MY EXPERIENCE

WITH

WIRELESS RF TRANSMITTERS AND RECEIVERS

This book is intended for educational purpose. The topic covered here is wireless RF Transmitter and Receiver. I have tried to cover each and everything necessary in successfully making a working wireless RF remote control, but still you may feel unfamiliar to some of the terms used in the book this required prior knowledge of digital encoders and digital communication basics. So if you want to go into the concepts thoroughly you need to study the book of digital electronics (for encoders) and digital communication (for ASK modulation) basics. You may also find some related tutorials in the *knowledge park* section of **www.saprorobotics.in**. Still if you find any query or want to give feedback, you may send it to info@saprorobotics.in.

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These days, one thing that I can sense that India is in the start of an automation revolution. I have also noticed one more thing that the country is now more filled up will engineering & technical institutions, colleges and universities (yes, I know but I will not comment on the quality of education. Think positive yaar…). The good thing is more and more students are rushing towards robotics. It is always a key event in any technical fest. Apart from this entire craze about robotics, students are still facing problems in accessing right information and resources. I myself have seen at least 100 students discussing with me about making a wireless RF remote control. They found it quite difficult. But actually it is not that difficult as it seems.

Here I have constructed a simple 433MHz ASK based wireless remote control capable of transmitting 4-bits of information i.e. you can directly interface this data with your motor driver to control your bot.

First of all you need suitable transmitter and receiver modules. The one that I found suitable are 433MHz ASK Transmitter. It looks like as shown below:

Fig. 1 ASK Transmitter

And 433MHz Receiver. It looks like as shown below:

Fig. 2 ASK Receiver

The frequency of operation of these modules is in UHF band from 315MHz to 433MHz. They work well at 5V. The transmitter accepts serial data at a maximum speed of 4800 bauds/sec. Bauds /second means symbols per second and a symbol may consist of varying number of bits, generally, 8-bits. You would be thinking that why I used only these TX-RX modules. This is because, they are easy to use. They can be interfaced to a microcontroller or can be directly interfaced with the encoder and decoder ICs at the transmitter and receiver side respectively.

Here we will be using it directly, so next thing we require is an encoder and decoder pair. Now our most of the job is done. We just left with the integration of the TX-RX module with the encoder/decoder ICs. Below is the block diagram of this whole system.

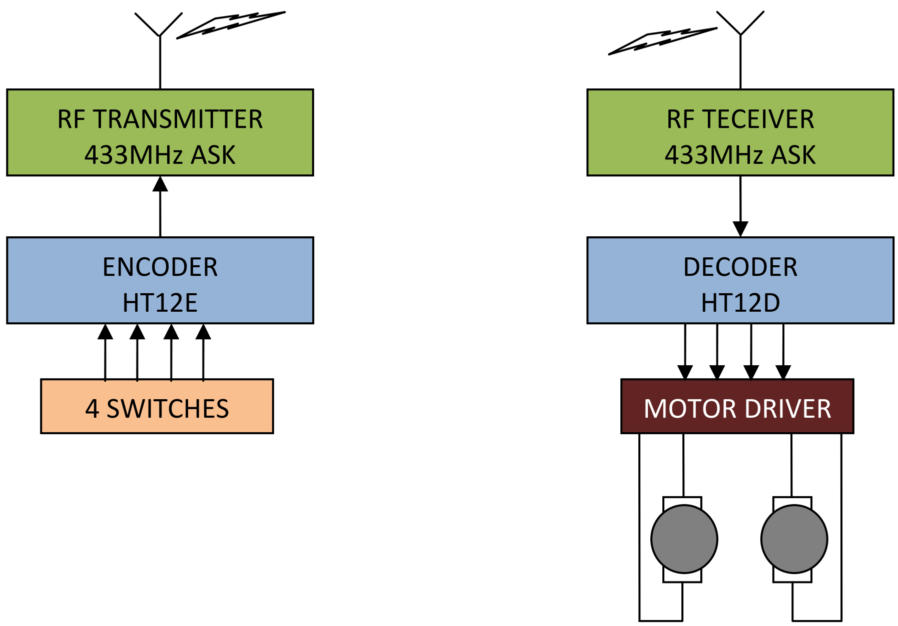


Fig. 3 block diagram of RF remote

Now, the question is that why to use encoder and decoder. Can't we use the TX and RX modules directly to send the data bits. Actually, what this encoder IC is doing is that it is converting the parallel data into serial data suitable for RF TX module. The TX module takes this data from encoder, modulates it with ASK (Amplitude Shift Keying) and transmits it through antenna.

