Mimic Diagram:

Controls and Indicators

Power On/Off:

Rocker switch for supplying power to the instrument

EMG Simulator:

Rotating knob for selecting the simulated EMG

LED Indication:

Visible LED indication for particular simulated EMG selected.

Block Diagram Description

This system picks up and amplifies electrical impulses (activity) a generated in the body surface because of general and skeletal muscle electrical activity. Amplifier functions as real time EMG Amplifier with fast response and setting time characteristics. The block diagram of an Electromyograph (EMG) kit is shown in figure 1. It consists of following blocks:

1. Input from electrodes.
2. Instrumentation amplifier section
3. Filter section
4. Main amplifier section
5. EMG Simulator section

Input from electrodes:

The bioelectric potentials generated by the muscular activities are measured from electrodes applied on the surface of the body near a muscle of interest or directly into the muscle by penetrating the skin with needle electrodes. The EMG measurements are intended to obtain an indication of the amount of activity of a particular muscle, or group of muscles, rather than of an individual muscle fiber. The pattern is usually a summation of the individual action potentials from the fibers constituting the muscle or muscles being measured.

Instrumentation Amplifier Section:

The EMG signals received from the patient are fed to the instrumentation amplifier section. It employs three operational amplifiers. It has a buffer amplifier similar to EEG, a circuit of high input impedance, low noise and low output impedance. It is kept close to the patient to reduce electrical interference from 50 Hz mains and noise from other sources. Instrumentation amplifier used for EMG is generally having input impedance of 1000 MΩ2 and frequency response 1 Hz to 10 KHz. It is preferable to mount the instrumentation amplifier very near to the subject in order to avoid undesirable effects of stray capacitance between cables.

Filter sections:

A low pass filter of frequency range 1Hz to 10 KHz is employed here to allow only a signal of selected bandwidth to pass to the next circuit.

Amplifier Section:

The amplifier section amplifies the signal to the desired level. The filtered signal has amplitude of some mill volts hence it is amplified using main amplifier with variable gain from 400 to 1000. To reduce the DC offset A.C amplifiers are used in this section.

EMG Simulator Section:

EMG simulator has a rotating knob for selecting the particular simulated EMG viz.

A	=	Normal EMG
B	=	Excited EMG
C	=	Raw EMG Data
D	=	100Hz Filtered
E	=	250 Filtered
F	=	1 KHz Filtered
G	=	EMG at 0.53Hz
H	=	EMG at 53Hz
I	=	Power Spectrum at 0.53Hz
J	=	Power Spectrum at 53Hz

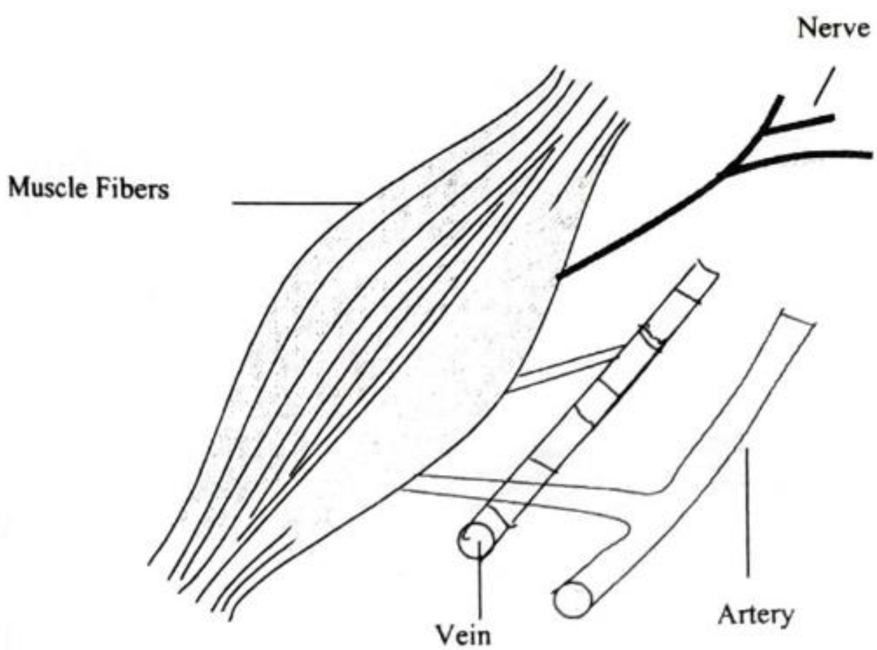
Selected simulated EMG can be viewed on Oscilloscope from test point 4

Theory

The Muscular System:

The muscle is one of the very important components of the body. It is the power generator or force-generating device of the body. It is responsible for movements of the body. Without a muscle, we are like a car or scooter engaged in neutral gear when the engine is running but the car is not able to move.

There are a large number of muscles through which the movements of the body takes place. The muscles are attached to the bones at most of the places in the body, except for some places in the head. The muscle of the human being consists of 75% water, 20% protein and 5% mineral salts, glycogen and fat. They are made up of fibers and they obtain required energy to contract from the oxidation of food particularly carbohydrates. You must realize that the muscle contraction occurs as a result of nerve impulses. A human muscle is shown in figure 2.



The flexible muscles are attached to bones in a very deliberate manner by bands called tendons. All the muscles have nerve cells. When a nerve impulse appears at the muscle an action potential is generated. This action potential further gets propagated throughout the muscle cells resulting in contraction of the muscle. The location of the muscles and the way they are connected to different bones decide the nature of movement.

The Electromyogram:

The skeletal muscle is the force-generating component of a human body. It is a system of many tiny contractile fibers placed in parallel. These fibers are organized in-groups called motor units. Each unit has a single motor neuron to convey motor impulses from the central nervous system. The contraction of muscle fiber involves depolarization and repolarization of cell membrane resulting into electrical potentials called myoelectric signals. Therefore, an Electromyogram or EMG is the representation of electrical signals generated by the neuro-muscular activation of a contracting muscle. The signal represents the current generated by the ionic flow across the membrane of the muscle fibers, which propagates through the intervening tissues to reach the detection surface of an electrode located in the environment. It is a complicated signal, which is affected by the anatomical and physiological properties of the muscle and control scheme of the nervous system, as well as the characteristics of the instrumentation used to detect it. The motor unit action potential (MUAP) of a single motor unit is shown in figure 3.

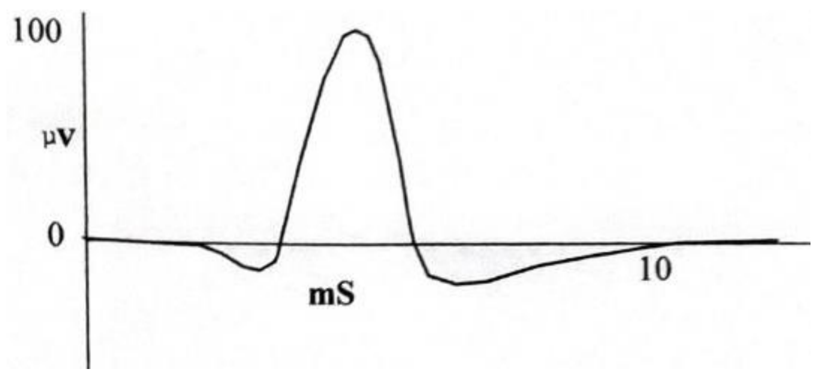


Figure 3 Motor Unit Action Potential

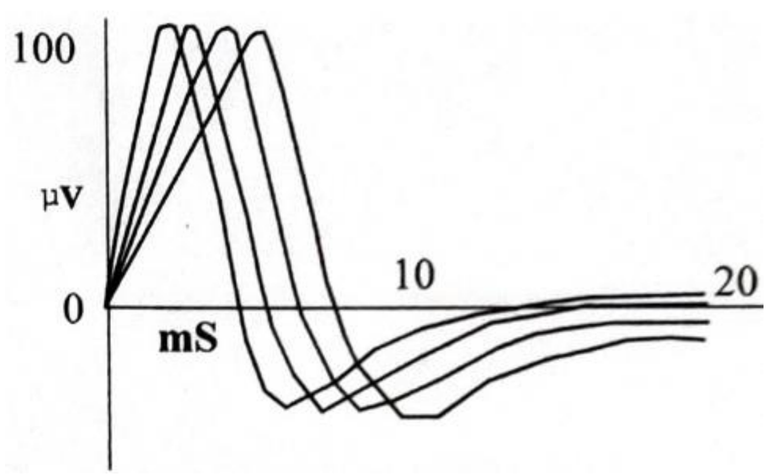


Figure 4 Motor Unit Action Potential Train

The motor units of a muscle are activated repeatedly to sustain contraction, resulting into sequence of MUAPs, known as motor unit action potential train (MUAPT). It is shown in figure 4. The summation of many trains of single motor unit potential is called gross myoelectric signal (GMS).

