32-bit RISC Microcontroller

TXZ Family

Reference Manual

CRC calculation circuit (CRC-A)

Revision 2.0

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TOSHIBA ELECTRONIC DEVICES & STORAGE CORPORATION

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Preface

Related document

Document name
Product Information

Conventions

- Numeric formats follow the rules as shown below:
  Hexadecimal: 0xABC
  Decimal: 123 or 0d123 – Only when it needs to be explicitly shown that they are decimal numbers.
  Binary: 0b111 – It is possible to omit the “0b” when the number of bit can be distinctly understood from a sentence.
- “_N” is added to the end of signal names to indicate low active signals.
- It is called “assert” that a signal moves to its active level, “deassert” to its inactive level.
- When two or more signal names are referred, they are described like as [m: n].
  Example: S[3: 0] shows four signal names S3, S2, S1 and S0 together.
- The characters surrounded by ***[ ]*** defines the register.
  Example: ***[ABCD]***
- “n” substitutes suffix number of two or more same kind of registers, fields, and bit names.
  Example: ***[XYZ1], [XYZ2], [XYZ3] → [XYZn]***
- "x" substitutes suffix number or character of two or more same kind of units and channels in same register name in the Register List.
  In case of unit, “x” means A, B, and C …
  Example: ***[ADACR0], [ADBCR0], [ADCCR0]→[ADxCR0]***
  In case of channel, “x” means 0, 1, and 2…
  Example: ***[T32A0RUNA], [T32A1RUNA], [T32A2RUNA] →[T32AxRUNA]***
- The bit range of a register is written like as [m: n].
  Example: Bit[3: 0] expresses the range of bit 3 to 0.
- The configuration value of a register is expressed by either the hexadecimal number or the binary number.
  Example: ***[ABCD]***<EFG> = 0x01 (hexadecimal), ***[XYZn]***<VW> = 1 (binary)
- Word and Byte represent the following bit length.
  Byte: 8 bits
  Half word: 16 bits
  Word: 32 bits
  Double word: 64 bits
- Properties of each bit in a register are expressed as follows:
  R: Read only
  W: Write only
  R/W: Read and Write are possible
- Unless otherwise specified, register access supports only word access.
- The register defined as reserved must not be rewritten. Moreover, do not use the read value.
- The value read from the bit having default value of "-" is unknown.
- When a register containing both of writable bits and read-only bits is written, read-only bits should be written with their default value, In the cases that default is “-“, follow the definition of each register.
- Reserved bits of the Write-only register should be written with their default value. In the cases that default is “-“, follow the definition of each register.
- Do not use read-modified-write processing to the register of a definition which is different by writing and read out.

Terms and Abbreviations

Some of abbreviations used in this document are as follows:

CRC	Cyclic Redundancy Check

1. Outline

CRC(Cyclic Redundancy Check) is used to detect an error for memory data and communication data. CRC calculation circuit is a hardware calculator of CRC.

Function classification	Function	Functional Description
CRC Calculation	Calculation for Single Data	Write single data to register, CRC calculate automatically and output to result register.
	Calculation for Continuous Data	Write data to register continuously, CRC calculate automatically and output to result register.
CRC data	Selection of input data width	Selection of input data width can be chosen from 8 bits (byte), 16 bits (half-word), and 32 bits (word).
	Selection of CRC form	Selection of CRC form can be chosen from CRC16 (16bitCCITT) or CRC32

2. Configuration

A CRC calculation circuit consists three registers and calculation circuit.

