AN2957
Application note

Implementing an RC5 infrared transmitter using the IR timer modulator of the STM8L10x microcontroller

Introduction

IR (infrared) light is a popular means of wireless communication for remote control applications. Many different protocol standards such as RC5, RC5x, RC6,… exist for transmitting commands via an infrared wireless interface.

This application note describes the widely-used RC5 coding scheme from Philips and presents a full working solution that implements a remote control device.

This application uses the STM8L10x microcontroller, it contains a powerful hardware modulator called IRTIM that combines signals from two internal timers to drive the IR interface. This feature makes the microcontroller especially well suited for applications that require IR signal generation capability.

Contents

1 STM8L10x IR interface description

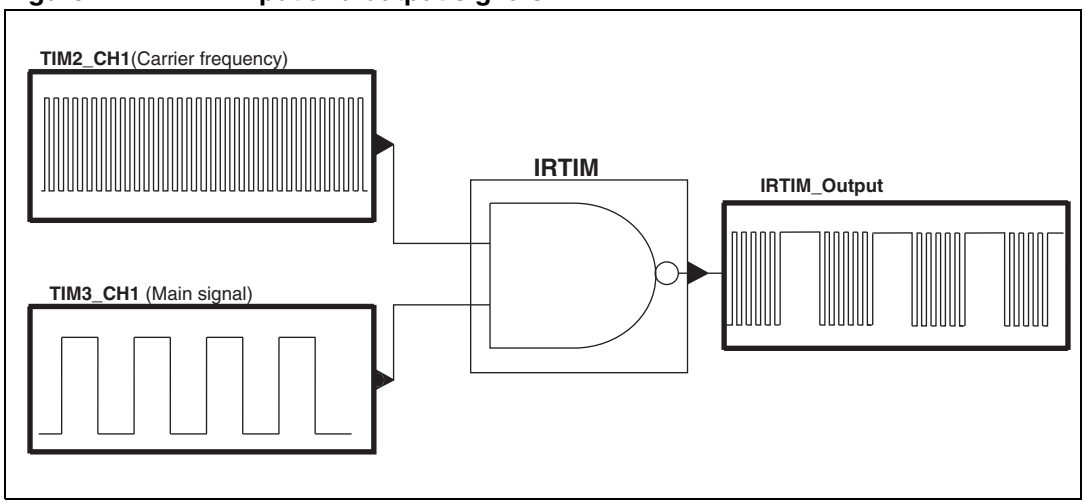
The IR digital interface is designed to output a digital signal to an infrared diode driver circuit.

It can output a signal using any of the existing modulation styles, the modulation style is dependent on the software algorithm.

The IR interface is very easy to configure and it uses 2 signals provided by two of the STM8L10x timers (TIM2 and TIM3).

TIM2 is used to provide the Carrier Frequency and TIM3 provides the actual signal to be sent.

Figure 1. IRTIM input and output signals



2 RC5 coding scheme

The RC5 coding scheme from Philips is a standard in infrared wireless command transmission.

The RC5 coding scheme can generate 2048 different commands organized on 32 groups, each group has 64 different commands.

The RC5 frame is a 14-bit word, composed of 3 parts:

- Header (3 bits)
- Device Address (5 bits)
- Device Instruction (6 bits)

The bits are transmitted in bi-phase code (also known as Manchester code) as shown in *Figure 3*.

The RC5 carrier frequency is 36 kHz.

Figure 2. RC5 frame format

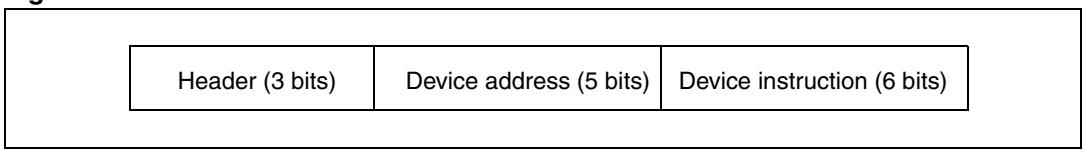
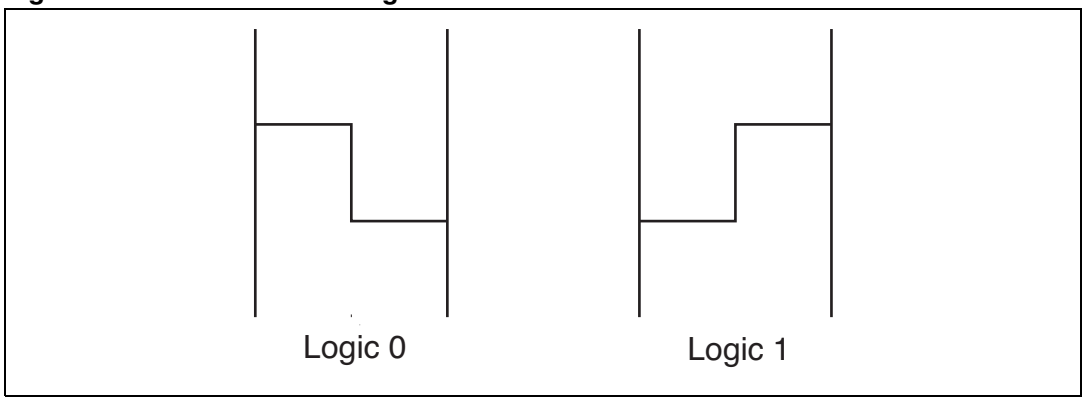


Figure 3. Manchester coding



2.1 Frame header description

The frame header is composed of three bits: The two first bits are start bits, which always have the value "1". The next bit is a control bit, which is toggled every time a button is pressed on the remote control transmitter (to determine whether a button is pressed and held down, or pressed and released continuously).