The electrical potentials generated by the muscle range from 5 microvolt to 5 mill volts and their duration range between 2 milliseconds to 15 milliseconds. EMG is a fastest signal inside our body. It is a signal, which has highest frequencies compared to the other electrical signals. The frequency of EMG signals approximately falls between 10 to 3000 Hz. In a relaxed muscle, there are normally no action potentials. The amplitude of EMG signal depends on type of electrode used and degree of muscular contraction. The needle electrode inserted into the muscle fiber generates spike type voltage, whereas a surface electrode picks many overlapping spikes and therefore produces an average effect.

As stated the action potential of a given muscle (or nerve fiber) has a fixed magnitude. regardless of the intensity of the stimulus that generates the response. Thus, in a muscle, the intensity with which the muscle acts does not increase the net height of the action potential pulse but does increase the rate with which each muscle fiber fires and the number of fibers that are activated at any given time. The amplitude of the measured EMG waveform is the instantaneous sum of all the action potentials generated at any given time. Because these action potentials occur in both positive and negative polarities at a given pair of electrodes, they sometimes add and sometimes cancel. Thus, the EMG waveform appears very much like a random-noise waveform, with the energy of the signal a function of the amount of muscle activity and electrode placement. Typical EMG waveforms are shown in figure 5.

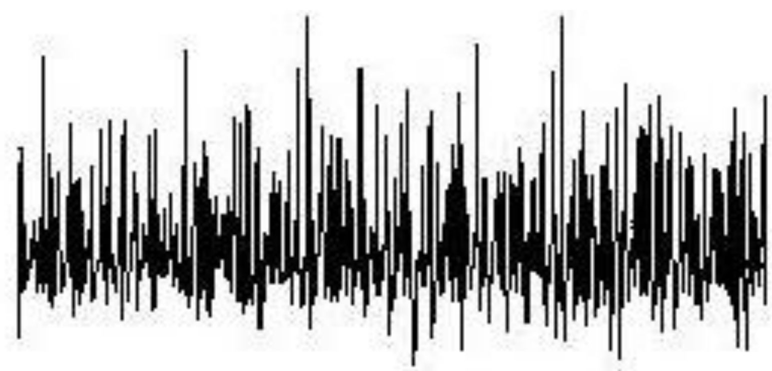


Figure 5 Typical Electromyogram waveform

Recording Techniques:

There are two basic methods for recording of EMG signals.

1. EMG with voluntary muscular action, and
2. EMG with electrical stimulation.

To obtain a good and noiseless EMG, it is essential to clean the recording site thoroughly. The disc or needle electrodes used must be clean and fixed on the recording site with conductive electrode jelly. The patient should be asked to relax completely to avoid activity from other muscles, which may otherwise, interfere or mix with the signals to be recorded from the selected site.

EMG with Voluntary Action:

In this recording method the action potential generated during voluntary contraction is picked up by needle electrode inserted into the muscle or by surface electrode placed over the muscle. The EMG produced during voluntary contraction may spread over a period of 100 milliseconds or more and can have number of spikes or a train of spikes. This is because the propagation delay from the spinal cord to the muscle concerned is different for all nerve fibers. Hence, impulses to the all-motor units do not reach at the same time. In mild contraction of a muscle, is possible to identify an action potential of even single motor unit. During a forceful voluntary contraction, many motor units are involved, the EMG obtained is a result of the action potential produced by all these motor units together. EMG generated during voluntary contraction is shown in figure 6.

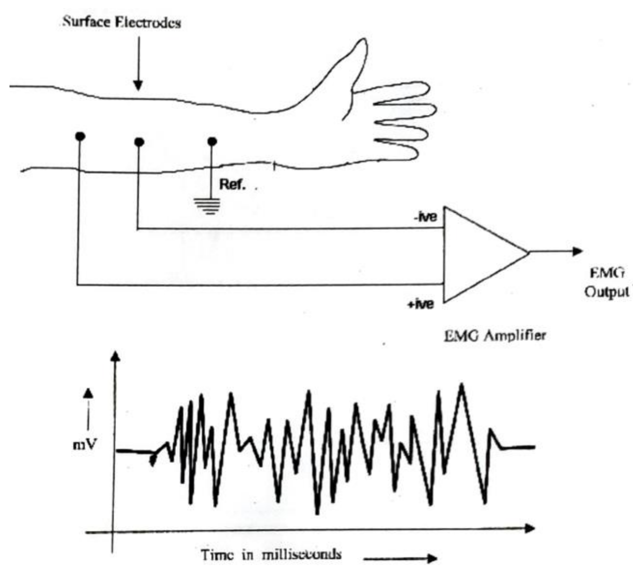


Figure 6 EMG Generated during Voluntary Contraction

EMG Generated during Voluntary Contraction

The quantity of electrical activity produced by voluntary muscle contraction depends on the strength of the contraction. Since it is difficult to estimate the quantity from an observation of the EMG waveform on the screen of the oscilloscope, the absolute integral of the EMG is used as a measure of this quantity. Being EMG information is in audible range; it is often presented in audio form. A trained listener can judge the condition of the muscle by listening to the volume and characteristic tones produced. during muscular contractions.

EMG with Electrical Stimulation:

As discussed above, an EMG produced during voluntary contraction has several action potentials. You know that an electrical impulse can be used to stimulate a nerve or muscle i.e. when an electrical current of certain quantity allowed to flow through the nerve or muscle cell, the cell gets depolarized. This phenomenon has been used in stimulation electromyography to activate all the fibers of a muscle at a time and to obtain synchronized action potential. Here, all neurons with thresholds above the set stimulation intensity are simultaneously stimulated by the electrical impulse. This therefore produces substantial activity for brief periods, which are less than 10 milliseconds. This is an unnatural occurrence referred as myographic response or muscle action potential. The electrical pulse used to initiate this response has pulse duration equals to either 0.1 milliseconds or 0.3 milliseconds and voltage above 100 volts. The typical EMG produced by electrical stimulation is shown in figure 7.

