

Overview

This document describes a Z8051-based DMX512-A Receiver reference design built with Zilog's Z51F0811 MCU. This receiver functions mainly as a light controller and, alternately, as a sound generator. As a lighting device, the receiver obtains data from the DMX controller that manages the display of four high-bright LEDs using the Z51F0811 MCU's PWM function. As a sound generator, the receiver activates a speaker that is connected to the Z51F0811 MCU's buzzer driver. The UART peripheral of the Z51F0811 MCU is used to connect the DMX512-A receiver to the DMX512-A controller.

The DMX512-A Receiver reference design is shown in Figure 1.



Figure 1. The DMX512-A Receiver Reference Design

- **Note:** The source code file associated with this reference design, [RD0015-SC01.zip](#), is available free for download from the Zilog website. This source code has been compiled using Keil μ Vision4 development tool, which is available from Keil.

Features

This DMX512-A Receiver reference design offers the following features:

- Configurable DMX base slot address via six-position DIP switch
- Optically-isolated DMX512-A interface
- Four high-brightness LEDs
- Buzzer for generating sound output
- Ability to manipulate NULL start code (0) and alternate start code (207)

Potential Applications

Use this DMX512-A Receiver reference design to develop a variety of lighting applications, as the following examples suggest:

- Dimmer light controls
- Changing color light controls
- Moving light controls
- Light sequence controls
- Goes Before Optics (GOBO) lighting devices

Discussion

This section discusses the DMX512-A Receiver reference design hardware and software architectures.

Hardware

The DMX512-A Receiver reference design is based on the 28-pin Z51F0811 microcontroller, which manages all functions related to the operation of this receiver. As the block diagram in Figure 2 shows, the Receiver design takes advantage of the specific peripherals of the MCU. The Z51F0811 microcontroller features four PWM channels for the LEDs, a buzzer driver for the buzzer/speaker, and a UART device for the DMX controller. The 8 MHz internal oscillator is used as a system clock. The unused GPIOs are used to address the Receiver.

The Receiver hardware is fabricated on a single circuit board and made as small as possible, as shown in [Figure 3](#) on page 4. This reference design can either be powered externally via a wall-mounted power supply ranging from 7V–12V or through a USB serial interface. A selector switch is implemented to allow for selection of the power source.

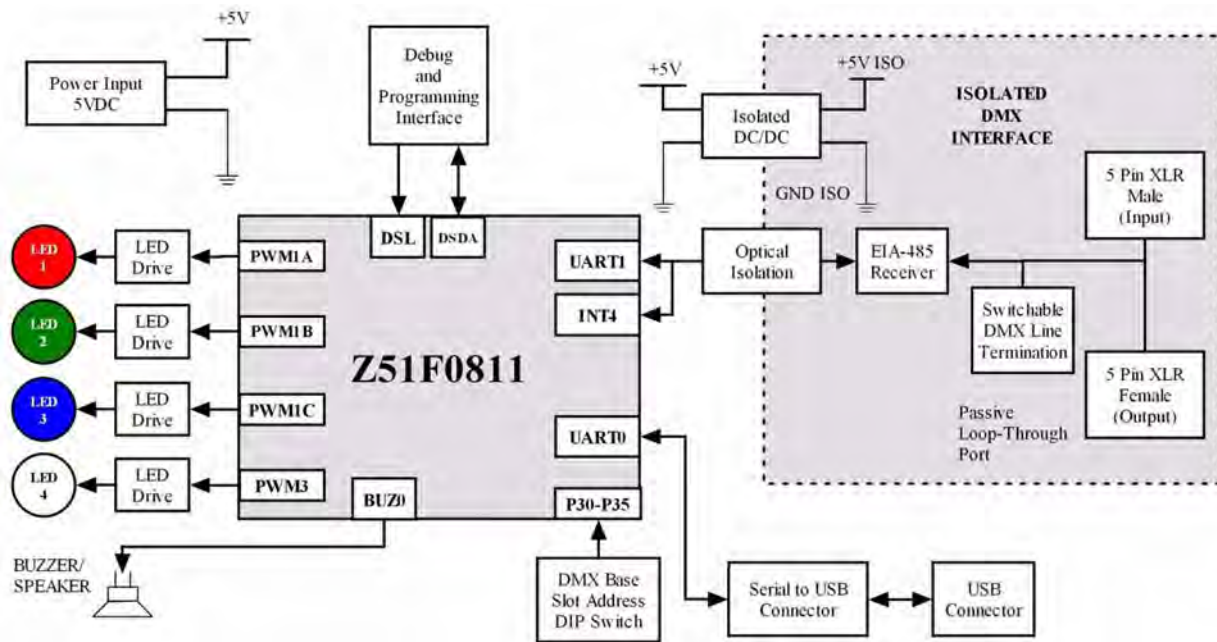


Figure 2. DMX512-A Receiver Reference Design Block Diagram

The DMX interface of the DMX512-A Receiver is optically isolated using an IXYS optocoupler and a DC/DC converter that meets the 30V AC/42VDC isolation requirement of the DMX specification. An on/off switchable line termination for both the primary and the secondary data links is provided. The DMX specification requires a 5-pin male XLR connector to be used as input to the receiver and a 5-pin female XLR connector to be used for the output.