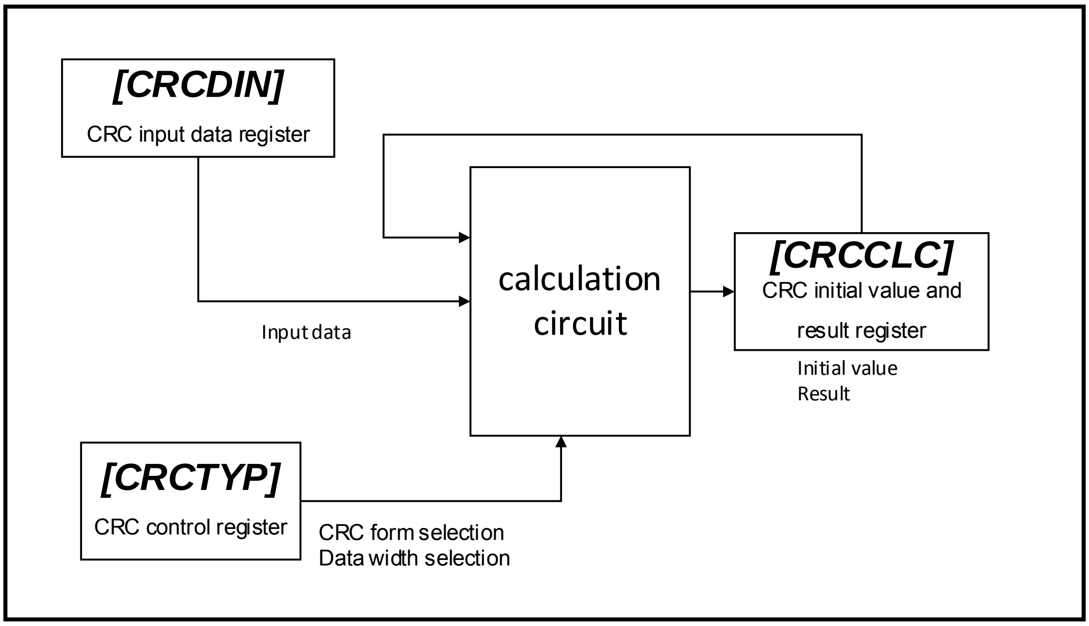

Figure 2.1 Block diagram of CRC calculation circuit

3. Operation Description

A CRC calculation circuit performs CRC calculation automatically, when single or continuous data is written in a register. After CRC calculation is performed, it is saved automatically, this value returns and CRC data is used for CRC calculation.

3.1. CRC Form

Using CRC16 and CRC32 is possible for CRC form. The polynomial is as follows.

CRC16: $X^{16}+X^{12}+X^{5}+1$ (16bit CCITT FALSE CRC16)
CRC32: $X^{32}+X^{26}+X^{23}+X^{22}+X^{16}+X^{12}+X^{11}+X^{10}+X^{8}+X^{7}+X^{5}+X^{4}+X^{2}+X+1$

3.2. CRC Input data

The input data width can be chosen for CRC input data format. Selection of input data width can be chosen from 8 bits (byte), 16 bits (half-word), and 32 bits (word).

3.3. CRC Calculation Result

CRC calculation result data is outputted to a CRC initial value result register ***[CRCCLC]*** at 32 bits.

3.4. Initial Setting

Write in the suitable initial value (CRC16:"0x0000FFFF" and CRC32:"0xFFFFFFFF") for a CRC initial value to result register ***[CRCCLC]***, before start newly CRC calculation.

CRC form is set to control register ***[CRCTYP]***<CFMT[1:0]> and the data width is set to ***[CRCTYP]***<DBIT[1:0]>.

3.5. CRC Operation for Single Data

CRC calculation is performed automatically by writing input data (DataIn) in a CRC input data register ***[CRCDIN]***. CRC calculation result can be obtained by reads ***[CRCCLC],*** after write in ***[CRCDIN]***. Please read ***[CRCCLC]*** twice and use the result of the 2nd time.