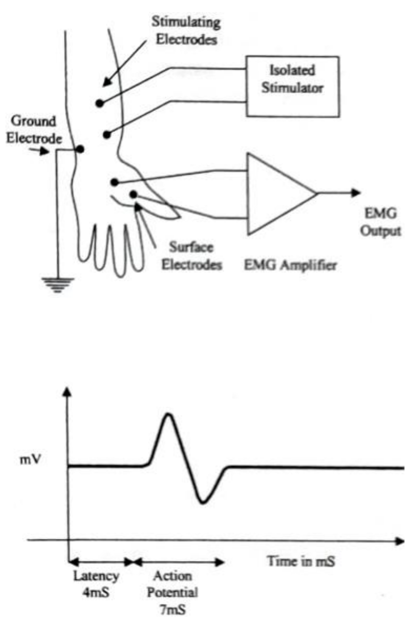


Figure 7 EMG Produced by Electrical Stimulation

Electrical Activity of Normal Muscle:

In clinical electromyography, electrical activity is recorded extracellularly from muscle fibers that are embedded in tissue, which is itself a conducting medium. The action potentials that are recorded in this way have a tri- or biphasic configuration. The basis for this is illustrated schematically in (figure 8) where the active electrode is shown on the surface of a fiber and the reference electrode is placed at a remote point in the conducting medium. Since there is a flow of current into the fiber (that is, a current 'sink') at the point of excitation and an outward flow of current in adjacent regions, the propagated impulse can be considered a moving sink of the current, preceded and followed by current sources Accordingly, when an impulse travels toward the active electrode, this electrode becomes relatively more positive as it comes to overlie the current source preceding the action potential (figure 8). A short time later, as the impulse itself arrives, the active electrode registers a negative potential in relation to the distance electrode (figure 8), and then a relatively positive potential as the impulse passes on and is followed by the current source behind it (figure 8). As this too passes on, the electrode comes again to be on a resting portion of the fiber and the potential between the two electrodes returns to the baseline (figure). Clearly, the recorded action potential will be biphasic with a negative onset (rather than triphasic with a positive onset) if the active electrode is placed over the region of the fiber at which the impulse is initiated.

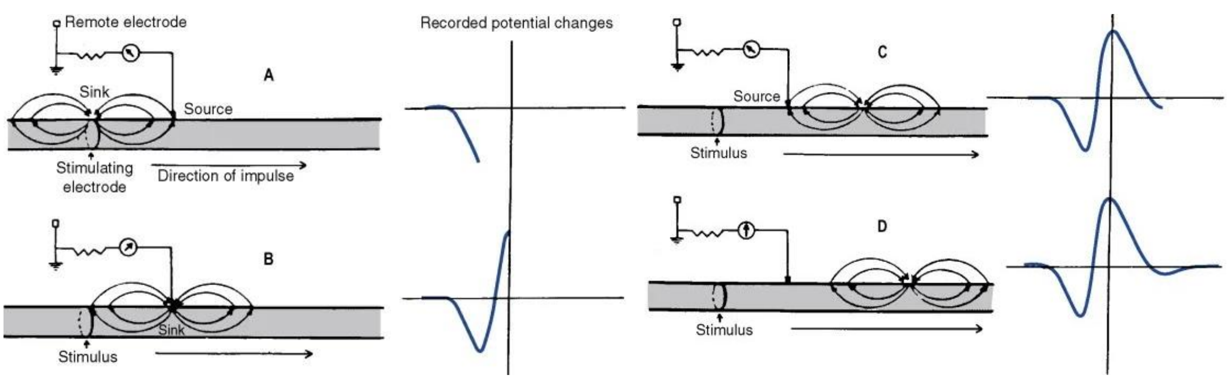


Figure 8 The passage of an action potential along a nerve or muscle fiber in a conducting medium. The active electrode is on the surface of the fiber and the reference electrode is at a remote point in the conducting medium

Electrical Activity at Rest:

Electrical activity usually cannot be recorded outside of the endplate region of healthy muscle at rest, except immediately after insertion or movement of the needle recording electrode. The activity related to electrode movement-insertion activity-is due to mechanical stimulation or injury of the muscle fibers and usually stops within 2 or 3 seconds of the movement (figure 9). After cessation of this activity, spontaneous activity may be found in the endplate region, but not elsewhere. This endplate noise, as it is called, consists of monophasic negative potentials that have an irregular, high frequency discharge pattern, duration of between 0.5 and 2.0 m sec, and amplitude that is usually less than 100 µV. The potentials correspond to the miniature endplate potentials that can be recorded with microelectrodes in experimental animals.. Biphasic potentials with a negative onset are also a constituent of endplate noise and have duration of 3 to 5 m sec and amplitude of 100 to 200µV. They have been self to represent muscle fiber action potentials arising sporadically due to spontaneous activity at the neuromuscular junction or activity in the intramuscular nerve fibers.

Electrical Findings during Activity:

1. Motor Unit Potentials:

Excitation of a single lower motor neuron normally leads to the activation of all of the muscle fibers that it innervates (i.e., those that comprise the motor unit) The motor unit potential is a compound potential representing the sum of the individual action are then and are potentials generated in the few muscle fibers of the unit that are within the pick-up range of the recording electrode. When recorded with a concentric needle electrode, motor unit potentials are usually bi or triphasic (Figure), but in the limb muscles about 12 percent may have five or more phases a described I as poly-phasic. The duration of the potentials, which is normally between 2 and 15 m sec, relates to the anatomic scatter of endplates of those muscle fibers in the units under study that are within the pick-up zone of the recording electrode This is because of the different distances along which the muscle fiber action potentials will have to be conducted from the individual endplates before they reach the recording zone of the electrode. The amplitude of the motor unit potentials is usually between 200µV and 3mV and is determined largely by the distance between the recording electrode and the active fibers that are closest to it. The number of

Figure 9 Insertion activity is evoked in normal muscle. In accordance with convention, an upward deflection in this and subsequent figure indicates relative negativity of the active electrode.

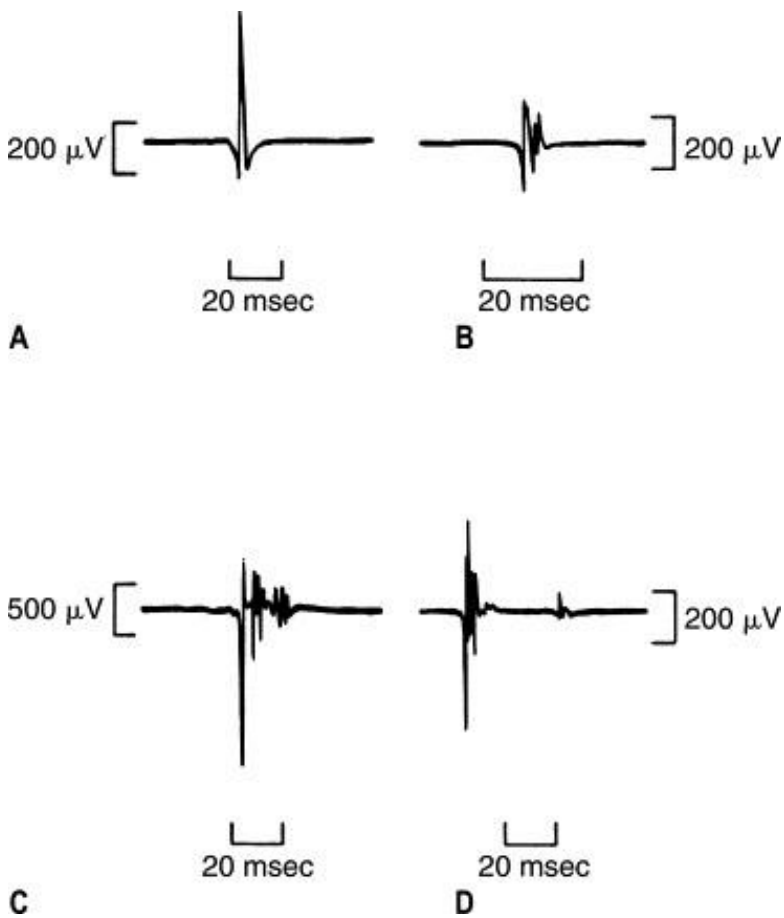


Figure 10 Motor unit potentials. (A) Normal potential. (B) Low-amplitude, short-duration, polyphasic potential. (C) Long-duration, polyphasic potential. (D) Polyphasic potential with a late component.

Active fibers lying close to the electrode and the temporal dispersion of their individual action potentials also affect the amplitude of the potentials, but to a lesser extent.