The DMX512-A Receiver is designed to control four high-brightness LEDs. Three of these LEDs (red, green, and blue) are controlled by three PWM outputs from the Timer 1 peripheral. A fourth LED (white) is controlled by the PWM output from the Timer 3 peripheral. The brightness of these LEDs depends on the PWM duty cycle output of these timer peripherals.

Additionally, four FET drivers are used to interface with these LEDs.

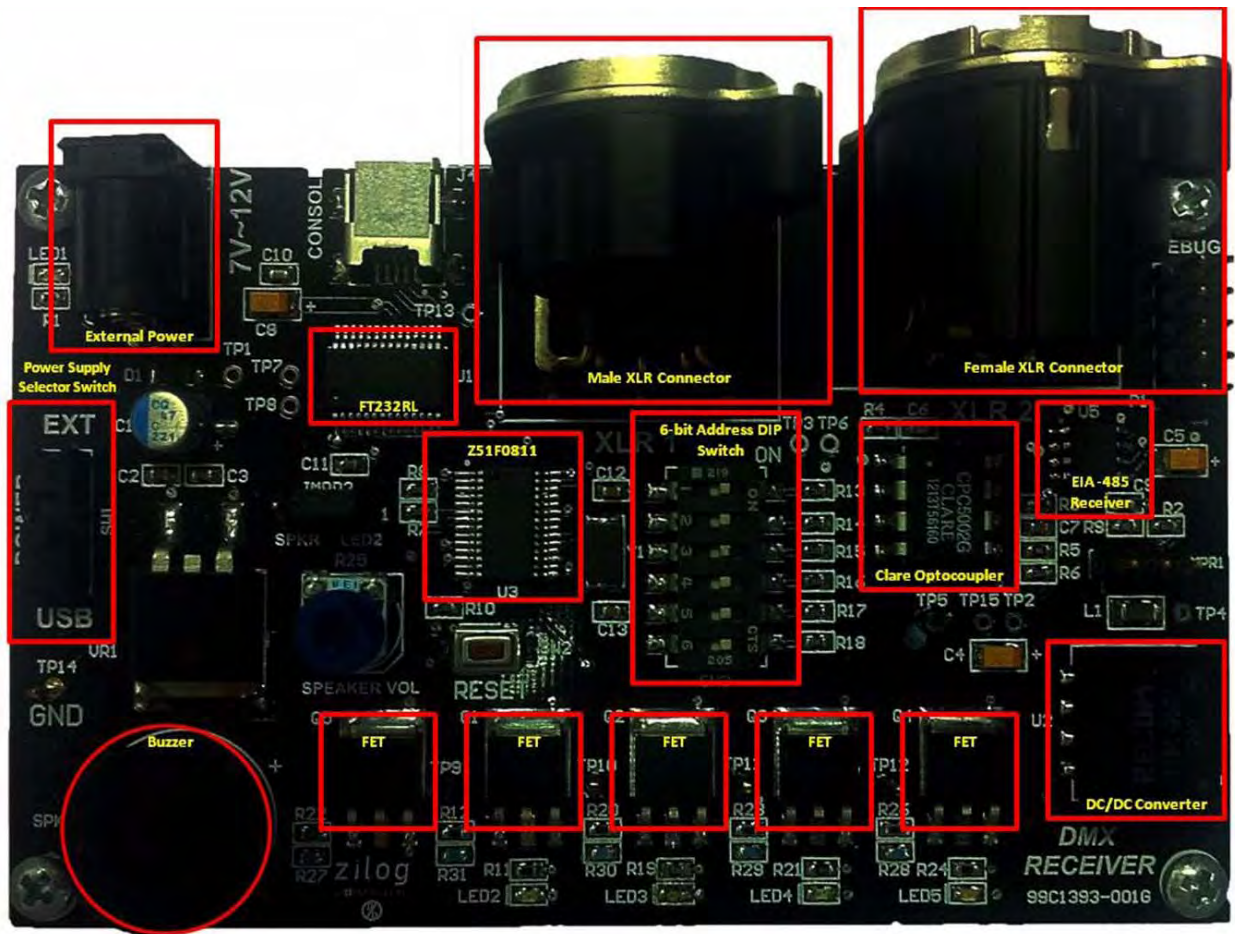


Figure 3. Top View of the DMX512-A Receiver Reference Design

Each LED occupies one DMX slot address. This address is an offset from the DMX base slot address defined by the 6-position DIP switch. Figure 4 shows the DIP switch used in this reference design.



Figure 4. The 6-Position DIP Switch for Setting the DMX512-A Receiver Address

The 6-position DIP switch can be configured in 64 different settings. Each setting assigns each LED with an equivalent DMX address or channel. Examples of these switch settings and the LED-equivalent DMX addresses are shown in Table 1.

Table 1. DMX512-A Receiver Addressing

Switch Settings						DMX Receiver Base Address	LED Channel			
1	2	3	4	5	6		Red	Green	Blue	White
ON	ON	ON	ON	ON	ON	1	CH1	CH2	CH3	CH4
OFF	ON	ON	ON	ON	ON	2	CH2	CH3	CH4	CH5
ON	OFF	ON	ON	ON	ON	3	CH3	CH4	CH5	CH6
OFF	OFF	ON	ON	ON	ON	4	CH4	CH5	CH6	CH7
		•				•			•	
		•				•			•	
		•				•			•	
		•				•			•	
OFF	OFF	OFF	OFF	OFF	OFF	64	CH64	CH65	CH66	CH67

An additional function of this reference design is the ability to generate sound via the buzzer driver of the Z51F0811 MCU. A buzzer/speaker is connected to the BUZ0 pin of the MCU. A 3-pin header is used to switch between the PWM1BA and BUZ0 functions.

