Sleep Staging (Scoring)

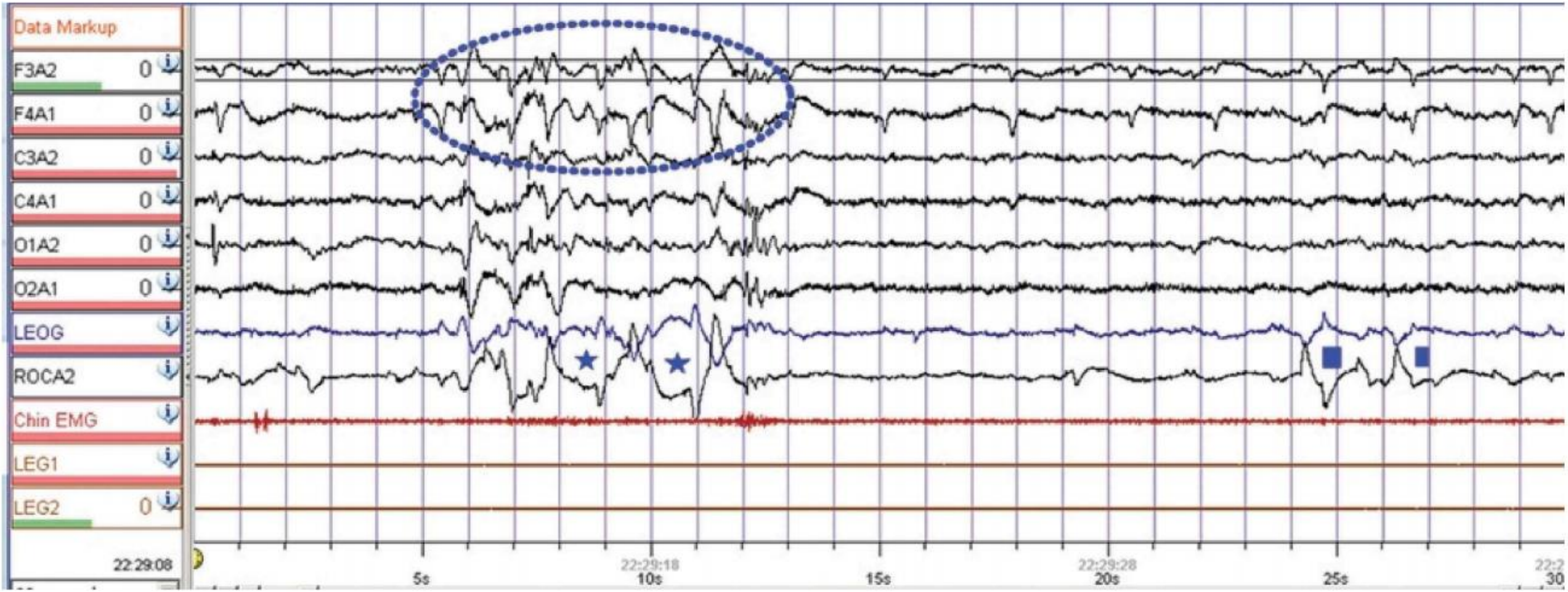


Figure 13.1 Active wakefulness is characterized by electrical activity in EEG channels that is low voltage, mixed frequency (Gamma-beta-theta), Reading eye movements (See Star) in opposite phase having initial slow phase followed by a rapid phase (LEOG and ROCA2) associated with eye blinks having frequency of 0.5–2 Hz (Frontal derivations) (see inside circle), and rapid eye movements, where initial deflection is less than 0.5 seconds (see Box) (30 seconds epoch).

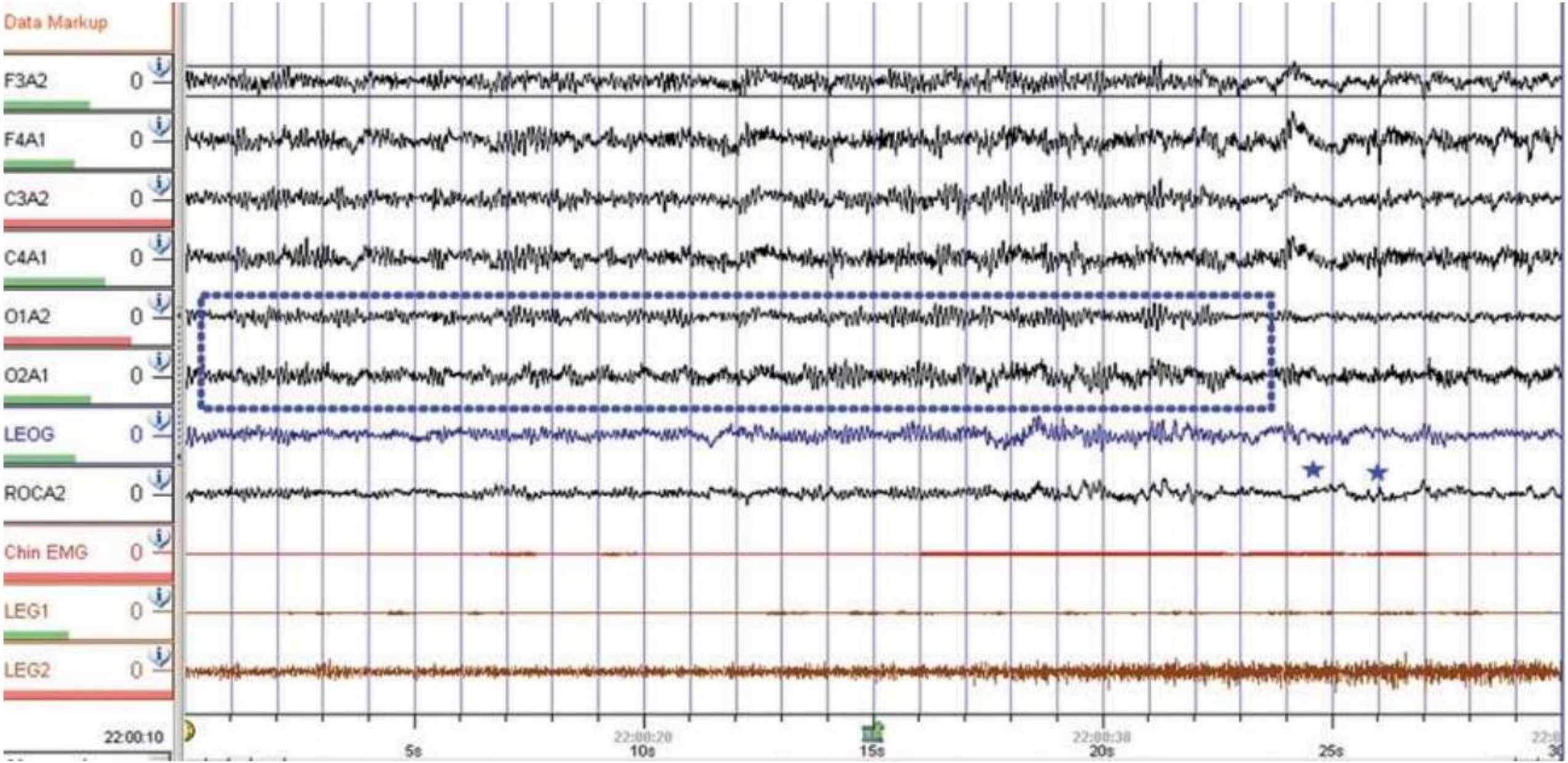


Figure 13.2 Quiet wakefulness is characterized by alpha rhythm in occipital derivations for more than 50% of epoch, slow eye movements (Star) (30 seconds epoch).

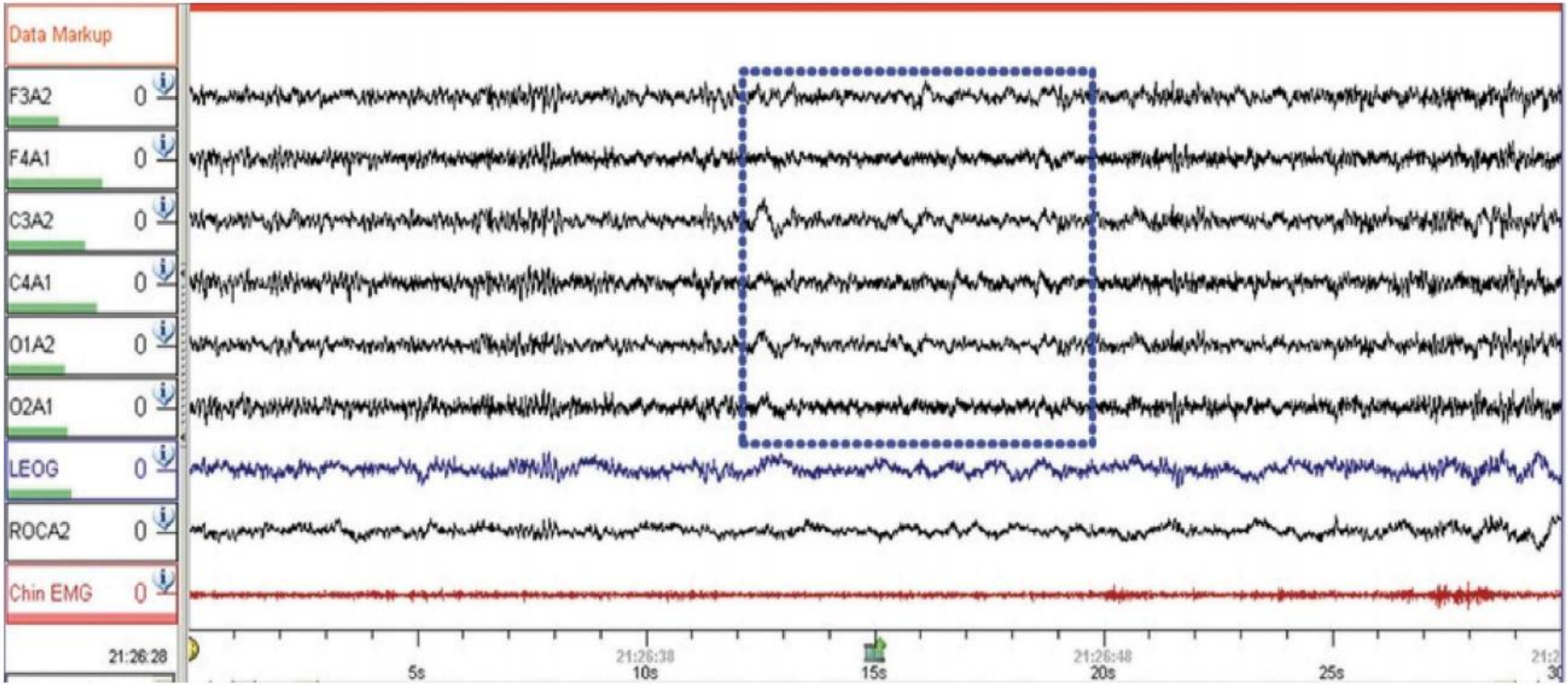


Figure 13.3 Microsleep: Please note that transition from wakefulness is gradual. Before a scorable N1 epoch, few epochs of microsleep are seen. In these epochs, EEG shows islands of theta rhythm (in the box) in between alpha. However, this epoch will be scored as Wake as alpha occupies more than 50% of epoch.

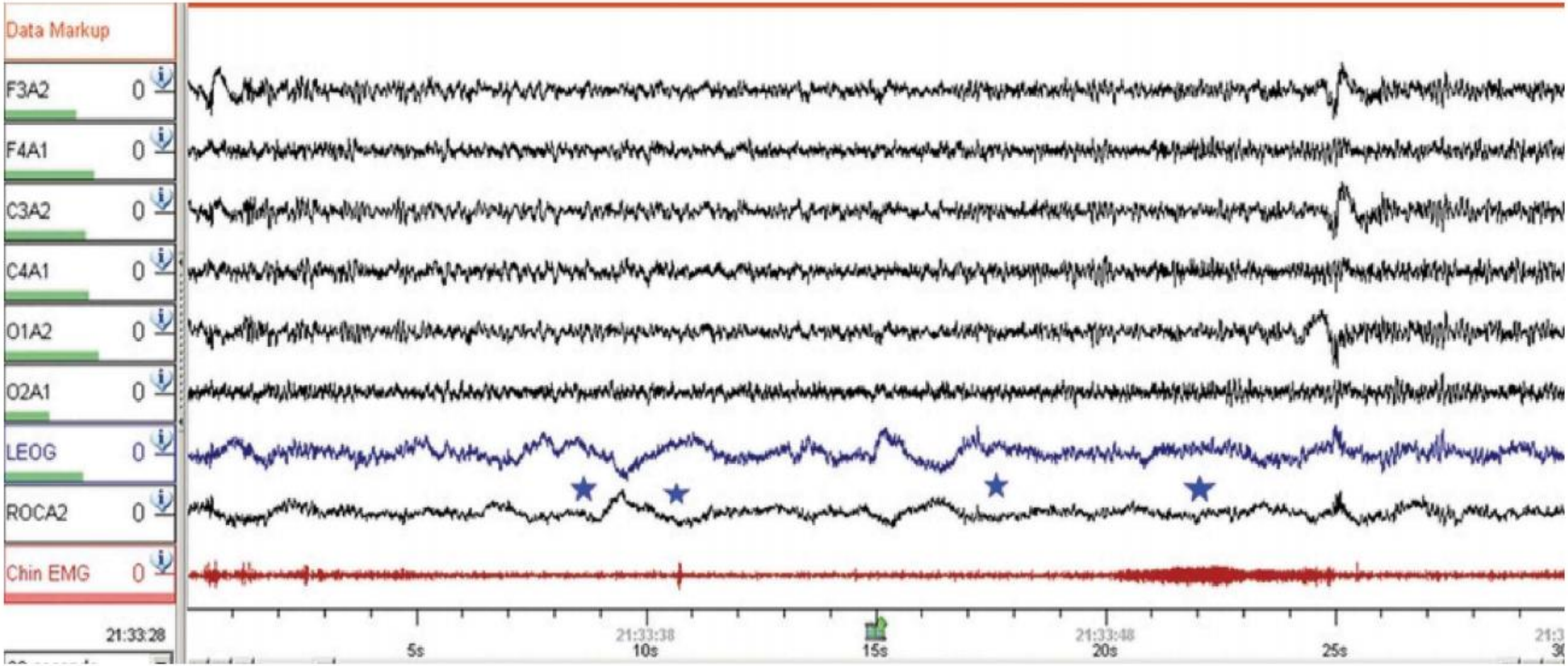


Figure 13.4 A Microsleep: Slow eye movements (star) are sinusoidal and duration of initial deflection is more than 0.5 seconds. They may persist during quiet wakefulness as well as during N1. This epoch shows SEMs while a person is drifting into sleep. Shall be scored as Wake as alpha occupies more than 15 seconds of epoch.