The configuration and dimensions of individual motor unit potentials are normally constant, provided that the recording electrode is not moved. They are, however; influenced by the characteristics of the recording electrode and apparatus in the electromyography system and by the physiologic factors, such as age, intramuscular temperature, the site of the recording electrode within the muscle, and the particular muscle under examination. With increasing age from infancy to adulthood there is an increase in the mean duration of motor unit potentials in limb muscles, probably due to growth in width of the territory over which end plates are scattered. Mean duration of motor unit potentials and the number of polyphasic potentials also increase as temperature declines. Abnormalities in the parameters of motor unit potentials occur in patients with neuromuscular diseases, as is discussed below.

2. Motor Unit Recruitment Pattern:

When a muscle is contracted weakly, a few of its motor units begin tiring irregularly and at a low rate. As the force of contraction increases, the firing rate of these active units' increases until it reaches a certain frequency when additional units are recruited eventually. So many units are recruited that the baseline is interrupted continuously by the potentials, and individual potentials cannot be distinguished from each other the resulting appearance of the oscilloscope trace is referred to as the interference pattern (Figure 11).

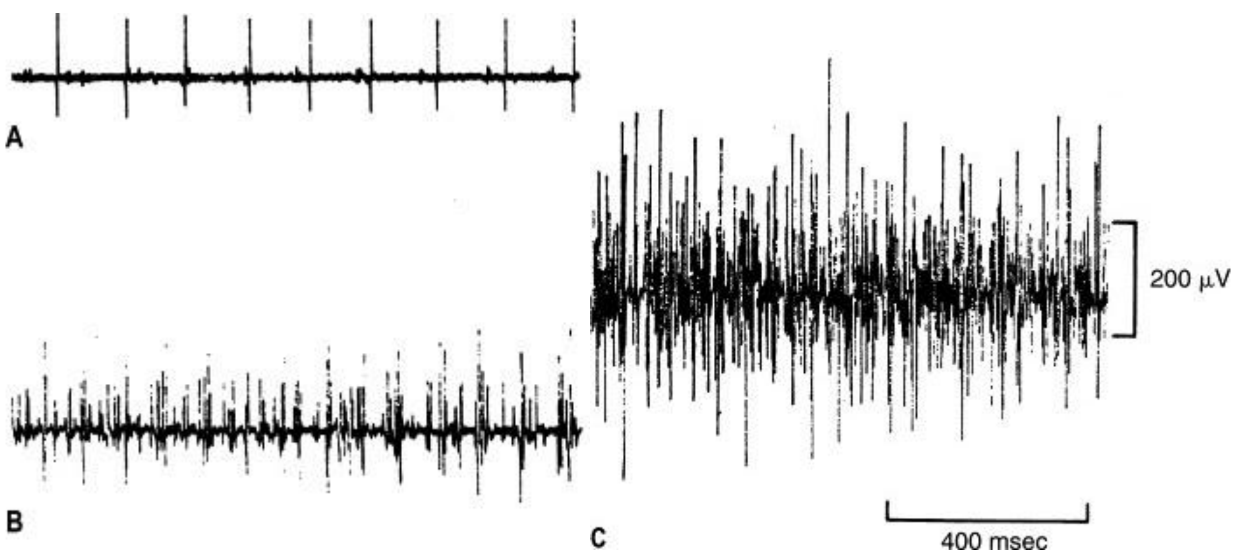


Figure 11 Motor unit potentials recorded during slight (A), moderate (B), and maximal (C) voluntary contraction of muscle.

Electromyograph graphic (EMG) Measurements:

The first attempt to obtain biopotential tracings in cases involving peripheral nerve paralysis, by R.P Proebster in 1928, has been credited with initiating clinical electromyography EMG). EMG has been a valuable clinical tool for muscular disorders since 1960.

Muscles fall into three general classifications: skeletal, cardiac, and smooth. The EMG is the bioelectronics measurement of limbs, thorax, heart, intestines, and involuntary muscles.

The EMG potentials from a muscle or group of muscles produce a noise like waveform that varies in amplitude with the amount of muscular activity. Peak amplitudes vary from 50μV to about 1mV, depending on the location of the measuring electrodes with respect to the muscle and the activity of the muscle. A frequency response from about 10 Hz to well over 3000 Hz is required for faithful reproduction.

A simplified diagram of an electromyographic device is shown in figure 12 Semiconductor amplifiers are used to magnify the small voltage input picked up by the electrodes to a level adequate for the operation for a readout device, such as the oscilloscope or loudspeaker.

Surface, needle, and fine-wire electrodes are all used for different types of EMG measurement. Surface electrodes are generally used where gross indications are suitable, but where localized measurement of specific muscles is required, needle or wire electrodes that penetrate the skin and contact the muscle to be measured are needed. As in neuronal firing measurements, both unipolar and bipolar measurements of EMG are used.

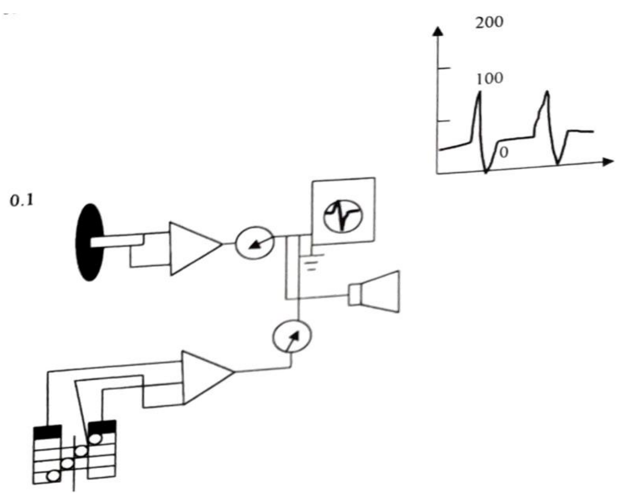


Figure 12

Figure 13 Digital Electromyograph Machine

Most Electromyograph includes an audio amplifier and loudspeaker in addition to the display to permit the operator to hear the "crackling" sounds of the EMG. This audio presentation is especially helpful in the placement of needle or wire electrodes into muscle. A trained operator is able to tell from the sound not only that his electrodes are making good contact with a muscle but also which of several adjacent muscles he has contacted.

Quantitative Aspects of Electromyography:

The EMG signal can be quantified in several ways. The simplest method is measurement of the amplitude alone. In this case, the maximum amplitude achieved for a given type of muscle activity is recorded. Unfortunately, the amplitude is only a rough indication of the amount of muscle activity and is dependent on the location of the measuring electrodes with respect to the muscle.

Another method of quantifying EMG is a count of the number of spikes, or, in some cases, zero crossings, that occur over a given time interval. A modification of this method is a count of the number of times a given amplitude threshold is exceeded. Although these counts vary with the amount of muscle activity, they do not provide an accurate means of quantification, for the measured waveform is a summation of a large number of action potentials that cannot be distinguished individually.

The most meaningful method of quantifying the EMG utilizes the time integral of the EMG waveform. With this technique, the integrated value of the EMG over a given time interval, such as 0.1 second, is measured and recorded or plotted. As indicated above, this time integral has a linear relationship to the tension of a muscle under certain conditions of isometric contraction, as well as a relationship to the activity of a muscle under isotonic contraction. As with the amplitude measurement, the integrated EMG is greatly affected by electrode placement, but with a given electrode location, these values provide a good indication of muscle activity.

In another technique that is sometimes used in research, the EMG signal is rectified and filtered to produce a voltage that follows the envelope or contour of the EMG. This envelope, which is related to the activity of the muscle, has much lower frequency content and can be recorded on a pen recorder, frequently in conjunction with some measurement of the movement of a limb or the force of the muscle activity.

Parameters of Action Potential Waveforms:

Each of the waveforms measured in clinical electromyography is a voltage fluctuation over time for which the extent, direction and duration of the voltage change are described. By convention, an upward deflection represents a relative negativity at the active electrode and a downward deflection represents a relative positivity. The voltage changes can be described by the parameters that follow. Each of these parameters can be measured manually from film or automatically by a digital computer. Quantization by computer requires more precise definitions of the measurements.