Figure 4 and *Figure 5* show examples of RC5 frame headers:

Figure 4. Frame header 1

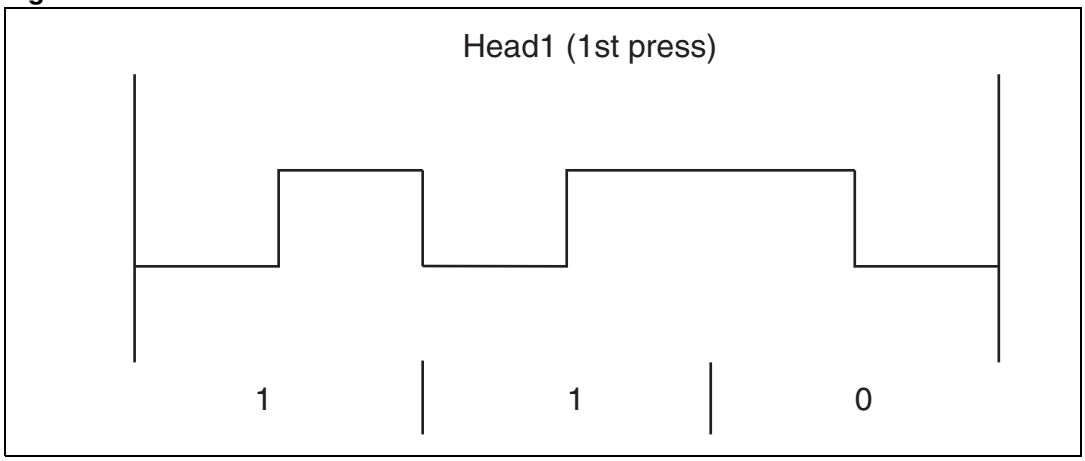
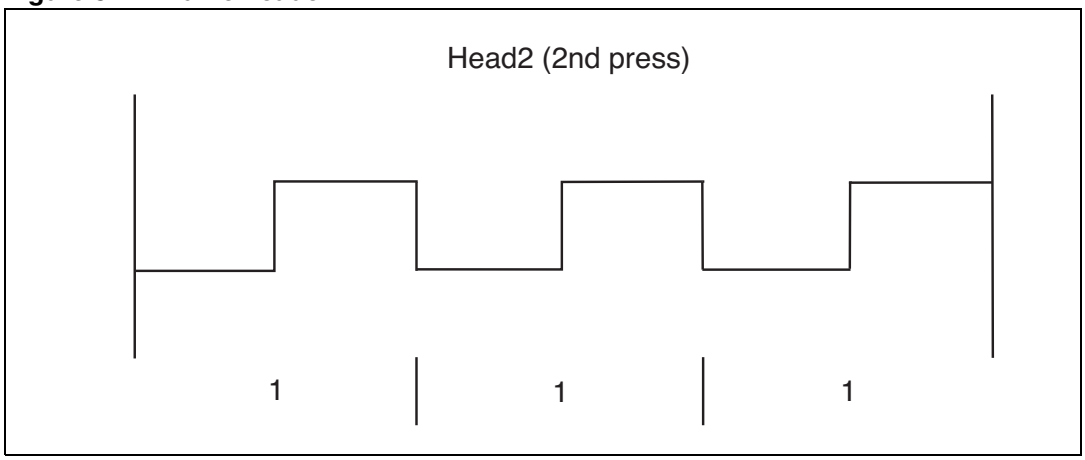


Figure 5. Frame header 2



2.2 Device addresses

The device address sequence is five bits long, allowing the control of up to 32 devices (2^5 = 32 addresses). *Table 1* gives the addresses of the controlled devices.

Table 1. RC5 device addresses

Address	Device
0	TV1
1	TV2
2	Videotext
3	Extension for TV1 and TV2
4	Laser vision player
5	VCR1
6	VCR2
7	Reserved
8	SAT1
9	Extension for VCR1 and VCR2
10	SAT2
11	Reserved
12	CD-video
13	Reserved
14	CD-photo
15	Reserved
16	Audio1 preamplifier
17	Tuner
18	Analogical magneto cassette
19	Audio2 preamplifier
20	CD
21	Rack audio
22	Satellite receiver
23	DCC Magneto
24	Reserved
25	Reserved
26	CD writable
27 to 31	Reserved (for experimental use)

2.3 Device instructions

The instruction sequence is six bits long, allowing up to 64 (2^6) different instructions per address.

There are two groups of instructions, the first group is common for all devices, the second group is reserved for television devices (TV1 and TV2).

Common instructions are given in *Table 2* and TV instructions are given in *Table 3*.

