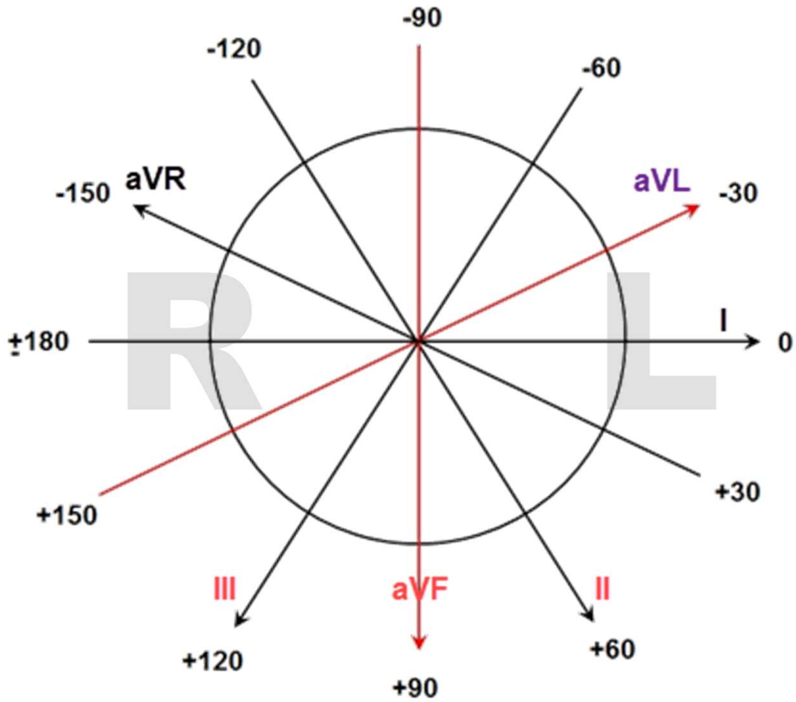
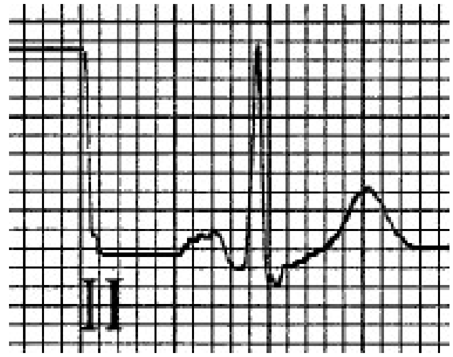
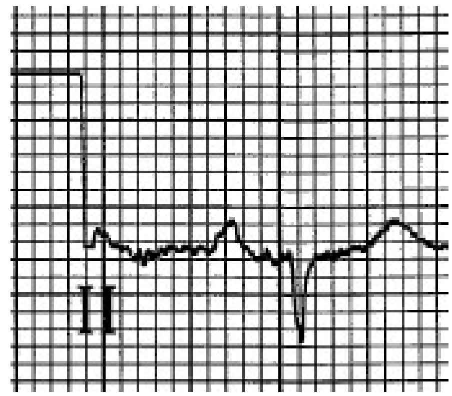
# The Hexaxial Reference Grid (HRG): Part 2