This transmitted signal is received by the receiver antenna where it first matches the address of transmitter and receiver. If the address is same then, receiver demodulates the received signal and transfers the serial data to the decoder IC. The decoder IC decodes the serially received bits and converts it into parallel data which was actually transmitted.

Now, we have 4-bits of wirelessly transmitted data. We can use it to drive our motors. If we want to control a DC motor, we require 2-bits of information. So, to drive two motors we require 4-bits of information which we are getting. So, simple naa….. I have seen most of the students having trouble with their remotes. They also do the same procedure, but still they don't get rid of the problem. This is because they don't use the compatible encoder and decoder ICs. Here, HT12E and HT12D are directly compatible with the data packets that these 433MHz ASK Transmitters and Receivers use. These are the 4-channel encoder and decoder ICs i.e. they capable of handling 4-bits of data. Below is the circuit diagram of transmitter side and the receiver side.

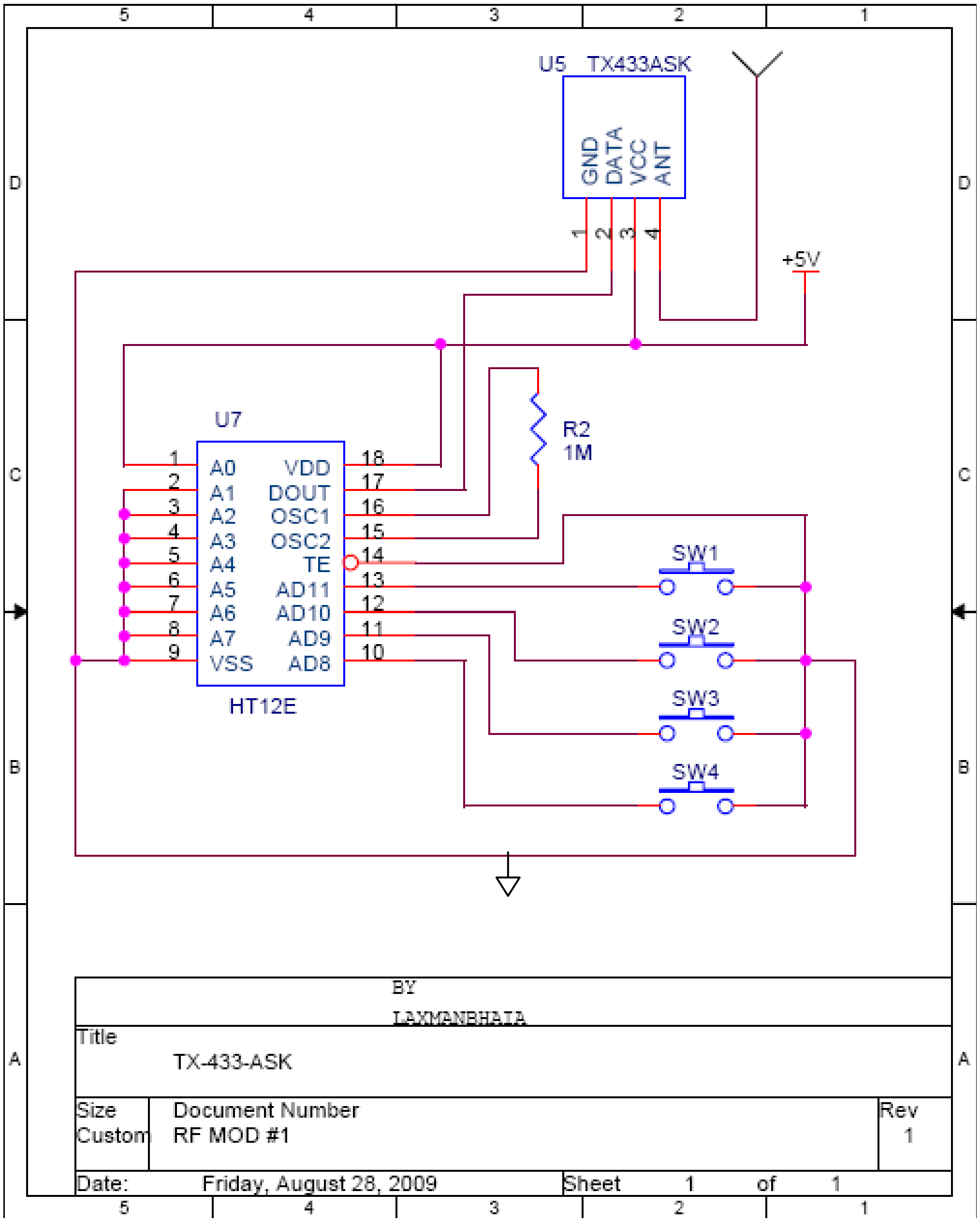


Fig. 4 Transmitter circuit diagram

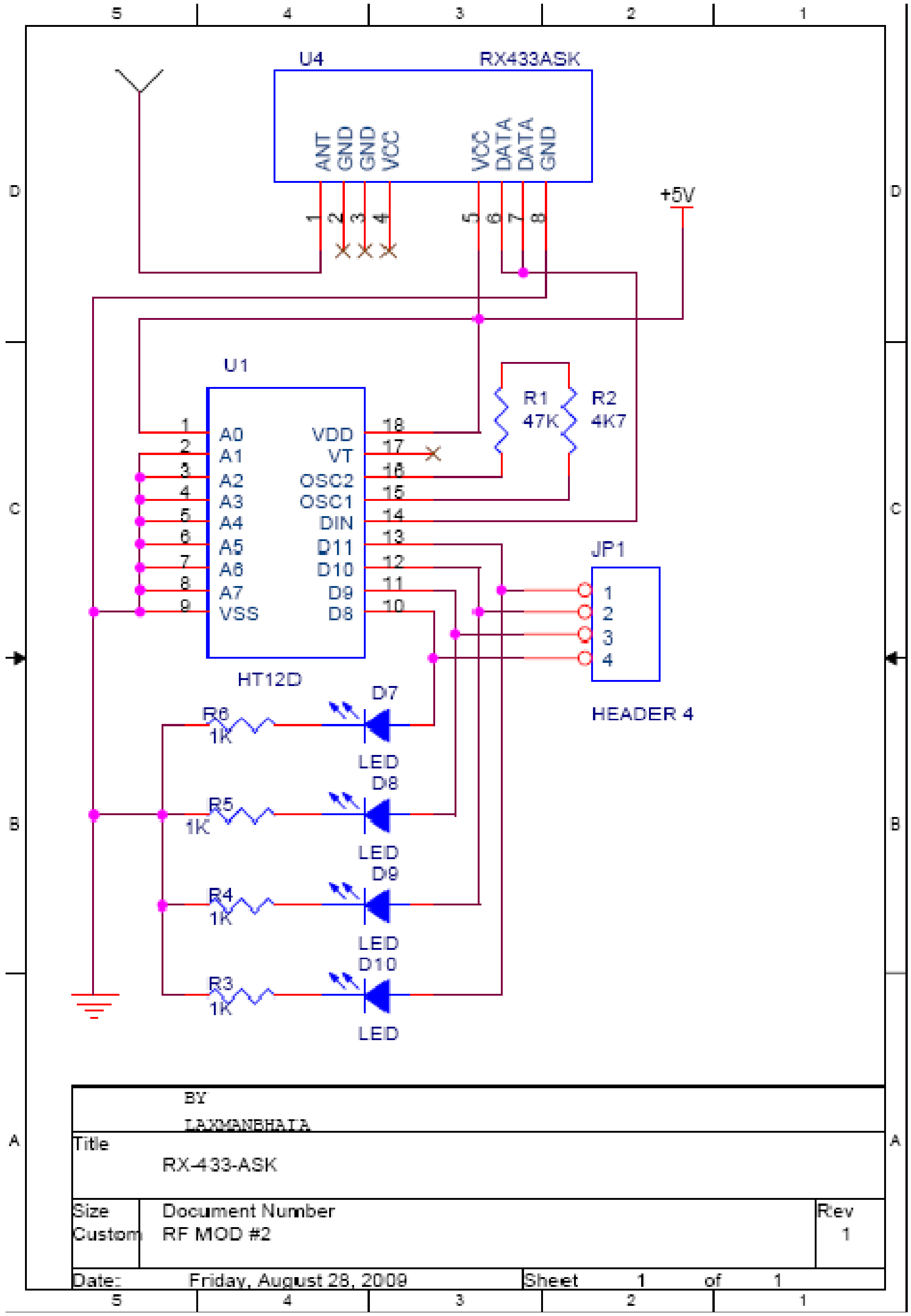


Fig. 5 Receiver circuit diagram

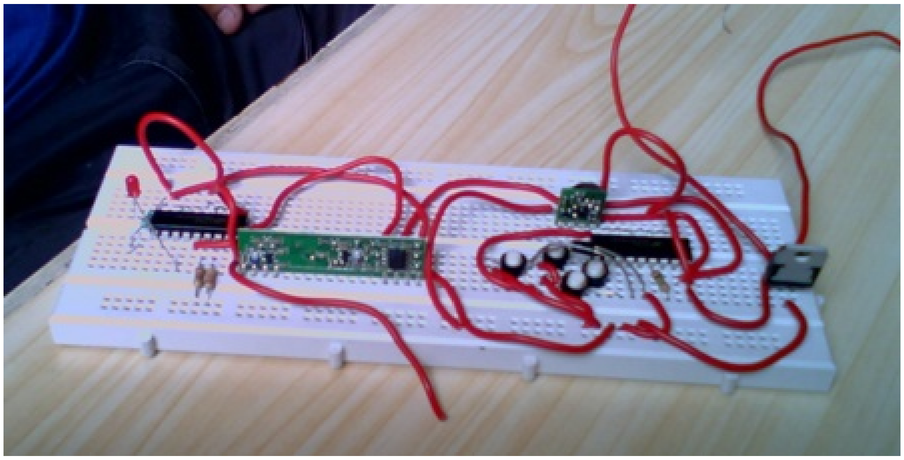


Fig.6 Front side view

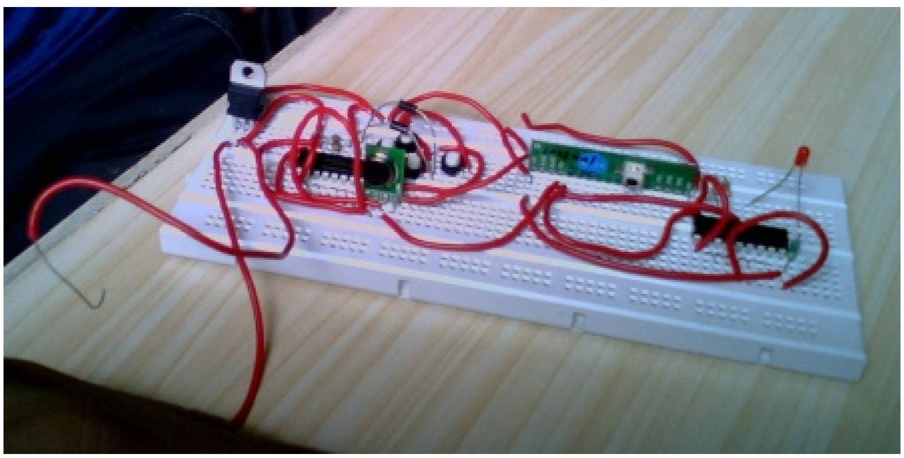
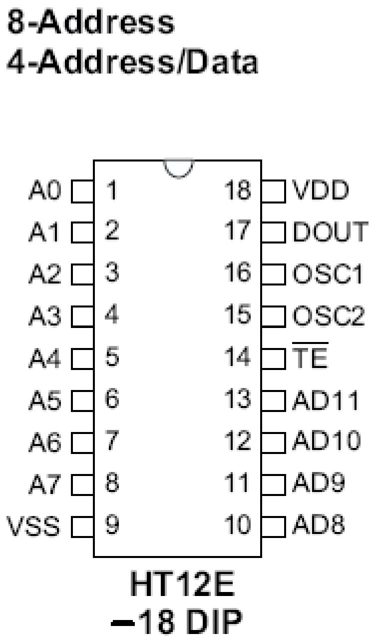


