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COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF BIOMEDICAL ENGINEERING

BM3491 Biomedical Instrumentation

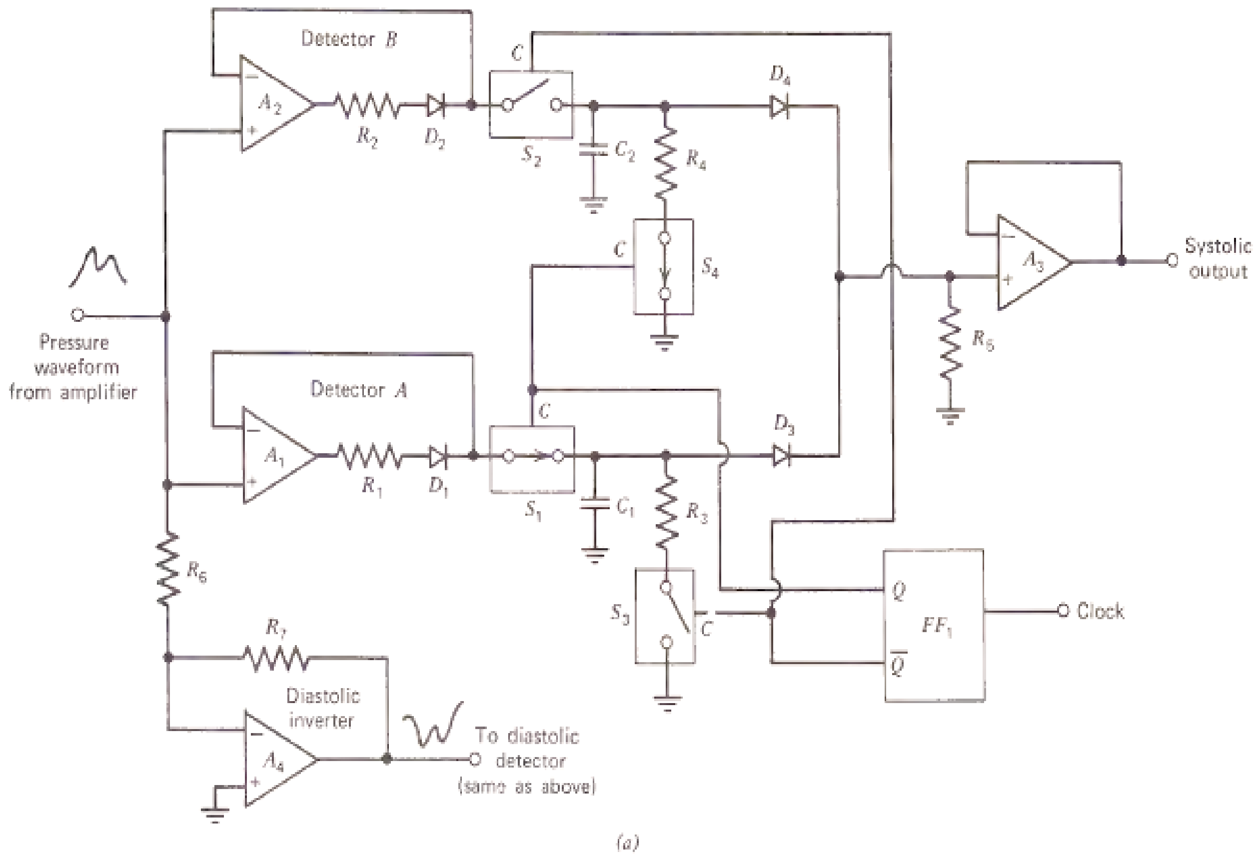
UNIT-IV MEASUREMENT OF BIO SIGNALS

4.3 Pressure amplifiers - systolic, diastolic, mean detector circuit.

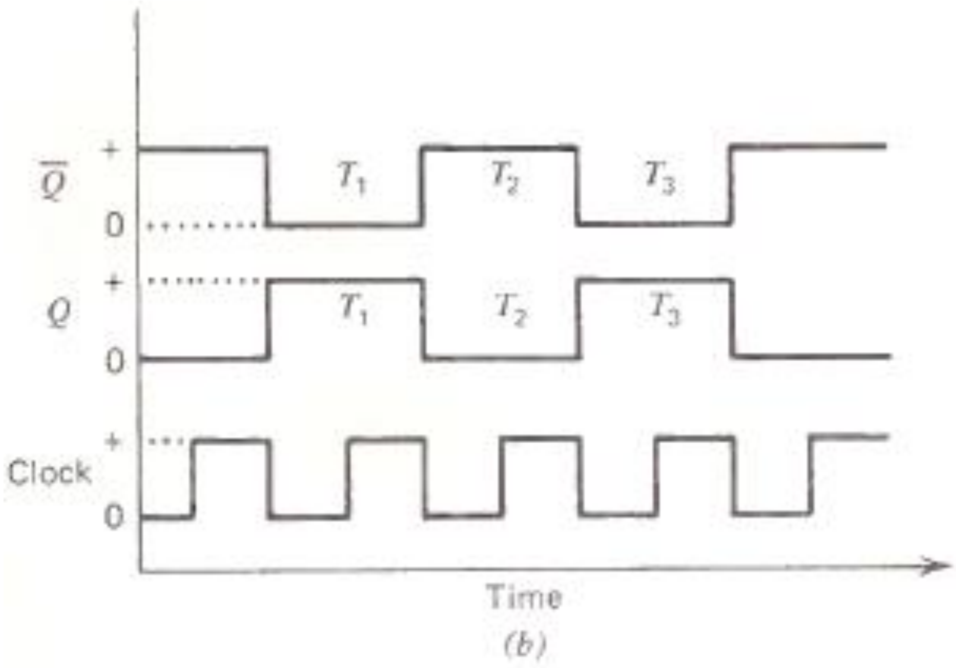
- The pressure amplifier produces an analog waveform with a ***peak amplitude*** representing the ***systolic pressure***, and a minimum, or '*valley*,' that represents the ***diastolic*** *pressure*.
- ***Additional circuitry is required that recognizes*** these points, and from them produce a steady DC voltage or current that can be used to drive a display meter.
- The pressure amplifier used for bedside applications is less complex and thus is less flexible and often somewhat less accurate.
- While its simplicity allows less well-trained personnel to successfully operate the instrument, it is more accurate than most indirect methods.
- In ICU/CCU/OR settings, the operator is usually a physician, nurse, or monitoring technician who has duties other than equipment operation and has limited time to calibrate pressure equipment.
- For these busy people, it is a valid trade-off to sacrifice a small amount of accuracy for simpler operation.
- In applications where superior accuracy is needed, a mercury or aneroid manometer is used to calibrate pressure equipment every time it is used.
- clinical pressure monitors have an internal calibration signal that is used for day-to-day operation, and it is checked periodically.

Systolic, Diastolic, and Mean Detector Circuits:

- The partial schematic of a pressure detector is shown in Figure (a), while the timing diagram is shown in Figure (b).