Software

The software provided for this reference design is developed using Keil μ Vision v4.72.9.0. The software is tested on the hardware per the schematic diagram shown in [Appendix A. Schematic Diagram](#) on page 16. This section describes the functionality of this reference design's multiple software blocks.

To learn more about this software, refer to the firmware contained in the [RD0015-SC01.zip](#) file, which includes the following files:

main.c

- Software main routine, the starting point of the program
- Initialization of the peripherals used
- Main program loop

osc.c

- System clock initialization

uart.c

- UART0 initialization
- UART0 transmit routine
- UART0 receive routine

pwm.c

- PWM initialization routine
- PWM output generation

buzzer.c

- Buzzer driver initialization routine
- Buzzer driver output generation

dmxline.c

- UART1 initialization
- UART1 interrupt service routine
- DMX break detection routine
- DMX data read routine

startcode.c

- LED brightness control/buzzer sound generation control
- DMX system information packet display

Light Control

The DMX512-A Receiver functions mainly as a light controller. Figure 5 presents a high-level code flow of the light controlling routine.

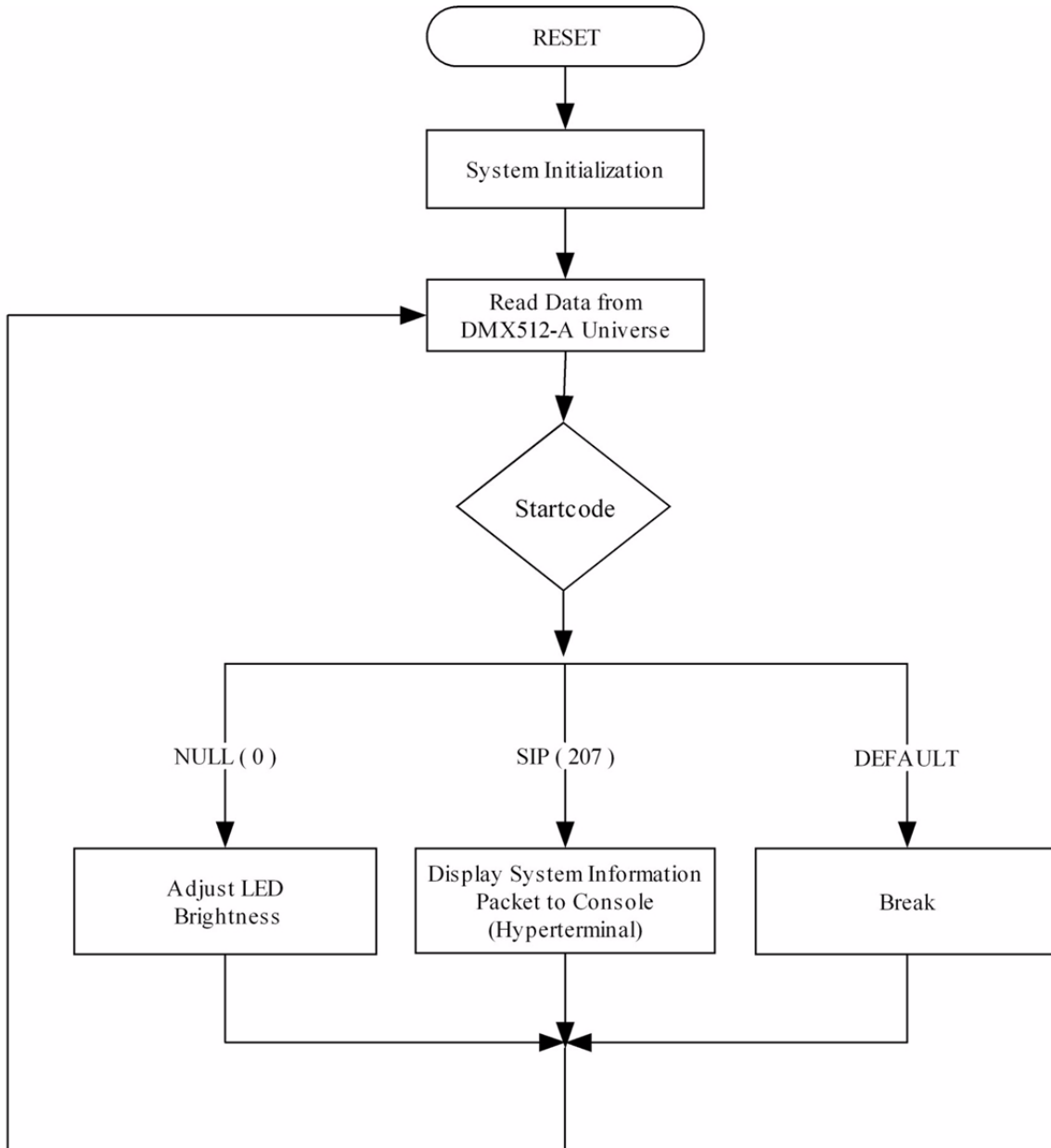


Figure 5. Code Flow for a Light Controller Routine

The flow chart in Figure 6 presents a more detailed flow of the main application loop.

