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Wireless Control via Mobile Communication

-Use of DTMF signals

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- This tutorial just provides the basic knowledge for the beginner to get started with the wireless communication via mobile phone without going into deeper details.
- The possibilities are seamless and can be extended easily to IVRS system as well. You do your bit to develop…

What is DTMF signal ?

- The 12 keys on a cellphone (0,1,…,8,9,*,#) has unique signal associated with itself. This is DTMF signal.
- When the call is on, the pressing of any numerical key leads to generation of DTMF signal which is audible on the other side.

Try Yourself !!!

- Take any Nokia cellphone (others I haven't tested), turn on keypad tones, press any key, the tone your hear is DTMF tone.

Note:
Don't confuse keypad tones with the tone that is heard on other side while call is on. The tone heard on other side(while call is on) is DTMF tone. Keypad tones can be different than DTMF tones (as in Samsung that use Sa Re Ga Ma … tone). It is just Nokia mobile manufacturer that uses DTMF tones for keypad tones also.

How are DTMF tone generated?

The DTMF tone for each key is sum of two sinusoidal waves of frequencies as given in following table. Thus each key has unique frequency pair and thus unique DTMF tone. For example, DTMF tone for key 6 is sum of two sunusodial waves of frequency 1477 Hz and 770 Hz.

	1209 Hz	1336 Hz	1477 Hz	1633 Hz
697 Hz	1	2	3	A
770 Hz	4	5	6	B
852 Hz	7	8	9	C
941 Hz	*	0	#	D

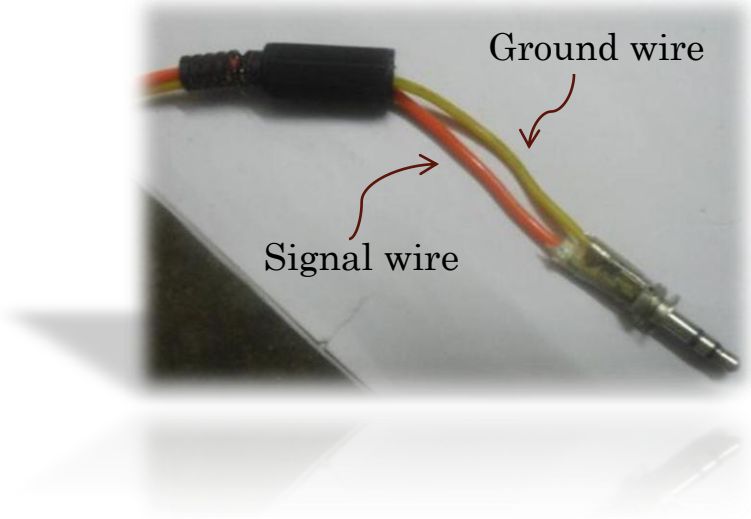
The extra keys A,B,C and D are not present on cell phone. They are actually specially used for special purposes. For example, public payphones that accept credit cards use these additional codes to send the information from the magnetic strip.

Don't worry if you don't understand this part !!!

Taking Input and Output from mobile

- Output can be taken from speaker (that is near to your ear while calling) and using microphone to convert sound waves to electrical signals …… tedious work.
- The other way is through earphone jack.