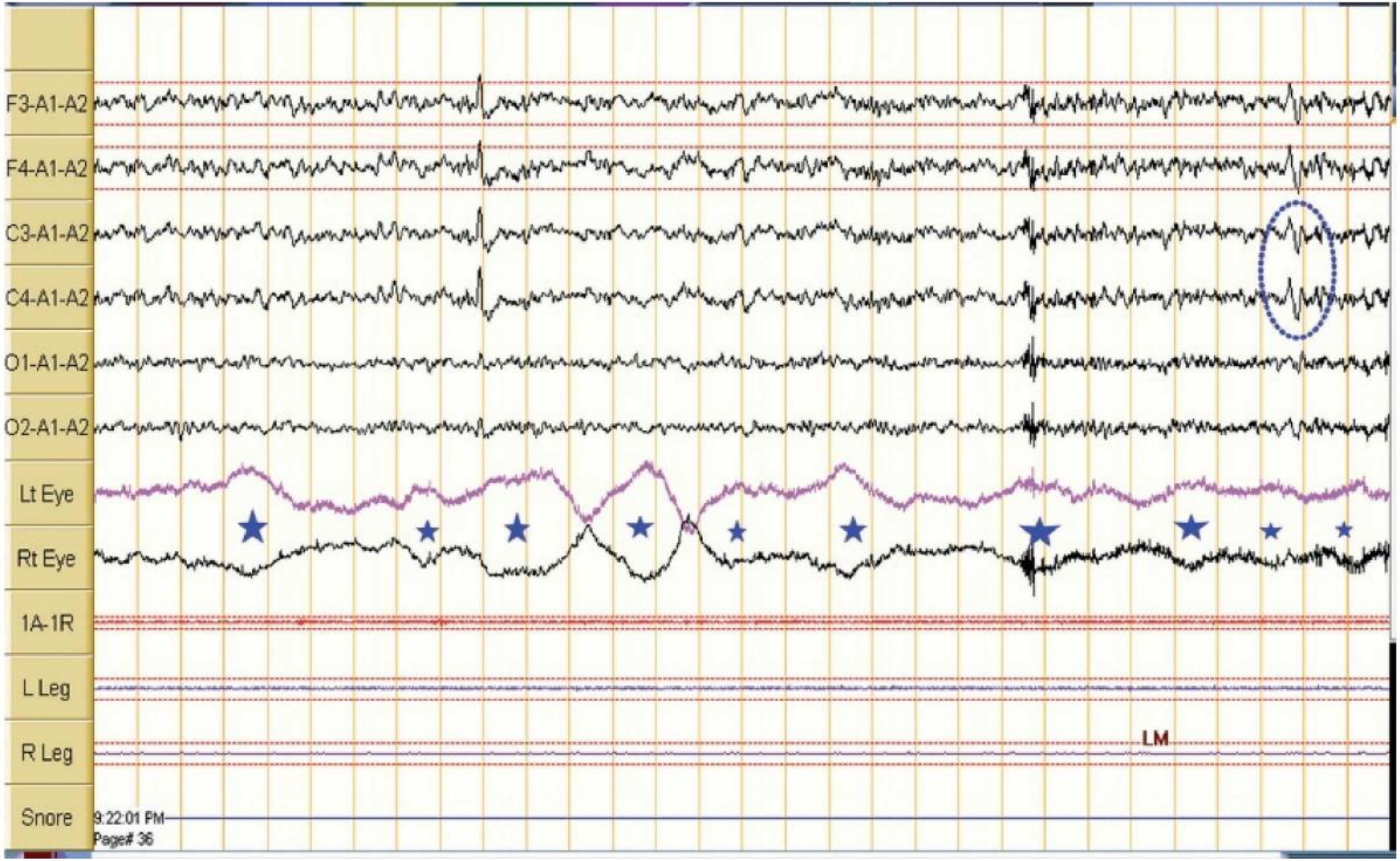


Figure 13.4B N1 is scored when alpha activity in EEG is replaced by low voltage mixed frequency activity in theta range in more than half of the epoch (> 15 seconds in an epoch of 30 seconds) and slow eye movements (satr). Chin tone goes down with N1. Vertex sharp waves (duration < 0.5 seconds and in circle) appear maximally in central derivations. First scorable N1 epoch also marks the sleep onset (30 seconds epoch)

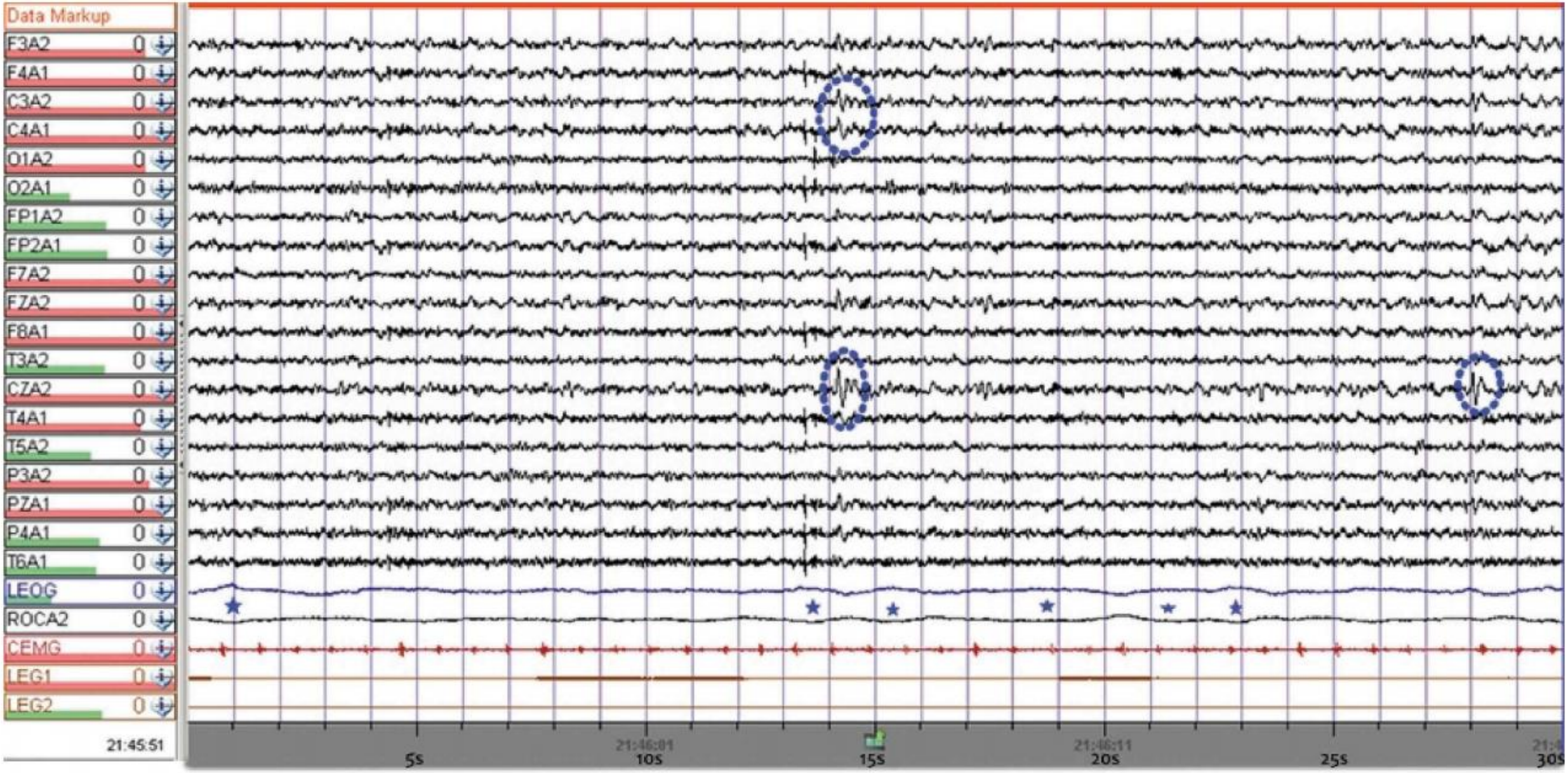


Figure 13.5 A Vertex waves in N1: Vertex waves are sharp waves that appear distinct to the background EEG in central derivations (Circle) and have duration less than half a second. Slow eye movements are also seen (star) and background EEG activity is low voltage mixed frequency in theta range during whole of epoch. So this is scored as N1.

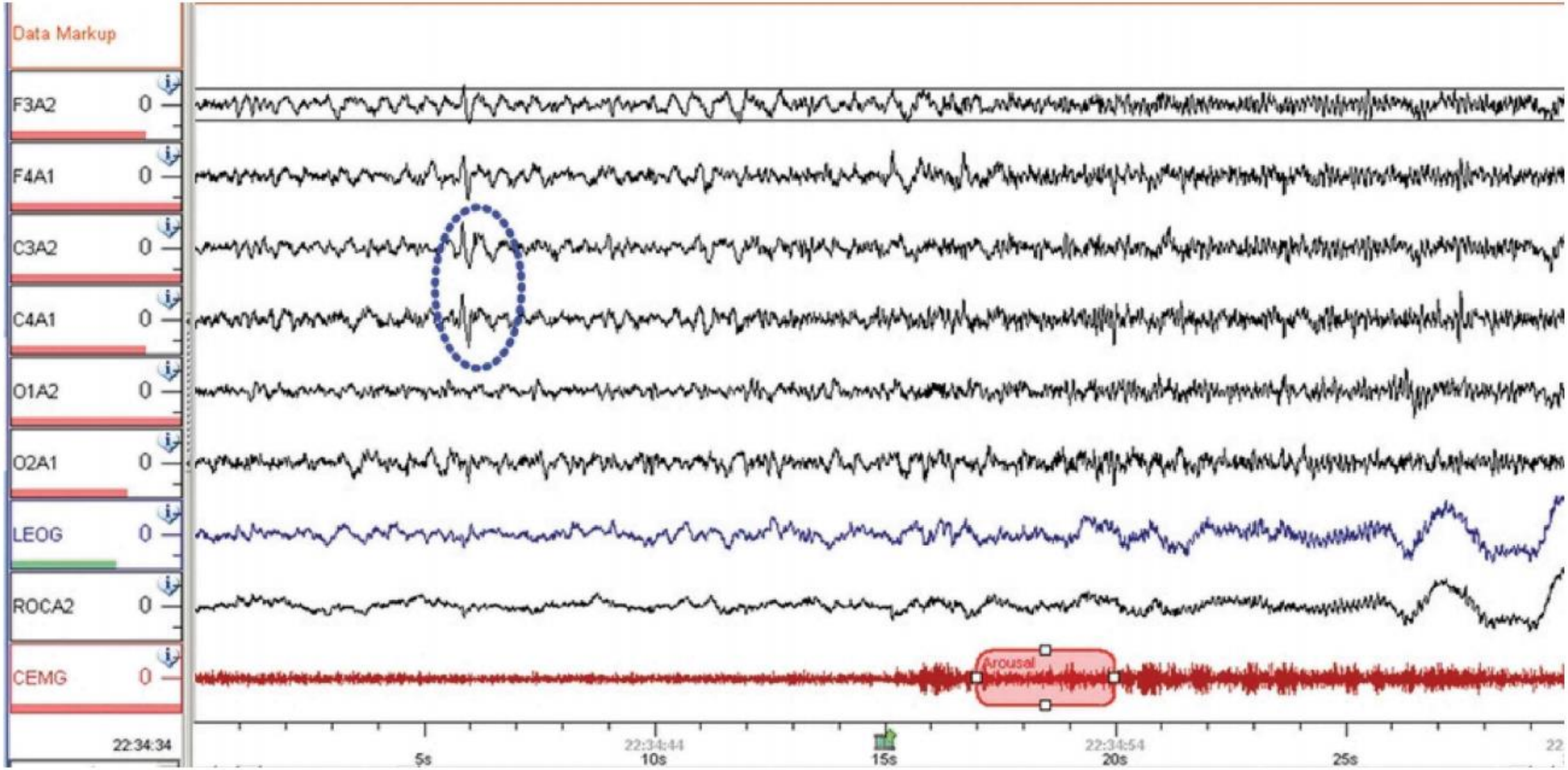


Figure 13.5 B N1: Vertex waves are sharp waves that appear distinct to the background EEG in central derivations (Ellipse) and have duration less than half a second. Background EEG activity is low voltage mixed frequency in theta range for more than 15 seconds. Though alpha is seen in the last part of epoch; but it occupies less than 50% of epoch, hence this epoch will be scored as N1.