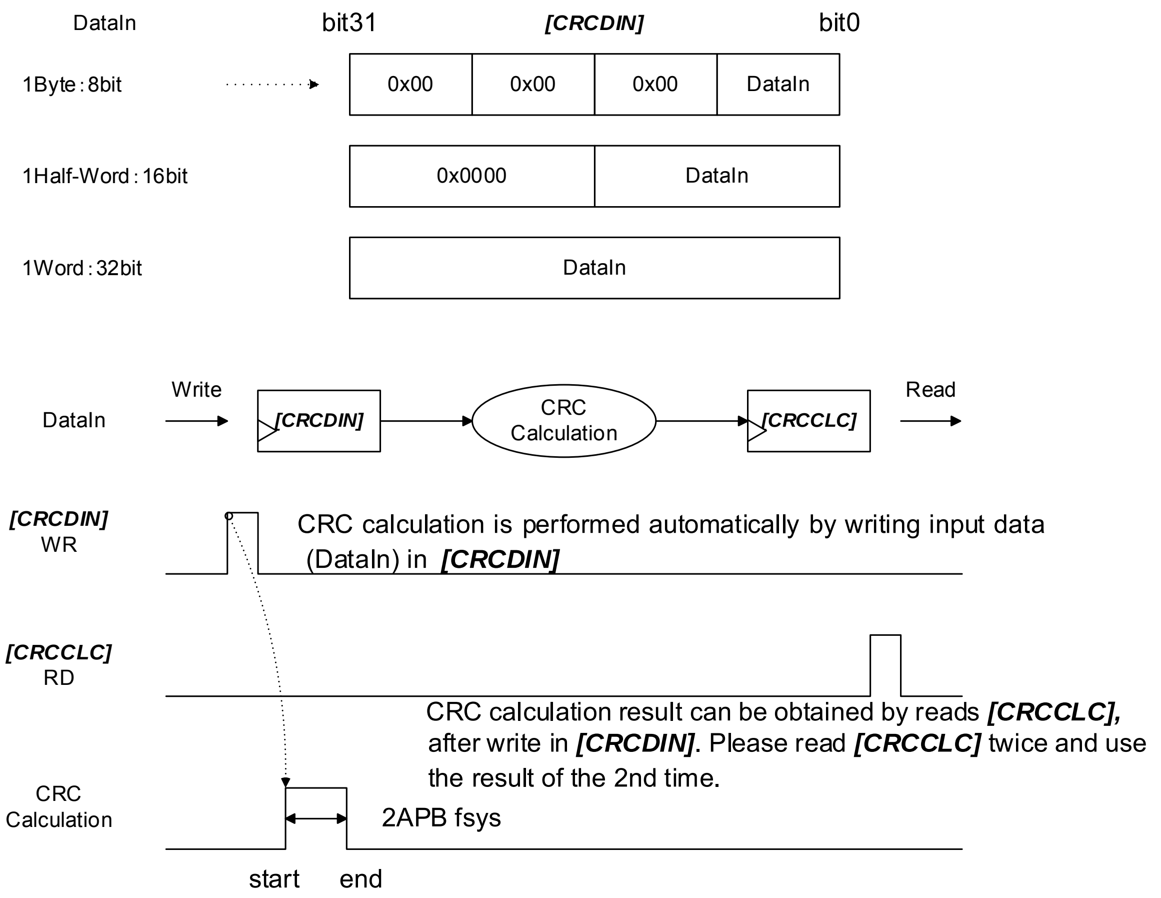

Figure 3.1 Timing chart of CRC calculation for a single data

3.6. CRC Operation for Continuous Data

In the case of continuous data, CRC calculation is performed automatically by writing data in a CRC input data register ***[CRCDIN]*** one by one.

When the bit width of the data to input changes, write data in ***[CRCDIN]*** after changing ***[CRCTYP]***<DBIT[1:0]> according to data. CRC calculation result can be obtained by reads ***[CRCCLC],*** after write in ***[CRCDIN]***. Please read ***[CRCCLC]*** twice and use the result of the 2nd time.