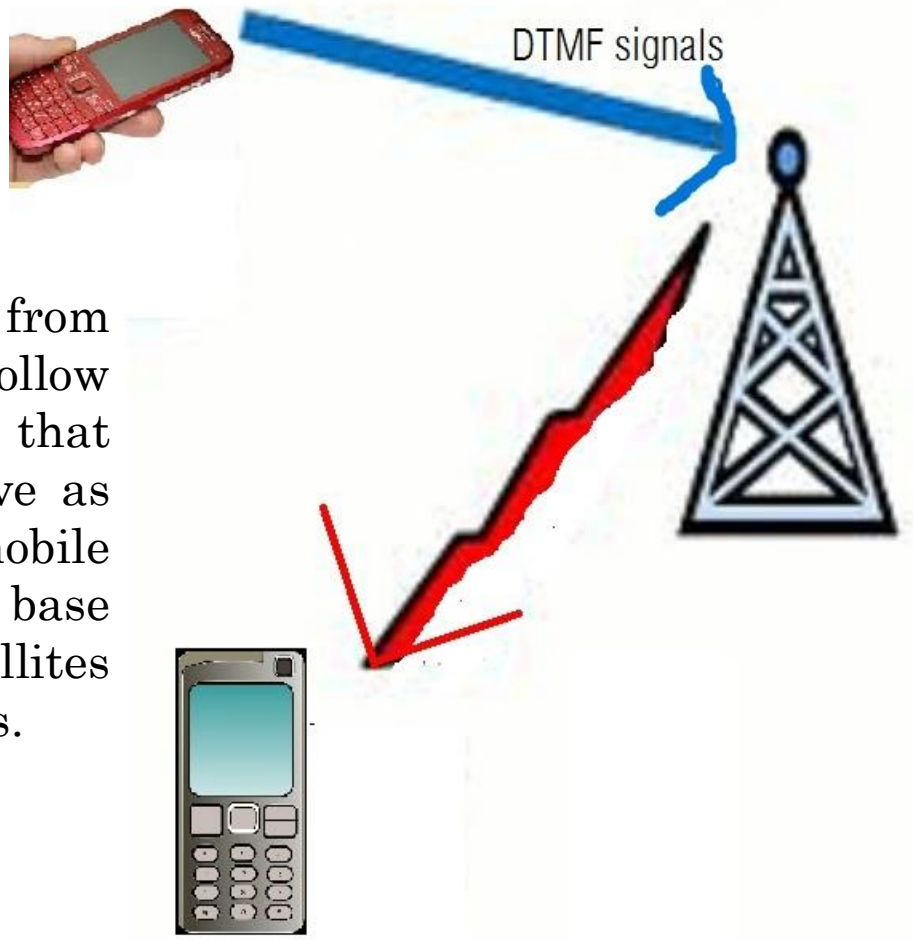
3.5 mm Earphone Jack



One wire comes from the ground terminal of the jack that is connected to common ground of the complete circuit. The other wire can be attached to any one of two signal terminals.

DTMF Signal through cellular network

The DTMF signals from source to destination follow the same path as that normal voice would have as you normally talk on mobile passing through many base stations and even satellites in case of large distances.



What do really mean when you say word "signal" ?

It may confuse you or make your concepts more clear. You can omit this topic.