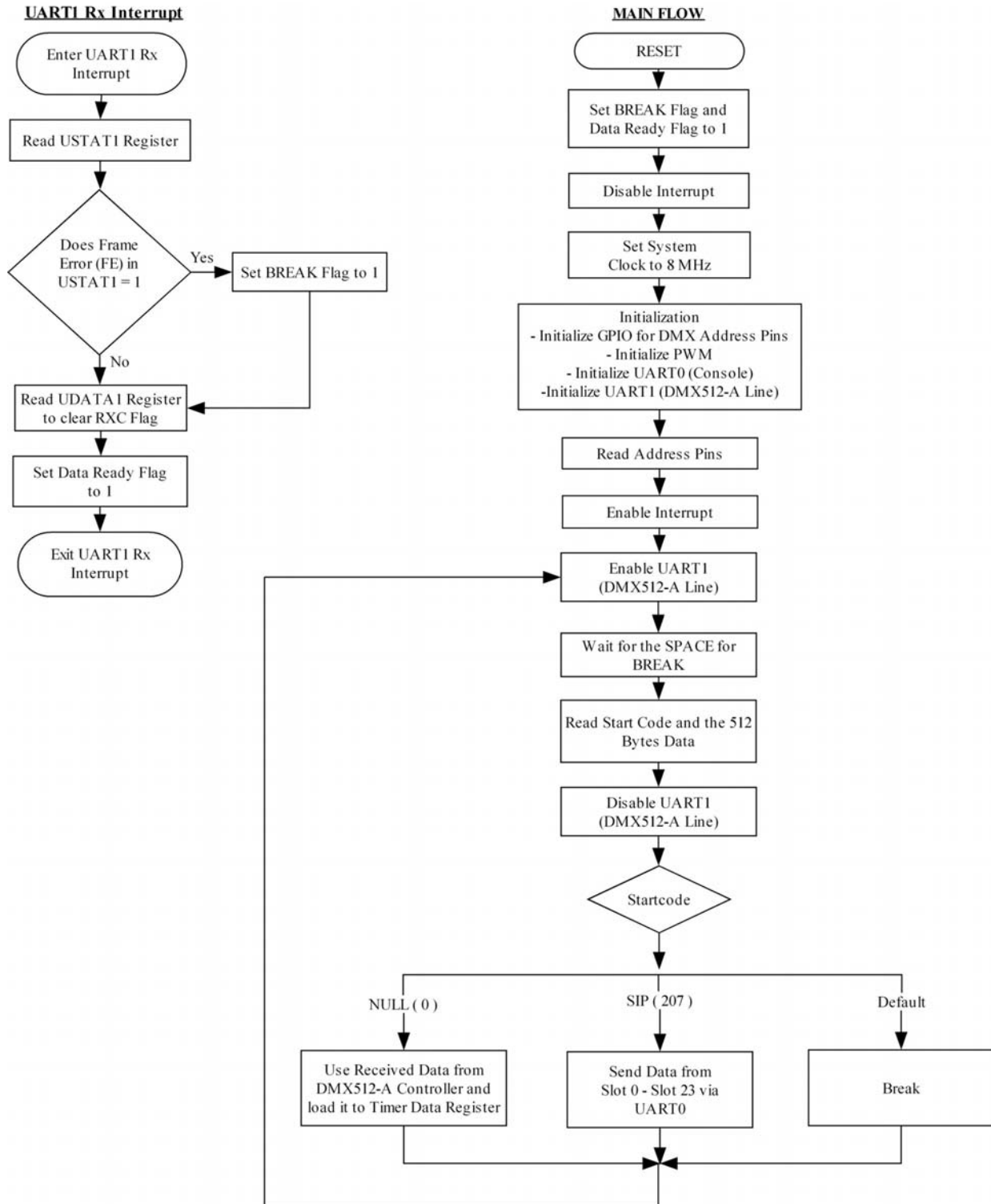


Figure 6. DMX512-A Receiver Reference Design Code Flow

The flow chart in Figure 7 shows a detailed flow for detecting the *Space for Break*, which marks the start of the DMX512-A data transmission.

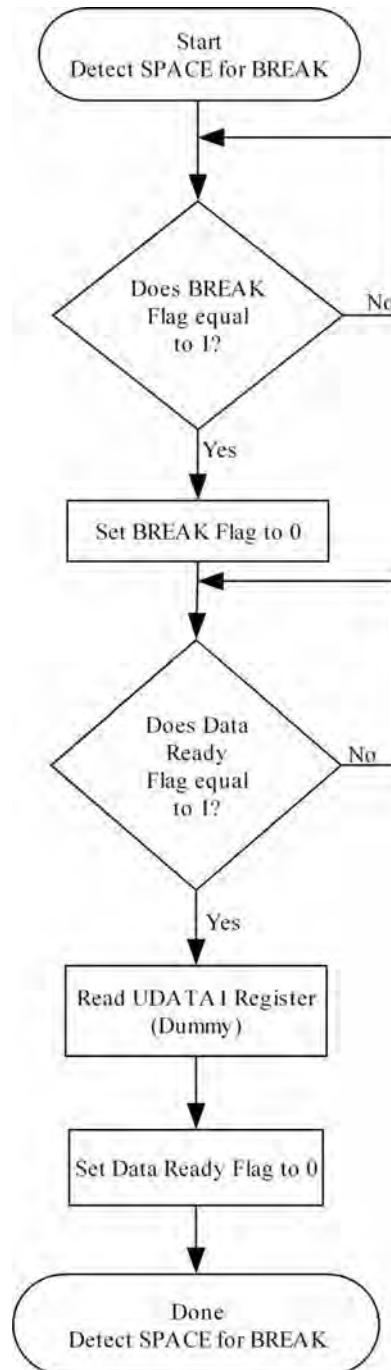


Figure 7. Space for Break Detection Code Flow

The flow chart in Figure 8 shows a detailed flow of reading the DMX512-A packets.