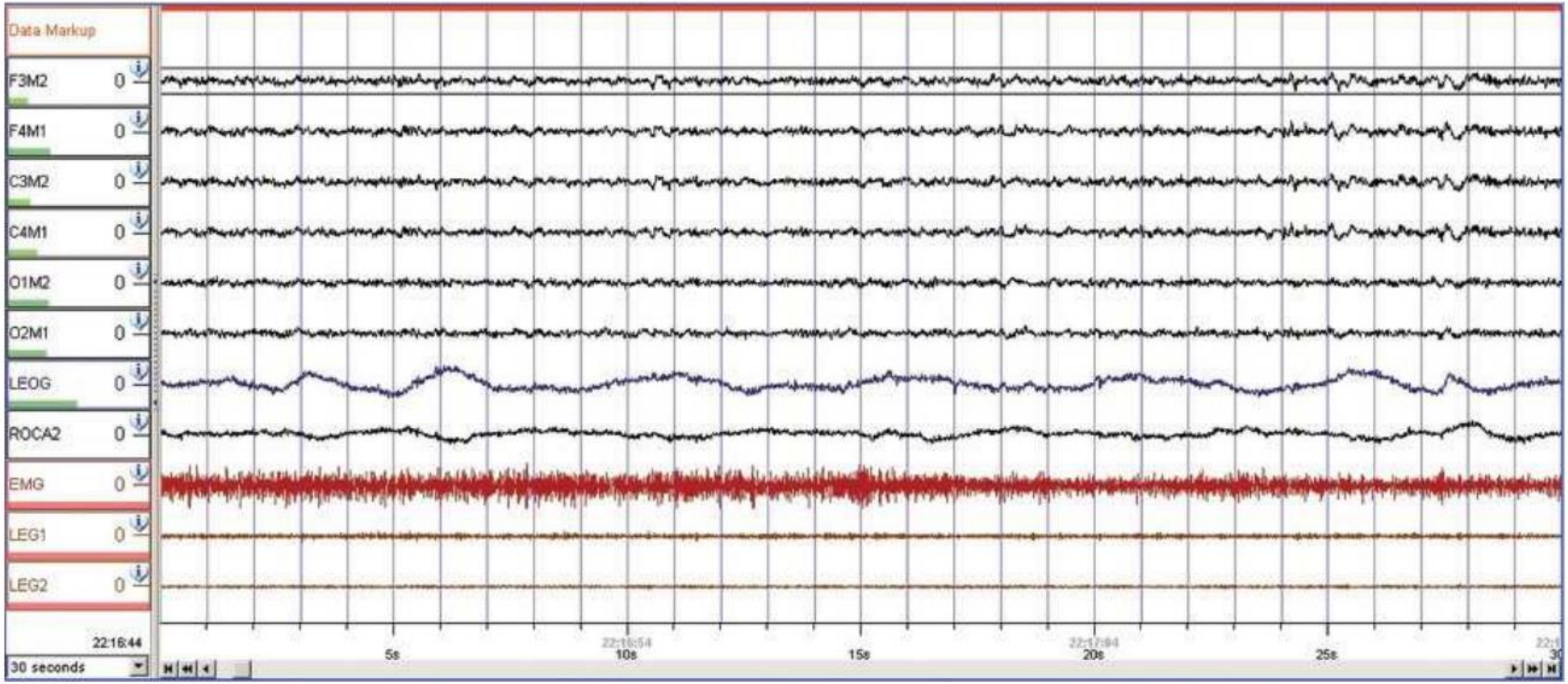


Figure 13.5C–G Scoring of N1 in subjects that do not produce alpha as posterior dominant rhythm: This epoch shows low voltage mixed frequency activity with high chin tone and slow eye movements. This is quiet wakefulness.

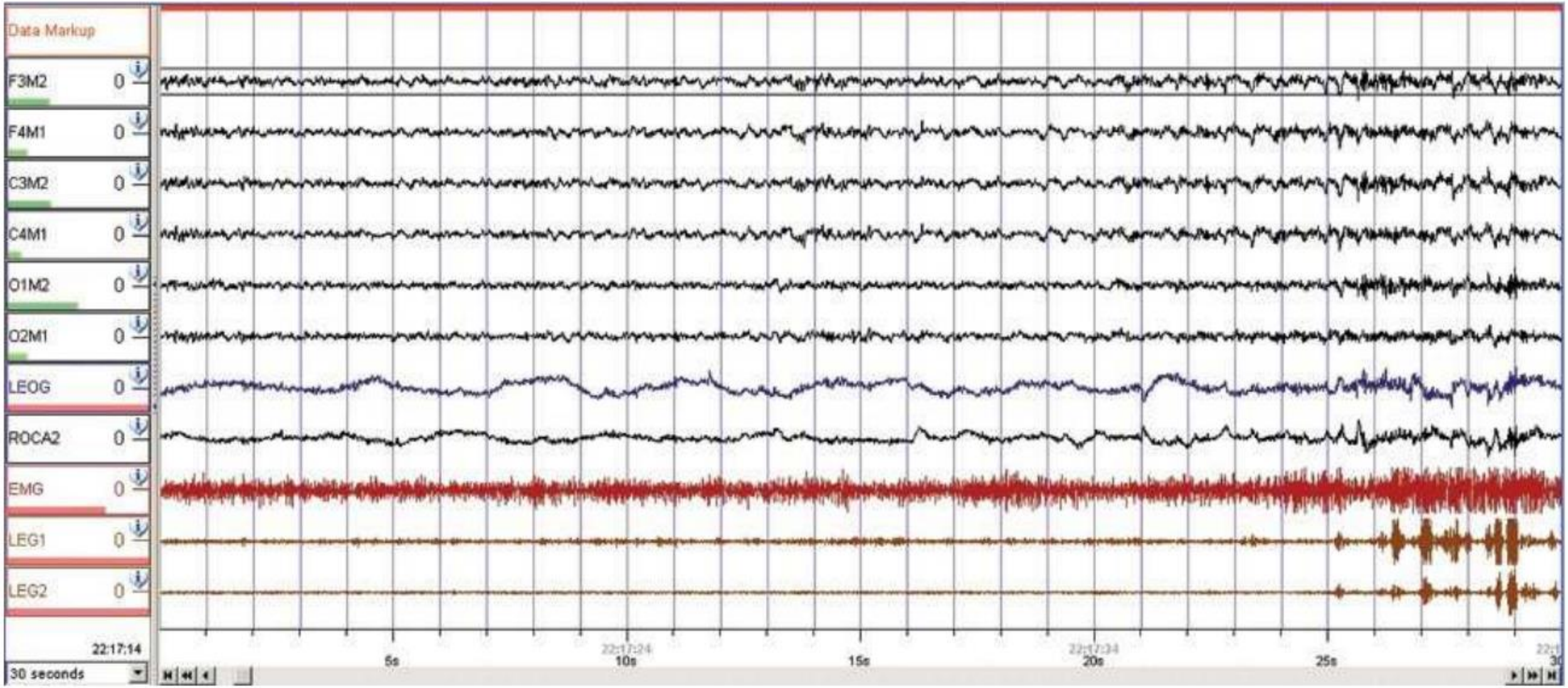


Figure 13.5D This epoch shows low voltage mixed frequency activity with high chin tone and slow eye movement. Last part of epoch shows eye blink artifacts, movement artifacts and further increase in chin tone. EEG activity is just like previous epoch. This will be scored as wake.

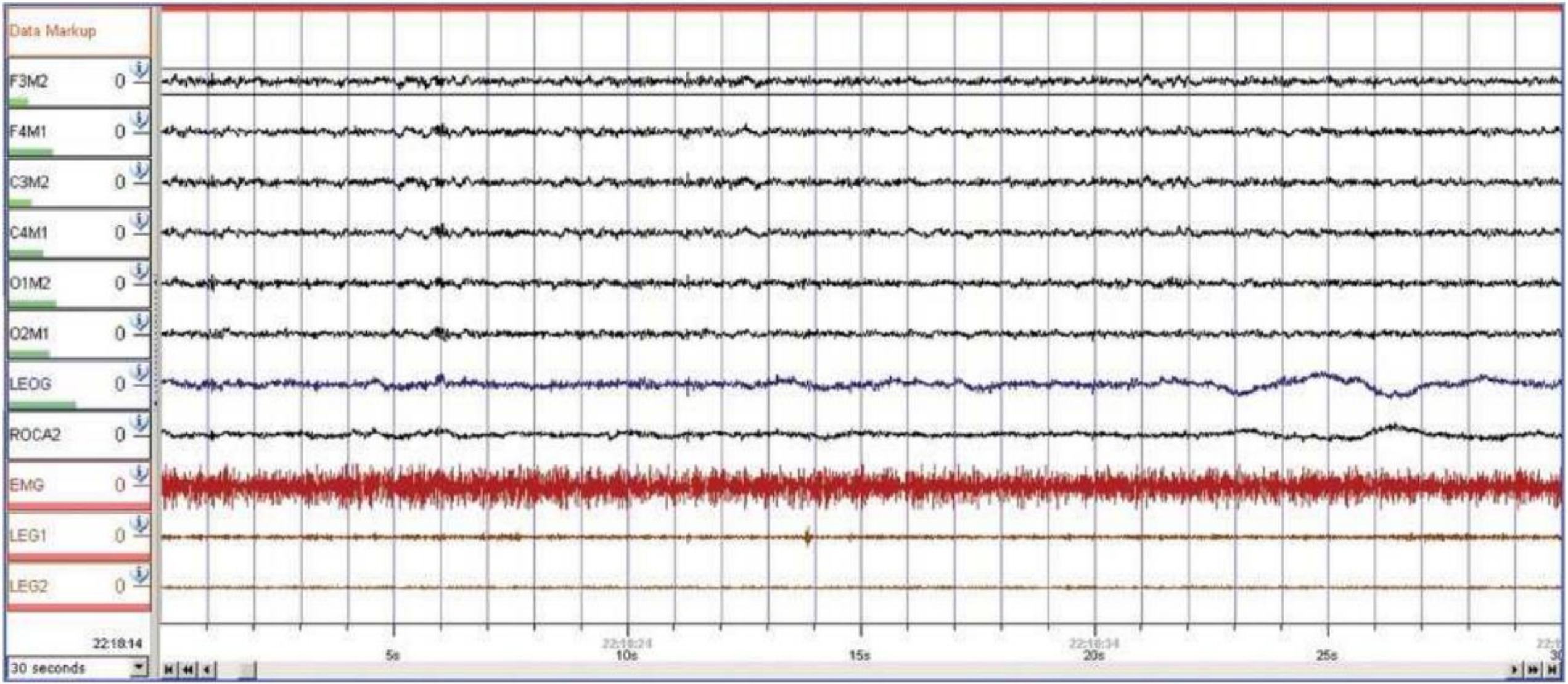


Figure 13.5E This epoch does not show any change in EEG, however, eye movements are lesser pronounced. This will also be scored as wake.

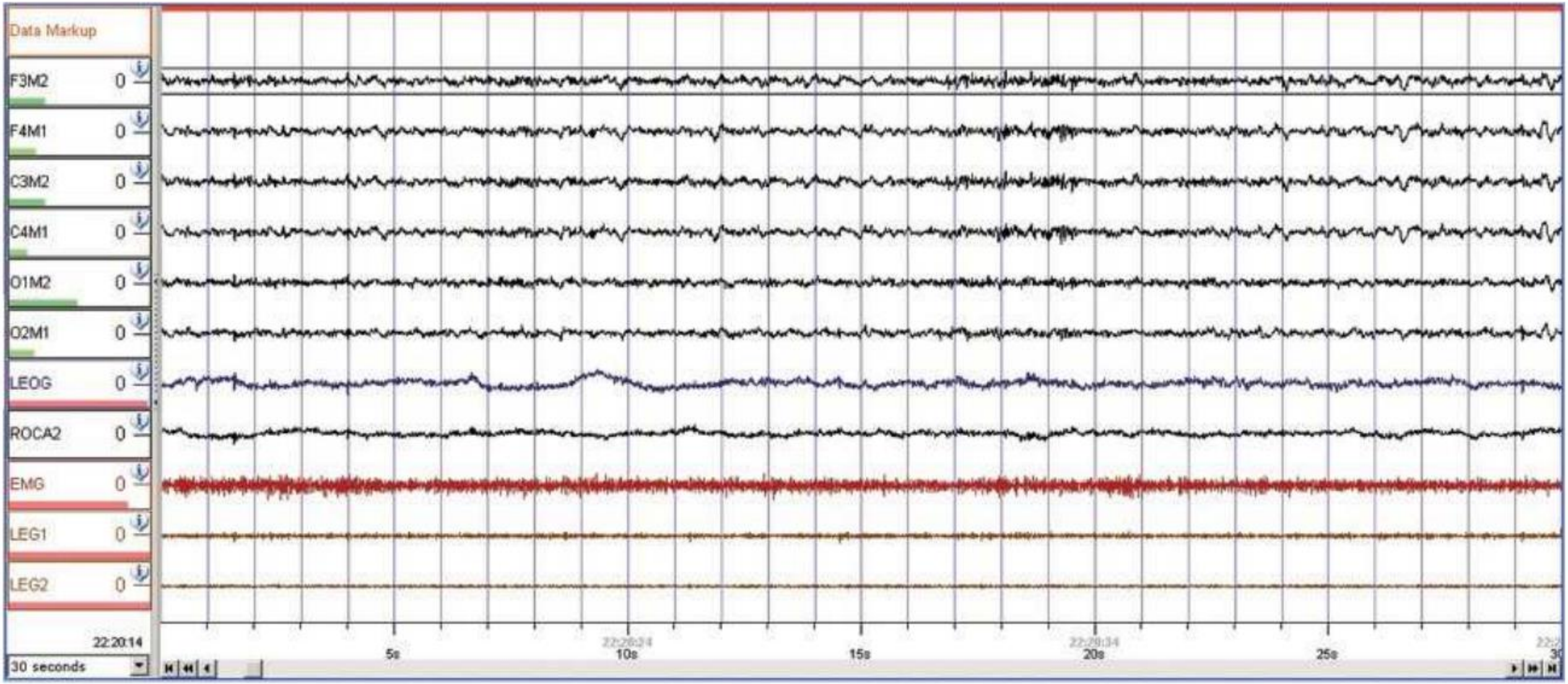


Figure 13.5F This epoch shows slowing of background EEG activity compared to previous epoch with lowering of chin tone and reduction of eye movement. This should be scored as N1.