Table 2. RC5 common instructions

Common instruction	Description
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
16	Volume +
17	Volume -
18	Brightness +
19	Brightness -
20	Color saturation +
21	Color saturation -
22	Bass +
23	Bass -
24	Treble +
25	Treble -
26	Balance right
27	Balance left
63	System select

Table 3. RC5 TV instructions

TV Instruction	Description
10	1/2/3 digits / 10
11	Freq./prog./ch./11
12	Standby
13	Mute/de-mute
14	Personal pref.
15	Display
28	Contrast +
29	Contrast -
30	Search +
31	Tint/hue -
32	Ch./Prog. +
33	Ch./Prog. -
36	Spatial stereo
37	Stereo/mono
38	Sleep timer
39	Tint/hue. +
40	RF switch
41	Store/execute/vote
42	Time
43	Scan fwd./increment.
44	Decrement
46	Sec con/menu
47	Show clock
48	Pause
49	Erase/correct
50	Rewind
51	Go to
52	Wind
53	Play
54	Stop
55	Record
56	External 1
57	External 2
59	Advance
60	TXT sub-mode/12

Table 3. RC5 TV instructions (continued)

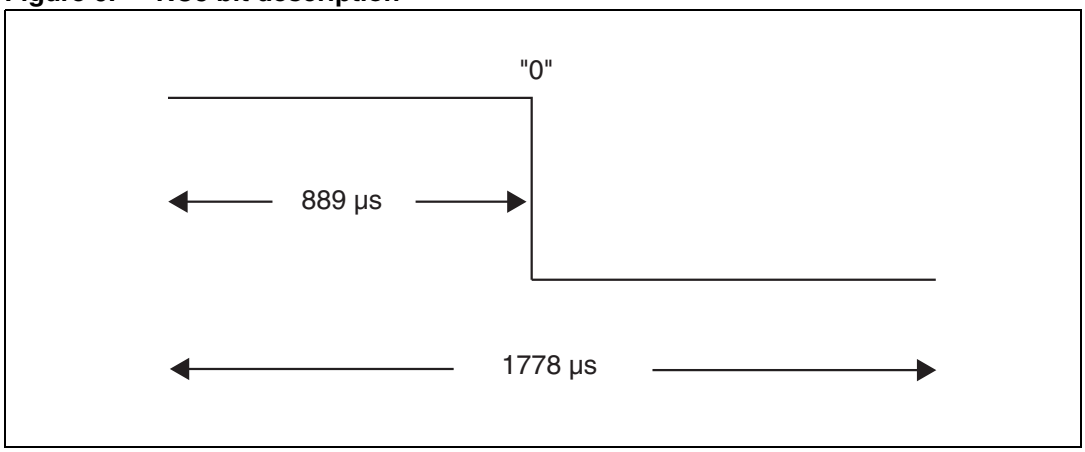
TV Instruction	Description
61	Sys. Standby
62	Crispener

2.4 Bit descriptions

RC5 bits are Manchester coded, this means that a bit is composed of 2 alternated half bits. A low to high transition means that the bit is "1", a high to low transition means "0".

The frequency used to code a bit is 562.429 Hz (1778 µs), half bits have the same width (889 µs each).

Figure 6. RC5 bit description

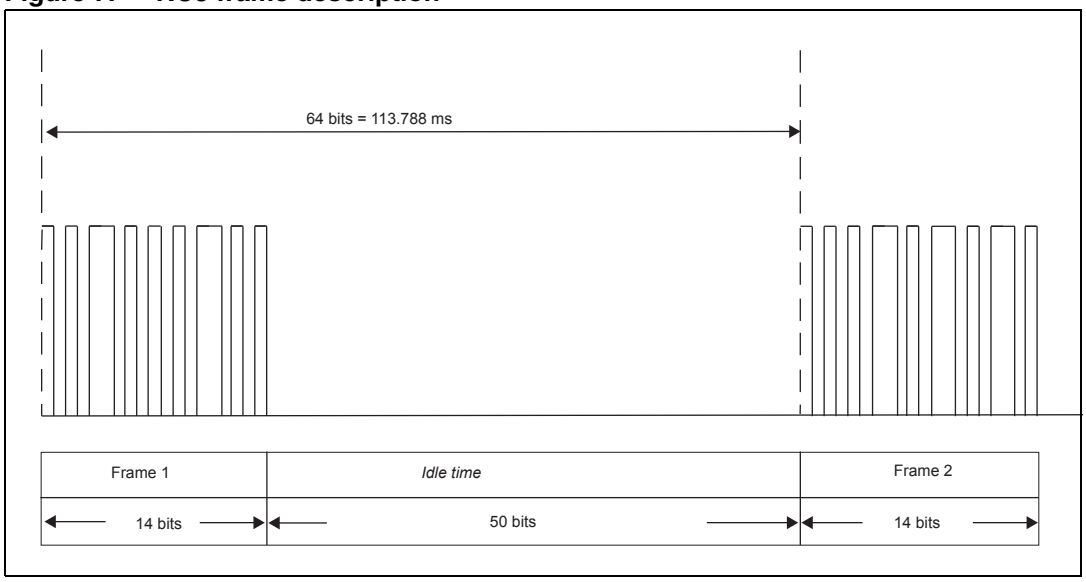


2.5 RC5 frames

RC5 frames are composed of 14 bits, the width of a frame is 24.892 ms (14 x 1.778 ms = 24.892 ms)

To avoid frame collisions, an idle time is inserted between two frames with a specific width. The idle time is defined as 50 bits wide. So the periodicity of a frame is 64 x 1 bit width: 64 x 1.778 = 113.792 ms (exactly 113.788 ms).

