IP Core Generator: Incrementor/Decrementor

Features

- **Incrementor/Decrementor by 1**
- **Incrementor/Decrementor by Value**
- **Accessible from the Macro Generator Dialog and HDLPlanner™ – Included in IDS for FPGA Devices and System Designer™ for AT94K FPSLIC™ Devices**
- **Incrementor/Decrementor Generation Selection**
- **Variable Pitch of Input Pins**
- **Variable Width of Input and Output Vectors**
- **Parallel Load Capability**
- **Optional Enable**
- **Initialization Polarity Selection**
- **Clock Inversion Capability**
- **Initialization Polarity Capability**
- **Preset Value Radix Selection**

Incrementor/Decrementor by 1

The Incrementor/Decrementor by 1 generator can be used to add/subtract 1 to/from the current registered value. This generator can be used to create a macro which increments or decrements by 1 a preloaded value or the data input on each rising (or falling) edge of the clock. The functional description of the generator is as follows[1]:

```
always @(posedge CLK or negedge R)
    begin
  if(R == 'b0)
      SUM = 0;
  else if (ENABLE && !LOAD) // Assuming Load is active low
      SUM = DATA;
  else if (ENABLE)
      begin
          if (INC_DEC)
      {COUT, SUM} = SUM + 1;
          else
      {COUT, SUM} = SUM - 1;
      end
    end
```

Note: 1. This code assumes that positive-edge clock and active-low reset have been specified.

Parameters

Parameter	Value	Explanation
Function	Increment	Generates an incrementor
	Decrement	Generates a decrementor
	Increment Decrement	Generates a programmable incrementor/decrementor
Pitch	Integer ≥ 1	Spacing between input pins. A pitch of 2 means one cell between input pins.
Width	Integer > 1	Width of input and output vectors
Load	Boolean	Macro has a parallel load capability
Enable	Boolean	Provides enable pin
Initialization	Reset	Registers can be reset to zero
	Set	Registers can be set to one
	None	Registers are automatically reset on power-up
	Preset	Registers can be asynchronously loaded with a constant value
Invert Clock	Boolean	Inverts the clock input
Initialization Polarity = Low	Boolean	Initialization input is active low
Preset Value Radix	Binary	Constants for preset are specified in binary representation
	Octal	Constants are specified in octal
	Decimal	Constants are specified in decimal
	Hex	Constants are specified in hexadecimal

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Pins

Type	Name	Option	Explanation
In	LOADIN	Yes	Loads the data if low
In	ENABIN	Yes	Enables the incrementor/decrementor, active high
In	INC_DEC	Yes	Incrementor if high, otherwise decrementor
In	DATA[Width - 1:0]	No	Data input, if LOADIN is low, as parallel load
In	CLK/CLKN	Yes	Clock (noninverted/inverted)
In	R/RN/S/SN/P/PN	Yes	Reset/Set/Preset (active high/low)
Out	SUM[Width - 1:0]	No	Accumulator output
Out	COUT	No	Carry out[1]