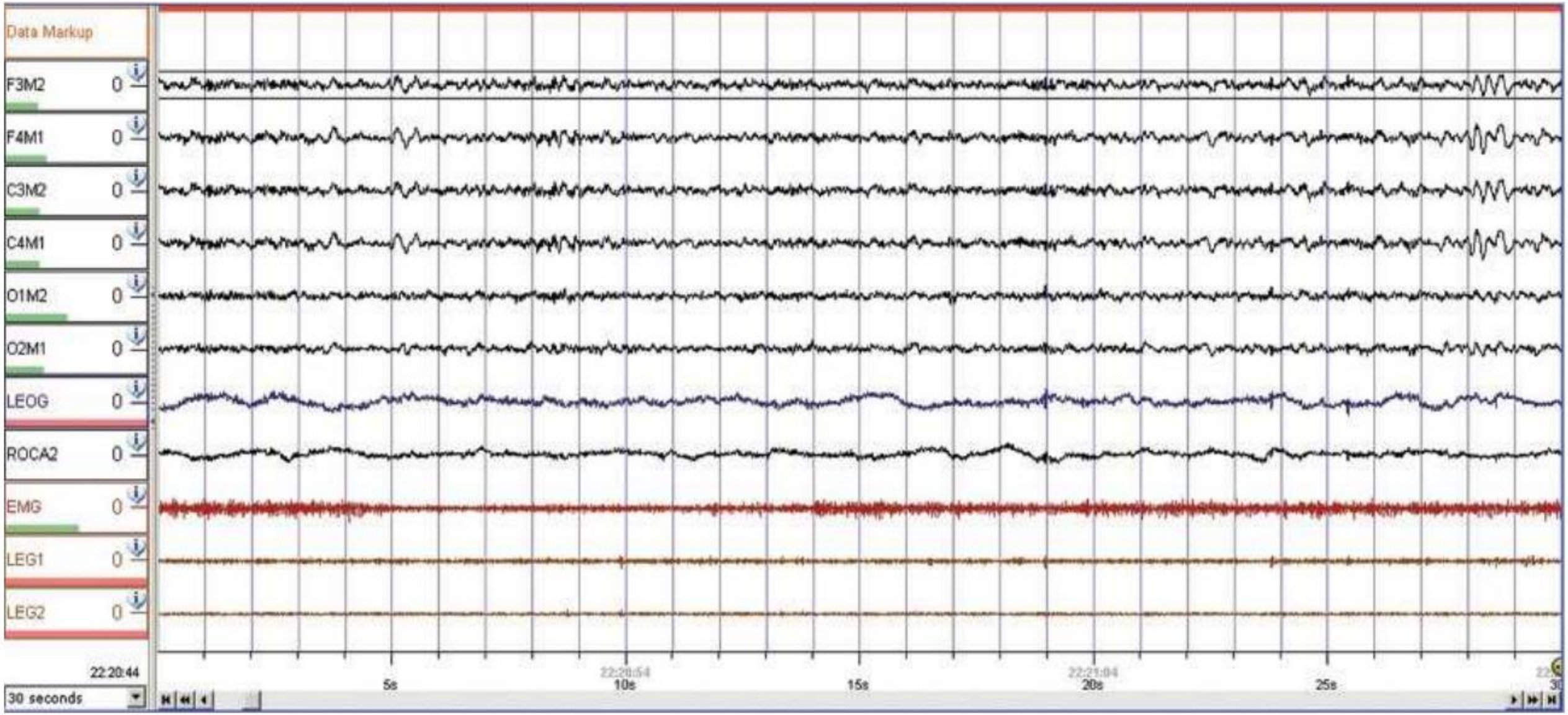


Figure 13.5G This epoch is like previous epoch showing N1 sleep.



Figure 13.6 Arousal in N1: An arousal in N1 is scored if the EEG activity shifts to alpha in the occipital and central derivations. To be scored as an arousal, the activity must last at least 3 seconds but not more than 15 seconds. If it is more than half the epoch, score the epoch as wake. At least 10 seconds of uninterrupted sleep must be present before an arousal.

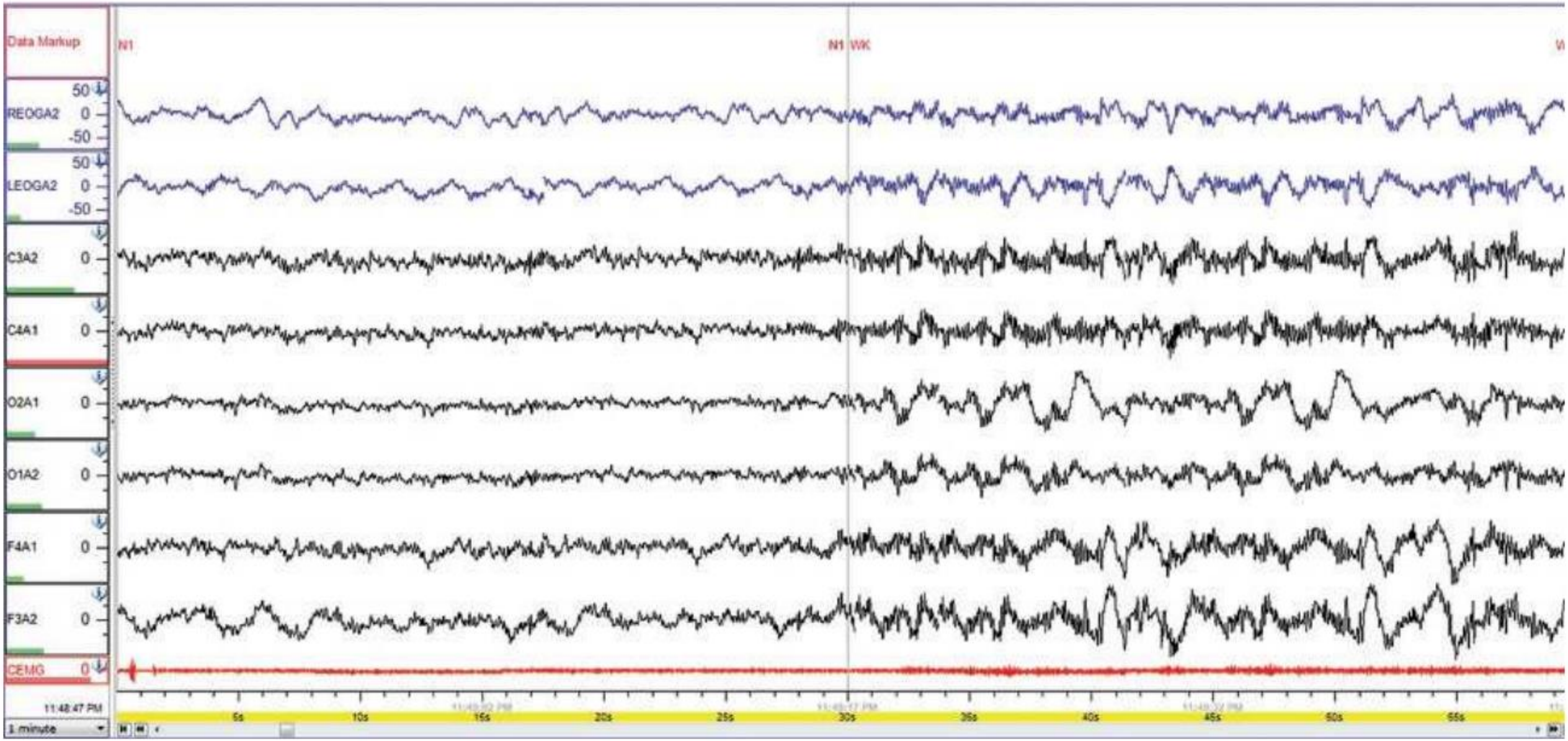


Figure 13.7 N1 to wakefulness: If the arousal lasts more than 15 seconds in an epoch, score it as wake (60 seconds epoch) Subsequent epoch must be scored based upon the waveforms present in epoch, as discussed in Figures 13.4 and 13.10.



Figure 13.8 A Distribution of Sleep spindles in EEG derivations: Sleep spindles (in box) are distinct waves of 11–16 Hz frequency that are seen most prominently in central derivations, having duration of at least 0.5 seconds and are easily distinguishable from the background. In this epoch (30 seconds) they appear in first half, hence this will be scored as N2.

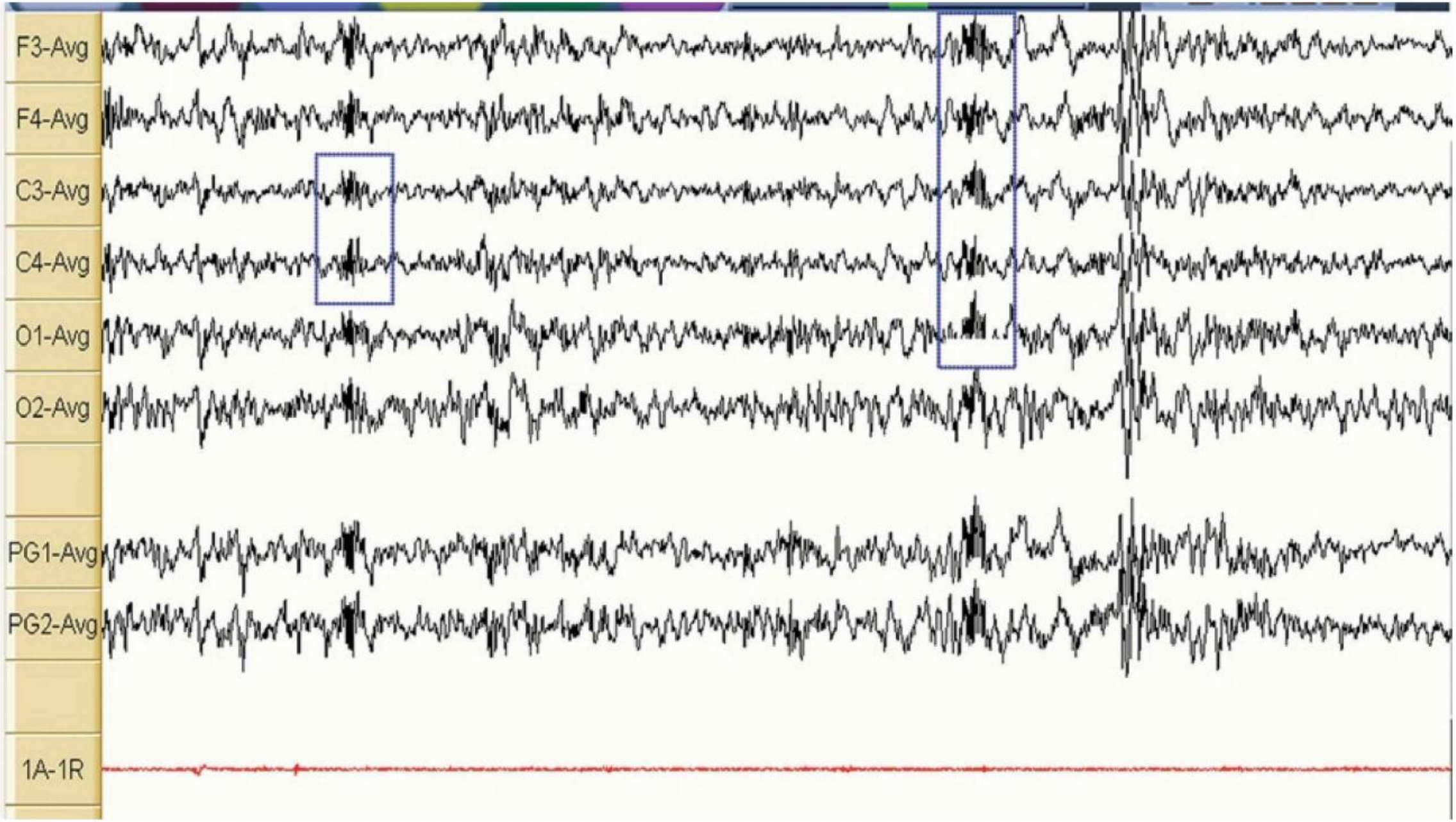


Figure 13.8 B Sleep spindles in N2: Sleep spindles (in box) are distinct waves of 11–16 Hz frequency that are seen most prominently in central derivations, having duration of at least 0.5 seconds and are easily distinguishable from the background. In this epoch (30 seconds) they appear in first half, hence this will be scored as N2.