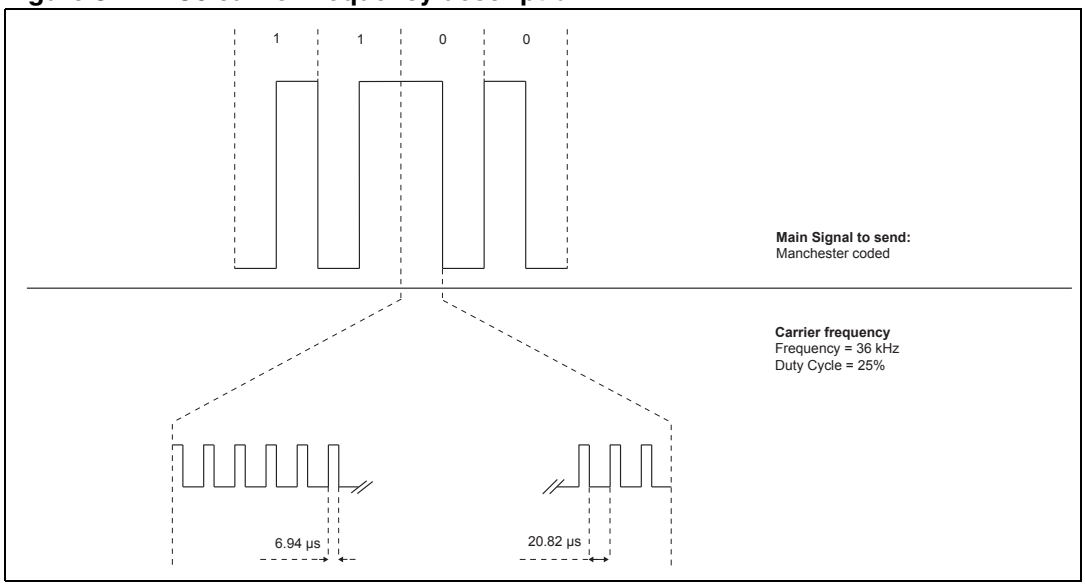
Figure 7. RC5 frame description



2.6 RC5 carrier frequency

The RC5 carrier frequency is 36 kHz. To minimize the power consumption, the duty cycle used for a pulse is fixed at 25%, so the width of a pulse is 6.94 µs.

Figure 8. RC5 carrier frequency description



3 Software description

3.1 Introduction

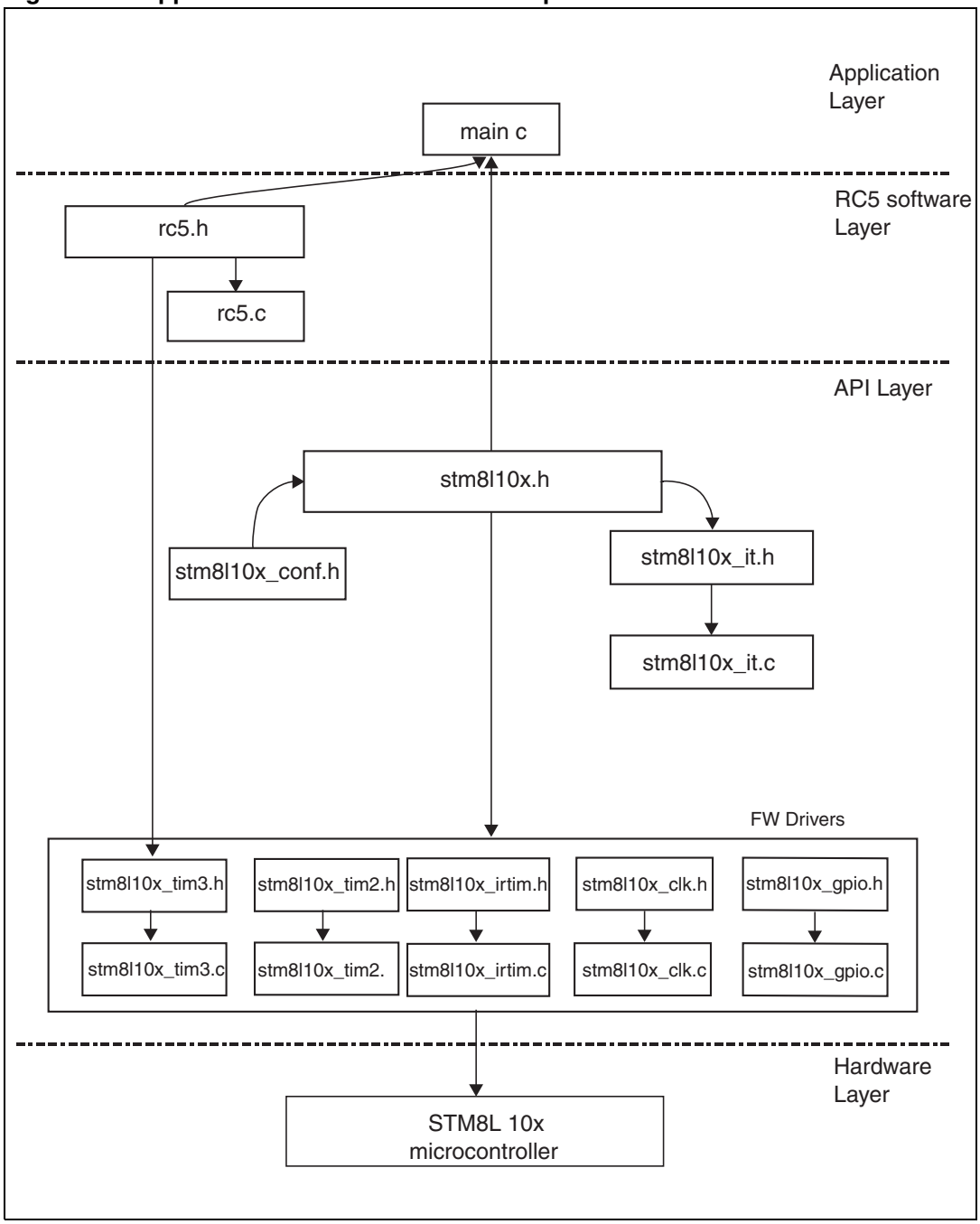
The software provided with this application note enables the user to send all RC5 instructions to all RC5 receiver devices. It contains an RC5 driver with functions and software flags.