Fig.7 Back side view

To drive the motors we will require a suitable motor driver at the output of decoder IC. As s driver we can use a relay, make an H-bridge using transistors, H-Bridge ICs like L293D, L298 etc., or use Darlington ICs like ULN2003, 2803 etc. to know how to drive motors, check out for the tutorial on motor driver.

One important thing to study in the circuit here is the encoder and decoder ICs. So, it is good to study their datasheets. I also share some important points about HT12E and HT12D which are important to make them work for you.

First of all look at the pin diagram of the encoder HT12E:



Pin1-8: These are the address pins. There are 8 address lines from A0 to A7 where A0 is LSB and A7 is MSB. So, we can address =256 different receivers depending on their address. We can also use it for security purpose. By making some address lines high and others low; we can assign a particular address for particular receiver. By doing so, only the transmitter with same address is capable to send data to our receiver. Our receiver will not receive data from any other transmitter of similar type (ASK) and similar frequency (433MHz). The address that I have assigned to my transmitter and receiver (as shown in figures above) is 00000001 in binary or 1 in decimals or 0x01H in hexadecimal.

Pin9: This pin is for applying negative voltage for IC. Here the negative voltage is ground so we connect it to ground.

Pin18: This pin is for applying positive voltage for IC. Here the positive voltage is +5V, so we connect it to our Vcc i.e. +5V.

Pin10-13: These are the data pins of IC. We can apply here the 4-bit data to be transmitted. The data applied here is transmitted when (TE bar) is grounded.

Pin14: This pin is active low. The data present at the data pin is transmitted when it is kept low. We have kept it permanently low so that the data can be transmitted all the times.

Pin15-16: these pins are for generating oscillating frequency for the proper operation of IC. Pin15 is for oscillating input and Pin16 is for oscillating output. We connect a resistance of proper value between these pins. The oscillator frequency is directly proportional to the oscillator frequency.

Pin17: the data is converted into serial form and transmitted out from this pin.