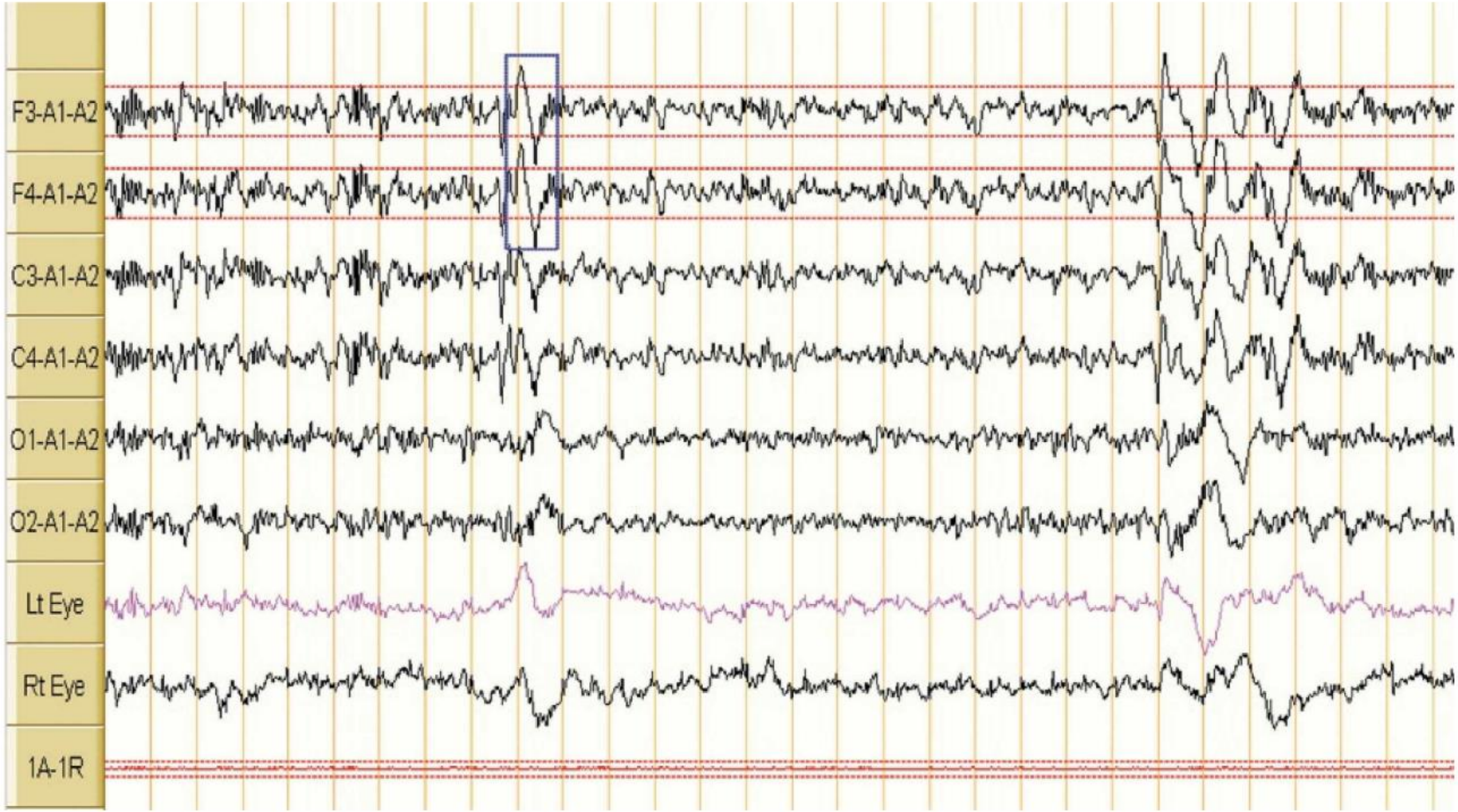


Figure 13.9 K Complexes in N2: K complex are prominently seen in frontal derivations and sometimes in EOG as well due to their proximity to frontal area (Box). Having a duration of more than half a second, they have initial negative deflection, followed by a positive deflection and the coming to baseline. They are quiet distinct from the background.

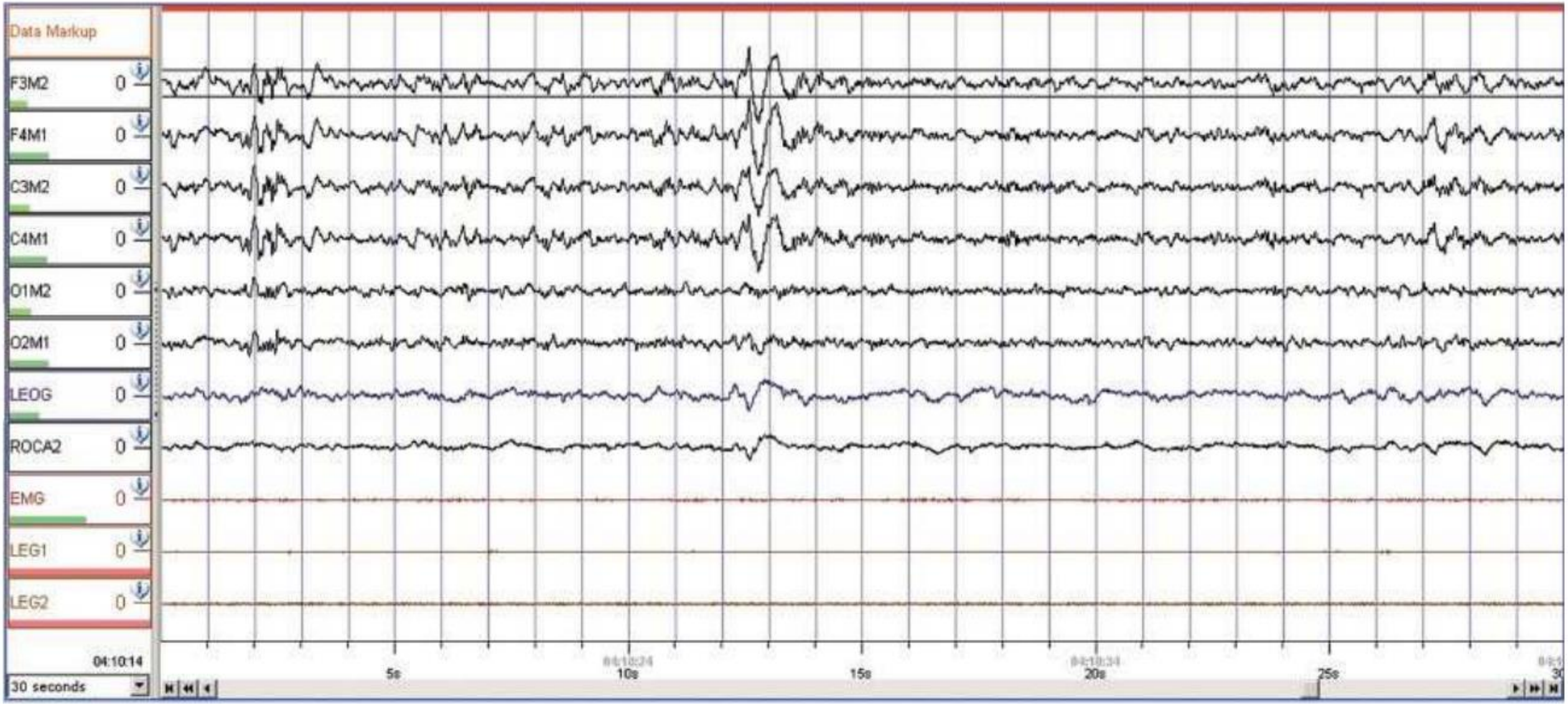


Figure 13.10A Initiation of N2: If an epoch shows either of the two-sleep spindles or K-complex in the first half, that epoch should be scored as N2. If it is seen in later half, score sleep stage in present epoch as that of previous epoch or whichever waveform dominates the present epoch. Here K complexes are seen in first half, no arousal is seen, hence tis will be scored as N2.



Figure 13.10B Figure shows low voltage mixed frequency activity, however, K complex is seen only in second half, hence this will be scored as epoch previous to this, i.e., N1. Epoch subsequent to this will be scored as N2, unless it is interrupted by arousal or shows waveforms confirming any other stage.

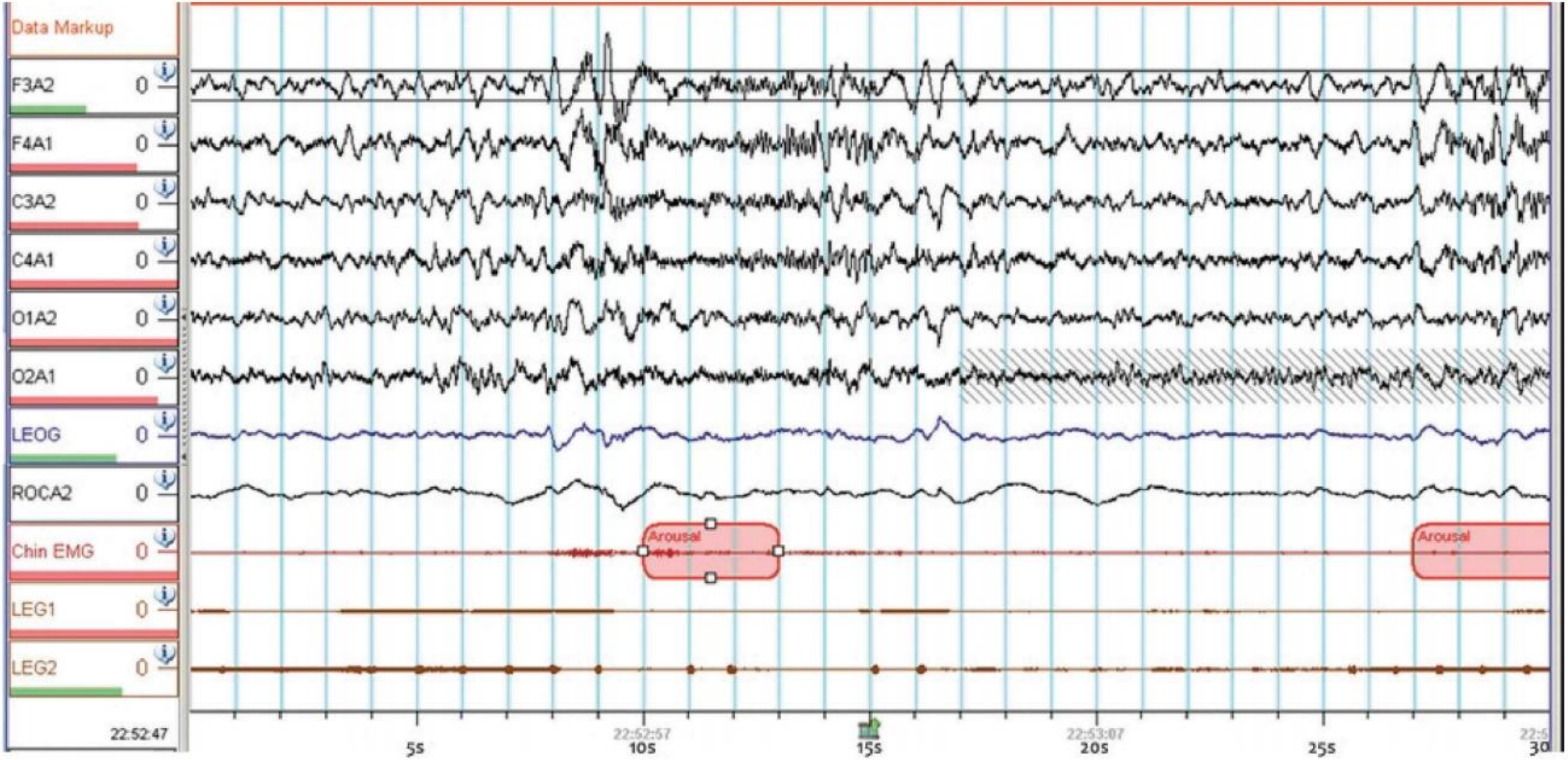


Figure 13.11 K arousal in first half of N2: If an arousal starts within 1 seconds of termination of K complex, it is not considered as K complex. Here K-arousal is apparent in first half of epoch, and sleep spindle or K complex are not seen before or after K-arousal, hence it should be scored as N1. Change the scoring of subsequent epochs to N2 according to Figure 13.10 A, B.

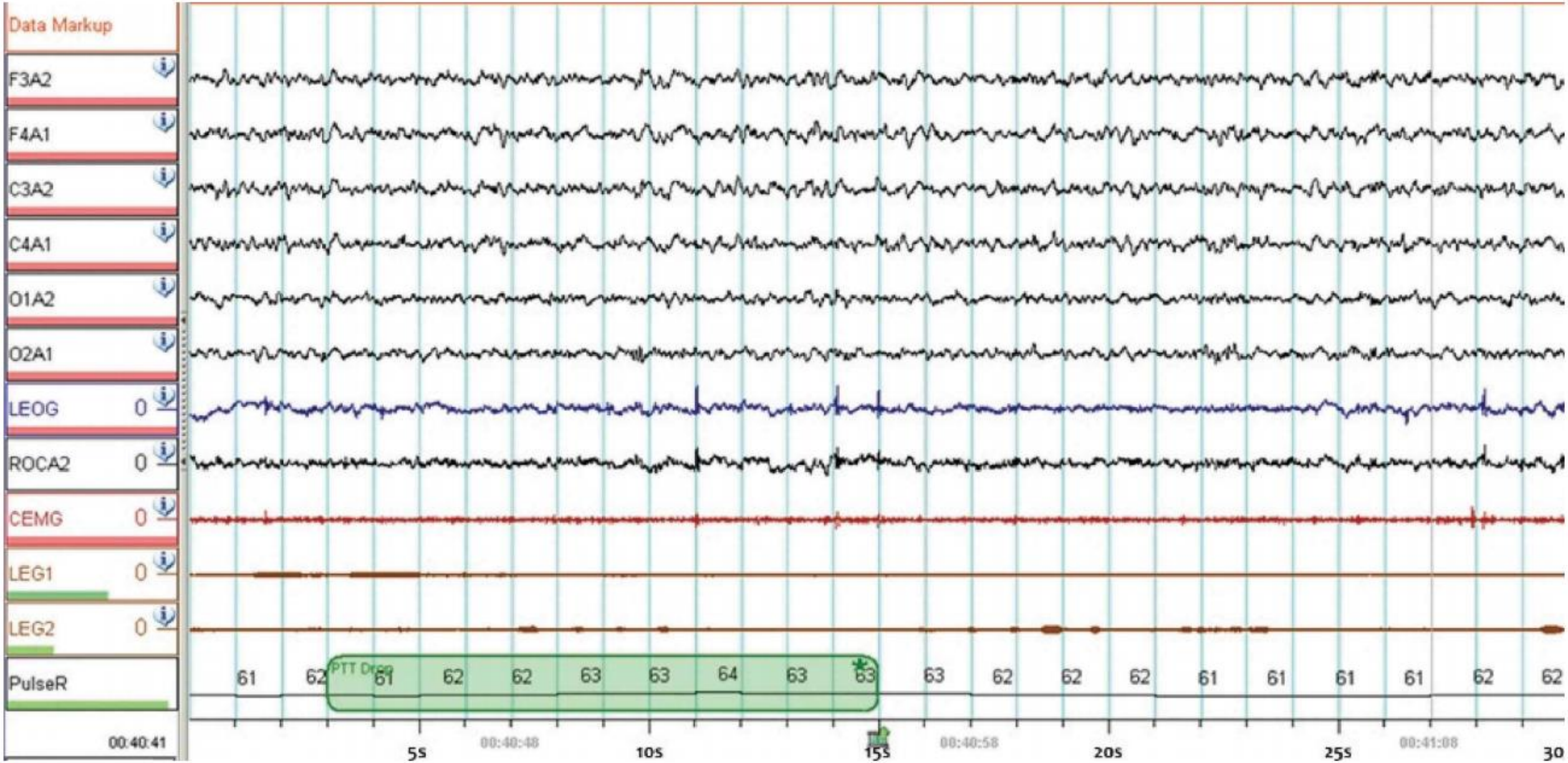


Figure 13.12 N2 scoring without spindle of K complex: Once started, scoring of N2 should be continued if low voltage mixed frequency activity is seen in EEG even in absence of K complex or sleep spindles. However, the previous epochs must have been scored as N2 and did not have intervening arousals.