The software is designed to avoid frame collisions; an idle time is inserted between two frames with a specific width (50 bits).

The application uses 5 peripherals:

- IRTIM: (IR interface with timers) generates the IR signal using TIM2 and TIM3
- TIM2: (Timer2) provides the Carrier signal with a frequency of 36 kHz
- TIM3: (Timer3) provides the main signal to be sent (RC5 Frame)
- GPIO: (General purpose I/O) provides the I/O to be connected to the buttons of the the remote control
- CLK: (Clock controller) enables the clocks and provides the correct clock frequency for the timers

Figure 9. Application architecture and description



3.2 RC5 functions

RC5_BinFrameGeneration function

Generates and returns a binary format of the RC5 frame: the flowchart of this function is described below

```
uint16_t RC5_BinFrameGeneration ( RC5_Address_TypeDef RC5_Address,
                                  RC5_Instruction_TypeDef RC5_Instruction,
                                  RC5_Ctrl_TypeDef RC5_Ctrl)
```

RC5_ManchesterConvert function

Converts an RC5 binary format Frame to a RC5 Manchester format frame.

```
uint32_t RC5_ManchesterConvert (uint16_t RC5_BinaryFrameFormat)
```

RC5_SendFrame function

Sends a Manchester Format RC5 Frame.

```
void RC5_SendFrame(uint32_t RC5_ManchesterFrameFormat)
```

RC5_CtrlBitReverse function

Reverses the state of the RC5 Control bit (can be used to determine whether a button is pressed and held down, or pressed and released continuously).

```
RC5_Ctrl_TypeDef RC5_CtrlBitReverse(RC5_Ctrl_TypeDef RC5_Ctrl);
```

3.3 RC5 flags

Table 4. RC5 flags

Flag name	Flag description
Send_Operation_Completed Flag	0: The RC5 frame is not completely sent
	1: The RC5 frame is completely sent
Send_Operation_Ready Flag	0: The RC5 frame is not yet ready to be send
	1: The RC5 frame is ready to be send