1. Negative components:

Negative components are upward deflections away from the baseline when the active electrode is negative relative, to the reference electrode. Negativity indicates that the area of depolarization is immediately adjacent to the active electrode. Negative components can be reliably recorded only if the active electrode is near the generator and there is no major intervening tissue. Distances of more than 1 or 2 cm or intervening tissue, such as bone distorts the potential into a complex waveform having latencies that are different from the actual latencies measured near the generator. Such recordings are called far-field recordings and are not reliable for standard studies; if they are used, they must be interpreted with caution.

2. Positive Components:

Positive components are downward deflections from the baseline when the active electrode is positive relative to the reference electrode. Positivity indicates that the major area of depolarization is some distance away from the active electrode. Positivity can distort negative waves in two ways. First, if two generators near each other are not in synchrony, the positive component of one may occur before the negative component of the other; this distorts the latter or ends it sooner. Second, placement of the reference electrode too near the active electrode can superimpose the negativity of the reference electrode on the negativity at the active electrode, producing distortion, latency changes, or early termination of the negative component. A reference electrode is best placed beyond the active electrode at a sufficient distance that the negative component ends at the active electrode before it arrives at the reference electrode. A reference electrode placed horizontally away from the generator records far-field potentials and is valid only if the potential is much larger at the active electrode than at the reference electrode.

3. Onset:

The first deflection away from the baseline in either direction represents the onset. The time of onset may be difficult to measure if onset is gradual, and it should measured at adequate amplifications. The time of onset becomes measurable earliest with higher amplification of the signal, because earliest components, which are below the level of resolution at lower amplification, can be recorded. When the onset of the potential is measured automatically by a computer, the criteria must be defined in terms of both the length of time that the potentials must remain outside a defined voltage and the slope of the waveform as it leaves the baseline. The time from a stimulus to the onset is the latency of a waveform.

4. Termination:

Because it more often ends gradually, the termination-the final return to the baseline is more difficult to measure than the onset. Measurement is also complicated by components of the potential that occur after the main component has returned to the baseline. These components (late components, satellite potentials, linked potentials, axon reflexes, and repetitive discharges) can occur with compound muscle action. potentials, sensory nerve action potentials, and motor unit potentials. The duration of the waveform should be measured both with and without these components.

5. Baseline Crossing:

The baseline is crossed when the voltage changes from positive to negative or from negative to positive. A baseline crossing designates the end of a phase. Measurement should include the time of the baseline crossing and the number of baseline crossings in the waveform. The number of total phases is one more than the number of baseline crossings. Individual muscle fiber potentials, normal compound muscle action potentials, and sensory nerve action potentials are usually triphasic waveforms. The presence of more than two baseline crossings is evidence of a loss of synchronization of the discharges of individual components in the potential. The time of the baseline crossings is measured to determine durations

6. Turns:

Turns are changes in direction of a potential. Measurement of turns requires defining the amount of change in voltage required to call a direction reversal a turn. This amount must be significantly more than the noise level in the signal. A turn represents the discharge of a distinct component in the potential, such as an individual muscle fiber, an individual motor unit or groups of nerve fibers. The number of turns measures the extent of dispersion of the number of components contributing to a waveform. The time of turn occurrence does not provide useful diagnostic information and is not measured. The time after a stimulus of the first major positive or negative turn can be used as a measure of latency.

7. Duration of Waveform:

The time from onset to termination is the duration of the waveform. Total duration measures the dispersion of all components and thereby measures the differences in conduction of the components. In waveforms with late components, the duration should be measured both to the end of the main segment and to the end of the late component.

8. Duration of Individual Phases:

Duration of individual phases is the time from the onset of a phase to its termination (baseline crossings). It is most commonly used to indicate the duration of the major negative component. Phase duration reflects the dispersion in conduction of components that have a similar range of conductions.

9. Rise Time:

Rise time is the duration of the rising phase (positive peak-to negative peak). The area of depolarization in nerve or muscle fibers has reached the active electrode when this reversal of potential from positive to negative occurs. The rate of rise (or slope) is directly related to the distance between the generator and the electrode. Intervening tissue acts as combined resistance and capacitance to slow the rate of rise of the potential. The rise time has no direct diagnostic significance, but it provides a useful criterion of the proximity of the generator in the measurement of the amplitude or area of compound muscle action potentials or sensory nerve action potentials.

10. Amplitude:

Amplitude is the voltage from the baseline to the maximum negative peak or from the maximal positive peak to the maximal negative peak. The amplitude of the negative component is proportional to the number and size of fibers that are depolarized, and therefore it provides an estimate of the amount of active tissue, the amplitude is also dependent on the distance between the recording electrode and the generator. This distance can be judged from the rise time. When a waveform has multiple components or is abnormally prolonged, the area provides a more accurate estimate of the amount of functioning tissue than does the amplitude.

11. Area:

The space under the curve of the wave-form is the area; usually, only the negative components are measured. Area cannot be measured reliably by hand or with standard equipment but can be readily measured by digital computers. Area provides the most direct estimate of the amount of functioning tissue that is generating the waveform. Positive components are not useful in this measurement because they are depolarization occurring either at a distance or under the reference electrode.

12. Stability/Variation:

With repeated stimulation, the response waveforms are normally identical each time they occur. They may decrease in amplitude or area because of conduction block in axons, neuromuscular junctions, or muscle fibers.

Prevention of EMG Noise:

If the patient keeps his muscles strained due to stress, cold, pains, bad posture, etc., electromyogram (EMG) may be introduced into the electromyogram. If this occurs, eliminate the cause of the strain.

Prevention of DC Shift:

The waveforms shift occurs due to following situations:

1. The connector of leads and main unit is dirty.
2. The connector is not securely connected.
3. An intermittent break in patient cable or lead wires.
4. Poor contact of the patient monitor switch.

In such cases check the connecting conditions. Check and clean the patient monitor and its parts frequently.

Prevention of AC Line Noise:

If indoor wiring, with an alternating current of 50 Hz or 60 Hz, overlaps with the electrode wiring of the electrocardiograph, an AC line noise will occur. Check the following items, if an AC line noise (50/60 cycle noise) occurs:

1. Is the monitor grounding wire connected securely?
2. Are the grounding wires of other ME units or a metallic bed connected to the same ground as the monitor ground? (Collecting the grounding to one point is called "one-point grounding")
3. Is any indoor wiring (such as electric heater, electric blanket, ratio receiver, TV set, fan, etc.) connected near the patient cable?
4. Are the patient cable connected properly and securely?

After checking these items, take steps to prevent poor contact of induction cords of the patient monitor. If there is poor contact of the patient cable and/or electrodes to the patient monitor.

Conclusion:

EMG is an instrument used to record the muscle potentials. If we apply voltage to a point near the thumb we can observe automatic bending of small fingers. This is due to the motor points. The motor points get voltages from central nervous system and thus the actuations of fingers takes place. EMG is a based on same principle of recording of motor point potentials.

EMG is useful instrument for orthopedic surgeon to analyze exact point of muscle breakage. This is detected by graph and sound record of EMG.

The physical actions of limbs, fingers etc. are due to electric potential stimulus given by brain. There are motor points in body. These are the points after the physical potential can be tapped. In the above example we have seen the control of fingers can be done electrically giving impulses at motor points. The hill top near thumb is a motor point for control actions of fingers.

A practical EMG instrument is shown by recording the muscle potentials of the motor points and by listening to the sound, the doctor can estimate amount of disturbance caused to body muscles.

EMG Simulator:

EMG Simulator provides a quick, accurate means for verifying the performance of EMG amplifier systems. This section generates trigger pulses at definite intervals to simulate operation of nerve and muscle contraction. The amplitude of simulating pulses is adjusted using independent controls.

This section consists of gain adjustment two outputs; one is single ended, while the other is differential output.