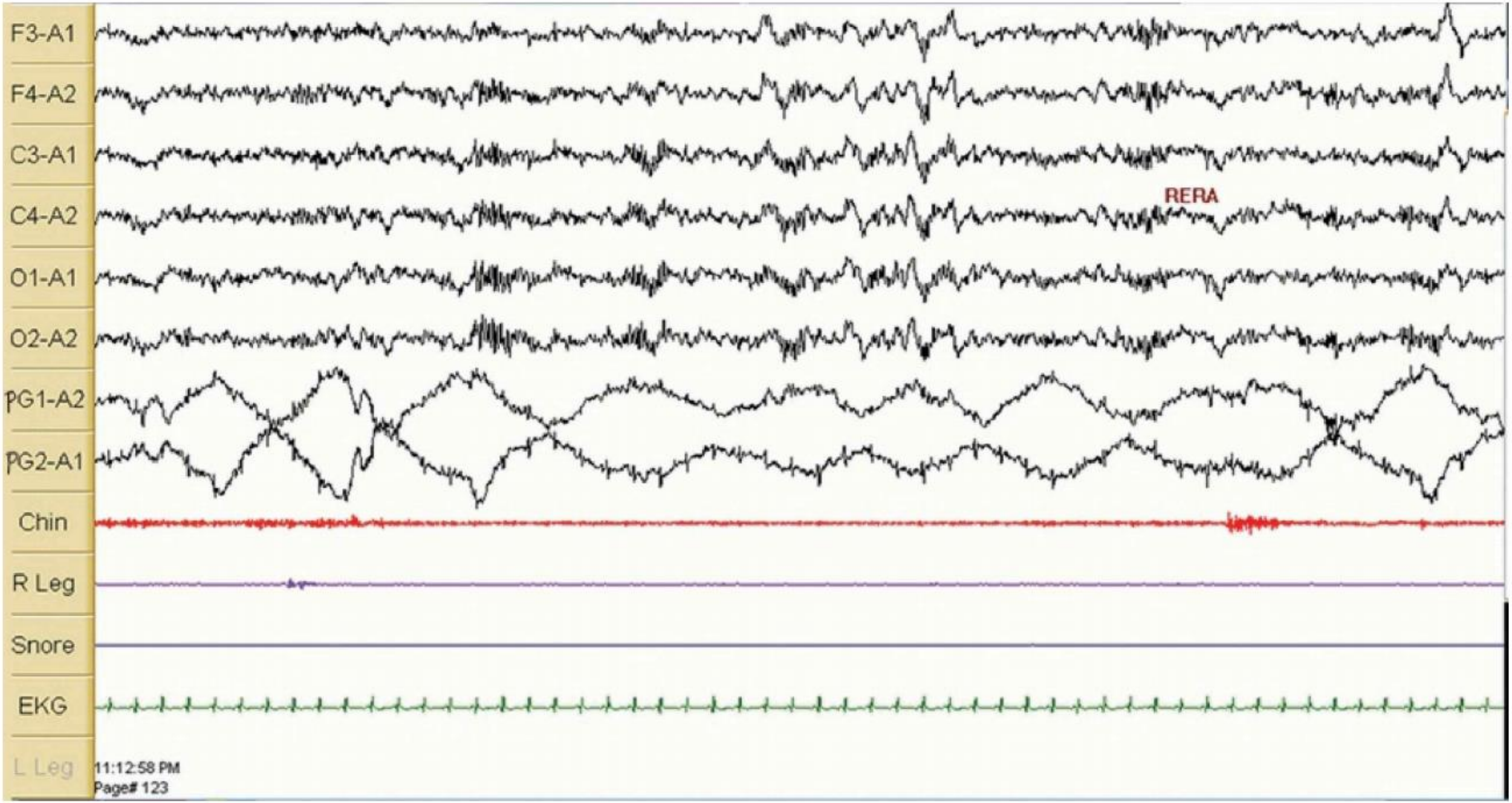


Figure 13.13 SEM during N2: Although eye movements are absent during N2, in some cases, slow eye movements may be seen during N2.

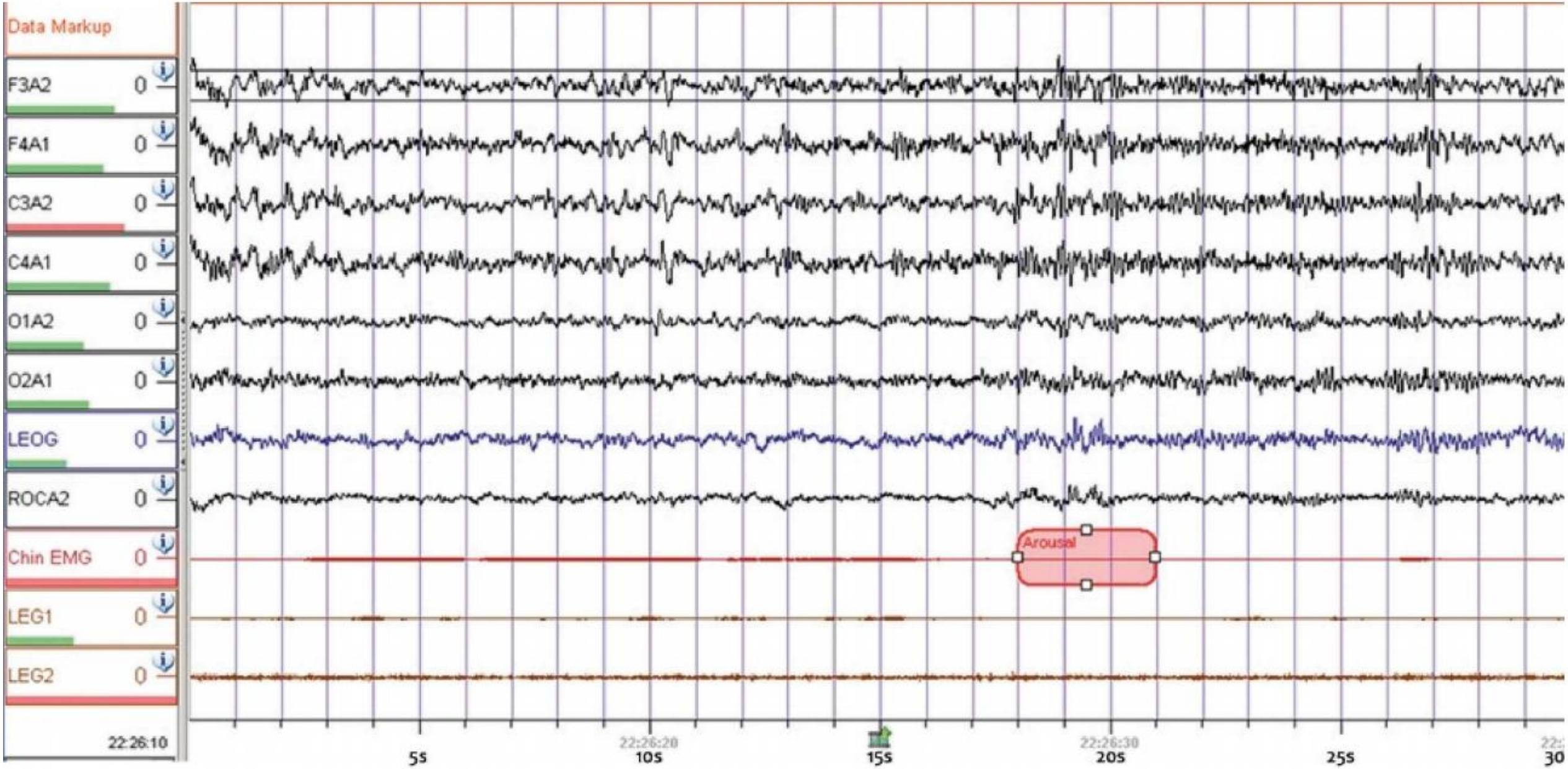


Figure 13.14 A Arousal in N2: An arousal in N2 is scored if the EEG activity shows an abrupt change to the higher frequencies- alpha, lasting for 3–15 seconds. If it occupies more than half of the epoch, score as wake. If less, score as N2. See that theta activity appears after alpha at the end of epoch, following epoch shall be scored as N1 anc continue to score N1 till an epoch with sleep spindle or K complex appears as mentioned in Figure 13.10.

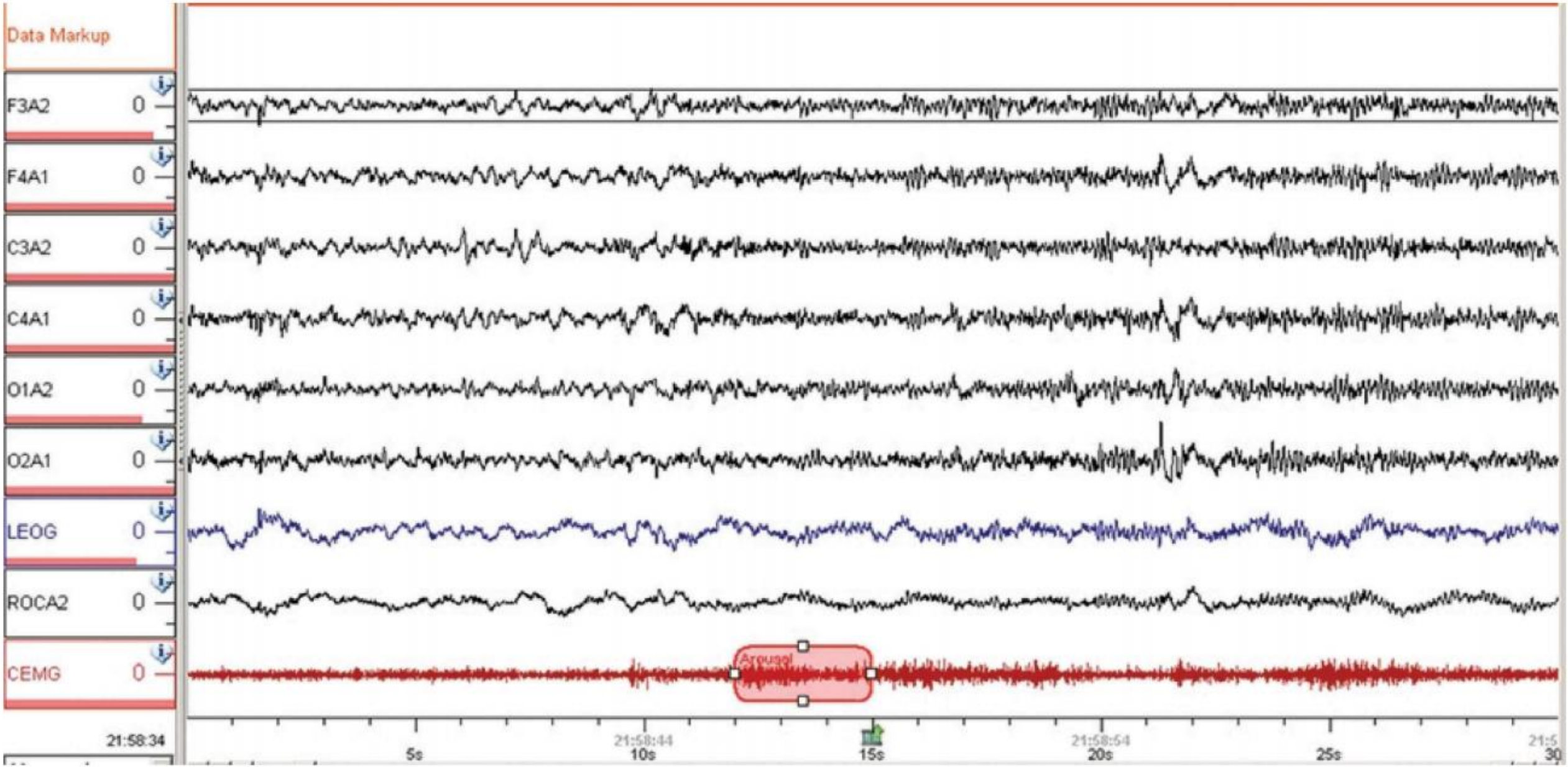


Figure 13.14 B Change of N2-wakefulness: Since the alpha is seen for more than 50% of the epoch, this epoch will be scored as wake.