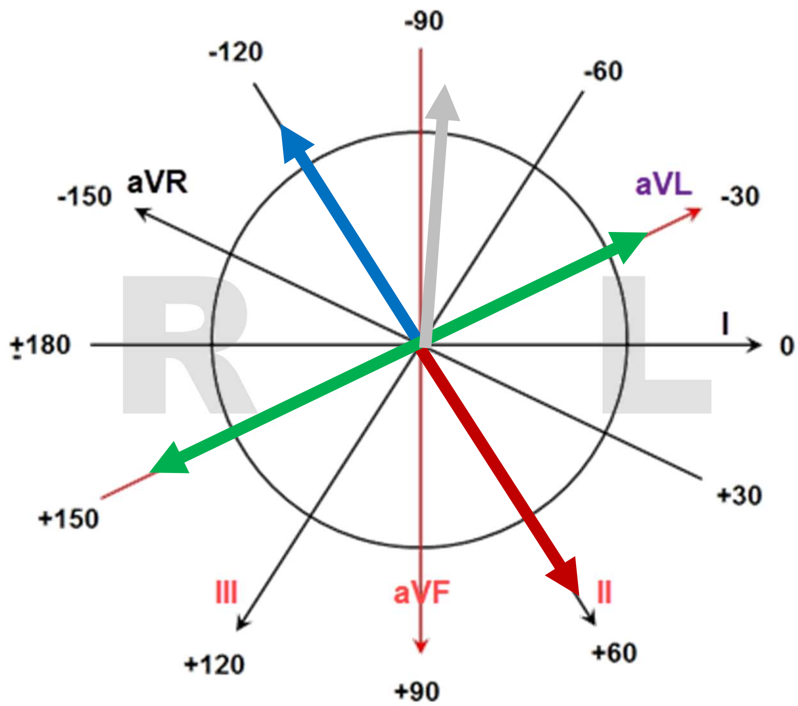



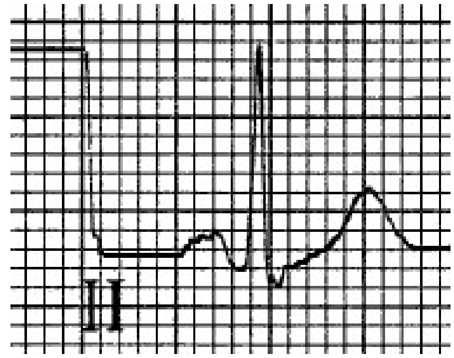

Here we have two Lead II snippets from different ECGs: one QRS is POSITIVE and the other is NEGATIVE. At what point does Lead II – or ANY lead, for that matter – turn from POSITIVE to NEGATIVE. To understand this, there are a couple of things about the HRG that you must know and engrain in your memory forever!

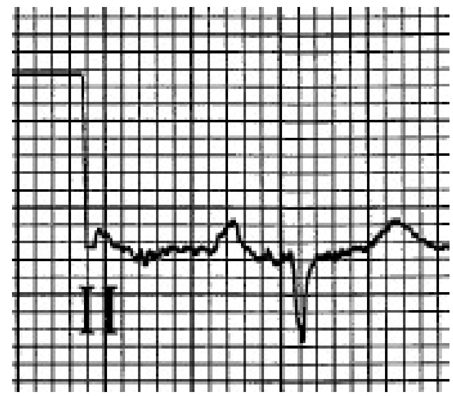
First, you MUST know the location of ALL the POSITIVE poles for *all six* limb leads! That's easy. You know that Lead I acts as the horizontal axis (**0°**) and Lead aVF acts as the vertical axis **(+90°**). Next, Leads aVR and aVL are just 30° above the Lead I axis. aVR is on the right ("R" for "right") at **-150°** and aVL is on the left ("L" for "left") at **-30°**. Only two more leads to go! Lead III is just 30° to the right of Lead aVF and is located at **+120°**. Lead II is 30° to the left of Lead aVF and is located at **+60°**. "Right" and "left" refer to a patient's "right" and "left."

Lead aVF acts as the middle of the inferior leads with Lead III on the RIGHT and Lead II on the LEFT. I would like to point out that in addition to being INFERIOR leads, **Lead III** is also a **RIGHT-sided lead** and **Lead II** is also a **LEFT-sided lead**.