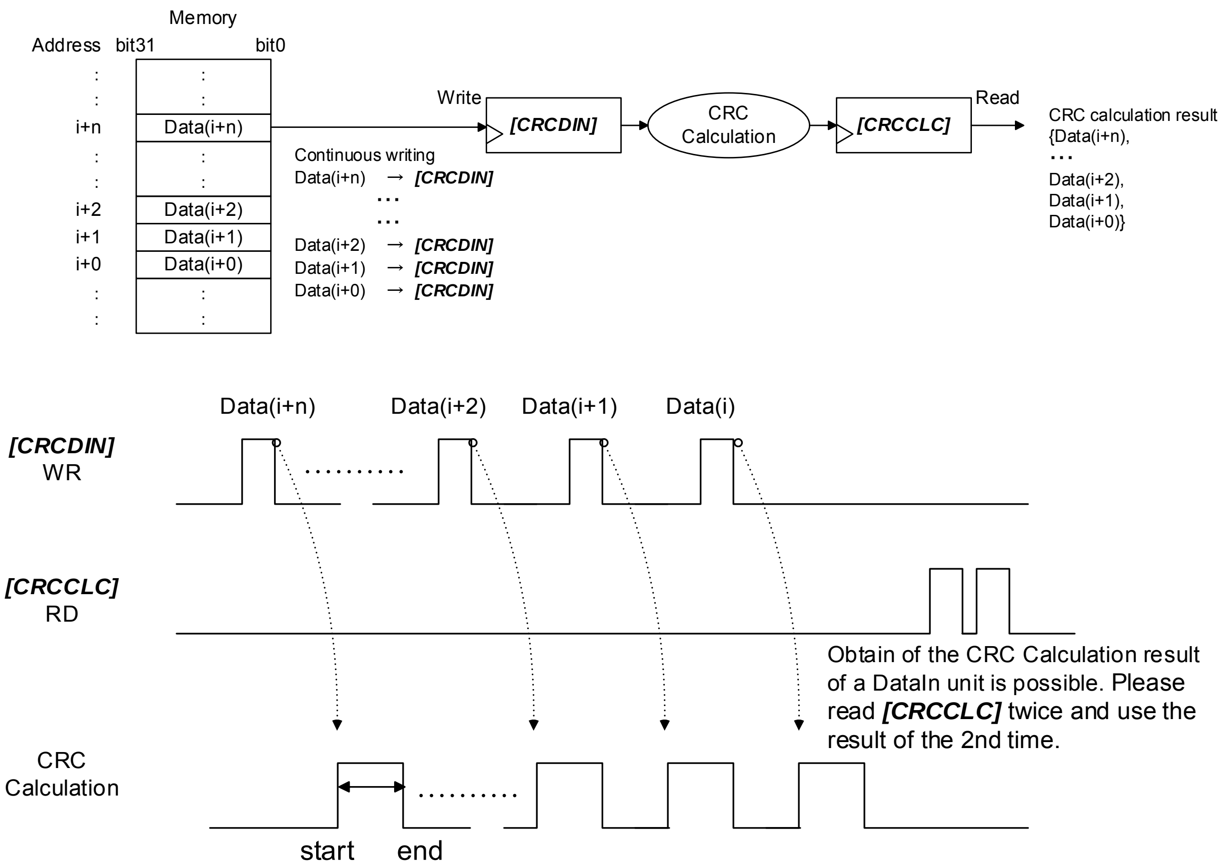

Figure 3.2 Timing chart of CRC calculation for continuous data

3.7. CRC Result Check

CRC calculation result should be checked by program.

A single or continuous input data (it is assumed that it is Dx) is written in a CRC input data register ***[CRCDIN]***, and CRC data is obtained. After that, this CRC result data (it is assumed that it is Cx) is written in ***[CRCDIN]***.

Then, please read the CRC initial value result register ***[CRCCLC]*** twice, and use the result of the 2nd time. If the result of having read ***[CRCCLC]*** is "0", then Cx is right CRC data for Dx.

3.8. Flow Chart Example

Following flow chart is example for check the input data is right, or not. This example show check that "123456789" (ASCII)'s CRC result is right, or not.