Most people interpret signal as varying voltage. But this is not only the case. Signal should be seen as piece of information and it may be present in any form. It can be varying voltage (as most of the cases are), varying currents, the pressure wave or sound wave (audible voice signals), electromagnetic signals (optical fibres), etc.

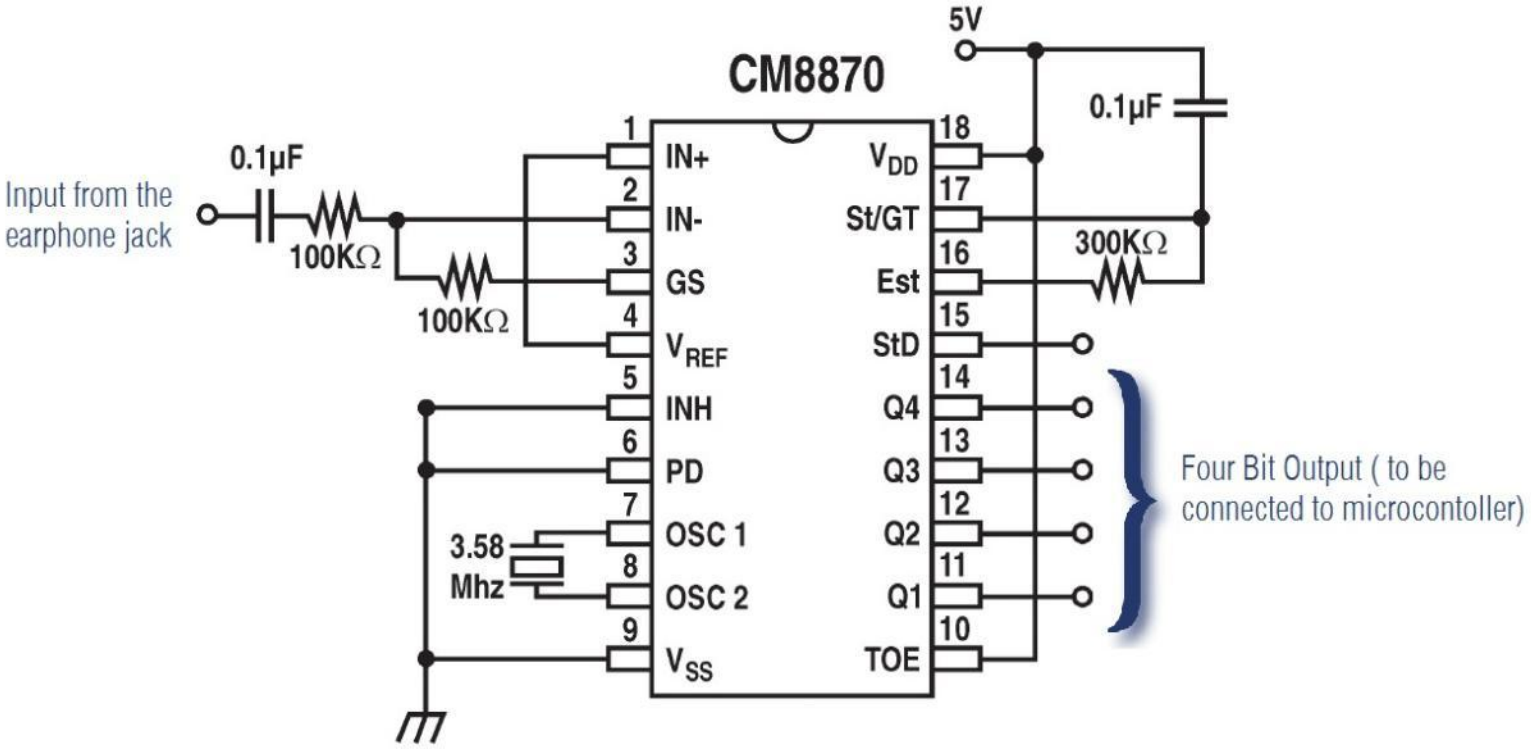
These forms are interchangeable to each other by use of some device. For example, microphone converts sound wave to voltage wave and speaker the vice versa. LED converts voltage signal to electromagnetic form. Photodiode converts light(electromagnetic signals) to varying current signals.