Note: 1. If Incrementor, then Carry out = SUM[Width - 1:0] + 1 > 2^n - 1
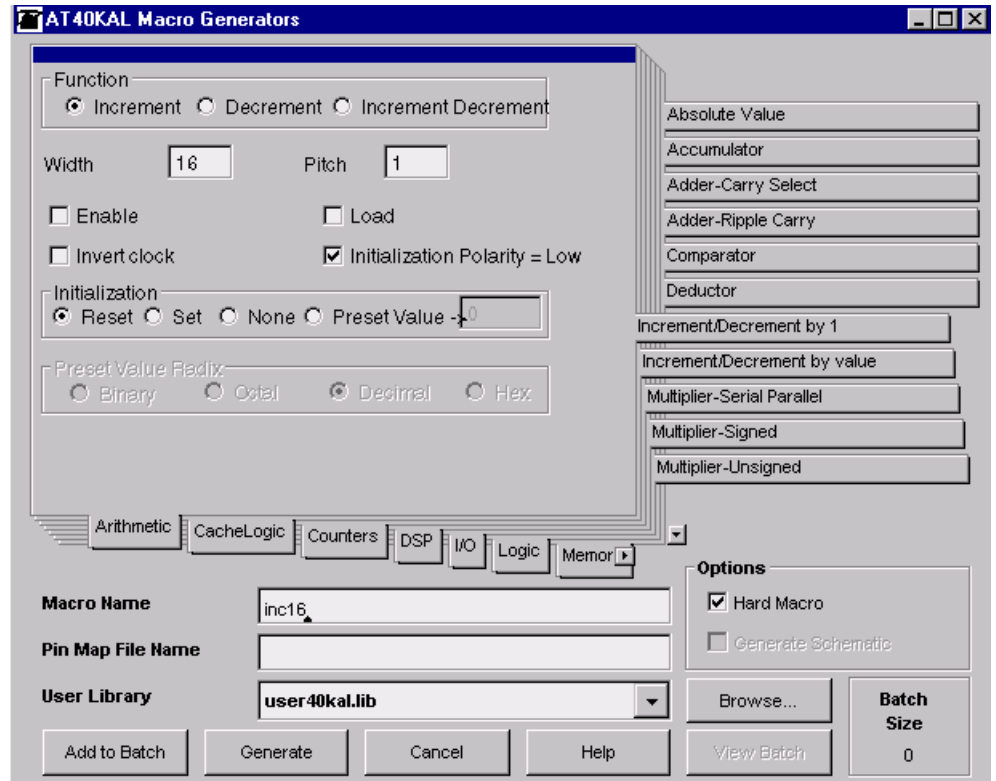else Carry out = SUM[Width - 1:0] - 1 < -2^n

Truth Table

Input				Output	
LOADIN	ENABIN	INC_DEC	DATA [W - 1:0]	SUM[W - 1:0]	COUT
0	x	1	A	A	1 if A + 1 > (2^W) - 1, 0 otherwise
0	x	0	A	A	1 if A - 1 < $-(2^W)$, 0 otherwise
1	0	x	x	Present State	Present State
1	1	1	x	SUM[W - 1:0] + 1	1 if SUM[W - 1:0] + 1 > (2^W) - 1, 0 otherwise
1	1	0	x	SUM[W - 1:0] - 1	1 if SUM[W - 1:0] - 1 > (2^W) - 1, 0 otherwise

Statistics

Device	Name	Speed (MHz)	Delay (ns)	Cells	Size (x * y)
AT40K	inc16	33.7	29.7	17	1 x 17
AT40K	inc8	60.8	16.5	9	1 x 9
AT40KAL/ AT94KAL	inc16	39.4	25.4	17	1 x 17
AT40KAL/ AT94KAL	inc8	64.8	15.4	9	1 x 9

Figure 1 shows an example of the inc16 macro options.

Figure 1. Incrementor/Decrementor by 1 Generator

IP Core Generator: Incrementor/Decrementor

Incrementor/ Decrementor by Value

The Incrementor/Decrementor by value generator can be used to add/subtract a value to/from the current registered value. This generator can be used to create a macro which increments or decrements a preloaded value or the data input by a user-specified amount on each rising (or falling) edge of the clock. The functional description of the generator is as follows[1]:

```
always @(posedge CLK or negedge R)
    begin
  if(R == 'b0)
      SUM = 0;
  else if (ENABLE && !LOAD)// Assuming Load is active low
      SUM = DATA;
  else if (ENABLE)
      begin
          if (INC_DEC)
      {COUT, SUM} = SUM + VALUE;
          else
      {COUT, SUM} = SUM - VALUE;
      end
    end
```

Note: 1. This code assumes that positive-edge clock and active-low reset have been specified.