3.4 Application flowcharts

Figure 10. Main loop flowchart

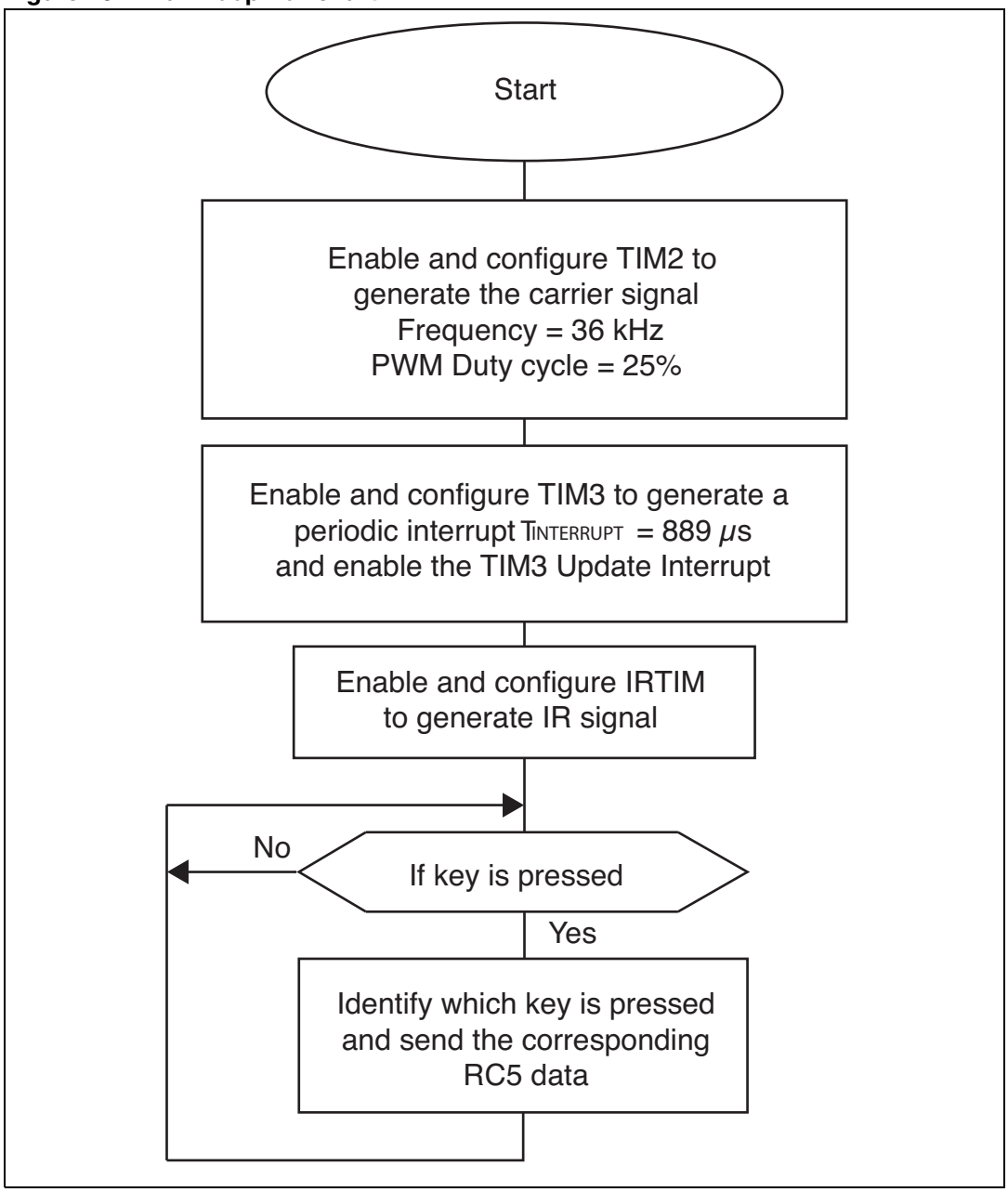


Figure 11. Send frame function flowchart

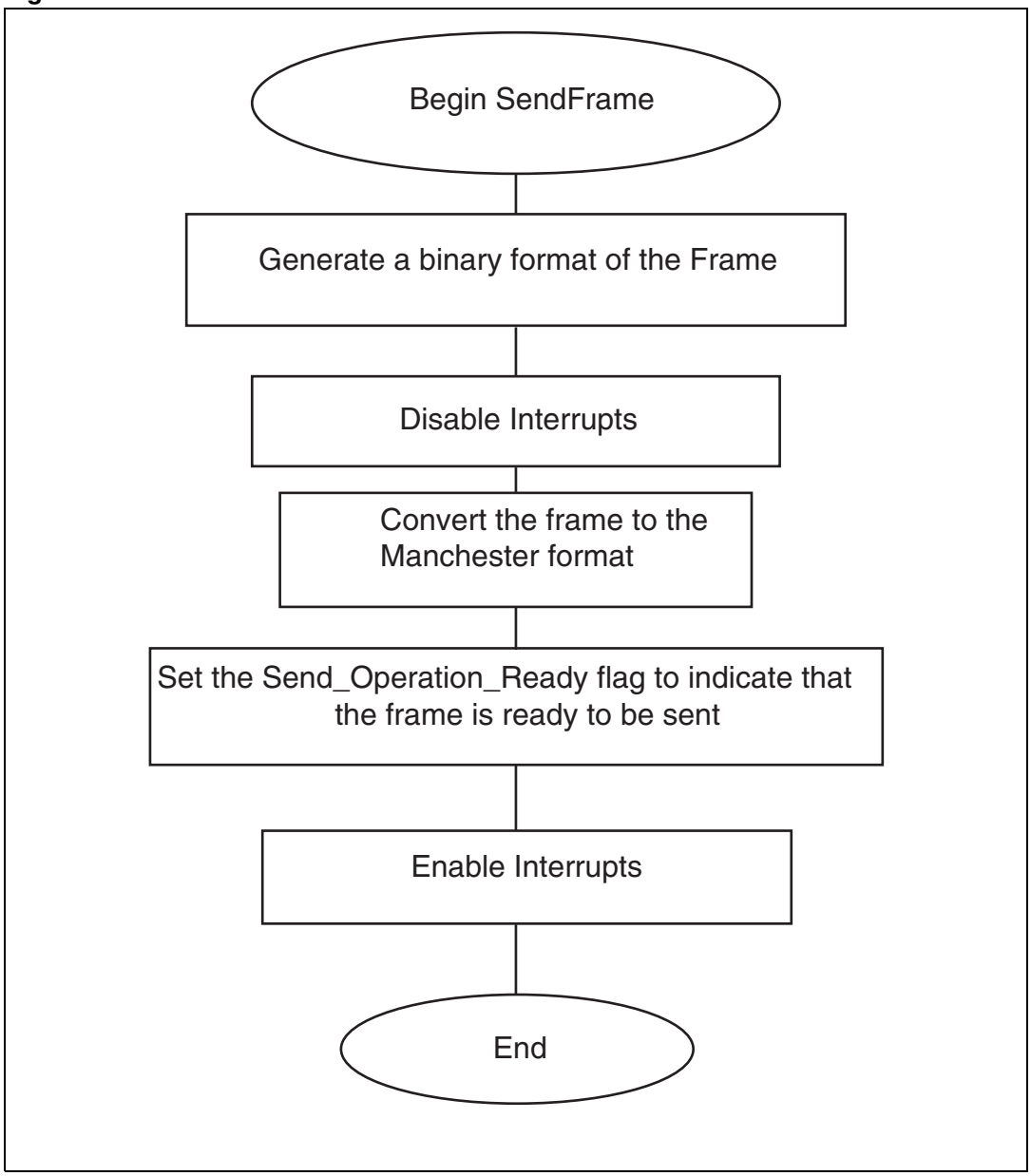
