

Беспроводной DMX512 приемник/передатчик



Общая информация

В данной статье я расскажу вам как создать передатчик и приемник DMX512 сигнала. Выложена принципиальная схема, схема платы, и вся разводка. Аппаратная часть построена на микроконтролере avr ATMEGA 328 от компании Atmel. Приемник и передатчик могут передавать все 512 каналов управления. Без антенны базовая конфигурация работает до 100

метров в прямой видимости(сможет работать до 1км при установке антенны)



Элементы используемые в схеме

Сборка состоит из микроконтролера

- [NRF24L01](#) два модуля.
- 12v Вход (5v и 3.3v регулятор напряжения)
- 2 x XLR вход и выход(папа и мама)
- 2 x Светодиода(для индикации)
- [ATMEGA328p-пи микроконтроллер](#).
- 3 x 100ом резисторы.
- 1 x 10кОМ резистор.
- 3 x 10uF конденсаторы.
- переключатель каналов, джампер.
- [16mHZ](#) кварц.

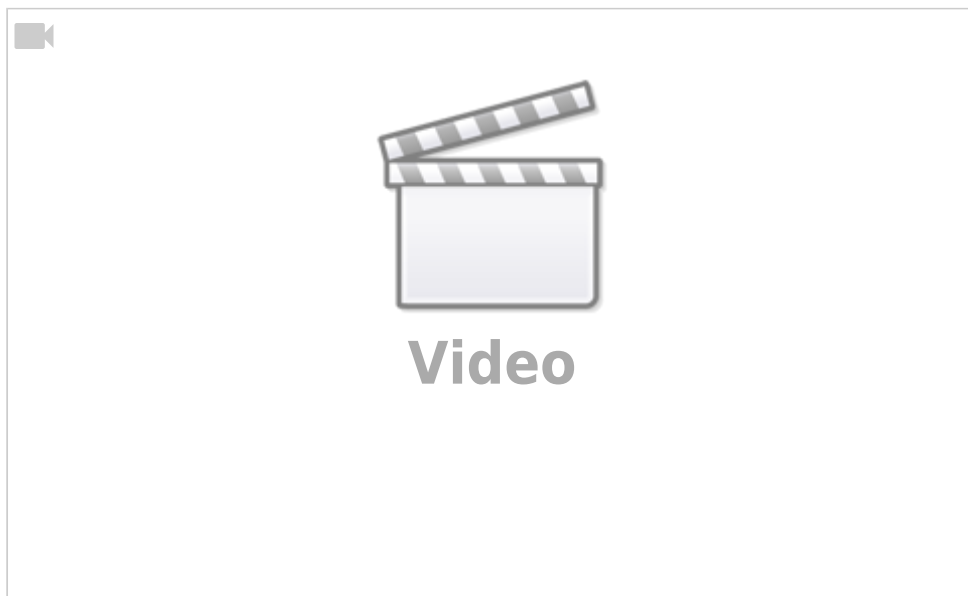
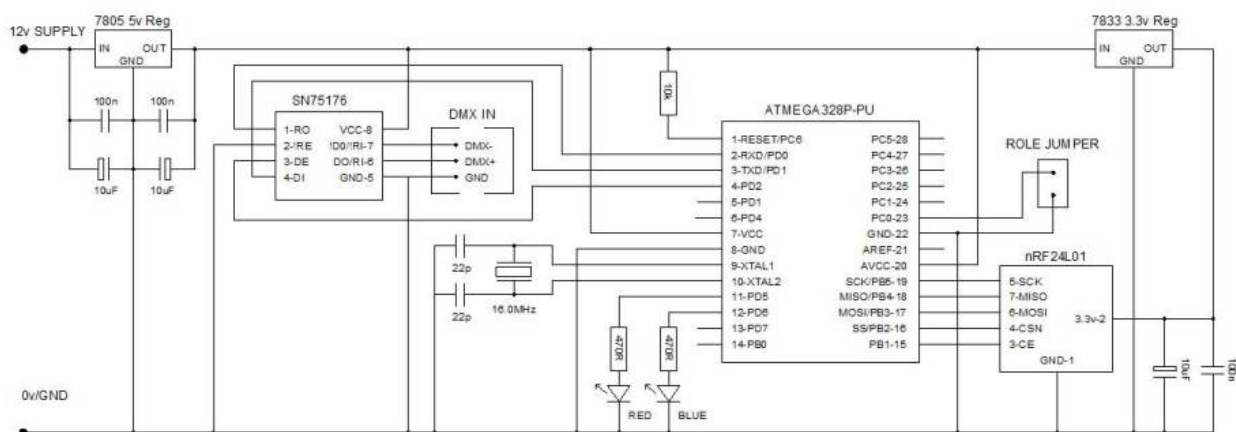