DTMF signal doesn't means it is electrical signal or audible voice signal(as intuition may guess). It is combination of two sinusoidal waves and sinusoidal waves may be present in any form. Infact the DTMF signal starts with electrical form on transmitter mobile, then encoded on electromagnetic wave, then again converted to electrical wave by receiver mobile and then to sound signal which is audible.

8870 DTMF Decoder

- It is an IC that takes DTMF signal as input and decodes it and shows the corresponding key as four bit output.

8870 Circuit Diagram



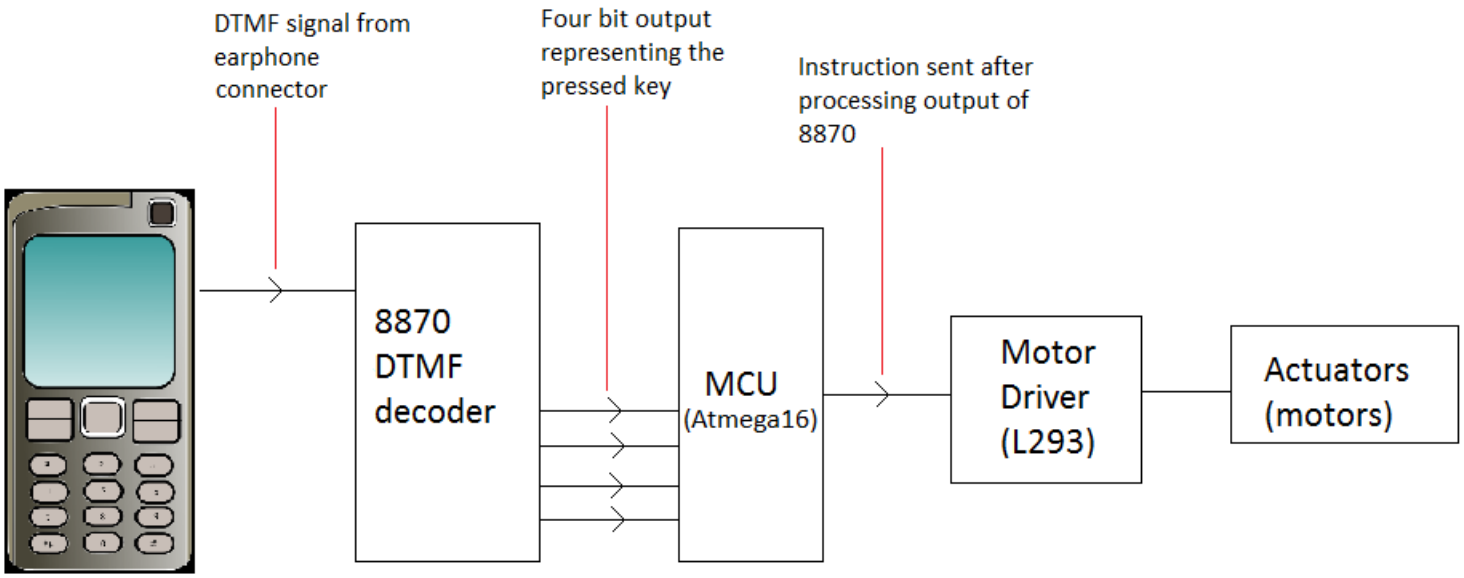
8870 Functional Table

TOW(or TOE) pin is enable pin which make the IC active when it is high. Note that in the circuit diagram TOE(pin10) is connected to 5V (high).
F_{low} and F_{high} represent the unique frequency pair for each key.
You only need to know the output 4 bit binary code for each key. Note that output for key '0' is not '0000'.

F_{LOW}	F_{HIGH}	KEY	TOW	Q_4	Q_3	Q_2	Q_1
697	1209	1	H	0	0	0	1
697	1336	2	H	0	0	1	0
697	1477	3	H	0	0	1	1
770	1209	4	H	0	1	0	0
770	1336	5	H	0	1	0	1
770	1477	6	H	0	1	1	0
852	1209	7	H	0	1	1	1
852	1336	8	H	1	0	0	0
852	1477	9	H	1	0	0	1
941	1209	0	H	1	0	1	0
941	1336	*	H	1	0	1	1
941	1477	#	H	1	1	0	0
697	1633	A	H	1	1	0	1
770	1633	B	H	1	1	1	0
852	1633	C	H	1	1	1	1
941	1633	D	H	0	0	0	0
-	-	ANY	L	Z	Z	Z	Z
L = logic Low, H = Logic High, Z = High Impedance							

Functional Diode Table

CONNECTING THINGS TOGETHER…



Note: Only lines carrying signal shown. Power supply, ground, clock, etc. ommitted for readability purpose

Points to note !!!

- You can use any mobile as transmitter.
- For receiver mobile, use mobile which has auto answer capability (most cell phones have). I suggest to get mobile with 3.5 mm jack(that one that is available on Nokia Music Express series and on desktop computer or laptop). The reason being the easy availability of its connector.

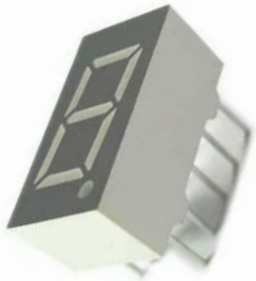
Points to note …

- For other type of earphone jack use converters.

(2.5 mm jack smaller than 3.5 mm jack)

Points to note …

- For initial debugging and testing, you may connect four bit output of 8870 IC to 7-Segment LED display through 7447 Decoder.



Conclusion

- One mobile is in your hand (cell 1) and other on the bot (cell 2). Cell 2 should be set to auto answering mode so that cell 2 automatically picks up the call. The earphone plug, 8870 DTMF decoder is connected to cell 2. You make a call from cell 1 to cell 2. Cell 2 being in auto-answering mode picks up the call. Now keypad of cell 1 acts as remote. As any key is pressed on cell 1, the corresponding 4-bit output appears on output pins of 8870 which can be further used.

YIPPIE !!! WIRELESS COMMUNICATION ACCOMPLISHED.

IVRS (ONLY FOR ROBO GEEKS … OTHERS IGNORE)

- Now you have basic idea about how mobile can be manipulated as remote. Here signals were sent only from one mobile to other. Can you think of such things like other mobile responding by sending back voice signal when some key is pressed. I mean developing IVRS. Of course it requires some more knowledge and thinking. You have learnt taking output from mobile. Find a way to give it an input. And think from where input to mobile will come. All others things, explore !!!

For the robo enthusiasts

Surf the net to learn more….

Don’t just rely upon the lectures, put your own effort.

If you want to discuss anything or you have new idea, feel free to contact me or drop a mail at nehchal@iitk.ac.in

If you feel any new things can be added in robotics club, give your ideas… be the pioneer