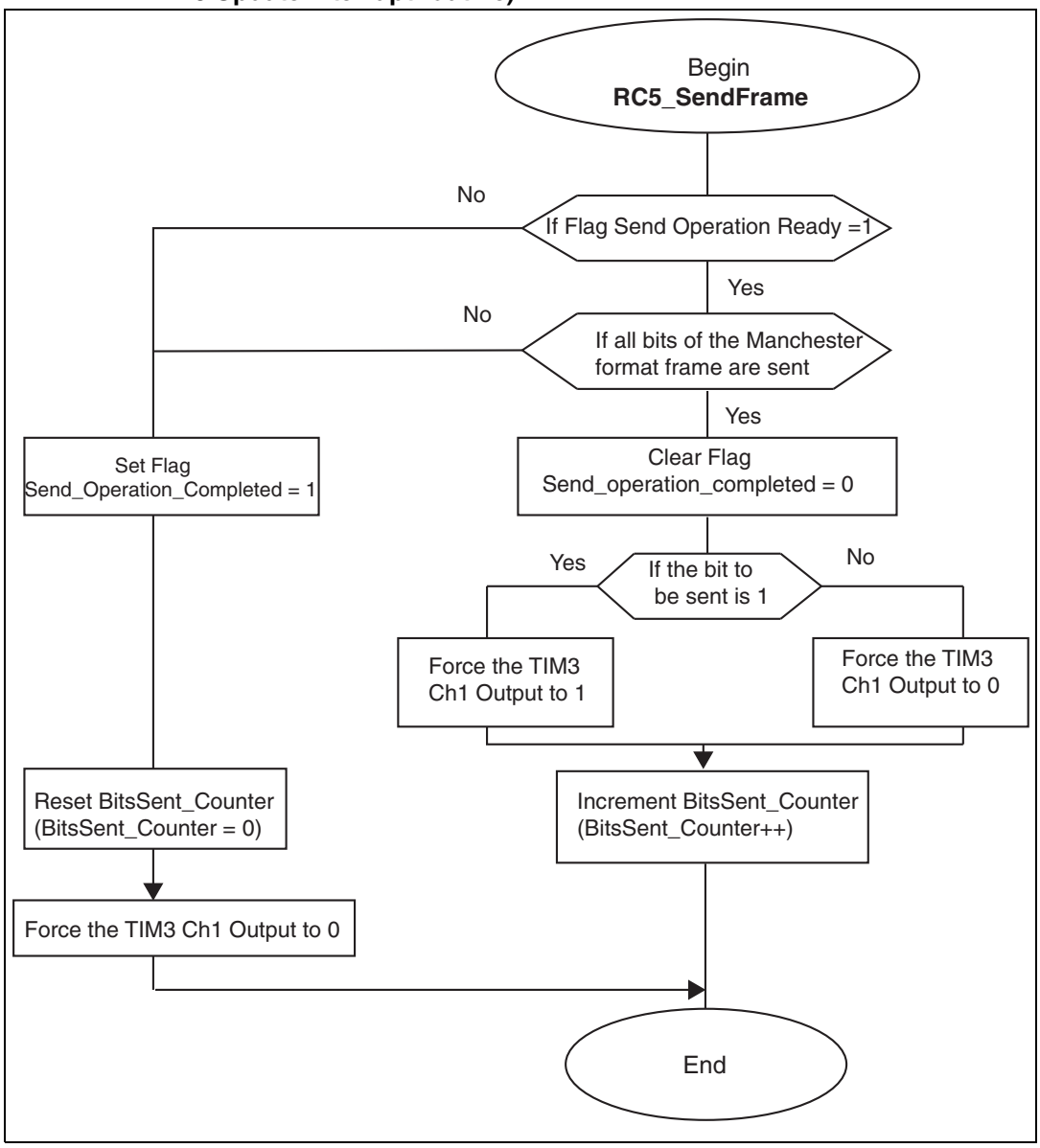


Figure 12. RC5 SendFrame function flowchart (this function is called during the TIM3 Update Interrupt routine)