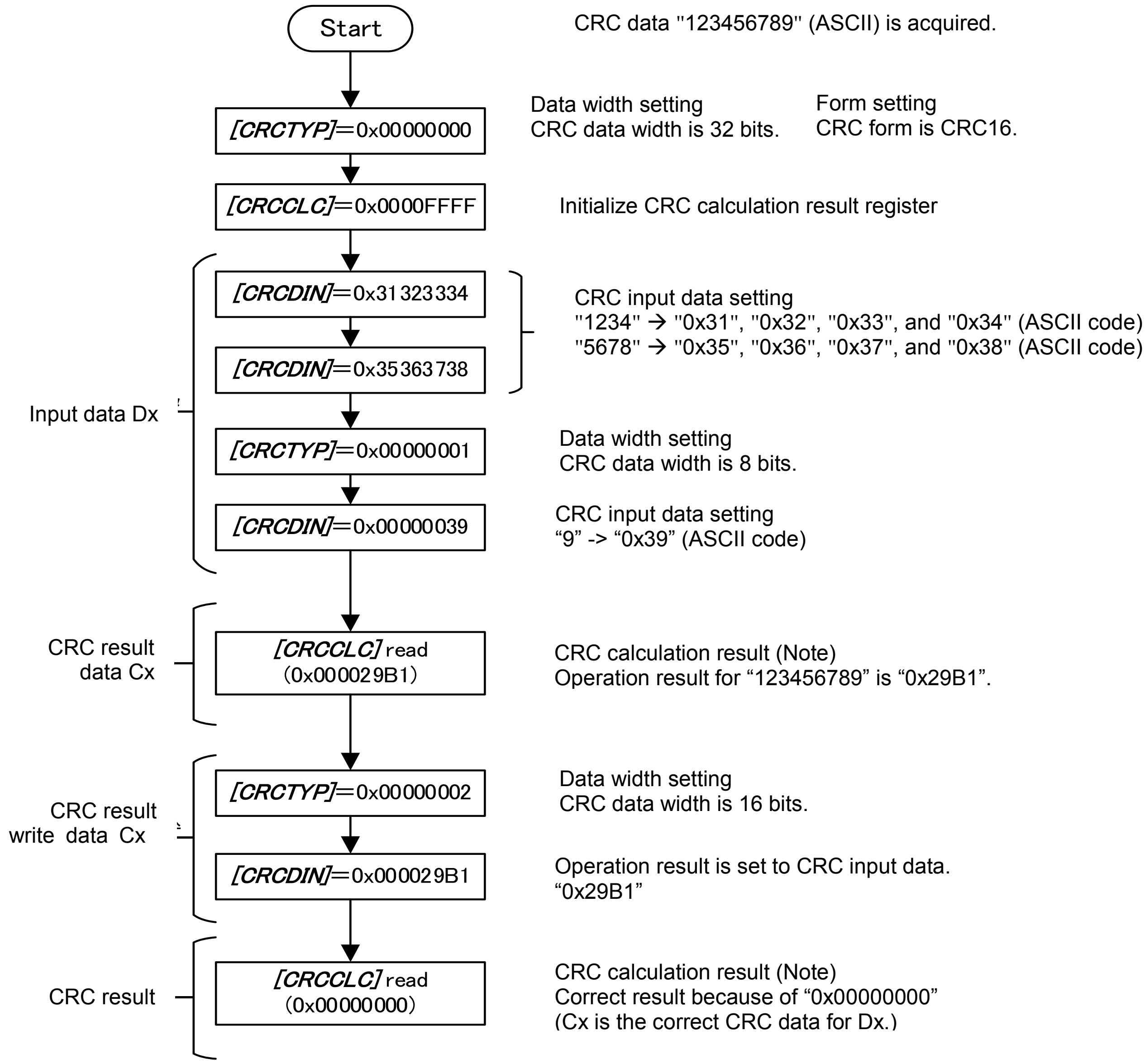

Figure 3.3 Flow chart example

Note: Please read ***[CRCCLC]*** twice and use the result of the 2nd time.

