EMBEDDED SYSTEMS(EE30004)
HW7

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Q.1 Write briefly about 16-bit serial ADCs.

16-bit serial ADCs are available in the semiconductor market in various forms. However, the most prevalent forms are those that communicate over SPI or I2C. The basic operating principle of these ADCs is the same as a generic parallel output ADC. The ADC is done by any of the methods – flash, sigma-delta or successive approximation followed by which the resulting 16-bit digital data is stored in a register. This register contains the actual data that is sent over the serial line. Regardless of the protocol, some packet overheads like start/stop/parity and address bits are padded before and after the data packet after which it is sent serially to the device requesting the information. Generally, the ADC IC acts as the slave and uses the clock sent from the master for synchronization. Unlike generic ADCs that require an ADC start conversion signal, here, only a chip enable or slave enable signal is sent by the master microcontroller after which data is sent over the serial line. The advantage of serial communication is that only a small number of communication links are present between the microcontroller and the IC saving on area cost. It also helps reduce pin count reducing IC manufacture cost too.

Q2. Write briefly about UART.

UART stands for Universal Asynchronous Receiver Transmitter. It is computer hardware used for asynchronous serial communication in which the data format is configurable as well as the transmission speeds(baud rate). It sends data from LSB to MSB. A UART mainly consists of an internal clock(not sent through communication channel but needed for sampling), input and output shift registers(value gets shifted as bits arrive/are sent one by one), transmit/receive control(through setting up control registers in the microcontroller generally), and read/write control logic. In the data packet that is transmitted/received, 1 start bits, data frame, 0 or 1 parity bit, and 1 or 2 stop bits are present.

For two UART's communicating, the following steps take place

- The transmitting UART receives the data to be transmitted through the data bus parallelly.

- This UART adds the start, parity, and stop bits set according to the logic.
- This compiled data packet is sent to the receiving UART serially and the data is sampled by the receiving UART at a predecided baud rate.
- The receiving UART discards the start, stop, and parity bits after checking parity if that logic is implemented.
- It then again converts the serial data to parallel i.e. in the shift register and sends it to the data bus parallelly.

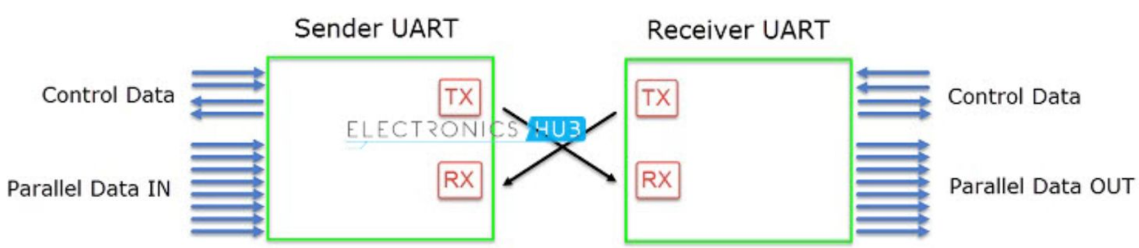


Fig. Full duplex communication mode between 2 UARTs

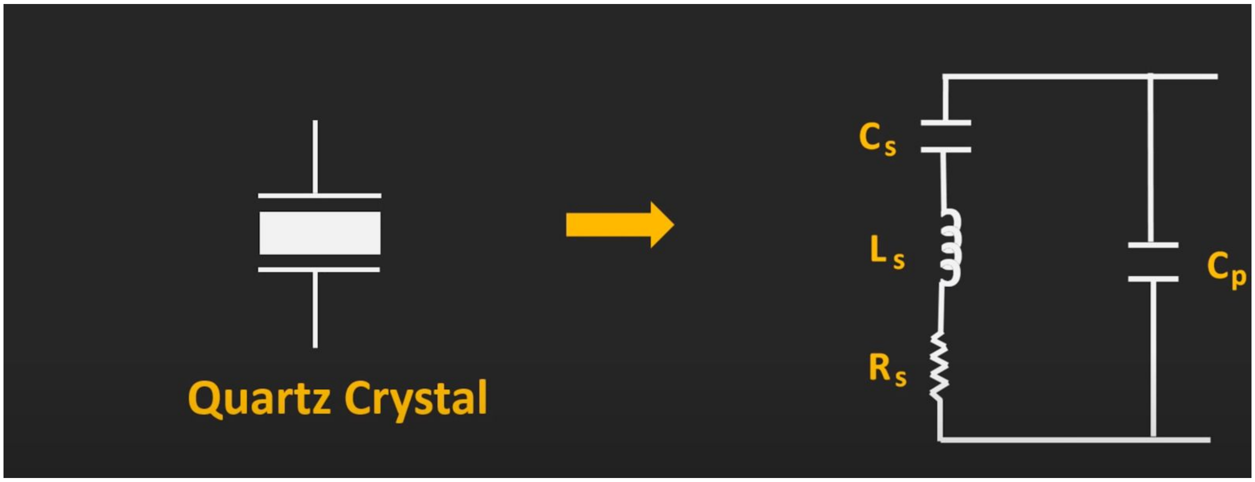
Today, UART is being used in many applications like GPS Receivers, Bluetooth Modules, GSM and GPRS Modems, Wireless Communication Systems, RFID based applications, etc.