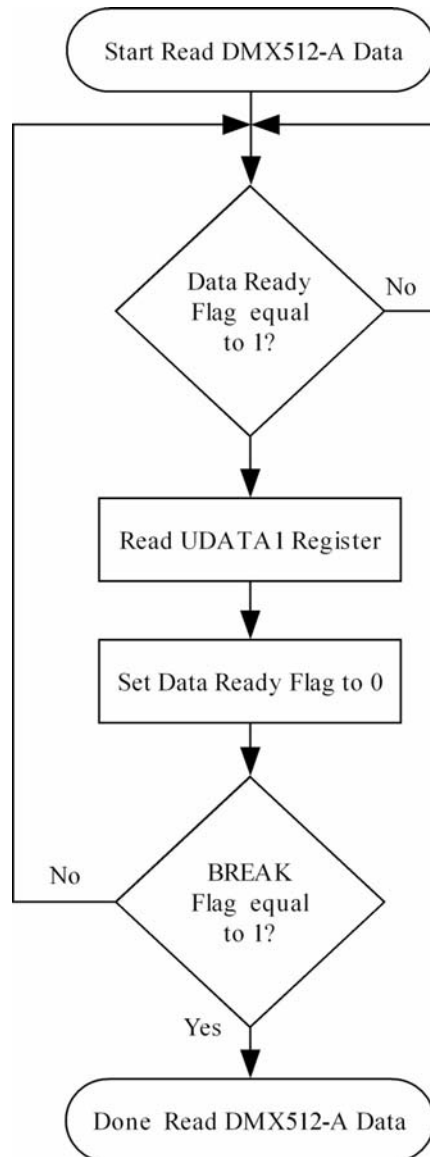


Figure 8. DMX512-A Data Read Code Flow

Sound Generation

The DMX512-A Receiver reference design can also generate sound via a buzzer/speaker which is connected to the Z51F0811 MCU's buzzer driver. To enable the sound generation function, a minor modification to the source code is required. In the `main.h` file, a *define switch* is commented out, as shown in the following code snippet:

```
//Enable to make Buzzer Work  
//#define BUZZER_ON
```

Uncomment the `define BUZZER_ON` line to enable the DMX512-A Receiver's sound generation function.

Figure 9 presents a high-level code flow of the sound generator function.