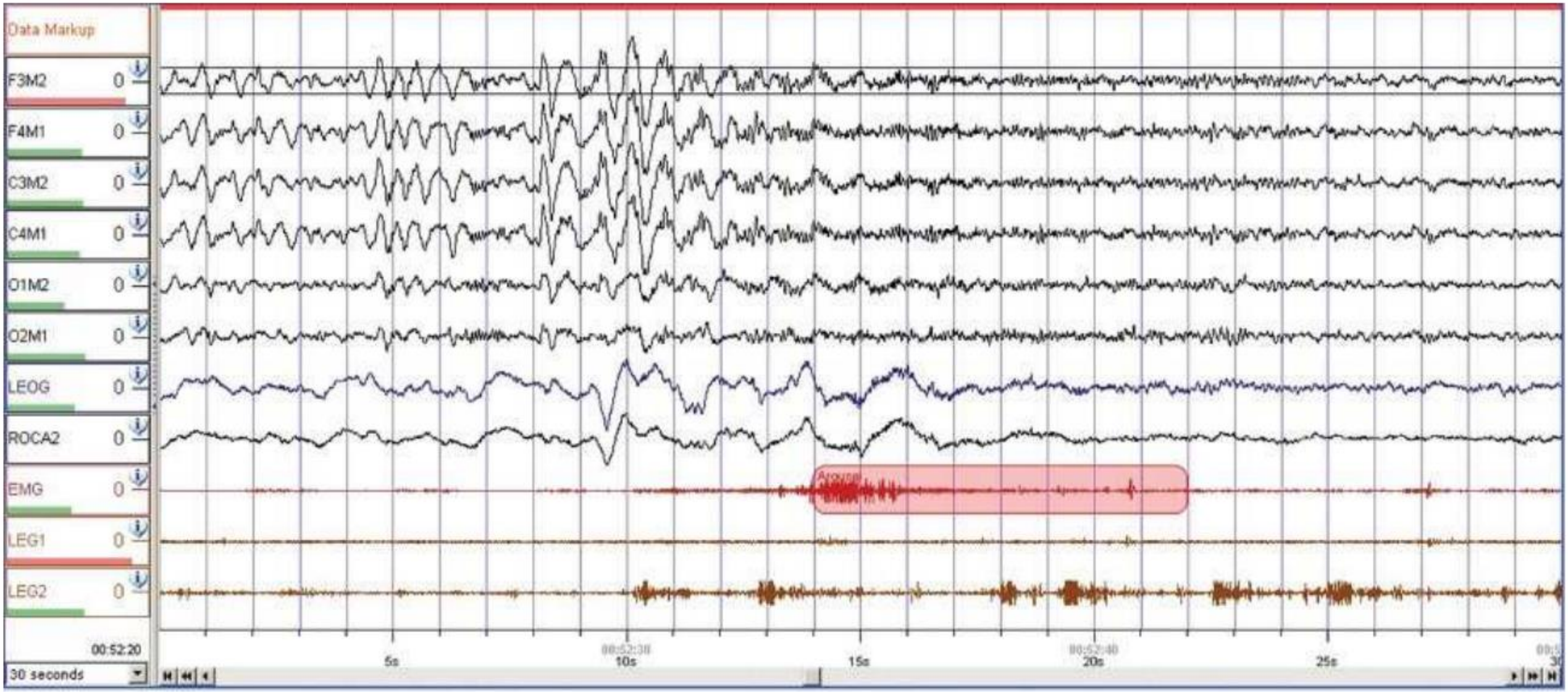


Figure 13.15 A–C Arousal in the later half of N2: A: This epoch shows arousal in second half. However, after arousal, waveforms suggestive of N1 are seen in last part. Since largest part of the epoch is covered by waveforms suggestive of N2, this will be scored as N2.

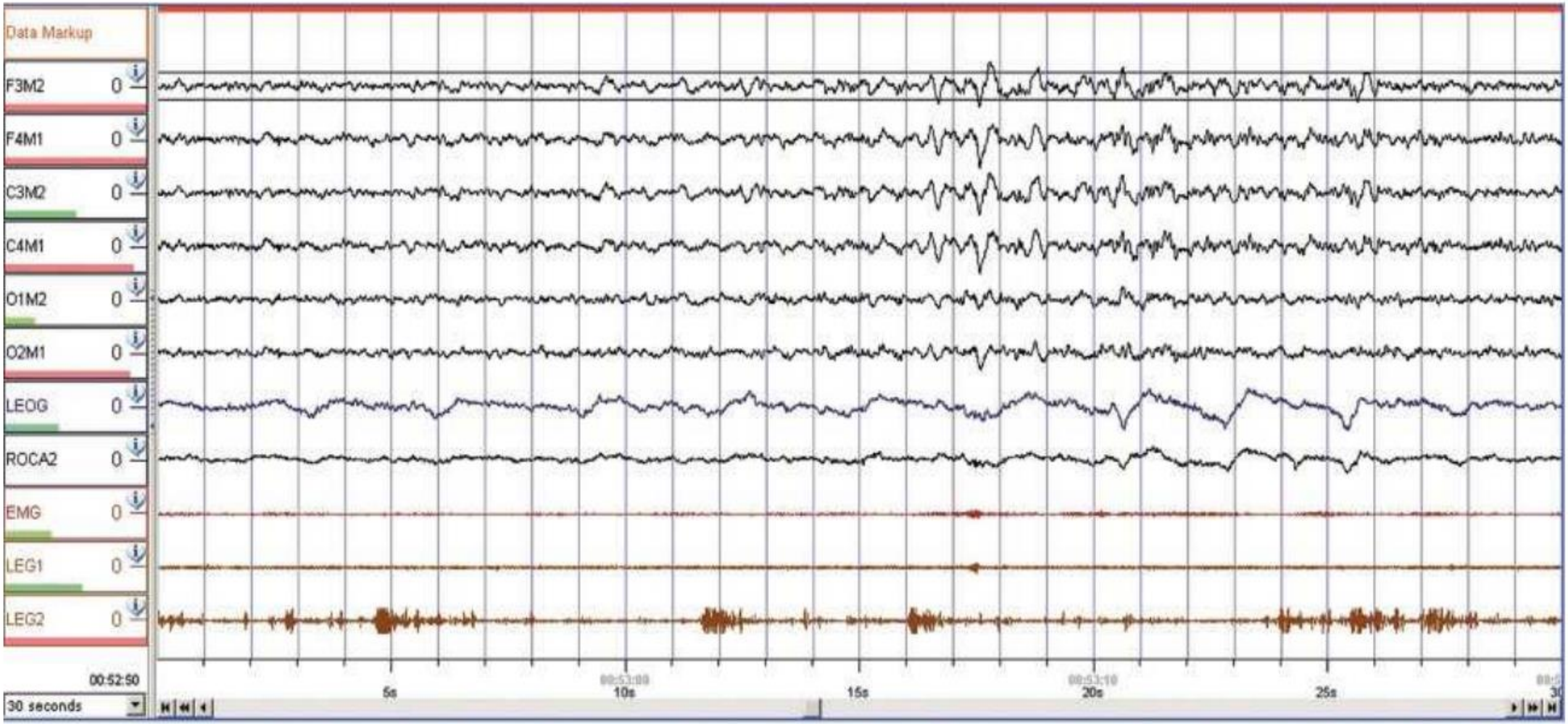


Figure 13.15 B This epoch does not show K complexes or spindles, hence will be scored as N1.

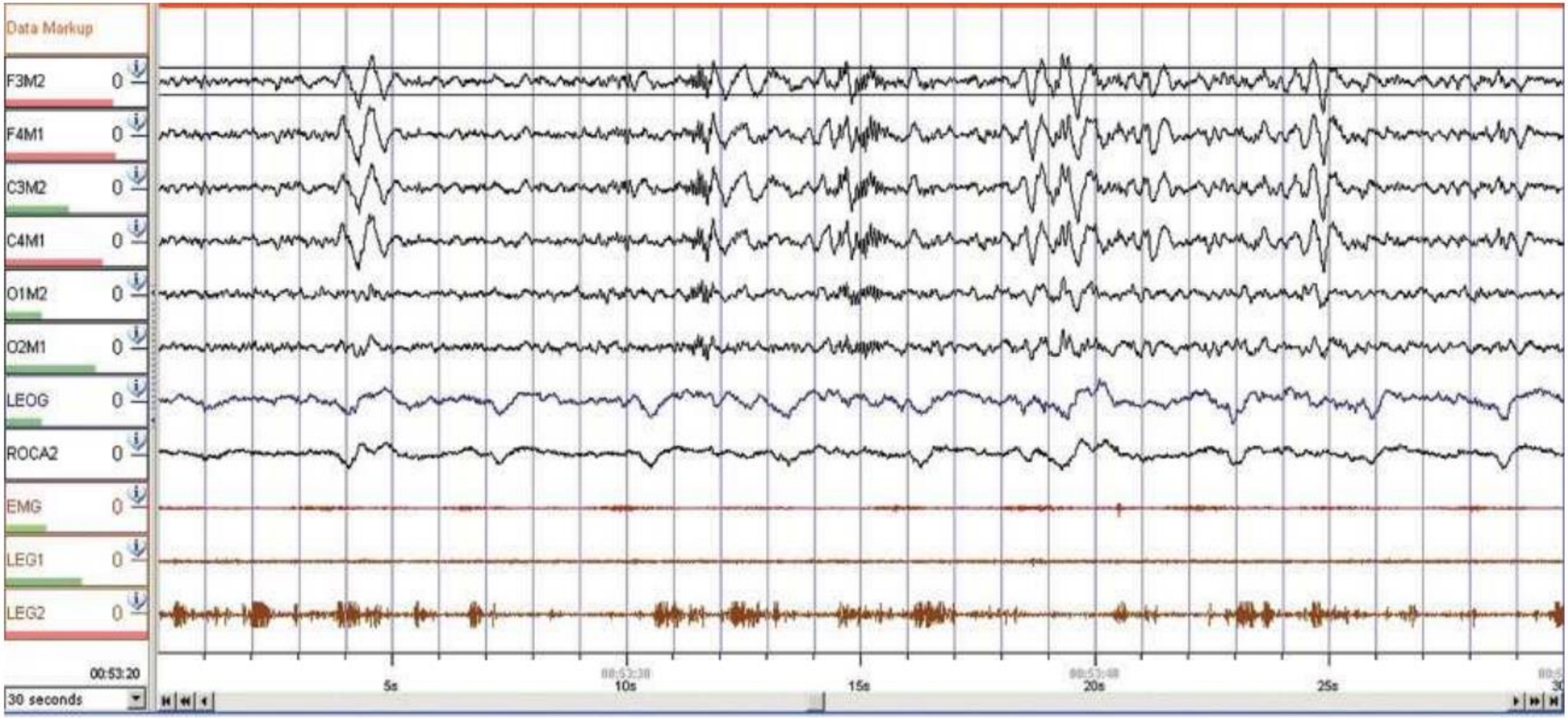


Figure 13.15C This epoch shows K complex in the first half, hence, it will be scored as N2.

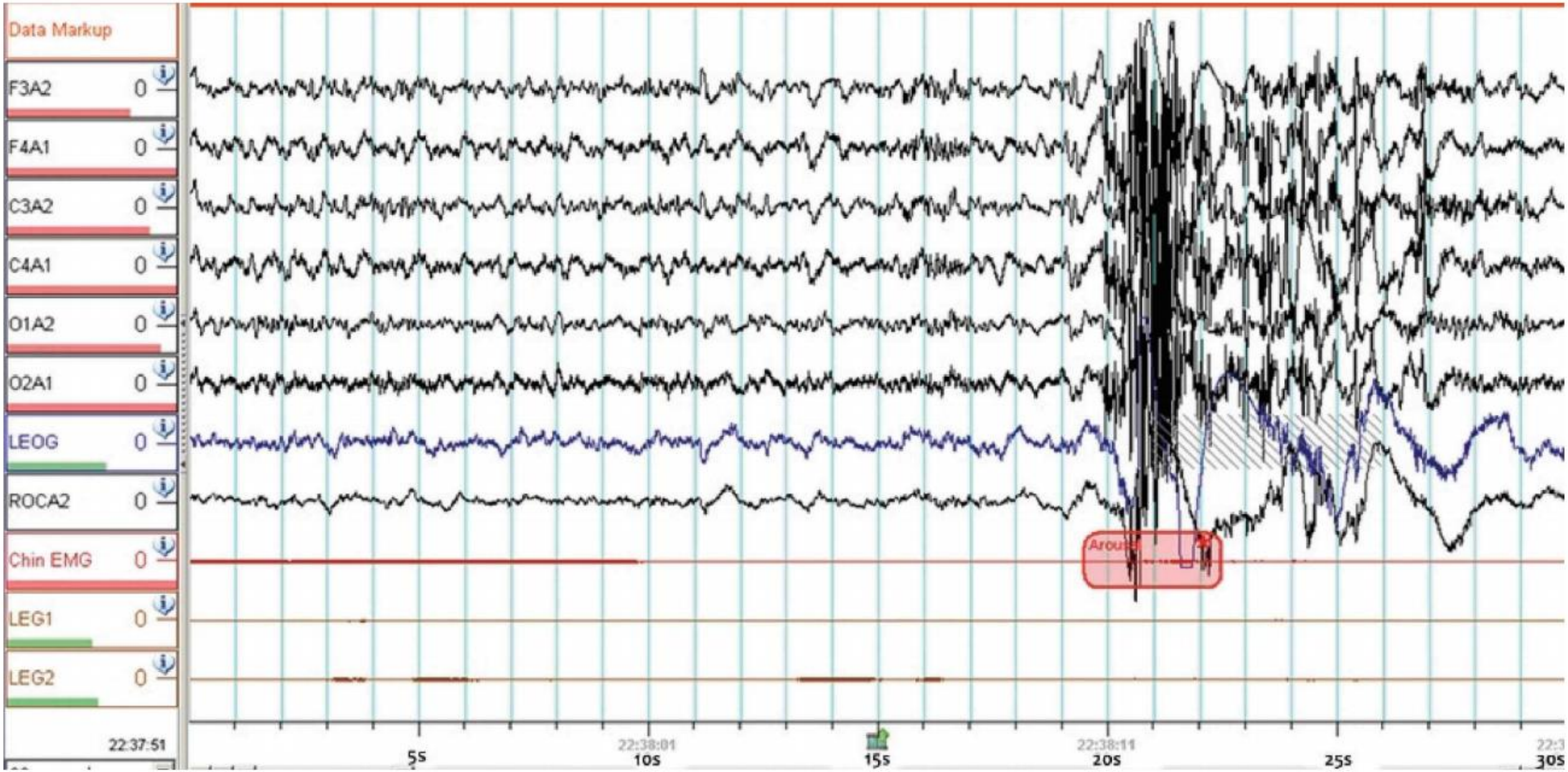


Figure 13.16 Body movement during N2: In this epoch body movement is followed by alpha but low voltage mixed frequency activity is present in most of the epoch, and preceding epoch was N2, hence this will be scored as N2.