Схема подключения

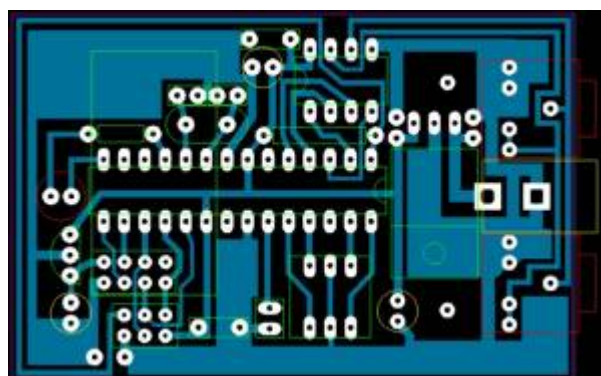
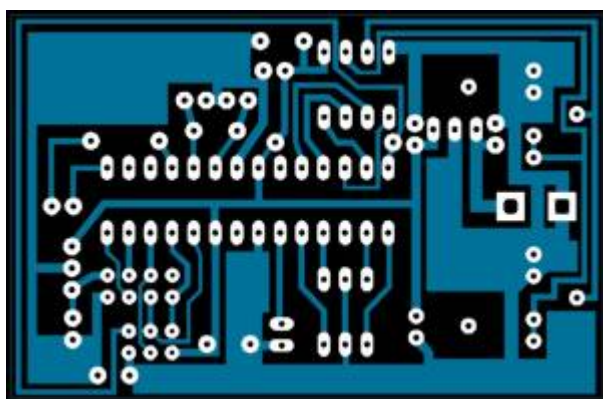


Беспроводной модуль в сборе

Для подключения радиомодуля использованы ножки аппаратного SPI микроконтроллера, поэтому разъемы подключения модуля и подключения программатор дублируют друг друга. Это сделано, чтобы удобнее было прошивать микроконтроллер на отладочной платке, например, если использовать программатор который подает на схему 5 вольт, а для NRF24L01 это слишком большое напряжение. Чтобы перепрошить управляющий микроконтроллер, достаточно выдернуть трансивер с платы, перепрошить и всунуть его обратно - без лишней возни с перепайкой.



Готовая плата



Существуют ситуации, когда где DMX кабель невозможно протянуть, или использование его просто не практично. Этот проект реализует беспроводную передачу сигнала DMX в диапазоне 2,4 ГГц, используя платформу Arduino и популярного модуля приемопередатчика NRF24L01 + из нордического полупроводника.

Протокол передачи

Прием и передача по протоколу DMX осуществляется на контроллере ATmega с помощью библиотеки DMXSerial. Реализация использует прерывания и является хорошей базой для реализации второго протокола на одном чипе. 2,4 Радиомодуль подключен к плате Arduino или микроконтроллеру ATmega с помощью интерфейса SPI. Библиотека для использования чипа находится здесь <https://github.com/gcopeland/Rf24> . После инициализации библиотеки можно передавать и принимать данные, используя прилагаемые функции библиотеки. Библиотека передает все команды и данные микросхемы nRF24L01 + также будет обрабатывать все детали передачи в фоновом режиме.

