AN752

CRC Algorithm for MCRF45X Read/Write Device

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INTRODUCTION

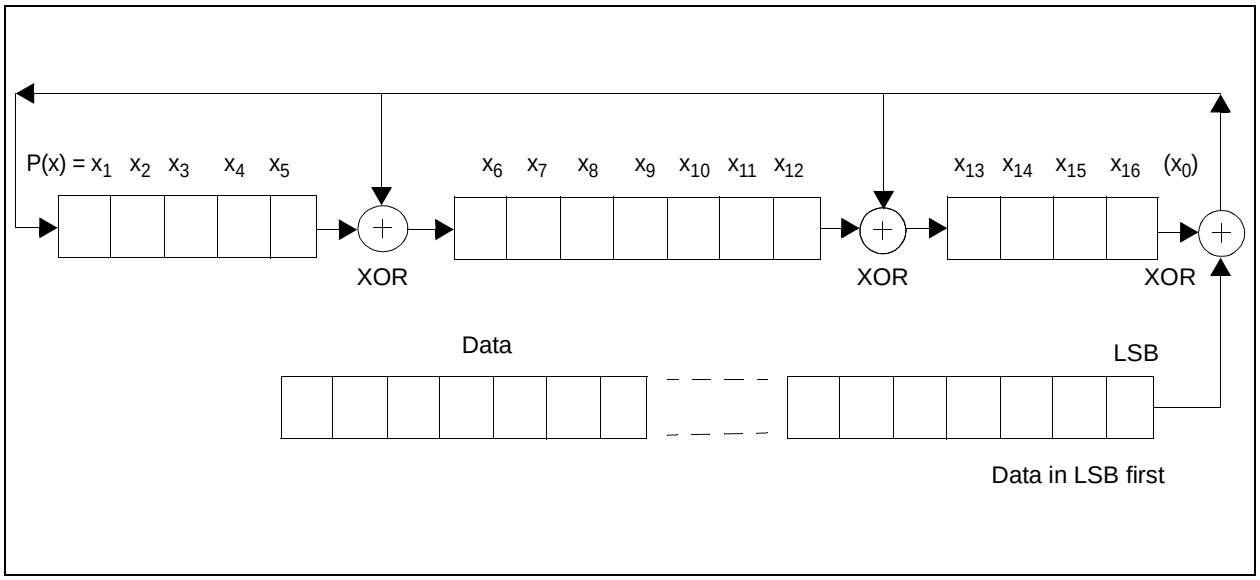
The 13.56 MHz read/write devices (MCRF4XX) use a 16-bit Cyclic Redundancy Code (CRC) to ensure the integrity of data. Its polynomial and initial values are:

CRC Polynomial: $X^0+X^5+X^{12}+X^{16}$ = `1000-0100-0000-1000-(1)` = 8408 (hex)

Initial Value: $FFFF

This polynomial is also known as CRC CCITT-16. The interrogator applies the same polynomial to the incoming and transmitting data.

FIGURE 1: CCITT-16 CRC ENCODER



COMPUTATION ALGORITHM

Figure 1 shows the CCITT-16 CRC encoder. Figure 2 is the computational flow chart for computer programming.

The encoder consists of 16 shift registers and 3 exclusive-OR gates. The registers start with `1111-1111-1111-1111` (or FFFF in hex). The encoder performs XOR and shifts its content until the last bit is entered. The final register's content after the last data bit is the calculated CRC value of the data set.

Example: The following procedure shows a workout example of the CRC calculation using the encoder.

Data: 8552F189 (hex): `0001-1010-1010-0100-1111-1000-1001` (binary, LSB first for each nibble).

Table 1 shows each step of the calculation. The content of the register after the last bit is 07F1. This 07F1 is the calculated CRC of the data.

When transmitting data, this calculated CRC is attached to the data. The interrogator sends the data and CRC with LSN (Least Significant Nibble) first. Therefore, the hex string to be sent will be: 981F25581F70 and for data = 8552F189.