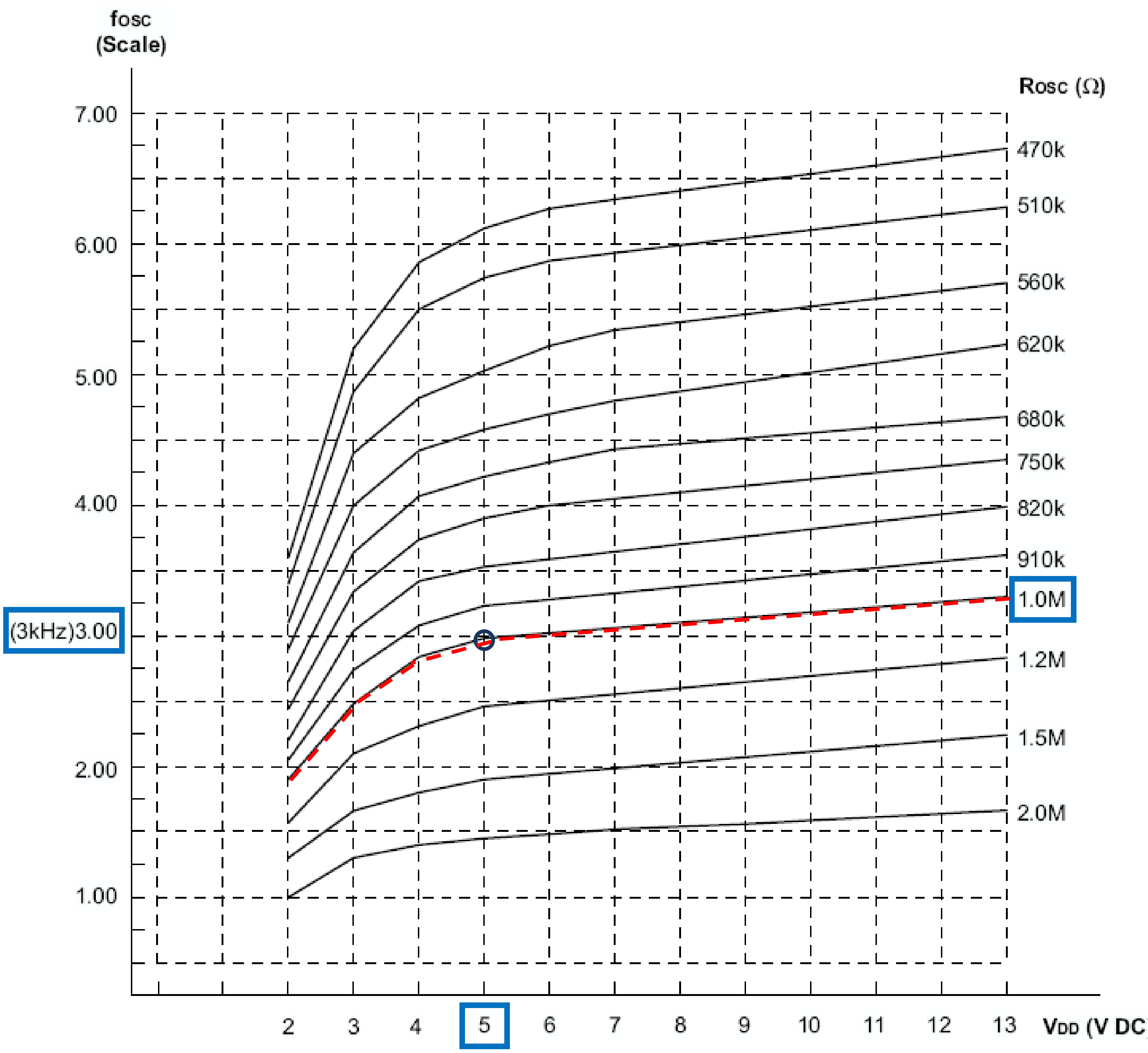
Electrical characteristics:

Have a look at the red circled data in the characteristics below. They are important to consider.

HT12E Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	—	2.4	5	12	V
I_{STB}	Standby Current	3V	Oscillator stops	—	0.1	1	µA
		12V		—	2	4	µA
I_{DD}	Operating Current	3V	No load f_{OSC}=3kHz	—	40	80	µA
		12V		—	150	300	µA
I_{DOUT}	Output Drive Current	5V	$V_{OH}=0.9V_{DD}$ (Source)	–1	–1.6	—	mA
			$V_{OL}=0.1V_{DD}$ (Sink)	1	1.6	—	mA
V_{IH}	"H" Input Voltage	—	—	$0.8V_{DD}$	—	V_{DD}	V
V_{IL}	"L" Input Voltage	—	—	0	—	$0.2V_{DD}$	V
f_{OSC}	Oscillator Frequency	5V	R_{OSC}=1.1MΩ	—	3	—	kHz
$R_{\overline{TE}}$	$\overline{TE}$ Pull-high Resistance	5V	$V_{\overline{TE}}$=0V	—	1.5	3	MΩ

The oscillator frequency is 3KHz when (R2 in figure 4) is 1.1MΩ and supply voltages is 5V. So, the operating frequency is nearly 3KHz because we have applied 1MΩ resistance between pin15 and pin16. The graph below shows different oscillating frequencies at different values of resistance at different supply voltages.



The recommended oscillator frequency for decoder f_{OSCD} (HT12D) = $50f_{OSCE}$ (HT12E)

HT12D decoder has similar characteristics. The resistance value selected for decoder is 51KΩ for 150KHz which is the required oscillating frequency for decoder. You can now check out for more details in the datasheets for these encoder and decoder pairs. That's all for now. I'll meet you soon in the next tutorial.