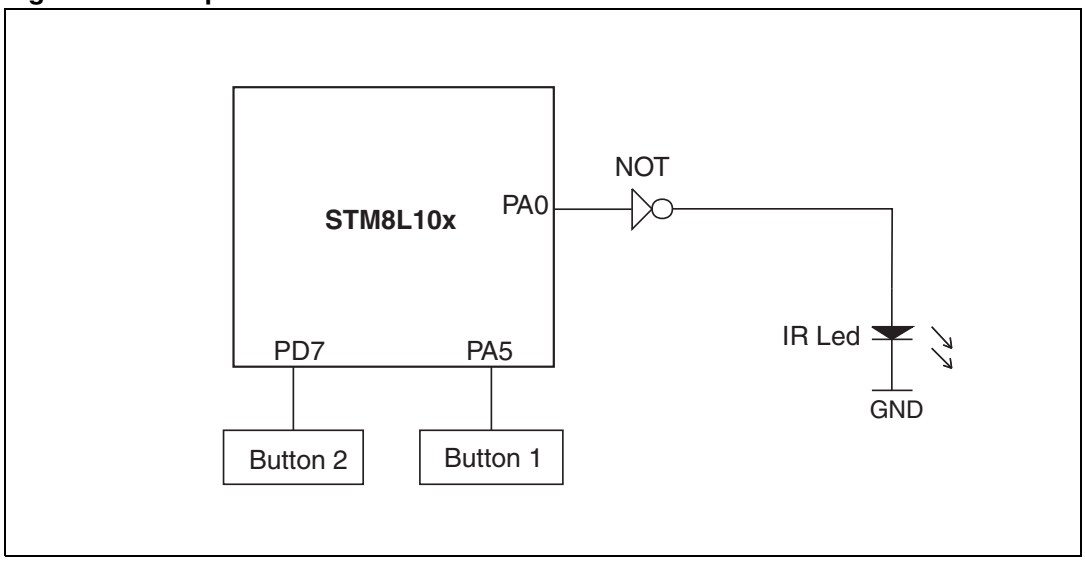
4 Application description

This Application note is provided with a basic application in which only two keys are used for remote control:

- Button 1 (PA5) enables user to send "VolumeUp" RC5 Instruction to "TV1" (Key button on STM8L1X-EVAL Board).
- Button 2 (PD7) enables user to send "VolumeDown" RC5 Instruction to "TV1" (Joystick Select button on STM8L1X-EVAL Board).

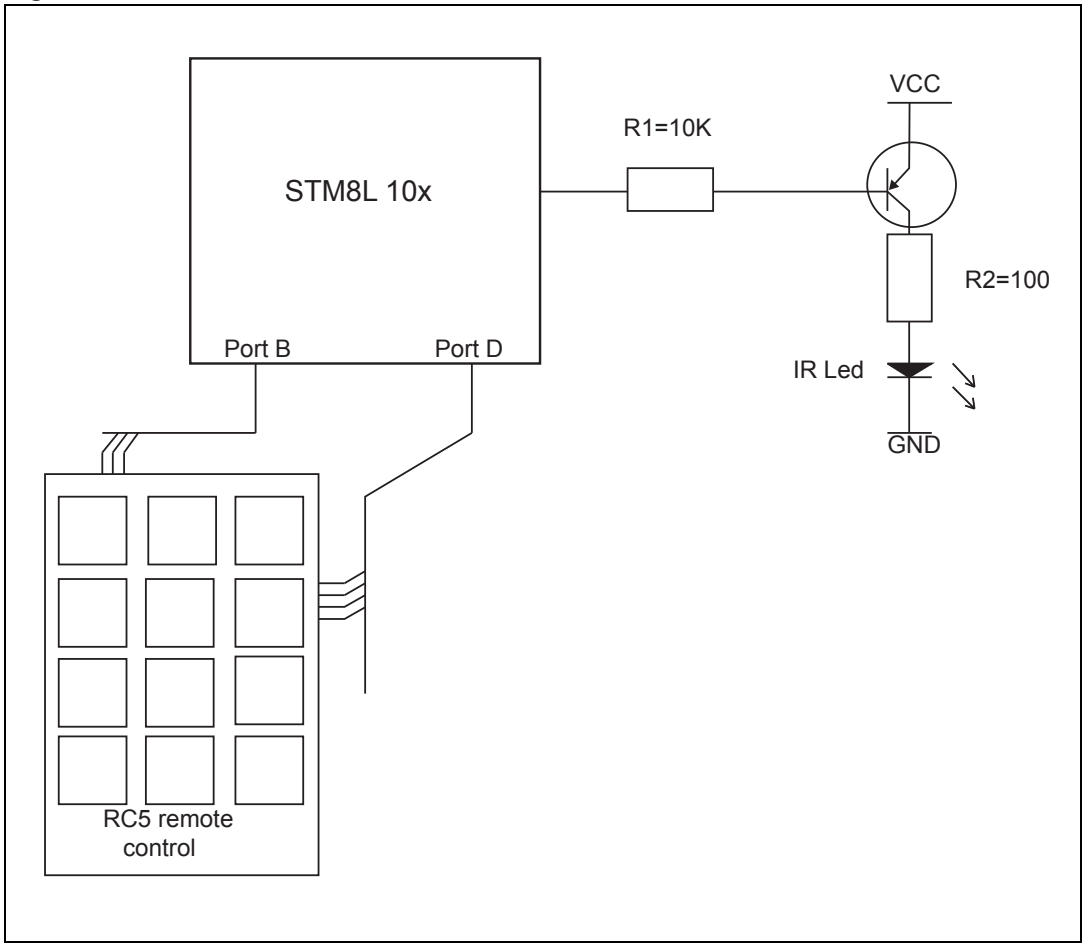
However, user can implement a bigger remote control to fit its application needs.

Figure 13. Simplified RC5 transmitter



5 Hardware description

Figure 14. RC5 transmitter



6 Revision history

Table 5. Document revision history

Date	Revision	Changes
23-Apr-2009	1	Initial release.
04-Jun-2010	2	Removed several common instructions (from 71 to 124) in *Table 2: RC5 common instructions on page 7* Removed several TV instructions (from 70 to 127) in *Table 3: RC5 TV instructions on page 8*