FIGURE 2: FLOW-CHART OF CRC COMPUTATION

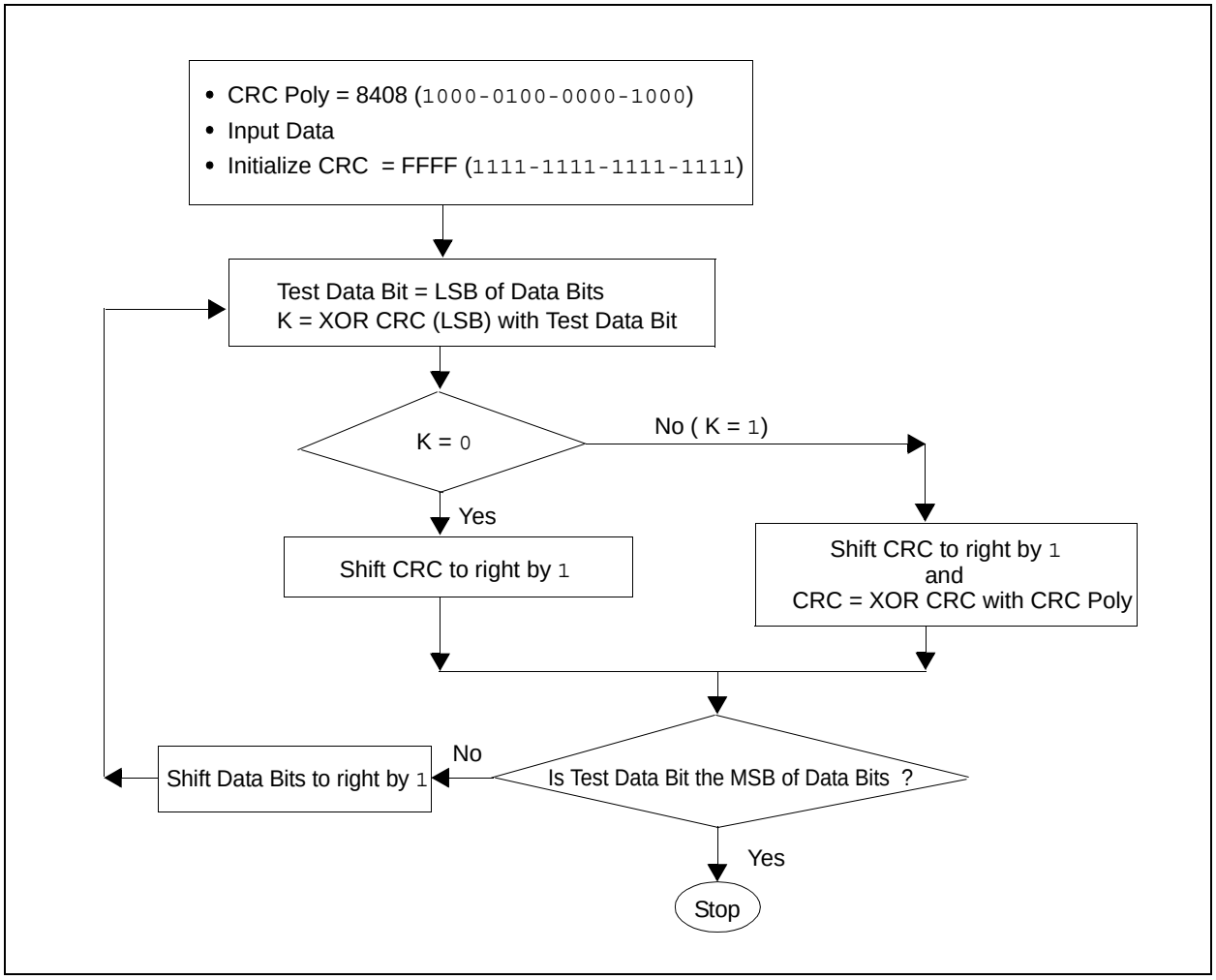


TABLE 1: CRC WORKOUT EXAMPLE FOR DATA = 8552F189 (HEX)