Скетч для микроконтроллера

ВНИМАНИЕ: перед компиляцией и заливкой скетча в микроконтроллер, необходимо установить и добавить в компилятор библиотеки nRF24L01 и RF24

```
// FOR ATMEGA328 16mhz ONLY //
// connection information...
// http://arduino-info.wikispaces.com/Nrf24L01-2.4GHz-HowTo
// SN75176 configuration :
//   DMXrx NRFtx : pin 2 = 0v | pin 3 = 0v
```

```
// NRFRx DMXtx : pin 2 = 0v | pin 3 = 5v
// pin 6 = DMX+ | pin7 = DMX-
// Ensure 3.3v is used to supply NRF24L01 board !!
//
// the Nrf24L01 board can only transmit from channel 0 to 83 in the USA,
// therefore we shall limit it to 0-80 in steps of 5

#include <EEPROM.h>
#include <SPI.h>
#include <nRF24L01.h> // library: https://github.com/maniacbug/RF24
#include <RF24.h>
#include <Wire.h>
#include <DMXSerial.h> // library:
http://www.mathertel.de/Arduino/DMXSerial.aspx //

#define MAX_DMX_CHANNELS 512 // full DMX
#define BYTES_PER_PACKET 16 // usable bytes per packet
#define PACKET_OVERHEAD 2 // group and time stamp
#define MAXPAYLOAD (BYTES_PER_PACKET+PACKET_OVERHEAD) // max payload size
// for nrf24l01
#define MAXGROUPS (MAX_DMX_CHANNELS/BYTES_PER_PACKET) // 32 groups of 16
// channels = 512 DMX channels

// 16way hex channel selector - hex switch mounted with zero at top (see PCB
// layout)
#define HEX_0 A4
#define HEX_1 A1
#define HEX_2 A2
#define HEX_3 A5
// nRF24L01 control
#define nRF_CE 9 // Chip enable
#define nRF_CSN 10 // Chip select not
// LEDs
#define LED_BLUE 6 // BLUE PWM
#define LED_RED 5 // RED PWM
// sn76175 control
#define DMX_NOT_EN 2
#define DMX_MODE 3
// other
#define ROLE A0 // if low (jumper on) then RX otherwise TX

RF24 radio(nRF_CE,nRF_CSN);

unsigned long RXtimer, flashTimer, taskTimer, lastFlash, refreshTimer,
radioTimer, rePairTimer;
uint64_t RXTXaddress, pairingAddress = 0xF0F0F0F0F0LL;
uint16_t rfQuality;
uint8_t payload[MAXPAYLOAD], shadow_DMX[MAX_DMX_CHANNELS];
uint8_t timeStamp, lastStamp, bestChannel;
uint8_t HEXchannel, _HEXchannel, RXTXchannel, pairingChannel = 80;
```

```
boolean role, _role, group_send;

void setup(void)
{
    // set DMX/rs485 interface
    pinMode(DMX_NOT_EN, OUTPUT);
    digitalWrite(DMX_NOT_EN, LOW);
    pinMode(DMX_MODE, OUTPUT);
    // set bicolour LED
    pinMode(LED_BLUE, OUTPUT);
    digitalWrite(LED_BLUE, LOW);
    pinMode(LED_RED, OUTPUT);
    digitalWrite(LED_RED, LOW);
    // set up ROLE switch
    pinMode(ROLE, INPUT_PULLUP);
    // set up HEX channel select switch
    pinMode(HEX_0, INPUT_PULLUP);
    pinMode(HEX_1, INPUT_PULLUP);
    pinMode(HEX_2, INPUT_PULLUP);
    pinMode(HEX_3, INPUT_PULLUP);
    if ( digitalRead(ROLE) ) { // jumper off : transmitter : initialise & read
EEPROM
        init_EEPROM();
    }
    radio.begin();

    // test nRF board, if it doesnt reply then flash LED indefinately, or until
it does reply
    while (!radio.isPVariant() ) { // check if board connected
        if (digitalRead(ROLE)) { blue(); delay(500); off(); delay(500); } //
Wireless TX : if no rf comms then flash BLUE 50%
        else { red(); delay(500); off(); delay(500); } // Wireless RX : if no
rf comms then flash RED 50%
    }

    // generic radio stuff
    radio.setAutoAck(false);
    radio.setPayloadSize(MAXPAYLOAD);
    radio.setPALevel(RF24_PA_HIGH);
    radio.setDataRate(RF24_250KBPS);
    radio.setRetries(0,0);
    //radio.setDataRate(RF24_1MBPS);
    //radio.setDataRate(RF24_2MBPS);

    HEXchannel = HEXread();

    // if this is a transmitter, do a channel scan, transmit network RXTXaddress
and clean RXTXchannel during rePair (every 2 secs)
    // only send clean channel data if channel selector is set to zero (send
0xFF if channel other than zero : manualPair)
    if ( digitalRead(ROLE) ) { // jumper off : transmitter
```

```
    bestChannelScan(); // only do channel scan if this is a transmitter -
bestChannel is required for manualPair and autoPair modes
    if (HEXchannel) { //
        bestChannelDisplay(); // if HEX switch not zero display best channel
number
    }
}
// if this is a receiver, go into pairing mode and wait (indefinitely) for
pairing & channel data
// only use received (clean) channel data if channel selector is set to zero
else {