Now back to the snippets…



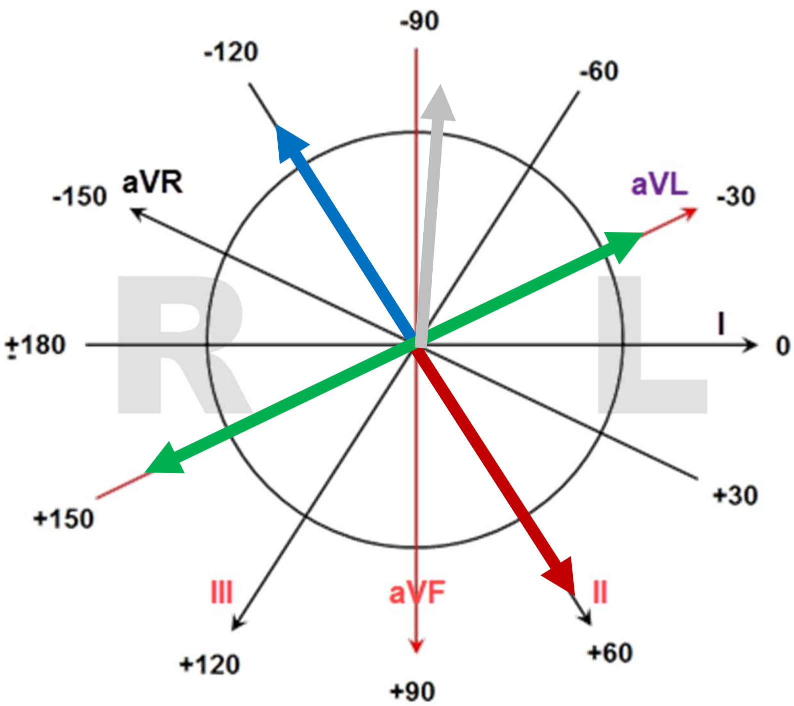



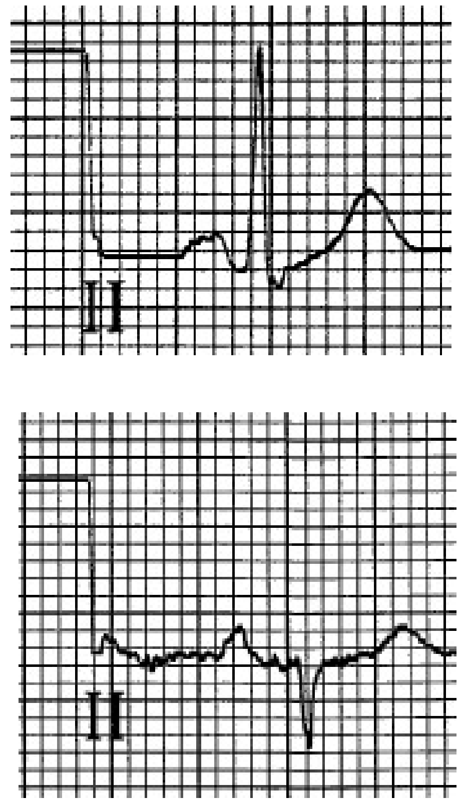




Look at the Lead II axis on the HRG. You can follow it from its POSITIVE pole at +60° to its NEGATIVE pole at -120°. Each lead axis – including Lead II – changes polarity where it intersects with the other lead axes. But – more specifically – it changes where it crosses the lead axis that happens to be perpendicular to it. In the case of Lead II, we can see that the lead axis perpendicular to **Lead II** is **Lead aVL** (green double-arrow). Please note that there are THREE perpendicular pairs and each pair includes one *standard lead* (I, II or III) and one *augmented lead* (aVR, aVL or aVF). *Perpendicular pairs cannot be of the same type of lead*, e.g., Lead I cannot be perpendicular to either Lead II or Lead III.

OK, it's easy to see that **Lead I and Lead aVF** are perpendicular to each other. And you just learned that **Lead II and Lead aVL** are perpendicular to each other. That leaves **Lead III and Lead aVR** as the third pair of perpendicular leads. So, looking at the HRG above, we can see that any vector that points from -29° around the lower part of the HRG to +149° will be seen in Lead II as a POSITIVE or primarily POSITIVE complex.

So, the mean QRS vector as seen in the upper snippet is located somewhere in that range. As the vector becomes more and more parallel to the lead axis – and if it is pointing *toward* the POSITIVE pole of that lead axis (like the red arrow) – the QRS will become taller and more completely positive. That is the case in the upper snippet – the QRS is very tall and almost completely POSITIVE except for a very small s wave. The mean QRS vector is pointing very close to the Lead II axis.



