
  0x00, 0x38, 0x6C, 0xC6, 0xFE,
  0xC6, 0x00, 0x00, // Char A
  ...
  font[font_row]
```

```
print_str(100, 85, blue, "Arbete Genom STUdier ");
print_char
```



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Communication protocol

- The communication between the software and the hardware is a best effort communication.
 - That is, the software read or write to the register without acknowledgment.



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VGA-driver – “print_vline”

Function: *print_vline(unsigned int address, unsigned int x_start, unsigned int y_start, unsigned int len, unsigned int RGB);*

Function description: Prints a vertical line with the color *rgb* with the length *len* which starts at the coordinate (*x_start*, *y_start*).



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Print_vline

```
print_vline(unsigned int address, unsigned int
x_start, unsigned int y_start, unsigned int len,
unsigned int RGB);
```



C-code?

```
#define VGA_WRITE(address, data)
IOWR_32DIRECT(PIXEL_RAM_BASE, address * 4, data);
// address = X + Y*320;
```

Pixel RAM
76800 rows
with three bits



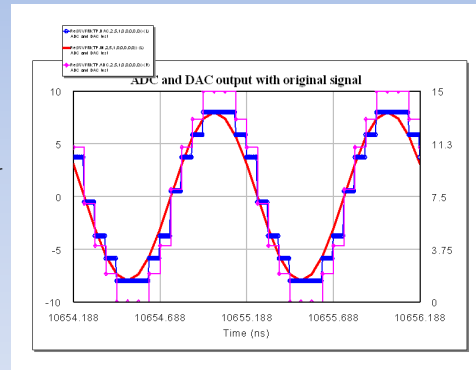
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Analog

Chapter 8. CASE 6

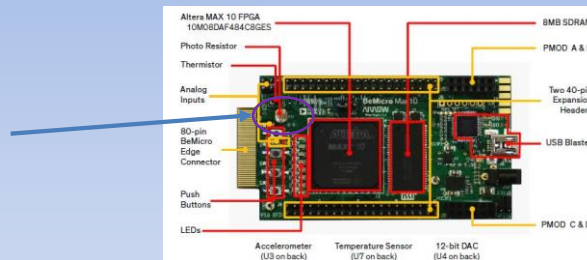
- ✓ Analog signals
- ✓ ADC: flash, **SAR**, dual slope
- ✓ Theory: resolution, quantization and quantization error
- ✓ Theory: sampling, sampling rate, sampling theorem
- ✓ MAX 10 ADC: "sequence", "sequencer"
- ✓ BeMicro board: LDR, temperature sensor



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Photo Resistor



Do CASE 6

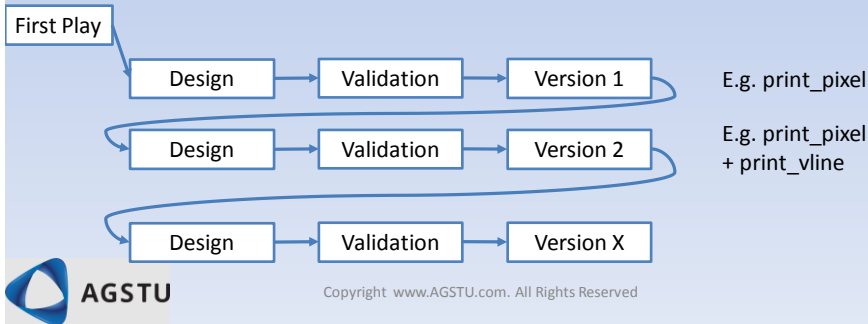


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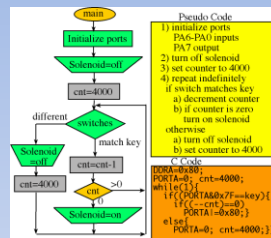
Development tips Structural Design Methods!

- Develop and test one function at the time
- Integrate and test the function one after another
- Backup after each new version



Tips

Pseudo Code =>
use as comments in
the C code



Write design
report



Test cases
Simple on
low level

Test Case Summary List - TCM Sample

WHERE		Test Case Execution Info		Version
Test Case ID	Test Case Name	Pass	Fail	Number
TC001	Test Case 1	Pass	Fail	1.0
TC002	Test Case 2	Pass	Fail	1.0
TC003	Test Case 3	Pass	Fail	1.0
TC004	Test Case 4	Pass	Fail	1.0
TC005	Test Case 5	Pass	Fail	1.0
TC006	Test Case 6	Pass	Fail	1.0
TC007	Test Case 7	Pass	Fail	1.0
TC008	Test Case 8	Pass	Fail	1.0
TC009	Test Case 9	Pass	Fail	1.0
TC010	Test Case 10	Pass	Fail	1.0
TC011	Test Case 11	Pass	Fail	1.0
TC012	Test Case 12	Pass	Fail	1.0
TC013	Test Case 13	Pass	Fail	1.0
TC014	Test Case 14	Pass	Fail	1.0
TC015	Test Case 15	Pass	Fail	1.0
TC016	Test Case 16	Pass	Fail	1.0
TC017	Test Case 17	Pass	Fail	1.0
TC018	Test Case 18	Pass	Fail	1.0