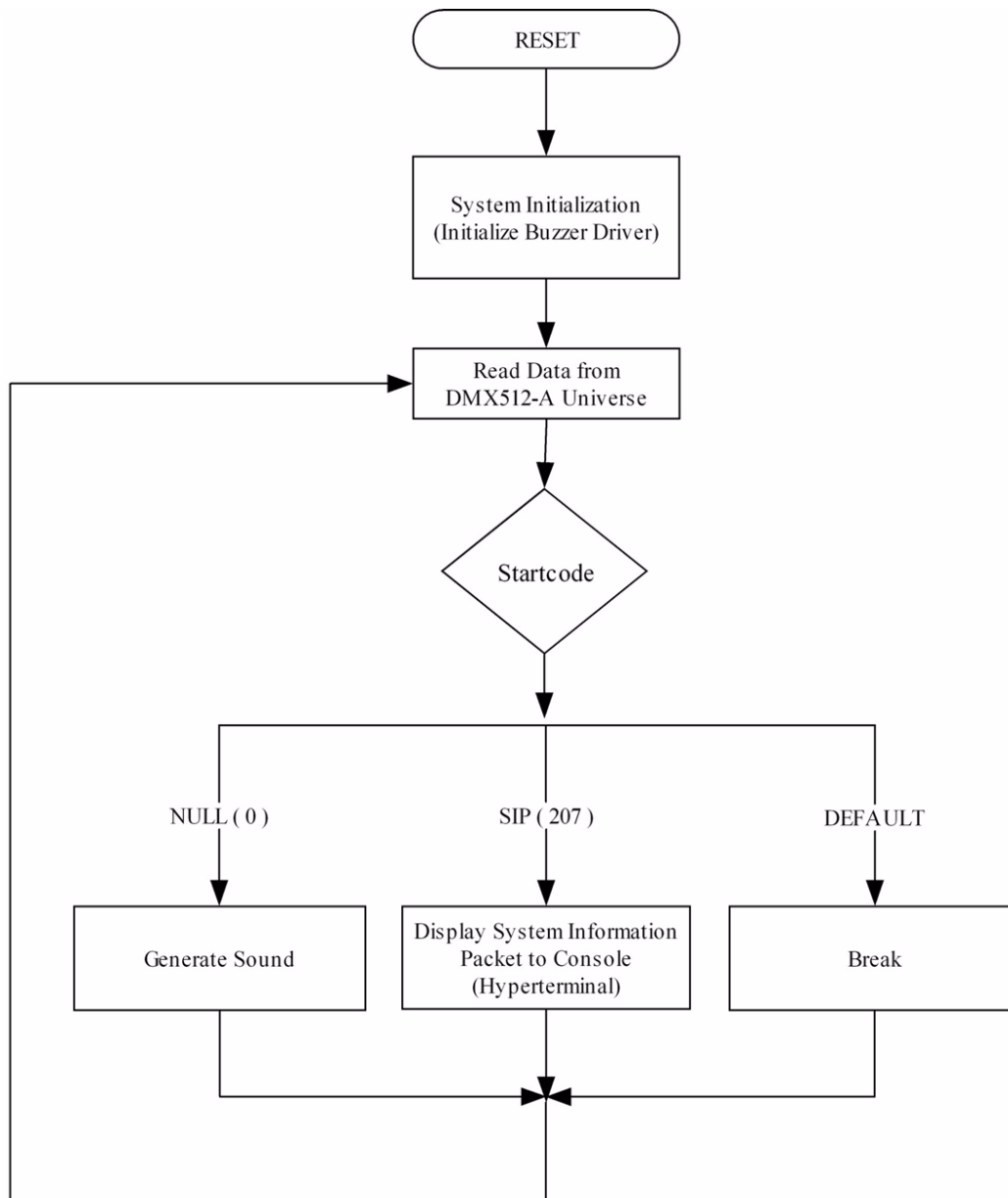


Figure 9. Code Flow for a Sound Generator Routine

Electrical Specifications

Table 2 presents electrical specifications for the DMX512-A Receiver reference design. These specifications reflect all available data as a result of testing, prior to qualification and characterization. Therefore, the data presented in this table are subject to change.

Stresses greater than those listed in Table 2 may cause permanent damage to the device. These ratings are stress ratings only. Operation of the device at conditions outside those indicated in the operational sections of these specifications is not implied. Exposure to absolute maximum rating conditions for extended periods affects device reliability. For improved reliability, unused inputs must be tied to one of the supply voltages, V_{DD} or V_{SS} .

Table 2. Electrical Specifications for the DMX512-A Receiver Reference Design

Parameter	Min.	Max.	Units
Input power supply	7	12	V
Current consumption	47.48	60.37	mA

Software Implementation

The source code for this application, [RD0015-SC01.zip](#), is available free for download from the Zilog website.

Equipment Used

The following equipment was used to build and test this reference design:

- Fluke 87V multimeter
- Intronix logic analyzer
- DMX-Pro Network Checker (<http://www.bpesolutions.com/dmxproduct.html#anchor1883330>)

See [Appendix B. Bill of Materials](#) on page 17 for a list of materials used to build this reference design.

Kit Contents

The DMX Reference Design Kit contains the following items:

- DMX Receiver Printed Circuit Board (PCB)
- DMX Controller PCB
- USB A-Male to Mini B-Male 2m cable
- 9V 2A wall power adapter

- Hosa XLR (Male-Female) 10 feet cable
- DMX Kit Insert (FL0175)

Ordering Information

The products associated with this DMX512-A Receiver Using a Z51F0811 MCU Reference Design ([RD0015](#)) and the DMX512-A Controller Using the Z51F3220 MCU Reference Design ([RD0016](#)) are available as a single DMX Reference Design Kit. This kit can be ordered from the [Zilog Store](#) using the part number listed in Table 3.

Table 3. DMX512-A Receiver Ordering Information

Part Number	Description	Store Product ID
Z51DMX00100KITG	DMX Reference Design Kit	RD10037

Results

The DMX512-A Receiver reference design was successfully tested to function as a light controller and a sound generator. As a light controller, the DMX512-A Receiver reference design interprets a DMX512-A data frame and sends an equivalent light display to the four high-bright LEDs. Alternatively, the DMX512-A Receiver generates sound based on the data received.

Summary

This document describes a Z8051-based DMX512-A Receiver reference design built with Zilog's Z51F0811 MCU. The DMX512-A Receiver can function as a light controller that controls the brightness of four high-bright LEDs. The brightness of these LEDs depends on the DMX512-A data that the Receiver obtains. Another function of the DMX512-A Receiver reference design is to generate sound. The DMX512-A Receiver was tested using the DMX512-A Controller reference design ([RD0016](#)).

References

Documents associated with the DMX512-A receiver are listed in Table 4. Each of the linked documents in this table can be obtained from the Zilog website by clicking the link associated with its Document Number.

Table 4. DMX512-A Receiver Documentation

Document Number	Description
PS0296	Z51F0811 Product Specification
PUG0033	Z8051 Tools Product User Guide

Table 4. DMX512-A Receiver Documentation (Continued)

Document Number	Description
RD0015	This DMX512-A Receiver Reference Design document
RD0016	DMX512-A Controller Reference Design document
UM0242	Z51F0811 Evaluation Kit User Manual
	DMX 101 Handbook. http://elationlighting.com/pdf/files/dmx-101-handbook.pdf
	DMX-Pro Network Checker Manual. http://www.bpesolutions.com/bpemanuals/NewDMX.Checker.pdf
	<i>Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories</i> . Entertainment Services and Technology Association (ESTA) American National Standard E1.11; 2008. Entertainment Technology USITT DMX512–A.