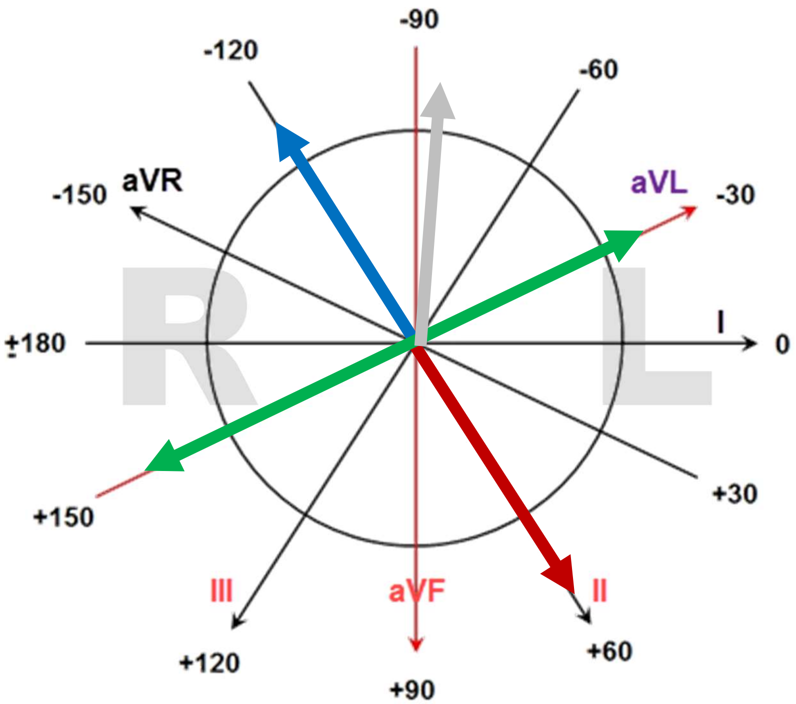



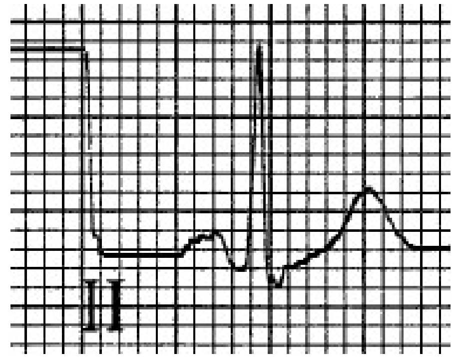

Now let's look at the lower snippet with a predominantly NEGATIVE QRS complex. We know immediately that the mean QRS vector – as seen by the Lead II POSITIVE electrode – must be on the *other side of the Lead aVL axis* (the axis *perpendicular* to Lead II – green double-arrow). Is the mean QRS vector represented by the blue arrow or the gray arrow? If it were pointed directly at the NEGATIVE pole of Lead II (blue arrow), it would be very deep and monophasic – all NEGATIVE. That's not quite the case here. The QRS is not what I would call very deep and there is a small r wave present initially. If the QRS vector were pointed directly at the NEGATIVE pole of Lead II, it would be completely monophasic. Therefore, the gray arrow more accurately represents the mean QRS vector.

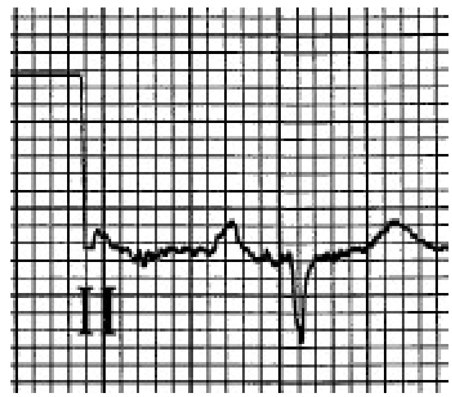
How would the mean QRS vector represented by the red arrow appear in Lead aVF? Well, any vectors below the Lead I axis (the perpendicular to Lead aVF) would result in QRS complexes that would appear POSITIVE or upright in Lead aVF.