Parameters

Parameter	Value	Explanation
Function	Increment	Generates an incrementor
	Decrement	Generates a decrementor
	Increment Decrement	Generates a programmable incrementor/decrementor
Pitch	Integer $\geq$ 1	Spacing between input pins. A pitch of 2 means one cell between input pins.
Width	Integer > 1	Width of input and output vectors
Incrementor/ Decrementor Value	Integer $\geq$ 1	Amount to increment/decrement by
Load	Boolean	Macro has a parallel load capability
Enable	Boolean	Provides enable pin
Initialization	Reset	Registers can be reset to zero
	Set	Registers can be set to one
	None	Registers are automatically reset on power-up
	Preset	Registers can be asynchronously loaded with a constant value
Invert Clock	Boolean	Inverts the clock input
Initialization Polarity = Low	Boolean	Initialization input is active low

Parameters (Continued)

Parameter	Value	Explanation
Preset Value Radix	Binary	Constants for preset are specified in binary representation
	Octal	Constants are specified in octal
	Decimal	Constants are specified in decimal
	Hex	Constants are specified in hexadecimal

Pins

Type	Name	Option	Explanation
In	LOADIN	Yes	Loads the data if low
In	ENABIN	Yes	Enables the incrementor/decrementor, active high
In	INC_DEC	Yes	Incrementor if high, otherwise decrementor
In	DATA[Width - 1:0]	No	Data input, if LOADIN is low, as parallel load
In	CLK/CLKN	Yes	Clock (noninverted/inverted)
In	R/RN/S/SN/P/PN	Yes	Reset/Set/Preset (active high/low)
Out	SUM[Width - 1:0]	No	Accumulator output
Out	COUT	No	Carry out[1]

Note: 1. If Incrementor, then Carry out = SUM[Width - 1:0] + IncDecValue > 2^n - 1
else Carry out = SUM[Width - 1:0] - IncDecValue < -2^n
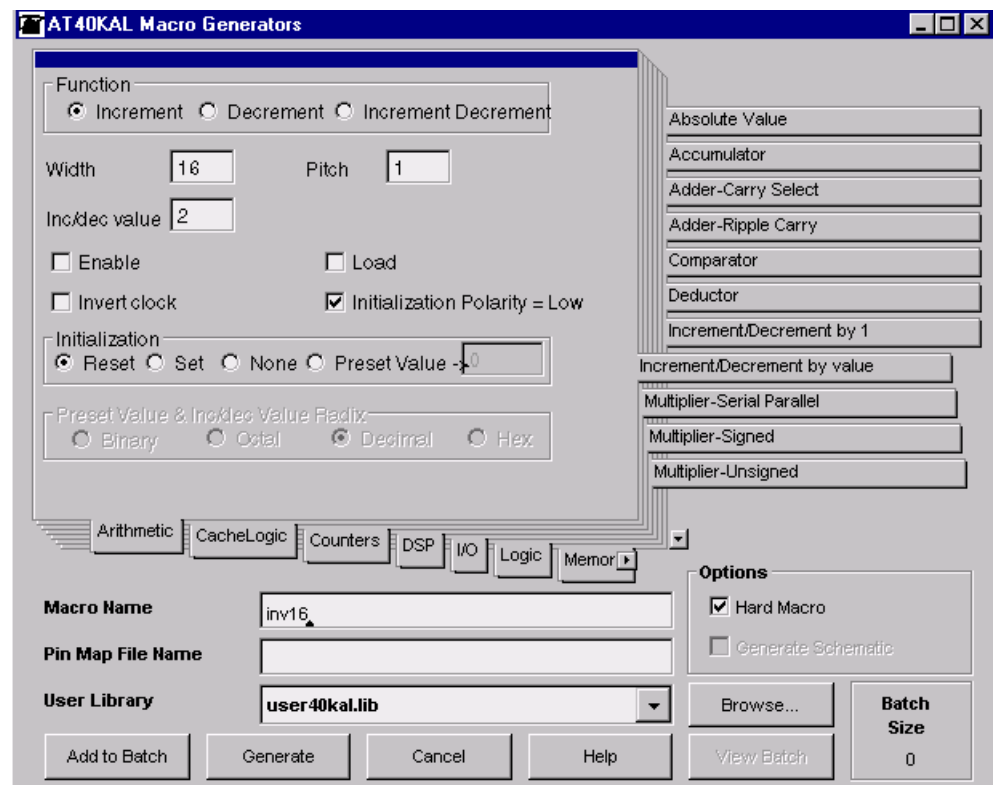
Truth Table