Appendix A. Schematic Diagram

Figure 10 shows a schematic diagram of the DMX512-A Receiver.

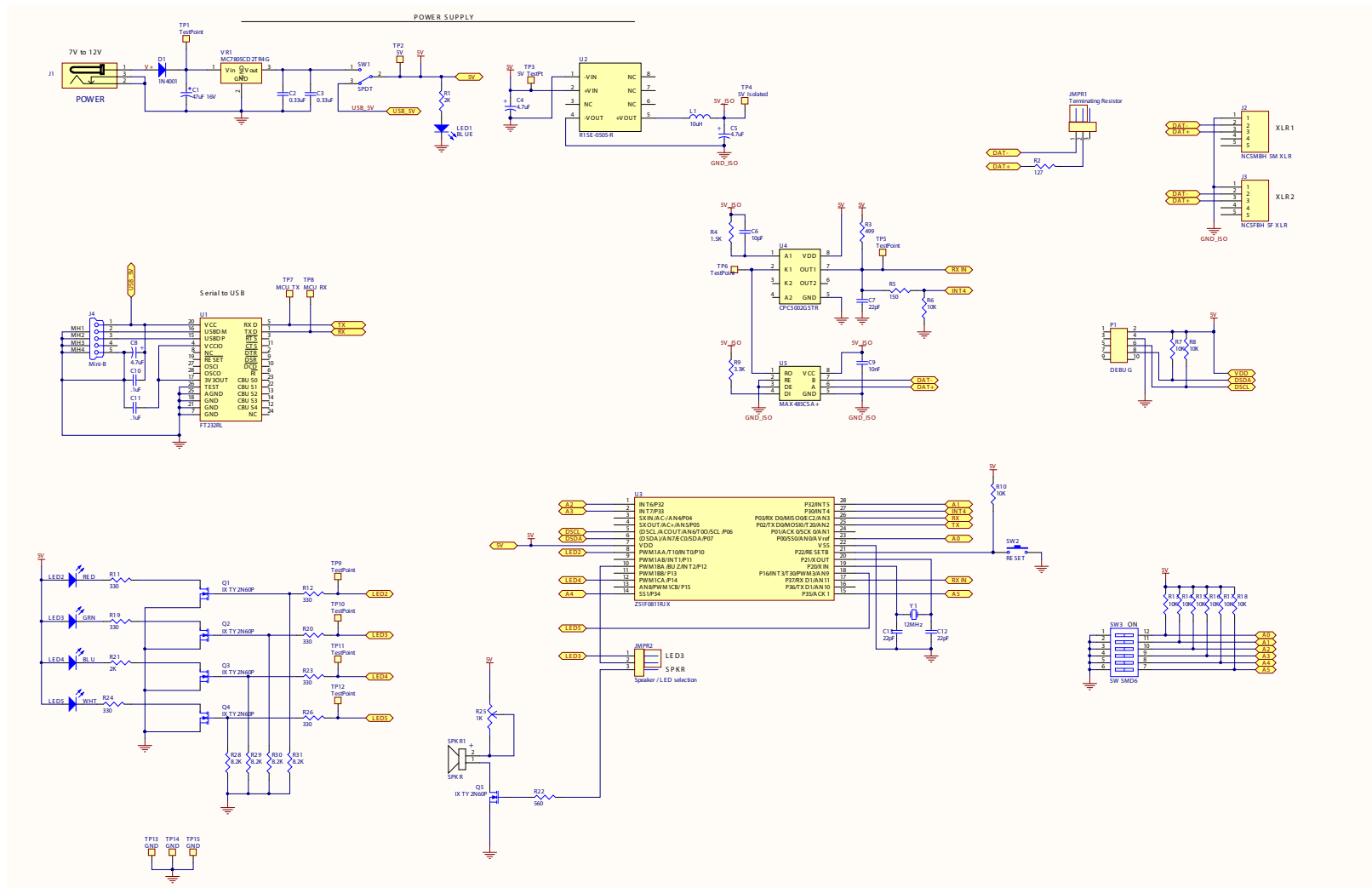


Figure 10. Schematic Diagram of the DMX512-A Receiver

Appendix B. Bill of Materials

Table 5 lists the components used to build this reference design.