Some advantages are, as it sends data serially less number of wires are required to send data as compared to parallel communication hence the circuit doesn't have many wires which makes it easier to debug and also less noise from less density of wires.

Data has to be converted between serial and parallel to transfer it from and to the data bus. Also as 1 bit is sent at a time, it takes longer than parallel communication.

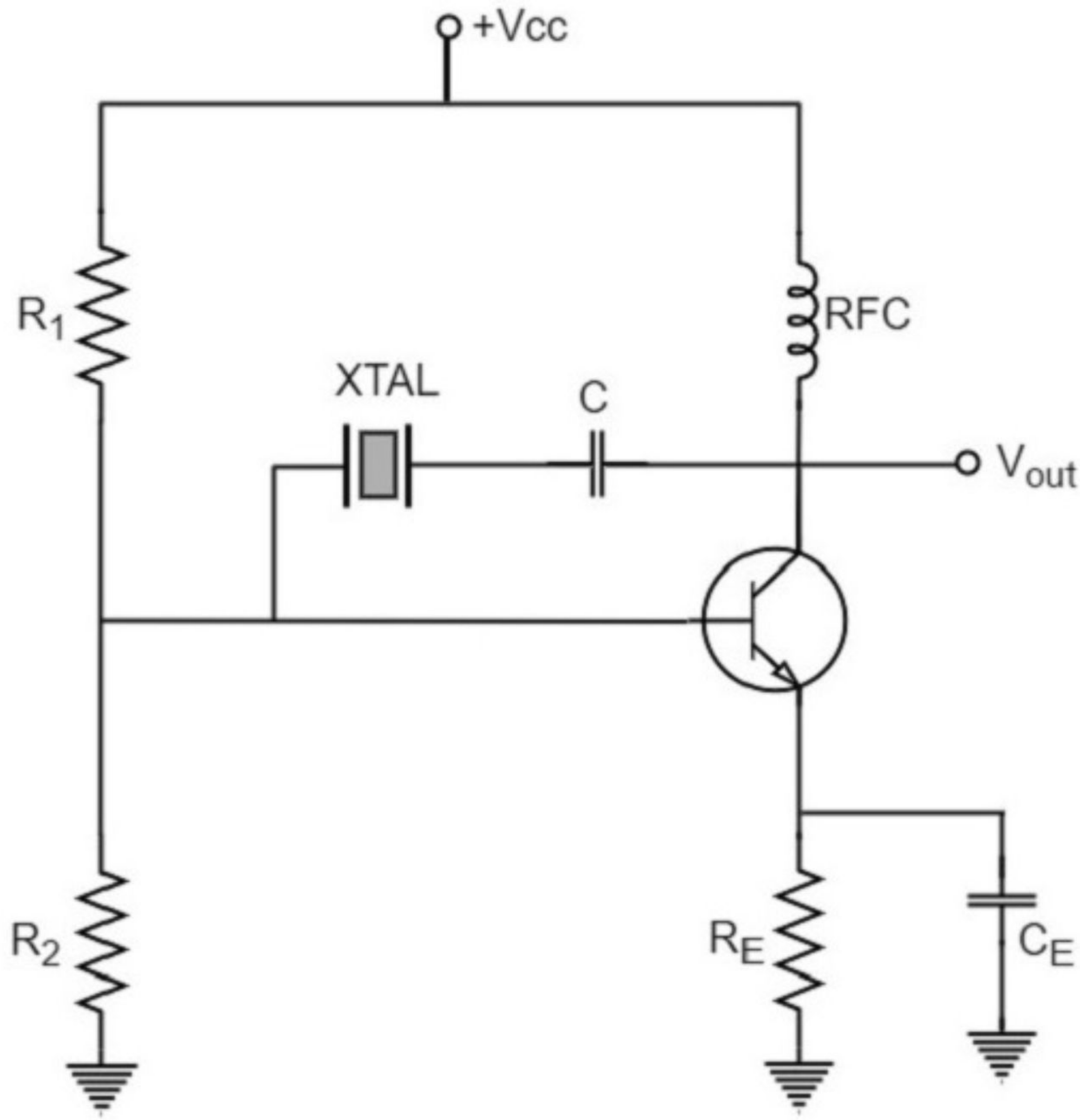
Q3. How to make crystal clock oscillator circuits?