3.9. Self-diagnosis Method before Using CRC calculation circuit

Before using CRC, it is necessary to check that there is no failure in the CRC circuit itself (a CRC calculation result is right). The example of self-diagnosis of a program base is shown below.

[Procedure]

A diagnostic data is input, and CRC is calculated. CRC calculation result register is read and the read data is compared with its expectation data.

(1) CRC calculation result register (***[CRCCLC]***) is set to "0x0000FFFF".
(2) CRC data width register (***[CRCTYP]***) is set to "0x00000001" (8bits data).
(3) The following diagnostic data is written to CRC input data register (***[CRCDIN]***) in order. Diagnostic data: "0x0000000F", "0x0000001E", "0x0000002D", "0x0000004B" and "0x00000087"
(4) CRC data width register (***[CRCTYP]***) is set to "0x00000000" (32bits data).
(5) The following diagnostic data is written to CRC input data register (***[CRCDIN]***) in order. Diagnostic data: "0x76543210" and "0x89ABCDEF"
(6) CRC data width register (***[CRCTYP]***) is set to "0x00000002" (16bits data).
(7) The following diagnostic data is written to CRC input data register (***[CRCDIN]***) in order. Diagnostic data: "0x0000FFFF" and "0x00000000"
(8) CRC calculation result register (***[CRCCLC]***) is read. (Note)
(9) CRC input data register (***[CRCDIN]***) is set to the data read in (8).
(10) CRC calculation result register (***[CRCCLC]***) is read. (Note)

If the read data is "0x00000000" each CRC register should be initialized. The program diagnosis finishes without any errors.

If the read data is not "0x00000000" CRC circuit may have some failure. The program diagnosis finishes with the failure.

Note: Please read ***[CRCCLC]*** twice and use the result of the 2nd time.

4. Registers

4.1. Register List

The following table lists the control registers and their addresses:

Peripheral	Function name	Channel/Unit	Base address		
			Type1	Type2	Type3
CRC	CRC	-	0x400BBC00	0x400A3100	0x40043100

Note: The Channel/Unit and Base address type are different by products. Please refer to "Product Information" of the reference manual for the details.

Register Name		Address
CRC input data register	***[CRCDIN]***	0x0000
CRC control register	***[CRCTYP]***	0x0014
Reserved	-	0x0028
CRC initial value and result register	***[CRCCLC]***	0x002C

4.2. Detail of Registers

4.2.1. *[CRCDIN]* (CRC input data register)

Bit	Bit Symbol	After reset	Type	Function
31:0	CRCDIN[31:0]	0x00000000	R/W	CRC calculation input data

4.2.2. *[CRCTYP]* (CRC control register)

Bit	Bit Symbol	After reset	Type	Function
31:7	-	0	R	Read as "0"
6:4	-	000	R/W	Write as "000"
3:2	CFMT[1:0]	00	R/W	CRC form selection 00: CRC16 01: Reserved 10: Reserved 11: CRC32
1:0	DBIT[1:0]	00	R/W	Input data width selection 00: 32bits data 01: 8bits data 10: 16bits data 11: Reserved

4.2.3. *[CRCCLC] (CRC* initial value and result register)

Bit	Bit Symbol	After reset	Type	Function
31:0	CRCCLC[31:0]	0xFFFFFFFF	R/W	CRC calculation result is stored. (Note) The set bit width of CRC result is valid. The other bits become to "0".

Note: An initial value should be written before CRC calculation starts.
"0x0000FFFF" should be written in CRC16 format, and "0xFFFFFFFF" should be written in CRC32.

5. Revision History

Table 5.1 Revision History

Revision	Date	Description
1.0	2017-09-14	First release
2.0	2018-07-13	-P6 Modified description -2.: Added description, Modified Figure2.1 -3.2.: Modified description. -3.9.: Modified description. -4.1.: Modified base address

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