TC019	Test Case 19	Pass	Fail	1.0
TC020	Test Case 20	Pass	Fail	1.0
TC021	Test Case 21	Pass	Fail	1.0
TC022	Test Case 22	Pass	Fail	1.0
TC023	Test Case 23	Pass	Fail	1.0
TC024	Test Case 24	Pass	Fail	1.0
TC025	Test Case 25	Pass	Fail	1.0
TC026	Test Case 26	Pass	Fail	1.0
TC027	Test Case 27	Pass	Fail	1.0
TC028	Test Case 28	Pass	Fail	1.0
TC029	Test Case 29	Pass	Fail	1.0
TC030	Test Case 30	Pass	Fail	1.0
TC031	Test Case 31	Pass	Fail	1.0
TC032	Test Case 32	Pass	Fail	1.0
TC033	Test Case 33	Pass	Fail	1.0
TC034	Test Case 34	Pass	Fail	1.0
TC035	Test Case 35	Pass	Fail	1.0
TC036	Test Case 36	Pass	Fail	1.0
TC037	Test Case 37	Pass	Fail	1.0
TC038	Test Case 38	Pass	Fail	1.0
TC039	Test Case 39	Pass	Fail	1.0
TC040	Test Case 40	Pass	Fail	1.0
TC041	Test Case 41	Pass	Fail	1.0
TC042	Test Case 42	Pass	Fail	1.0
TC043	Test Case 43	Pass	Fail	1.0
TC044	Test Case 44	Pass	Fail	1.0
TC045	Test Case 45	Pass	Fail	1.0
TC046	Test Case 46	Pass	Fail	1.0
TC047	Test Case 47	Pass	Fail	1.0
TC048	Test Case 48	Pass	Fail	1.0
TC049	Test Case 49	Pass	Fail	1.0
TC050	Test Case 50	Pass	Fail	1.0
TC051	Test Case 51	Pass	Fail	1.0
TC052	Test Case 52	Pass	Fail	1.0
TC053	Test Case 53	Pass	Fail	1.0
TC054	Test Case 54	Pass	Fail	1.0
TC055	Test Case 55	Pass	Fail	1.0
TC056	Test Case 56	Pass	Fail	1.0
TC057	Test Case 57	Pass	Fail	1.0
TC058	Test Case 58	Pass	Fail	1.0
TC059	Test Case 59	Pass	Fail	1.0
TC060	Test Case 60	Pass	Fail	1.0
TC061	Test Case 61	Pass	Fail	1.0
TC062	Test Case 62	Pass	Fail	1.0
TC063	Test Case 63	Pass	Fail	1.0
TC064	Test Case 64	Pass	Fail	1.0
TC065	Test Case 65	Pass	Fail	1.0
TC066	Test Case 66	Pass	Fail	1.0
TC067	Test Case 67	Pass	Fail	1.0
TC068	Test Case 68	Pass	Fail	1.0
TC069	Test Case 69	Pass	Fail	1.0
TC070	Test Case 70	Pass	Fail	1.0
TC071	Test Case 71	Pass	Fail	1.0
TC072	Test Case 72	Pass	Fail	1.0
TC073	Test Case 73	Pass	Fail	1.0
TC074	Test Case 74	Pass	Fail	1.0
TC075	Test Case 75	Pass	Fail	1.0
TC076	Test Case 76	Pass	Fail	1.0
TC077	Test Case 77	Pass	Fail	1.0
TC078	Test Case 78	Pass	Fail	1.0
TC079	Test Case 79	Pass	Fail	1.0
TC080	Test Case 80	Pass	Fail	1.0
TC081	Test Case 81	Pass	Fail	1.0
TC082	Test Case 82	Pass	Fail	1.0
TC083	Test Case 83	Pass	Fail	1.0
TC084	Test Case 84	Pass	Fail	1.0
TC085	Test Case 85	Pass	Fail	1.0
TC086	Test Case 86	Pass	Fail	1.0
TC087	Test Case 87	Pass	Fail	1.0
TC088	Test Case 88	Pass	Fail	1.0
TC089	Test Case 89	Pass	Fail	1.0
TC090	Test Case 90	Pass	Fail	1.0
TC091	Test Case 91	Pass	Fail	1.0
TC092	Test Case 92	Pass	Fail	1.0
TC093	Test Case 93	Pass	Fail	1.0
TC094	Test Case 94	Pass	Fail	1.0
TC095	Test Case 95	Pass	Fail	1.0
TC096	Test Case 96	Pass	Fail	1.0
TC097	Test Case 97	Pass	Fail	1.0
TC098	Test Case 98	Pass	Fail	1.0
TC099	Test Case 99	Pass	Fail	1.0
TC100	Test Case 100	Pass	Fail	1.0

Next
version

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