How would the mean QRS vector represented by the red arrow appear in Lead I? Well, any vectors to the left of the Lead aVF axis (the perpendicular to Lead I) would result in QRS complexes that would appear POSITIVE or upright in Lead I.

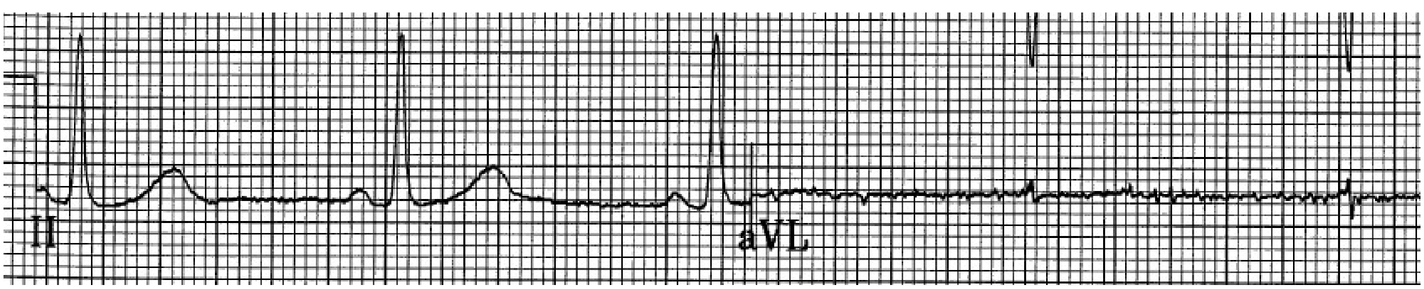
How would the mean QRS vector represented by the red arrow appear in Lead aVL? This is a tricky question. You see that the vector (red arrow) is *directly on* the Lead II axis (we say that it