    receivePairingAddress();
}
rePairTimer = flashTimer = taskTimer = millis(); // TXtimer =
DMXSerial.maxChannel(MAX_DMX_CHANNELS);
rfQuality = 0;
// read and initialise HEX switch and Role jumper
readPins(true);
} // end of init

void loop(void) {
// once per second, test for changes in HEX Switch and Role jumper (rx/tx)
    if (millis() - taskTimer > 1000) {
        taskTimer = millis();
        readPins(false);
    }

// JUMPER OFF : DMX --> WIRELESS Tx
// LED Wireless TX : Solid BLUE, broken with very short flash of RED only if
DMX data is being received.
    if (digitalRead(ROLE)) { // if a wireless transmitter
        // SEND OUT BURSTS OF RADIO DATA EVERY 30ms....
        for (uint8_t group = 0; group < MAXGROUPS; group++) { // scan through
the groups of DMX data, 30 bytes at a time
            uint16_t group_ptr = group*BYTES_PER_PACKET; //30; // create group
pointer for array
            if (millis() - refreshTimer > 1000) { // allow ALL radio data (full
DMX array) to be send once per second, regardless of changes
                group_send = true; // force ALL send
                refreshTimer = millis();
            } //if refresh timer
            else {
                group_send = false; // preset flag to false, only set it if there
has been a data change since last time
            } // not refresh timer
            for (uint8_t chan = 1; chan < BYTES_PER_PACKET+1; chan++) {
                if ( DMXSerial.read(group_ptr+chan-1) !=
shadow_DMX[group_ptr+chan-1] ) { // compare test : current DMX against old
DMX
```

```
        shadow_DMX[group_ptr+chan-1] = DMXSerial.read(group_ptr+chan-1);
// if changed, update shadow array of DMX data and payload
        group_send = true; // set flag so that THIS group packet gets sent
    } // if data compare
    payload[chan+1] = DMXSerial.read(group_ptr+chan-1); // ensure ALL
up-to-date data gets through on this packet
    } // for chan
    if (group_send) { // only send the data that has changed, any data
change in a group will result in whole group send
        payload[0] = group; // set first byte to point to group number
(groups of 30 bytes)
        payload[1] = timeStamp++; // second byte helps us monitor
consistency of reception at receiver with a continuous frame counter
        radio.write( payload, sizeof(payload) ); // dump payload to radio
    } // if group_send
} // for group
if ( (DMXSerial.noDataSince() < 2000) && (millis() > 1000) ) { // if DMX
has been received within the last 2 seconds make LED flash
    if (!(millis() & 0b1111000000)) {
        red();
    }
    else { // SIMPLE DMX FLASHER
        digitalWrite(LED_RED,0);
        analogWrite(LED_BLUE,5); // low level Blue
    }
}
else { // no DMX data present, no flash
    digitalWrite(LED_RED,0);
    analogWrite(LED_BLUE,5);
}
// trigger rePair information send, just once every 2 seconds
if (millis() - rePairTimer > 2000) {
    rePairTimer = millis();
    rePairTX(); // single burst of pairing information on pairing channel
using pairing network address
}
} // if role

// JUMPER ON
// WIRELESS --> DMX
// LED Wireless RX : Solid RED, broken with flash of BLUE if wireless is
being received (channel match)
//           the gaps between the BLUE flashes are dependant on
consistency of consecutive packets, relating to timeStamp
    else {
        if (millis() - RXtimer > 20000) { // after 20 seconds without receving
any radio data, try and rePair
            receivePairingAddress();
        }
        else if (millis() - RXtimer > 2000) { // after 2 seconds of no radio
data, stop blinking
```

```
    rfQuality = 0;
}
if ( radio.available() ) {
    if (!rfQuality) {
        rfQuality = 50; // just to show that channel and address are locked
on !
    }
    RXtimer = millis();
    radio.read( payload, sizeof(payload) ); // get data packet from radio
    if ( payload[1] == (lastStamp+1) ) { // check for continuous
timestamps, increase quality indicator if good
        if (rfQuality < 255) { rfQuality++; }
    }
    else { // if incontinuous, reduce quality indicator/LED brightness
        if (rfQuality > 50) { rfQuality--; }
    }
    lastStamp = payload[1]; // reset last time stamp to current for