Single ended output provides amplified EMG output i.e. bioelectric potentials generated during muscular contraction. These signals can be observed on oscilloscope by connecting the positive probe of the oscilloscope to the EMG output (Test point Tp16) and Negative of scope to the ground. You will observe EMG waveform. On the oscilloscope will the help of pot you can vary the amplitude of the EMG Waveform.

To check the differential output, you need on EMG amplifier connect the differential Output of EMG simulator to the Preamplifier section of EMG Amplifier with the help of cables provided and connect the output of that channel to the oscilloscope. And observe the waveform.

Operating Instructions

1. Electrodes must be placed carefully along with GEL so that the proper EMG signals can be obtained during muscular contraction.
2. During the monitoring, patient should be completely in rest position otherwise the signal obtained will be incorrect.
3. It is recommended that, switch ON the trainer after placement of electrode over hands.

Experiment 1

Objective:

To study Real time EMG waveforms of subject (Human body)

Equipment's Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. Now place the electrodes for EMG signals observation at the surface of the body near a-muscle of interest. (See figure 6) properly with Gel and connect the cables to the kit.
4. Observe the EMG waveforms in Instrumentation amplifier block output on DSO. Also observe the effects on signals due to muscular contraction.
5. Observe the signal at filter block output
6. Observe the signal at main amplifier output on DSO. Also observe the effects on signals due to muscular contraction.

Conclusion:

1. EMG wave is coming in correct shape
2. Little variation is there when there is an muscle movement
3. Level of noise is slightly higher because EMG has been measuring by disposable silver chloride electrodes

Questions:

1. What is the function of Muscular System?
2. What do muscles consist of?
3. What is the full form of EMG?

Experiment 2

Objective:

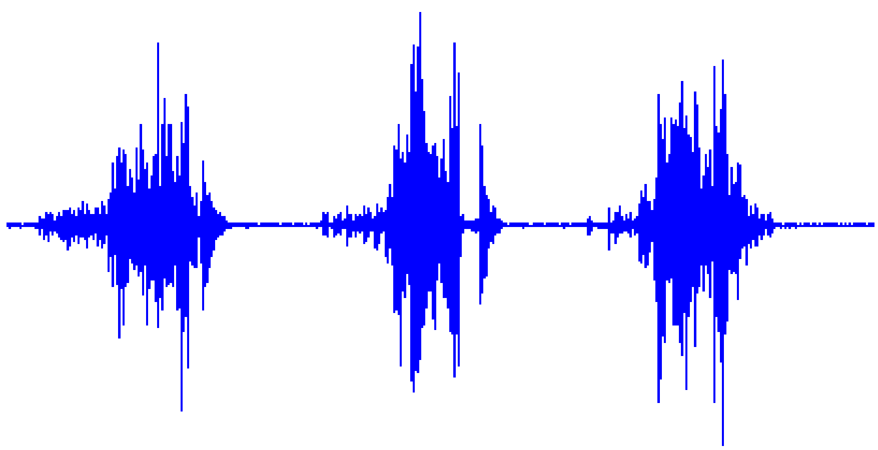
To study Normal EMG waveform generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the Normal EMG by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO.



Conclusion:

1. Normal EMG wave is observed in correct shape
2. Electrical activity produced by group of muscle is coming in bulk form
3. Higher peaks shows the maximum level of activation of muscle

Questions:

1. What is EMG Simulator?

Experiment 3

Objective:

To study Excited EMG waveform generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the Excited EMG by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO.

Conclusion:

1. Excited wave is observed in correct shape
2. Level of noise is high because of excitation of muscle fibers
3. Amplitude is slightly higher than normal wave form

Questions:

1. On which parameters does amplitude of EMG signal depend?
2. Name the methods for recording of EMG signals?

Experiment 4

Objective:

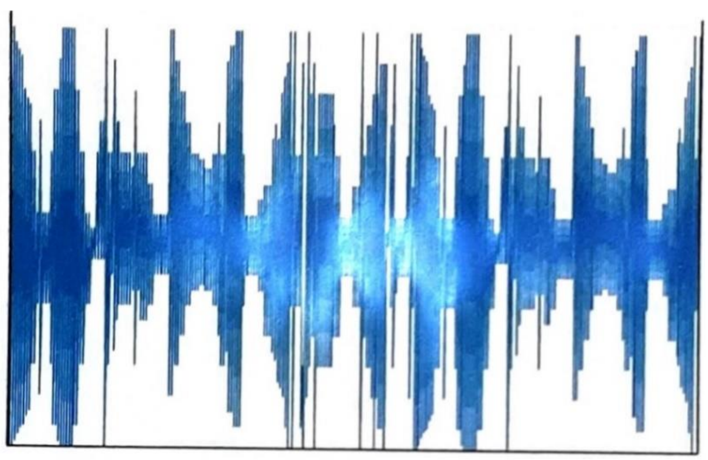
To study Raw EMG waveform generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the Raw EMG by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO.



Conclusion:

1. Raw EMG data is observed in correct shape
2. Amplitude is high and contains lot of noise
3. Frequency of the coming data is high in comparison with excited data

Questions:

1. On which parameters does amplitude of EMG signal depend?
2. Name the methods for recording of EMG signals?
3. How is good and noiseless EMG obtained?

Experiment 5

Objective:

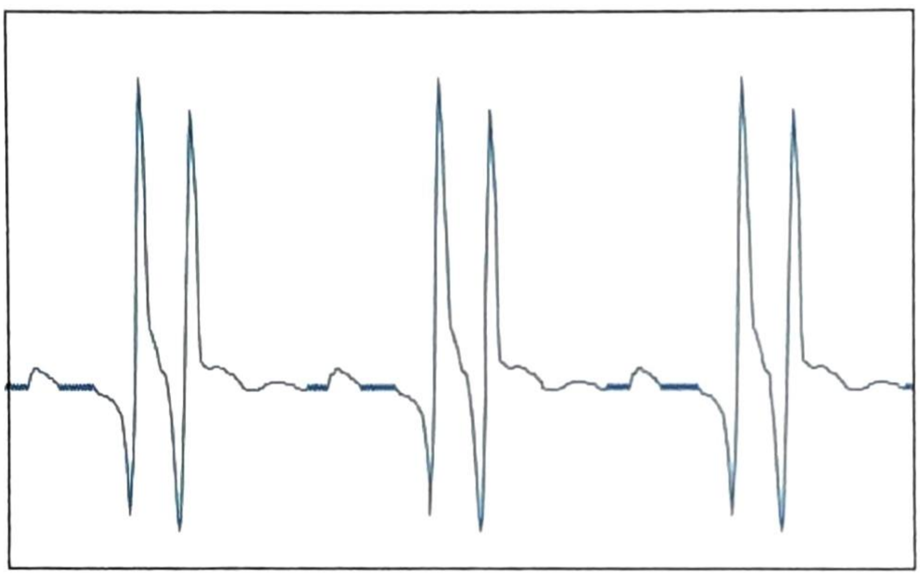
To study 100Hz Filtered EMG waveform generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the 100Hz Filtered EMG by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO.