Input				Output	
LOADIN	ENABIN	INC_DEC	DATA [W - 1:0]	SUM[W - 1:0]	COUT
0	x	1	A	A	1 if A + IncDecValue > (2^W) - 1, 0 otherwise
0	x	0	A	A	1 if A - IncDecValue < $-(2^W)$, 0 otherwise
1	0	x	x	Present State	Present State
1	1	1	x	SUM[W - 1:0] + IncDecValue	1 if SUM[W - 1:0] + IncDecValue > (2^W) - 1, 0 otherwise
1	1	0	x	SUM[W - 1:0] - IncDecValue	1 if SUM[W - 1:0] - IncDecValue < $-(2^W)$, 0 otherwise

IP Core Generator: Incrementor/Decrementor

Statistics

Device	Name	Speed (MHz)	Delay (ns)	Cells	Size (x * y)
AT40K	inv16	31.9	31.3	17	1 x 17
AT40K	inv8	55.2	18.1	9	1 x 9
AT40KAL/ AT94KAL	inv16	37.6	26.6	17	1 x 17
AT40KAL/ AT94KAL	inv8	60.0	16.7	9	1 x 9

Figure 2 shows an example of the inv16 macro options.

Figure 2. Incrementor/Decrementor by Value Generator

Atmel Headquarters

Corporate Headquarters
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 441-0311
FAX 1(408) 487-2600

Europe
Atmel SarL
Route des Arsenaux 41
Casa Postale 80
CH-1705 Fribourg
Switzerland
TEL (41) 26-426-5555
FAX (41) 26-426-5500

Asia
Atmel Asia, Ltd.
Room 1219
Chinachem Golden Plaza
77 Mody Road Tsimhatsui
East Kowloon
Hong Kong
TEL (852) 2721-9778
FAX (852) 2722-1369

Japan
Atmel Japan K.K.
9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
TEL (81) 3-3523-3551
FAX (81) 3-3523-7581

Atmel Operations

Memory
Atmel Corporate
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 436-4270
FAX 1(408) 436-4314

Microcontrollers
Atmel Corporate
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 436-4270
FAX 1(408) 436-4314

Atmel Nantes
La Chantrerie
BP 70602
44306 Nantes Cedex 3, France
TEL (33) 2-40-18-18-18
FAX (33) 2-40-18-19-60

ASIC/ASSP/Smart Cards
Atmel Rousset
Zone Industrielle
13106 Rousset Cedex, France
TEL (33) 4-42-53-60-00
FAX (33) 4-42-53-60-01

Atmel Colorado Springs
1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
TEL 1(719) 576-3300
FAX 1(719) 540-1759

Atmel Smart Card ICs
Scottish Enterprise Technology Park
Maxwell Building
East Kilbride G75 0QR, Scotland
TEL (44) 1355-803-000
FAX (44) 1355-242-743

RF/Automotive
Atmel Heilbronn
Theresienstrasse 2
Postfach 3535
74025 Heilbronn, Germany
TEL (49) 71-31-67-0
FAX (49) 71-31-67-2340

Atmel Colorado Springs
1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
TEL 1(719) 576-3300
FAX 1(719) 540-1759

Biometrics/Imaging/Hi-Rel MPU/
High Speed Converters/RF Datacom
Atmel Grenoble
Avenue de Rochepleine
BP 123
38521 Saint-Egreve Cedex, France
TEL (33) 4-76-58-30-00
FAX (33) 4-76-58-34-80

Atmel Programmable SLI Hotline
(408) 436-4119

Atmel Programmable SLI e-mail
fpga@atmel.com – fpslic@atmel.com

FAQ
Available on web site

e-mail
literature@atmel.com

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