checking next time
    for (uint8_t i = 0; i <BYTES_PER_PACKET; i++) {
        DMXSerial.write((BYTES_PER_PACKET*payload[0])+i, payload[i+2]); //
spill radio data into dmx data array
    }
} // if radio avail
lastFlash = millis() - flashTimer;
if (lastFlash < 64) {
    digitalWrite(LED_RED,0);
    analogWrite(LED_BLUE,rfQuality); // show rfQuality as brightness of
BLUE LED
}
else if (lastFlash >= 64) {
    digitalWrite(LED_BLUE,0);
    analogWrite(LED_RED,5); // switch back to RED at low level
}
if (lastFlash > 1024) {
    flashTimer = millis(); // reset timer after 1 second(ish)
}
} // else
} // loop

// read HEX switch and Role jumper, if there has been a change in settings
then an update can be made
void readPins(boolean initialise) {
    _HEXchannel = HEXread(); // get temp HEXchannel
    _role = digitalRead(ROLE); // get temporary Role
    if (_role != role || initialise) { // has the ROLE changed ?? - initialise
will override any change in settings
        role = _role;
        if (role) { // JUMPER OFF : this is a wireless transmitter
            digitalWrite(DMX_MODE,LOW); // enable rs485 for input
            DMXSerial.init(DMXReceiver); // enable DMX to receive
```

```
    radio.openWritingPipe(RXTXaddress); // set network address
    radio.stopListening(); // start talking !
    digitalWrite(LED_RED,0);
    analogWrite(LED_BLUE,5); // low level BLUE to start...
}
else { // JUMPER ON : this is a wireless receiver
    digitalWrite(DMX_MODE,HIGH); // enable rs485 for output
    DMXSerial.init(DMXController); // enable DMX for output only
    radio.openReadingPipe(1,RXTXaddress); // set network address
    radio.startListening(); // start listening for data
    digitalWrite(LED_BLUE,0);
    analogWrite(LED_RED,5); // low level RED to start...
}
}
if (_HEXchannel != HEXchannel || initialise) { // has the CHANNEL changed
? - 'initialise' overrides any change in settings
    HEXchannel = _HEXchannel;
    rfQuality = 0; // reset this so that led stops flashing
    if (!role) {
        radio.stopListening(); // if this is a receiver...
    }
    if (HEXchannel) {
        RXTXchannel = HEXchannel*5; // create real channel number from HEX
read
    }
    radio.setChannel(RXTXchannel); // set the channel
    if (!role) {
        radio.startListening(); // if this is a receiver...
    }
}
}
}

void red(void) {
    digitalWrite(LED_BLUE,0);
    digitalWrite(LED_RED,1);
}
void blue(void) {
    digitalWrite(LED_BLUE,1);
    digitalWrite(LED_RED,0);
}
void off(void) {
    digitalWrite(LED_BLUE,0);
    digitalWrite(LED_RED,0);
}

// manualPair & autoPair information
// selecting HEXchannel 0 instigates "autoPair" mode on transmitter and
receivers, therefore channel zero cannot be used in manualPair mode
// The transmitter and receivers MUST be set to either ALL autoPair(0) or
ALL manualPair(1-15) to work correctly
// manualPair mode can only select RXTXchannels 5 to 75 (via hex switch
```

```
positions 1-15)
// manualPair & autoPair (on the Transmitter) has a 'bestChannelScan' on
power-up
// autoPair : The best(quietest)channel will be transmitted with the network
address on pairing
// manualPair : The best(quietest)channel is shown by number of blinks
(shown as 3 groups of blinks) (bestChannelDisplay)
// The RXTXchannel number is 5 times that indicated - example 5 blinks =
channel 60
// In manualPair, the transmitter and all receivers must be manually set to
that channel via the hex switch

// Transmitter : every 2 seconds, the transmitter sends its network
address/pipe number as data on channel 80, using a a pairing address/pipe
// Receivers : on power up, receiver(s) are in pairing mode, receiver goes
to channel 80 and listens on the pairing address/pipe for the network
address and channel number to go to
// receivers change to the network channel and wait for
DMX/Radio data to arrive. If any receiver loses pairing, after 20 seconds it
will start to repair again.

void bestChannelScan(void) {
    uint8_t carriers[16], reps, i, best=200;
    for (reps=0; reps<200; reps++) { // scan all channels 200 times
        for (i=1; i<16; i++) {