- Amplifiers A_1 through A_3; are ***operational amplifiers*.**
- Switches S_1 through S_4 are CMOS ***electronic switches***.
- Note that the operational amplifiers **may be *integrated* types, as shown, or** may be constructed of ***discrete*** *component*s in older models.



(a) Systolic detector circuit



(b) Timing diagram

- This circuit operates from a two-phase clock created by flip-flop FF_1. The Q and not-Q ($\overline{Q}$) outputs are complementary, so one will be high when the other is low.
- Switches S_1 and S_4 are turned on when the Q is high, and switches S_2 and S_3 are turned on when the $\overline{Q}$ is high.
- The analog waveform from the output of the pressure amplifier is applied simultaneously (i.e., in parallel) to the inputs of A_1 and A_2. The waveform, therefore, appears simultaneously at the outputs of A_1; and A_2.
- During period T_1, (Figure b), the Q output of FF_1 is high, so switches S_1 and S_4 are closed. When S_4 is closed, capacitor C_2 is discharged, so it has no effect on the output. Closing switch S_1 allows the signal ap-pearing at the output of A_1 to charge capacitor C_1 to the peak voltage, representing the **systolic pressure**.
- The voltage across capacitor C_1 for-ward biases diode D_3, which then conducts and applies the voltage to the input of amplifier A_3. The output of amplifier A_3 goes to the systolic output meter.
- The situation reverses during the time T_2: The not-Q of FF_1 becomes high and the Q is low. This turns on switches S_2 and S_3 and turns off S_1 and S_4. Closing S_2 causes capacitor C_2 to rapidly charge to the peak

voltage of the input signal. This will occur within less than a second in most cases.