Table 5. DMX512-A Receiver Bill of Materials

Item #	Designator	Value	Footprint	Quantity	Description	Manufacturer	Mfg. Part Number
1	C1	47uF 16V	CAP 5MM	1	Poly Alum 16V	Nichicon	PCG1C470MCL1GS
2	C2, C3	0.33uF	0603	2	CAP CER 0.33UF 25V 10%	TDK	C1608X5R1E334K080A C
3	C4, C5, C8	4.7uF	CAP 1206	3	CAP 4.7uF 16V A	AVX	TAJA475M016RNJ
4	C6	10pF	0603	1	CAP 10pF 50V	Murata	GRM1885C1H100JA01D
5	C7, C12, C13	22pF	0603	3	CAP CER 5% 50V	Murata	GRM1885C1H220JA01D
6	C9	10nF	0603	1	CAP 10pF 50V	Murata	GRM188R71H103KA01 D
7	C10, C11	.1uF	0603	2	CAP CER 25V 0603	Murata	GRM188F51E104ZA01D
8	D1	1N4001	DO-221	1	Diode 1A 50V	Micro Commercial	SM4001PL-TP
9	J1	POWER	JACKPWR 2.1x5.5MM	1	CONN POWER JACK 2.1x5.5 MM	CUI Inc	PJ-002A
10	J2	NC5MBH 5M XLR	NC5M XLR	1	XLR Connectors 5C PCB MALE	Neutrik	NC5MBH
11	J3	NC5FBH 5F XLR	NC5F XLR	1	XLR Connectors 5C PCB FEMALE RECEPT	Neutrik	NC5FBH
12	J4	Mini-B	USB_MINI_B	1	CONN RECPT USB MiniB	Hirose	UX60-MB-5ST
13	JMPR1	Terminating Resistor	HDR1X3	1	Header Male	FCI	68000-103HLF
14	JMPR2	LED3/Speaker Select	HDR1X3	1	Header Male	FCI	68000-103HLF
15	L1	10uH	1206	1	100 Ohm 3A	Laird Signal Integr	HI1206N101R-10
16	LED1, LED4	BLU	LED0603	2	LED BLUE 0603 2.9V 5mA	Panasonic	LNJ937W8CRA
17	LED2	RED	LED0603	1	LED RED 0603 2.2V 20mA	LiteON	LTST-C193KRKT-5A
18	LED3	GRN	LED0603	1	LED GRN 2.03V 10mA 0603	Panasonic	LNJ314G83RA



Table 5. DMX512-A Receiver Bill of Materials (Continued)

Item #	Designator	Value	Footprint	Quantity	Description	Manufacturer	Mfg. Part Number
19	LED5	WHT	LED0603	1	LED WHITE 0603 SMD	Vishay	VLMW1300-GS08
20	MH#1, MH#2, MH#3, MH#4	#4	MH#4	4	MTG HOLE #4	Keystone	2025
21	P1	DEBUG	HDR5X2 M	1	Header Male 10 Pin	FCI	67997-210HLF
22	Q1, Q2, Q3, Q4, Q5	IXTY2N60P	TO-252	5	FET N-CH 2A	IXYS	IXTY2N60P
23	R1, R21	2K	0603	2	RES 2.0K 1%	Yageo	RC0603FR-073K3L
24	R2	127	0603	1	RES 127 1/10W 1% 0603	Yageo	RC0603FR-07127RL
25	R3	499	0603	1	RES 499 OHM 1/10W 1% 0603 SMD	Panasonic	ERJ-3EKF4990V
26	R4	1.5K	0603	1	RES 1.5K 1/10W 1% 0603	Vishay	CRCW06031K50FKEA
27	R5	150	0603	1	RES 150 0603 1/8W 1%	Stackpole Elect	RNCP0603FTD150R
28	R6, R7, R8, R10, R13, R14, R15, R16, R17, R18	10K	0603	10	RES 10K 1/10W 1% 0603	Yageo	RC0603FR-0710KL
29	R9	3.3K	0603	1	RES 3.3K 1% 0603	Yageo	RC0603FR-073K3L
30	R11, R12, R19, R20, R23, R24, R26	330	0603	7	RES SMD 1/10W	Panasonic	ERJ-3EKF3300V
31	R22	560	0603	1	RES 560 0603 1% 1/10W	Yageo	RC0603FR-07560RL
32	R25	1K	Pot3306	1	Potentiometer	Bourns Inc	3306F-1-102
33	R27, R28, R29, R30, R31	8.2K	0603	5	RES 560 0603 1% 1/10W	Yageo	RC0603FR-07560RL
34	SPKR1	SPKR	SPEAKER 15MM	1	SPEAKER 8OHM .3W 87DB	PUI Audio	AST-01508MR-R
35	SW1	SPDT	SW SPDT SLIDE	1	Switch Slide SPDT	E-SWITCH	EG1218
36	SW2	RESET	SW SMD 6.8x3.7MM	1	SW PB SMD 6.1x3.7mm	C&K	PTS635SK25SMTR LFS
37	SW3	SW SMD6	SW SMD6 GW	1	SWITCH 6 POS SPST	CTS	219-6LPST
38	U1	FT232RL	SSOP28	1	IC USB TO SERIAL UART	FTDI	FT232RL-REEL



Table 5. DMX512-A Receiver Bill of Materials (Continued)

Item #	Designator	Value	Footprint	Quantity	Description	Manufacturer	Mfg. Part Number
39	U2	R1SE-0505-R	RISE-0505-R	1	DC/DC CONVERTER 1W 5VIN 5VOUT	RECOM POWER	R1SE-0505-R
40	U3	Z51F0811RJX	TSSOP28	1	MCU 8BIT 8KB FLASH	Zilog	Z51F0811RJX
41	U4	CPC5002GSTR	SMP8	1	ISOLAT DGTL 3.75KVRMS 2CH	IXYS	CPC5002GSTR
42	U5	MAX485CSA+	SO8	1	IC TXRX RS485/RS422 LOWPWR	Maxim	MAX485CSA+
43	VR1	MC7805CD2TR 4G	D2PAK-3	1	IC REG LDO 5V 1A D2PAK	ON Semi	MC7805CD2TR4G
44	Y1	12MHz	Crystal 5x3.2mm	1	XTAL 12MHz	ABRACON	ABM3-12.000MHZ-B2-T
45	MH#1, MH#2, MH#3, MH#4	4-40x1/4"	Screw Phillips	4	Pan Head	B&F Fastener Sup	PMSSS 440 0025 PH

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