Bit No.	Input Data	Register Contents																	Hex Value
		X_1	X_2	X_3	X_4	X_5	-	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	-	X_{13}	X_{14}	X_{15}	X_{16}	
Initial		1	1	1	1	1	-	1	1	1	1	1	1	1	-	1	1	1	1	FFFF
1	0	1	1	1	1	1	-	0	1	1	1	1	1	1	-	0	1	1	1	FBF7
2	0	1	1	1	1	1	-	0	0	1	1	1	1	1	-	0	0	1	1	F9F3
3	0	1	1	1	1	1	-	0	0	0	1	1	1	1	-	0	0	0	1	F8F1
4	1	0	1	1	1	1	-	1	0	0	0	1	1	1	-	1	0	0	0	7C78
5	1	1	0	1	1	1	-	0	1	0	0	0	1	1	-	0	1	0	0	BA34
6	0	0	1	0	1	1	-	1	0	1	0	0	0	1	-	1	0	1	0	5D1A
7	1	1	0	1	0	1	-	0	1	0	1	0	0	0	-	0	1	0	1	AA85
8	0	1	1	0	1	0	-	0	0	1	0	1	0	0	-	1	0	1	0	D14A
9	1	1	1	1	0	1	-	1	0	0	1	0	1	0	-	1	1	0	1	ECAD
10	0	1	1	1	1	0	-	0	1	0	0	1	0	1	-	1	1	1	0	F25E
11	1	1	1	1	1	1	-	1	0	1	0	0	1	0	-	0	1	1	1	FD27
12	0	1	1	1	1	1	-	0	1	0	1	0	0	1	-	1	0	1	1	FA9B
13	0	1	1	1	1	1	-	0	0	1	0	1	0	0	-	0	1	0	1	F945
14	1	0	1	1	1	1	-	1	0	0	1	0	1	0	-	0	0	1	0	7CA2
15	1	0	0	1	1	1	-	1	1	0	0	1	0	1	-	0	0	0	1	3E51
16	0	1	0	0	1	1	-	0	1	1	0	0	1	0	-	0	0	0	0	9B20
17	1	1	1	0	0	1	-	0	0	1	1	0	0	1	-	1	0	0	0	C998
18	1	1	1	1	0	0	-	0	0	0	1	1	0	0	-	0	1	0	0	E0C4
19	1	1	1	1	1	0	-	1	0	0	0	1	1	0	-	1	0	1	0	F46A
20	1	1	1	1	1	1	-	1	1	0	0	0	1	1	-	1	1	0	1	FE3D
21	1	0	1	1	1	1	-	1	1	1	0	0	0	1	-	1	1	1	0	7F1E
22	0	0	0	1	1	1	-	1	1	1	1	0	0	0	-	1	1	1	1	3F8F
23	0	1	0	0	1	1	-	0	1	1	1	1	0	0	-	1	1	1	1	9BCF
24	0	1	1	0	0	1	-	0	0	1	1	1	1	0	-	1	1	1	1	C9EF
25	0	1	1	1	0	0	-	0	0	0	1	1	1	1	-	1	1	1	1	E0FF
26	0	1	1	1	1	0	-	1	0	0	0	1	1	1	-	0	1	1	1	F477
27	0	1	1	1	1	1	-	1	1	0	0	0	1	1	-	0	0	1	1	FE33
28	1	0	1	1	1	1	-	1	1	1	0	0	0	1	-	1	0	0	1	7F19
29	1	0	0	1	1	1	-	1	1	1	1	0	0	0	-	1	1	0	0	3F8C
30	0	0	0	0	1	1	-	1	1	1	1	1	0	0	-	0	1	1	0	1FC6
31	0	0	0	0	0	1	-	1	1	1	1	1	1	0	-	0	0	1	1	0FE3
32	1	0	0	0	0	0	-	1	1	1	1	1	1	1	-	0	0	0	1	**07F1 (CRC Value)**