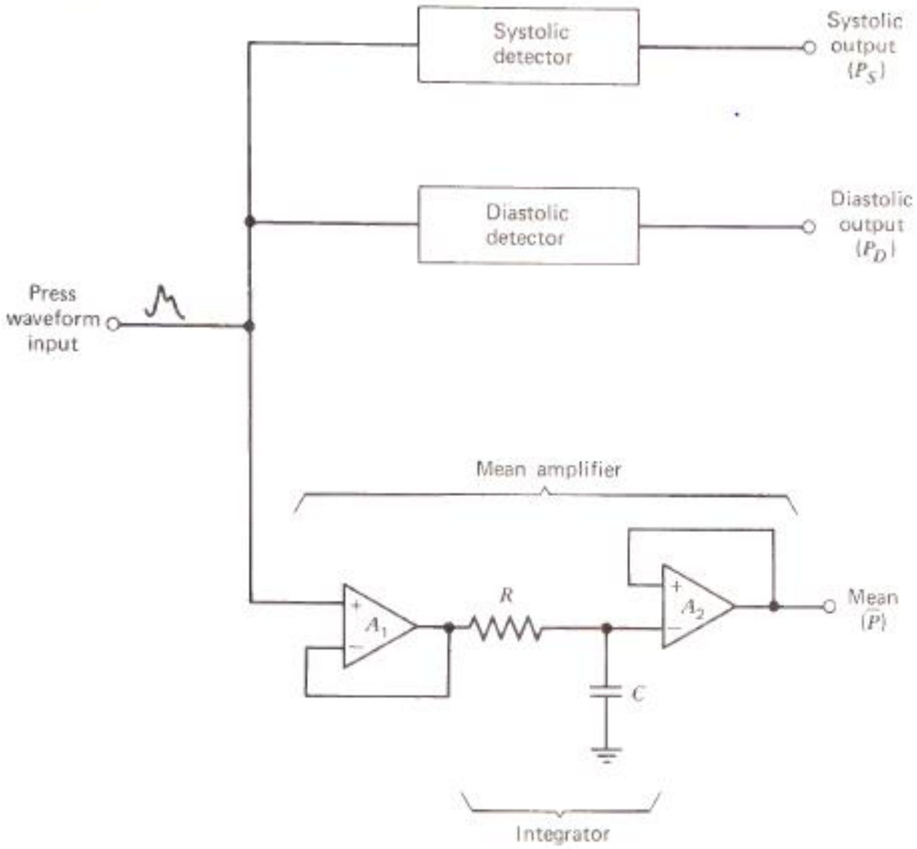
- Switch S_3; closes to allow capacitor C_1 to discharge slowly through resistor R_3. The charge on C_2 will reach peak before any appreciable decay of the C_1 charge takes place. In some models each charge switch is operated directly from FF_1, while the discharge switch is operated by the same signal after it has passed through an R-C network delay line. This network insures that one capacitor is fully charged before the other begins to decay.
- The voltage at the output of Figure (a) represents the peak of the waveform, which corresponds to the systolic pressure. The same circuit may be used to detect the diastolic voltage by inverting the waveform so that the diastolic feature becomes the peak.
- ***The mean arterial pressure*** is found by taking the time average (i.e., integrating) the pressure waveform (Figure). An example of a simple mean value integrator is shown in Figure 6-165. Most pressure monitors use a simple R-C integrator with buffering amplifiers rather than regular operational amplifier integrators.
- The mean reading may create a bit of con-fusion to some medical and nursing personnel, who were taught the functional definition of mean arterial pressure, which is

$$\bar{P} = P_d + \frac{P_s - P_d}{3}$$

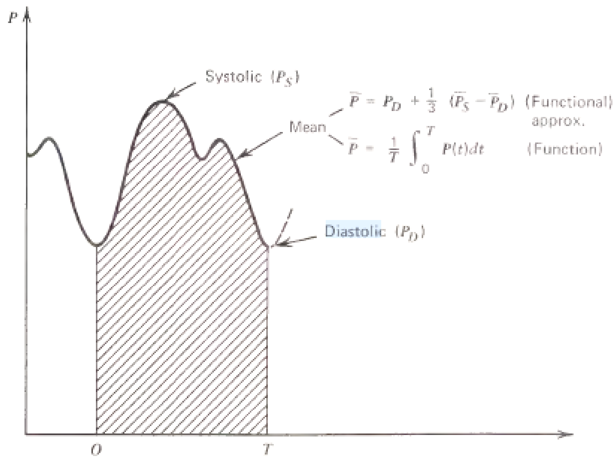
where $\bar{P}$ is the mean arterial pressure in mm Hg

P_d is the diastolic pressure in mm Hg

P_s is the systolic pressure in mm Hg



Mean arterial pressure detector.



Graphical and mathematical meaning of (b) "mean arterial pressure."

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