Conclusion:

1. Filtered data is observed in correct shape
2. Peak to peak voltages of excited EMG muscle fiber are filtered properly

Questions:

1. What is EMG Simulator?

Experiment 6

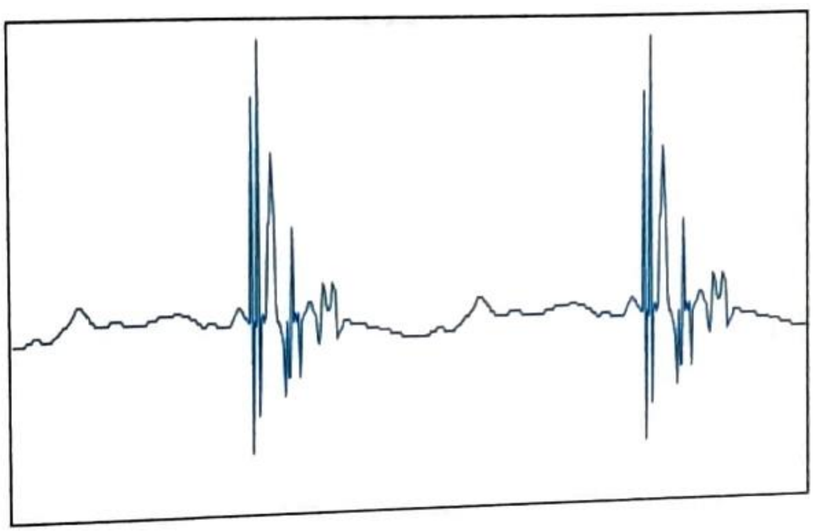
Objective:
To study 250Hz Filtered EMG waveform generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the 250Hz Filtered EMG by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO



Conclusion:

1. Filtered data is observed in correct shape
2. Little noise is coming along with the signal of interest

Questions:

1. What is the strength (Peak to peak voltage) of EMG signal?

Experiment 7

Objective:

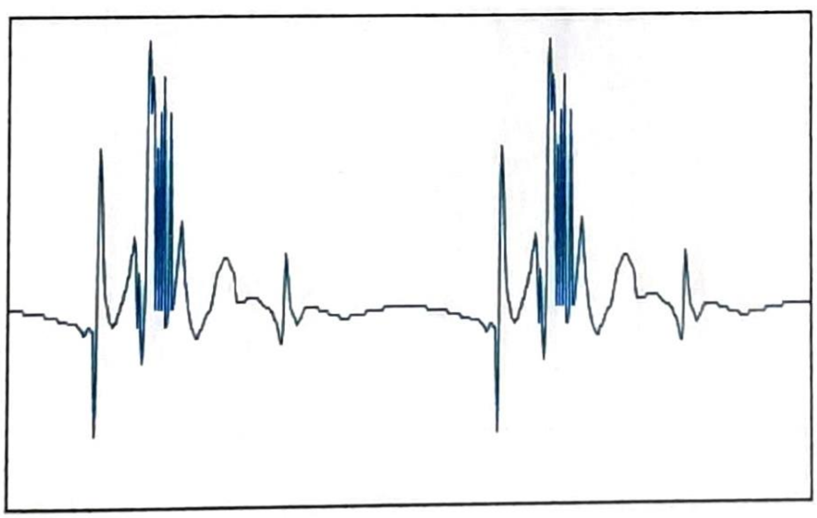
To study 1KHz Filtered EMG waveform generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the 1KHz Filtered EMG by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO



Conclusion:

1. Wave is observed in correct shape
2. Noise level is high because of filter range selection

Questions:

1. How EMG noise can be prevented?
2. How wave form shift occurs?

Experiment 8

Objective:

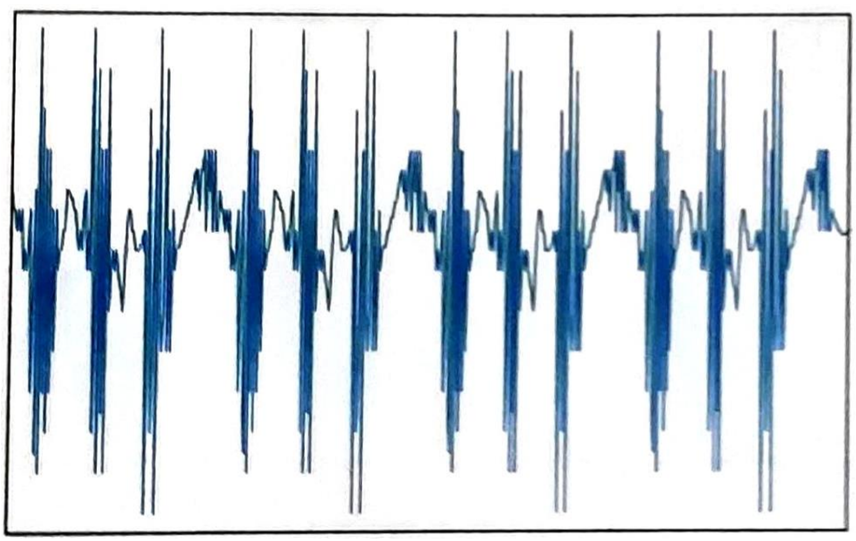
To study EMG waveform at 0.53Hz generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the EMG at 0.53Hz by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO



Conclusion:

1. Wave is observed in correct shape
2. Signal is observed along with noise because of low value filter selection.

Questions:

1. What is the function of Surface electrodes?
2. What is EMG Simulator?

Experiment 9

Objective:

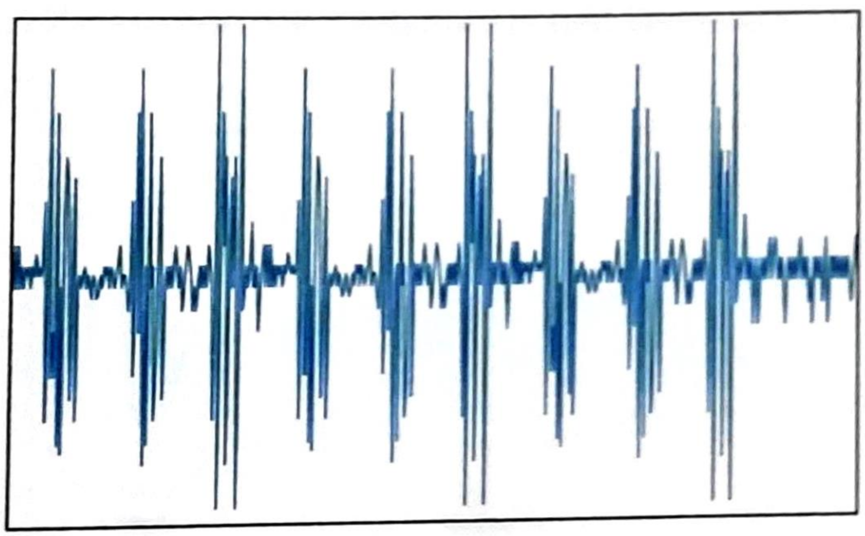
To study EMG waveform at 53Hz generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the EMG at 53Hz by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO



Conclusion:

1. Wave is observed in correct shape
2. Signal is observed along with noise because of low value filter selection

Questions:

1. On which parameters amplitude of EMG signal depends?
2. Name the methods for recording of EMG signals?

Experiment 10

Objective:

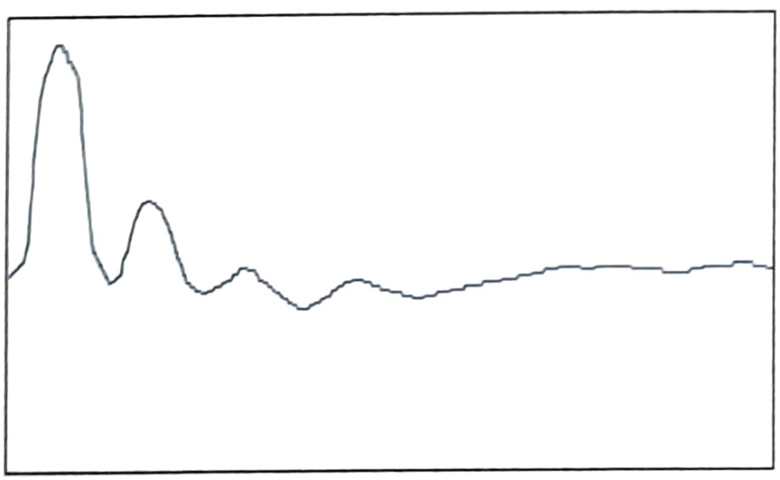
To study Power Spectrum at 0.53Hz generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the Power Spectrum at 0.53Hz by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO



Conclusion:

1. Wave is observed in correct shape
2. Power spectrum shows continuous decay of the signal because of continuous decrement in the excitation level of EMG wave form