APPENDIX A: EXAMPLE WITH C-SOURCE CODE FOR CRC CALCULATION

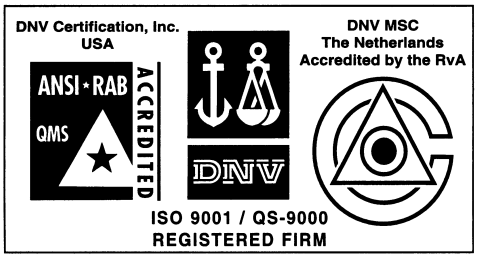
```
# include  <stdio.h>
# include <stdlib.h>
# include "onescnt.h"
# define NULL 0
# define true 1
# define false 0
void main (int argc, char *argv[ ])
{
int i, j, k, message[40], num_bits, bitcount, bytecount, crc, next_bit, crc_temp, message_temp;
int maskreg[8] = {1, 2, 4, 8, 16, 32, 64, 128};
int crc_nibble[4];
char ch
FILE *fin;
if (argc != 2)
{ printf ("proper usage is CCITT {indata file with data in hex}\n"); abort (); }
if ( (fin =fopen(argv[1], "r")) ==NULL)
                {printf("Can't open %s\n", argv[1]; abort();}
i = 0;
while ( (ch=fgetc(fin)) !=EOF)
{
message_temp = 0;
//retrieve the input data field and convert to an integer message field
if ((ch >= 'a') && (ch <= 'f')) ch = ch - 0x20
if ((ch >= 'A') && (ch <= 'F')) ch = ch - 0x70
if ((ch >= '0') && (ch <= '?'))
{
message_temp = ch - '0';
 message[i++] = message_temp;
}
}
// At this point, message[ ] holds data with nibbles (4 bits on each array). This will be used for
CRC calculation
message[ i ] = -1;
k = i
// The above is used for array checking and k value is the total number of nibbles.
printf ("Read in %d nibbles. \n", k);
printf ("Original data in hex read in from data file: \n");
 for (i = 0; i < k; i++)
printf("%x ", message[ i ]);
printf("\n\n");

// Now computing the CRC of data
//----------- Initialization ------------------------------
crc = 0xffff; //initial CRC value
crc_poly = 0x8408; //1000-0100-0000-1000
//-------------------------------------------------------
printf ("Initial  CRC value in hex: %x ... \n", crc);
num_bits = k*4;
for ( i = 0; i < num_bits; i++)
{
bitcount = i % 4;
bytecount = i/4;
next_bit = (message[bytecount] & maskreg[bitcount]); //This will find the next data bit to apply
next_bit = ((next_bit >> bitcount) & 1); //This will move the current data bit to LSB of next_bit
// and make all bits except LSB bit to zero
crc_temp = crc^next_bit; //xor the last nibble of crc (actually the last bit of CRC) with next_bit
if (crc_temp & 1)
{
printf ("xor = 1\n");
crc = crc >> 1; //Shift the crc by 1 to right
crc = crc^crc_poly ; //xor current crc with crc_poly
```

```
crc = crc|0x8000; //this may not be necessary
}
// if it is zero, just shift crc by 1
if (!(crc_temp &1))
{
printf ("xor = 0\n");
crc = crc >> 1;
crc = crc & 0x7fff;// this may not be necessary
}
printf("Temp CRC after iteration %d: ", i);
for (j = i; j<num_bits; j++)
printf("  ");
}
printf("%d\n", crc);
}
crc_nibble [0] = crc & x000f;
crc_nibble [1] = (crc & x000f >> 4;
crc_nibble [2] = (crc & x000f >> 8;
crc_nibble [3] = (crc & x000f >> 12;
printf("Bit order for shifting in nibbles in LSB first. \n");
printf ("\n CRC at end: %x  ", crc);
printf ("Send %x %x %x %x \n", crc_nibble[0], crc_nibble[1],crc_nibble[2],crc_nibble[3],);
printf("\n\n");
fclose(fin);
}
```

NOTES:

Trademarks



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