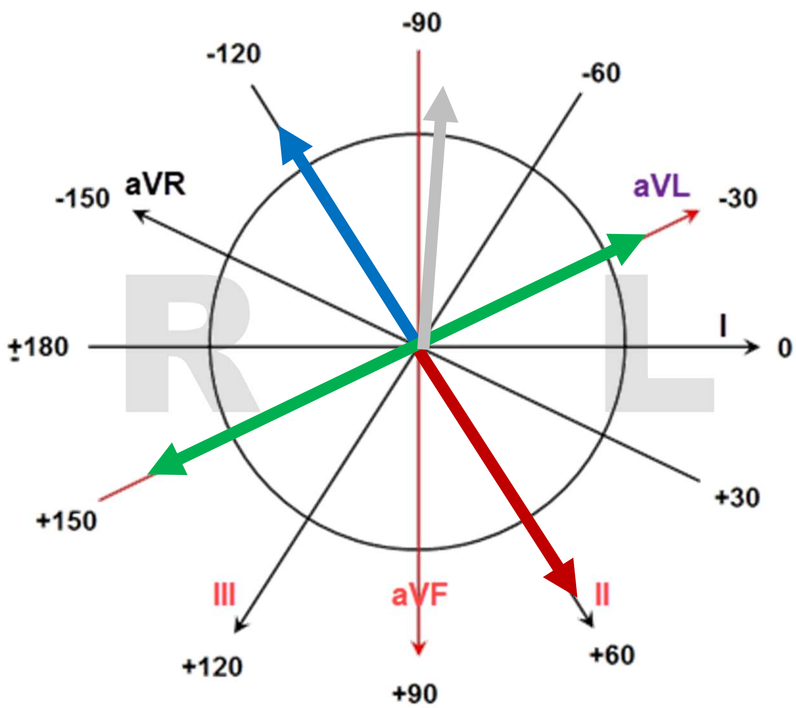



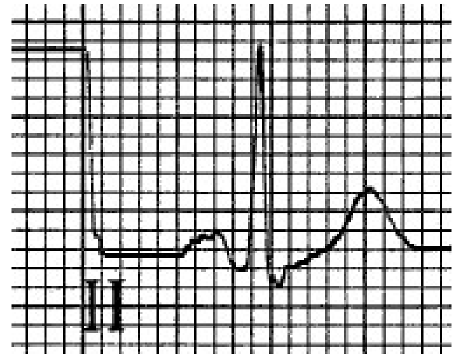



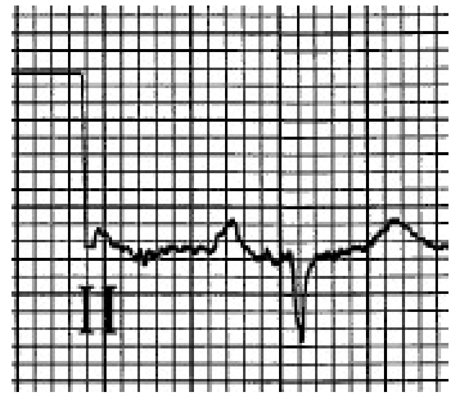

is "parallel" to the Lead II axis). That means the mean QRS vector is exactly perpendicular to Lead aVL. Remember: Leads II and aVL are "perpendicular pairs." ***When a vector is exactly perpendicular to a Lead axis, it will be invisible to that Lead***. On the ECG tracing, it may appear as *isoelectric* (flat baseline) or *equiphasic* (equal positive and negative deflections). In this case, you see a nearly isoelectric (flat) baseline replacing the QRS complex. Here is an example of that concept from a real 12-lead ECG…




Here, in Lead II, we have a tall, completely monophasic R wave representing the QRS. The mean QRS vector is pointing *directly* at the POSITIVE pole of Lead II located at +60°. In Lead aVL – the "other half" of the perpendicular pair – we see what is *essentially a flat, isoelectric baseline*. Does the flat baseline in Lead aVL represent a *problem* – some *pathology*, perhaps? No! This is just an effect caused by the mean QRS vector and its appearance in Lead II and the perpendicular lead to Lead II, which is Lead aVL. The QRS vector for this real ECG would be perfectly represented by the red arrow in the illustration above. Familiarity with the **Hexaxial**




**Reference Grid**, and how the mean QRS vectors are represented on it, can avoid unnecessary consults and workups.

Here's a ***Lagniappe*** (a little something extra) for you…

Have you ever wondered why a vector that is perpendicular to a lead may appear as an ***isoelectric flat line*** or as an ***equiphasic QRS complex***? Well, recall that a vector that is exactly perpendicular to a lead is not detectable to that lead, i.e., it is "invisible" to that lead. But how does a lead "detect" a vector in the first place? ***By its voltage!*** It also detects motion *toward* or *away from* the lead, but *there is no such motion when the vector is perfectly perpendicular*. A vector manifests 0 voltage (yes, ZERO voltage) in a lead that is perpendicular to it. That can be represented on the lead's tracing by *a flat baseline with NO QRS* or by a QRS that has *equal positive and negative deflections* (which, of course, equal ZERO).

**Question 1:** What would the QRS look like in Lead aVR based on the vector represented by the red arrow? [Answer below.]

**Question 2:** What would the QRS look like in Lead aVR based on the vector represented by the gray arrow? [Answer below.]

***A thought to ponder:*** Most mean QRS vectors cluster around +60°. This often makes the QRS complexes in Lead aVL rather small (see an example on the previous page). Consider how easy it would be to miss an ST elevation in such a small QRS. A J-point elevation > 50% of the R wave height would still be very miniscule and easily missed! ***Always beware of Lead aVL!***

**Answer to Question 1:** Since the perpendicular to Lead aVR is Lead III, and we can see that the arrow is on the same side of the Lead III axis as aVR’s **NEGATIVE** pole, the QRS would be primarily **NEGATIVE** in aVR.

**Answer to Question 2:** Since the perpendicular to Lead aVR is Lead III, and we can see that the arrow is on the same side of the Lead III axis as aVR’s **POSITIVE** pole, the QRS would be primarily **POISITVE** in aVR.