            radio.setChannel(i*5); // scan from channel 5 to 75 in steps of 5
            radio.startListening();
            delayMicroseconds(128);
            radio.stopListening();
            if ( radio.testCarrier() )
                ++carriers[i]; // if there is any signal present, increase value in
array
        } // i
    } // reps
    for (i=15; i>0; i--) { // find quietest channel, starting from highest
channel
        if (carriers[i] < best) {
            best = carriers[i]; // save quietest value
            RXTXchannel = i*5; //and save corresponding channel number
        }
    }
}

// BestChannel will only display if transmitter is not on HEX SWITCH 0
void bestChannelDisplay(void) {
    uint8_t i, x;
    for (x=0; x<3; x++) {
        for (i=0; i<RXTXchannel/5; i++) {
            blue();
            delay(25);
        }
    }
}
```

```
        off();
        delay(375);
    }
    delay(1000);
}

// read the value of the Hex Switch
uint8_t HEXread(void) {
    return (!digitalRead(HEX_0)) | (!digitalRead(HEX_1) << 1) |
    (!digitalRead(HEX_2) << 2) | (!digitalRead(HEX_3) << 3);
}

// regularly, the transmitter sends out a short burst of the config data on
the pairing channel and using the pairing address
void rePairTX(void) {
    radio.openWritingPipe(pairingAddress);
    radio.setChannel(pairingChannel);
    radio.stopListening();
    payload[0] = (uint8_t) (RXTXaddress);
    payload[1] = (uint8_t) (RXTXaddress >> 8);
    payload[2] = (uint8_t) (RXTXaddress >> 16);
    payload[3] = (uint8_t) (RXTXaddress >> 24);
    payload[4] = (uint8_t) (RXTXaddress >> 32);
    if (HEXread()) { payload[5] = 0xFF; }
    else { payload[5] = RXTXchannel; }
    radio.write( payload, sizeof(payload) ); // dump pairing data to radio
    radio.openWritingPipe(RXTXaddress);
    radio.setChannel(RXTXchannel);
    radio.stopListening();
}

void receivePairingAddress(void) {
    uint8_t p, q;
    radio.stopListening();
    radio.openReadingPipe(1,pairingAddress);
    radio.setChannel(pairingChannel);
    radio.startListening();
    digitalWrite(LED_BLUE,LOW);
    while ( !radio.available() ) {
        analogWrite(LED_RED,p++); delay(2); // slowly pulse RED LED while
awaiting pairing connection
    }
    radio.read( payload, sizeof(payload) ); // get data packet from radio if
available
    RXTXaddress = (uint64_t)(payload[0]) | (uint64_t)(payload[1] << 8) |
    (uint64_t)(payload[2] << 16);
    RXTXaddress |= (uint64_t)(payload[3] << 24) | (uint64_t)(payload[4] <<
32); // get RXTX address from payload
    if ( payload[5] == 0xFF ) {
        RXTXchannel = HEXread()*5; // use channel from hex switch
    }
}
```

```
else {
    RXTXchannel = payload[5]; // use best channel from scan
}
radio.stopListening();
radio.openReadingPipe(1,RXTXaddress);
radio.setChannel(RXTXchannel);
radio.startListening();
RXtimer = millis();
}

void init_EEPROM(void) {
// do this only if a transmitter
// if the EEPROM hasnt already been set (all bytes at 0xFF) then set an
address using 2 random numbers to make up unique 40bit address
// the address will be used in pairing. Once it has been set the first time
it wont need to be set again
    if ( digitalRead(ROLE) ) { // jumper off : transmitter
        if ( (EEPROM.read(0) == 0xff) && (EEPROM.read(1) == 0xff) ) { // check
for uninitialised/used eeprom memory
            randomSeed(analogRead(A3)); // seed from unused floating analog port
            EEPROM.write(0,random(255)); // unique lowest byte only
            EEPROM.write(1,random(255)); // initialise 40 bit address number into
eeprom, this makes up bytes 1-4 in address
        }
        RXTXaddress = (uint64_t) (EEPROM.read(0)) | (uint64_t)(EEPROM.read(1) <<
8) | (uint64_t)(EEPROM.read(1) << 16);
        RXTXaddress |= (uint64_t)(EEPROM.read(1) << 24) |
(uint64_t)(EEPROM.read(1) << 32); // reconstruct RXTXaddress from eeprom,
byte 0 is unique, bytes 1-4 are the same
    }
}
```

#define ROLE A0 - Эта строка отвечает за прием и ли передачу. Если нужен приемник то A0, передатчик A1

Следите за правильным напряжением, радиомодули очень чувствительны, напряжение должно быть в пределах 3.3v

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