Questions:

1. What is the function of Muscular System?
2. What is the range of signals generated by muscles?

Experiment 11

Objective:

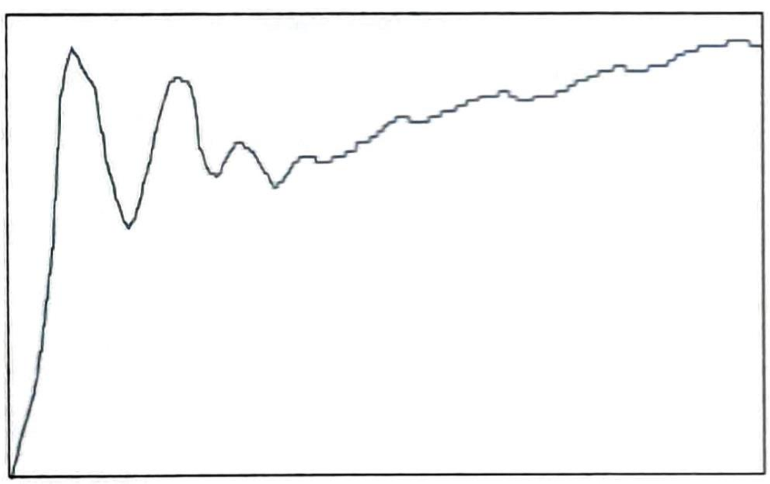
To study Power Spectrum at 53Hz generated by built-in EMG Simulator.

Equipments Needed:

1. Scientech 2354A
2. EMG electrodes and connecting cable
3. Digital Storage Oscilloscope (RIGOL DS1102C) or equivalent

Procedure:

1. Connect one end of the power supply to Scientech 2354A, while other end to mains power supply
2. Switch ON the Mains power supply, then Scientech 2354A
3. EMG Simulator consists of 10 EMG waveforms;
   select the Power Spectrum at 53Hz by rotary switch.
4. For particular selected EMG the corresponding LED will be glowed.
5. Observe EMG waveform at Simulated output terminal on the DSO



Conclusion:

1. Wave is observed in correct manner
2. Power spectrum shows continuous decay of the signal because of continuous decrement in the excitation level of EMG wave form

Questions:

1. What is power spectrum?
2. What are the different techniques to understand it?

Frequently asked Questions

1. What is the function of Muscular System?

It is the power generator or force-generating device of the body. It is responsible for movements of the body. Without a muscle, we are like a car or scooter engaged in neutral gear when the engine is running but the car is not able to move.

2. What do muscles consist of?

The muscles of the human being consist of 75% water, 20% protein and 5% mineral salts, glycogen and fat. They are made up of fibers and they obtain required energy to contract from the oxidation of food particularly carbohydrates.

3. What is the full form of EMG?

Electromyogram

4. What is the function of EMG?

EMG is the representation of electrical signals generated by the neuro-muscular activation of a contracting muscle. The signal represents the current generated by the ionic flow across the membrane of the muscle fibers, which propagates through the intervening tissues to reach the detection surface of an electrode located in the environment.

5. What is the range of signals generated by muscles?

The electrical potentials generated by the muscle range from 5 microvolt to 5 mill volts.

6. What is the duration of signals generated by muscles?

The duration range is between 2 milliseconds to 15 milliseconds.

7. What is the frequency range of muscles?

The frequency of EMG signals approximately falls between 10 to 3000 Hz.

8. On which parameters amplitude of EMG signal depends?

The amplitude of EMG signal depends on type of electrode used and degree of muscular contraction. The needle electrode inserted into the muscle fiber generates spike type voltage, whereas a surface electrode picks up many overlapping spikes and therefore produces an average effect.

9. Name the methods for recording of EMG signals?

There are two basic methods for recording of EMG signals.

1. EMG with voluntary muscular action, and
2. EMG with electrical stimulation.

10. How is good and noiseless EMG obtained?

To obtain a good and noiseless EMG, it is essential to clean the recording site thoroughly. The disc or needle electrodes used must be clean and fixed on the recording site with conductive electrode jelly. The patient should be asked to relax completely to avoid activity from other muscles, which may otherwise, interfere or mix with the signals to be recorded from the selected site.

11. What is the function of EMG with Voluntary Action?

In this recording method the action potential generated during voluntary contraction is picked up by needle electrode inserted into the muscle or by surface electrode placed over the muscle. The EMG produced during voluntary. contraction may spread over a period of 100 milliseconds or more and can have number of spikes or a train of spikes.

12. In which form EMG information is presented?

Being EMG information is in audible range; it is often presented in audio form.

13. What is the function of instrumentation amplifier?

An amplifier that accepts a voltage signal as an input and produces a linearly scaled version of this signal at the output; it is a closed-loop fixed-gain amplifier, usually differential, and has high input impedance, low drift, and high common-mode rejection over a wide range of frequencies.

14.What is the function of DSO?

The Digital Storage Oscilloscope or DSO for short replaces the unreliable storage method used in analog storage scopes with digital memory, which can store data as long as required without degradation. It also allows complex processing of the signal by high-speed digital signal processing circuits.

15.What is EMG Simulator?

EMG Simulator provides a quick, accurate means for verifying the performance of EMG amplifier systems. This section generates trigger pulses at definite intervals to simulate operation of nerve and muscle contraction.

16.What is the full form of LED?

Light emitting diode

17.What is the full form of DSO?

Digital storage oscilloscope

18.What is the function of motor units?

Motor units control groups of muscle fibers

19.What is the function of Surface electrodes?

The function of Surface electrodes is to detect myoelectric energy.

20.What are the negative components?

Negative components are upward deflections away from the baseline when the active electrode is negative relative, to the reference electrode. Negativity indicates that the area of depolarization is immediately adjacent to the active electrode.

21.What are the positive components?

Positive components are downward deflections from the baseline when the active electrode is positive relative to the reference electrode. Positivity indicates that the major area of depolarization is some distance away from the active electrode.

22.How Positivity can distort negative waves?

Positivity can distort negative waves in two ways. First, if two generators near each other are not in synchrony, the positive component of one may occur before the negative component of the other; this distorts the latter or ends it sooner. Second, placement of the reference electrode too near the active electrode can superimpose the negativity of the reference electrode on the negativity at the active electrode, producing distortion, latency changes, or early termination of the negative component.

23.What is base line crossing?

The baseline is crossed when the voltage changes from positive to negative or from negative to positive. A baseline crossing designates the end of a phase.

24.What is rising time?

Rise time is the duration of the rising phase (positive peak-to negative peak).

25.Why positive components are not useful in measurement?

Positive components are not useful in this measurement because they are depolarization occurring either at a distance or under the reference electrode.

26.How EMG noise can be prevented?

If the patient keeps his muscles strained due to stress, cold, pains, bad posture, etc., Electromyogram (EMG) may be introduced into the Electromyogram. If this occurs, eliminate the cause of the strain.

27.How wave form shift occurs?

The waveforms shift occurs due to following situations:

1. The connector of leads and main unit is dirty.
2. The connector is not securely connected.
3. An intermittent break in patient cable or lead wires.
4. Poor contact of the patient monitor switch.

In such cases check the connecting conditions. Check and clean the patient monitor and its parts frequently.

28.How AC line noise occurs?

If indoor wiring, with an alternating current of 50 Hz or 60 Hz, overlaps with the electrode wiring of the electrocardiograph, an AC line noise will occur.

29.How does EMG function?

EMG is an instrument used to record the muscle potentials. If we apply voltage to a point near the thumb we can observe automatic bending of small fingers. This is due to the motor points. The motor points get voltages from central nervous system and thus the actuations of fingers takes place. EMG is a based on same principle of recording of motor point potentials.

30.What is the usefulness of EMG?

EMG is useful instrument for orthopedic surgeon to analyze exact point of muscle breakage. This is detected by graph and sound record of EMG.