Crystal clock oscillators work on the principle of the piezoelectric effect. There are some compounds which if given a certain voltage across them, mechanically deform and oscillate with that same frequency. Conversely, if it is mechanically vibrated, then it produces a voltage with the same frequency across the plates connected to make electrical connections. The equivalent circuit is as follows



C_s- Motional Capacitance which depends on elasticity, the thickness of quartz etc.
L_s - Motional inductance which denotes the mass/inertia of the crystal while oscillating
R_s - To denote resistive power loss
C_p - Denotes the electrode plates connected to make connections

A crystal oscillator circuit can be constructed in a number of ways like a Crystal controlled tuned collector oscillator, a Colpitts crystal oscillator, a Clap crystal oscillator etc. But the transistor pierces crystal oscillator is the most commonly used one. This is the circuit that is normally referred to as a crystal oscillator circuit.



In this circuit, the crystal is connected as a series element in the feedback path from the collector to the base. The resistors R1, R2 and RE provide a voltage-divider stabilized d.c. bias circuit. The capacitor CE provides a.c. bypass of the emitter resistor and RFC (radio frequency choke) coil provides for d.c. bias while decoupling any a.c. signal on the power lines from affecting the output signal. The coupling capacitor C has negligible impedance at the circuit operating frequency. But it blocks any d.c. between collector and base.

The circuit frequency of oscillation is set by the series resonant frequency of the crystal and its value is given by the relation,

$$f_0 = \frac{1}{2\pi\sqrt{(LC)}}$$

Circuital changes don’t affect the frequency as it is stabilized by the crystal

Q4. Write about different types of RS.

Asynchronous Serial Protocols are very essential for long-distance reliable data transfer. Asynchronous communication does not require a common clock between the transmitting and receiving devices. Each device independently sends and receives data at a previously agreed-upon baud rate. These devices are synchronized so that they aren’t out of synch and erroneous data transfer is avoided. Some protocols for this used today are RS232, RS422, RS485 etc.

RS232: The RS232 is a point-to-point topology with a maximum of one device connected and covers a distance of up to 15 meters at 9600 bps. Information on the RS-232 interface is transmitted digitally by logical 0 and 1. The logical "1" (MARK) corresponds to a voltage in the range from -3 to -15 V. The logical "0" (SPACE) corresponds to a voltage in the range from +3 to +15 V.

RS422: RS422 was introduced to enable higher data rates to be transferred over serial data lines than was possible with RS232. RS422 is able to provide data rates of up to 10 Mbps at distances up to 50 feet. However using reduced data rates, RS422 is able to transmit data over distances of 4000 feet, the maximum is 100 kbps at this distance. The key reason why RS422 is able to achieve these improvements results from the use of differential or balanced transmission techniques. RS422 uses both differential transmitters and receivers which means that it is much more resilient to common-mode interference, a key issue with long lines. Space is represented by a line voltage level in the band between +2 and +6 volts while a mark is represented by a voltage in the range of -2 to -6 volts.

RS485: RS485 defines not only a single device-to-device interface but also a communications bus that can be used to form simple networks of multiple devices. Its configuration and specifications also extend the range and data rate beyond the RS-232 interface capabilities. Here too differential signal transmission on two lines rather than single-ended is used to eliminate common-mode noise in long transmission distances.