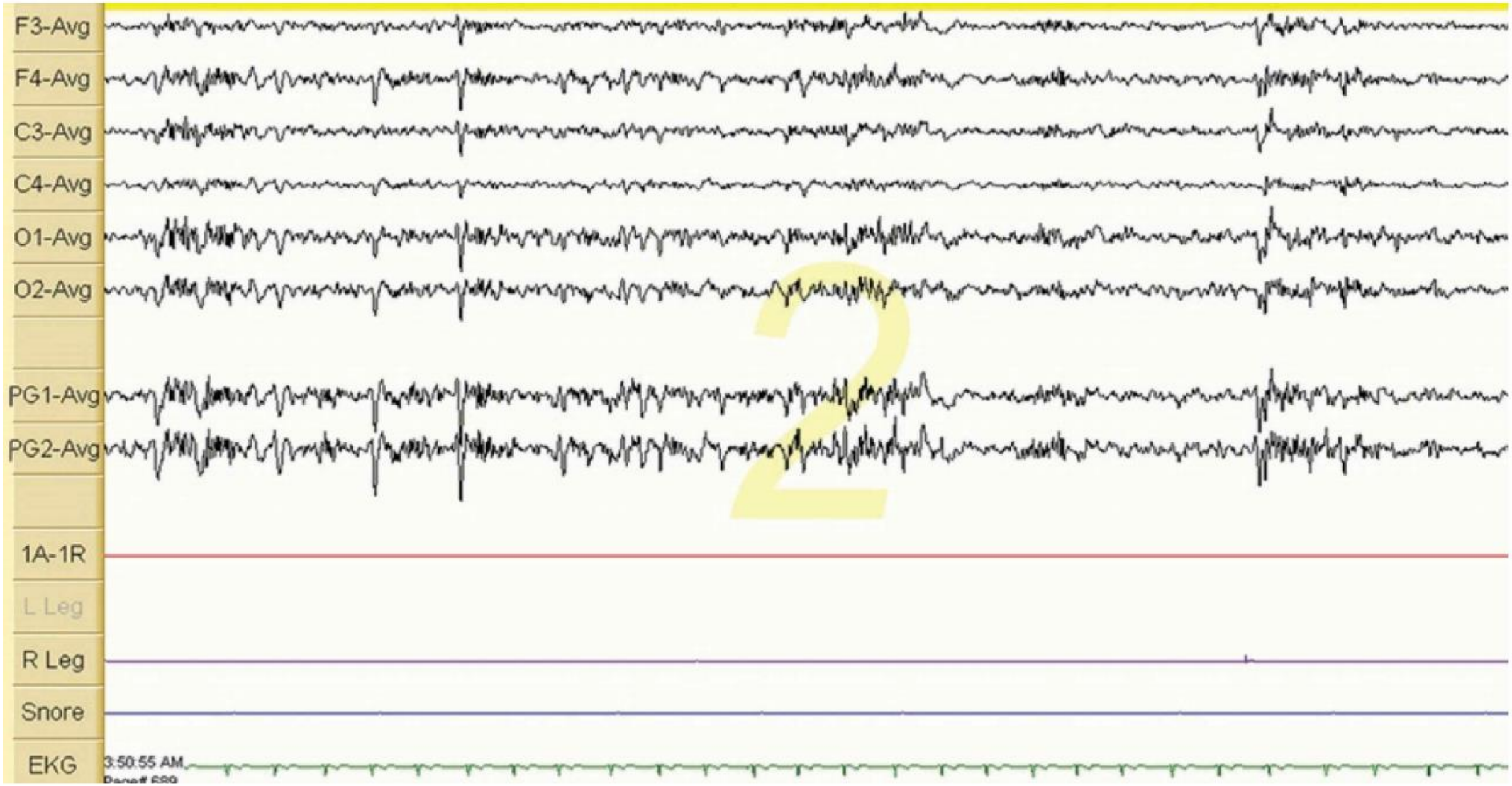


Figure 13.17 A–C Major body movement during N2: If a major body movement (defined as obscuring EEG beyond recognition in more than 50% epoch as in 13.17 B2) follows an epoch of undisputed N2 epoch (13.17 B1) and also follows an epoch of undisputed N2 (13.17 B3), epoch of movement will be scored as N2.

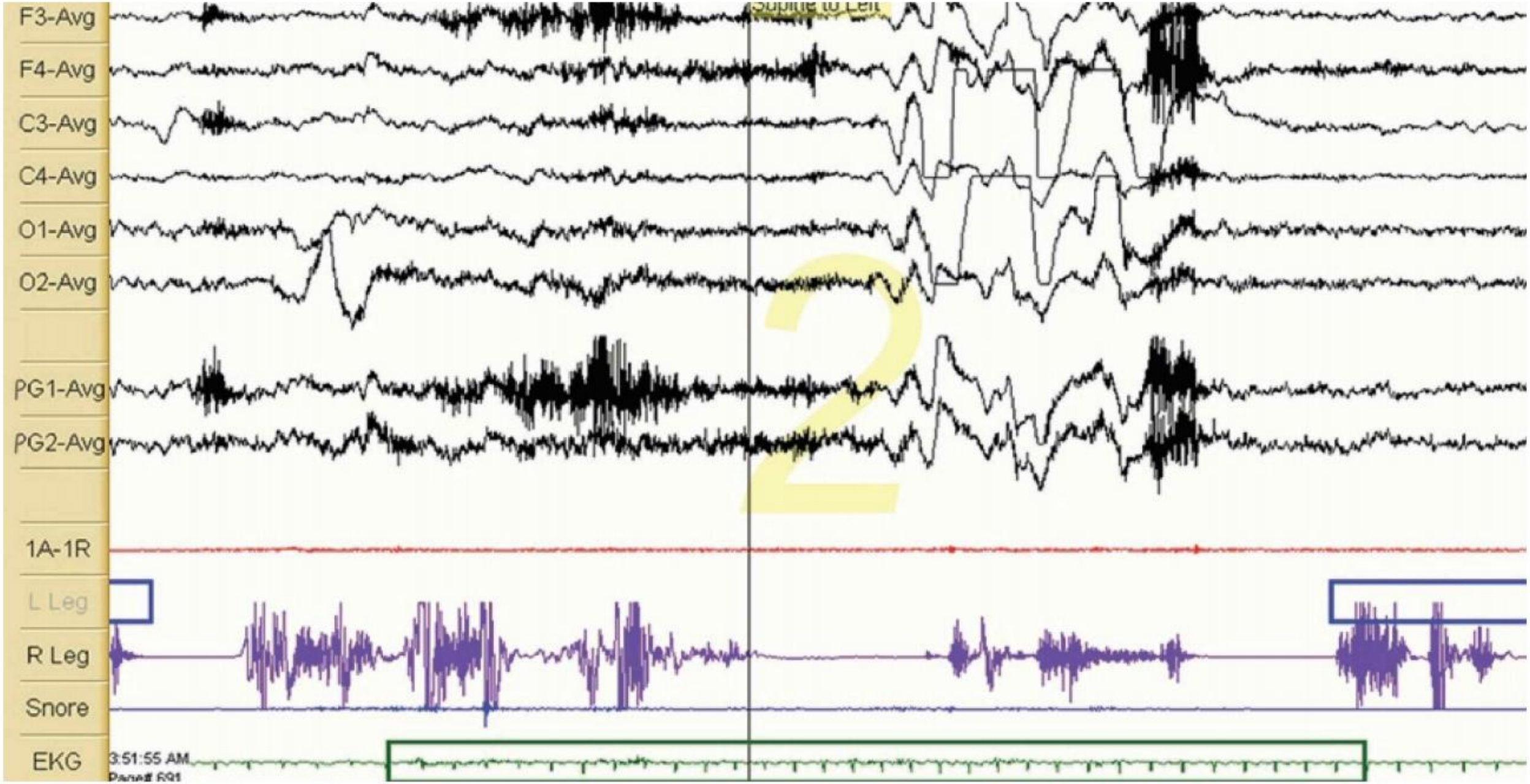


Figure 13.17 B Major body movement during N2: If a major body movement (defined as obscuring EEG beyond recognition in more than 50% epoch as in 13.17 B) follows an epoch of undisputed N2 epoch (13.17 A) and also follows an epoch of undisputed N2 (13.17 C), epoch of movement will be scored as N2.

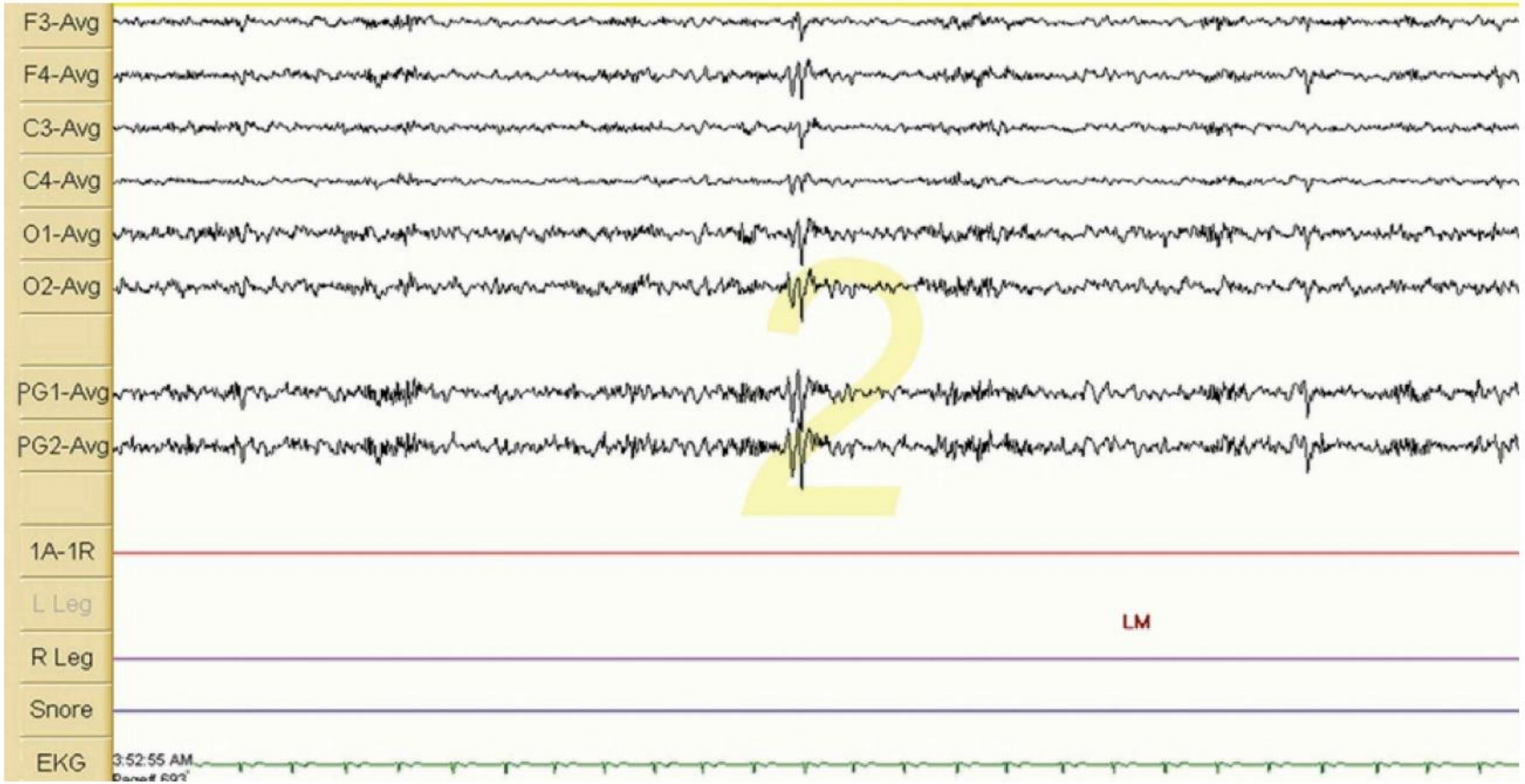


Figure 13.17 C Major body movement during N2: If a major body movement (defined as obscuring EEG beyond recognition in more than 50% epoch as in 13.17 B2) follows an epoch of undisputed N2 epoch (13.17 B1) and also follows an epoch of undisputed N2 (13.17 B3), epoch of movement will be scored as N2.

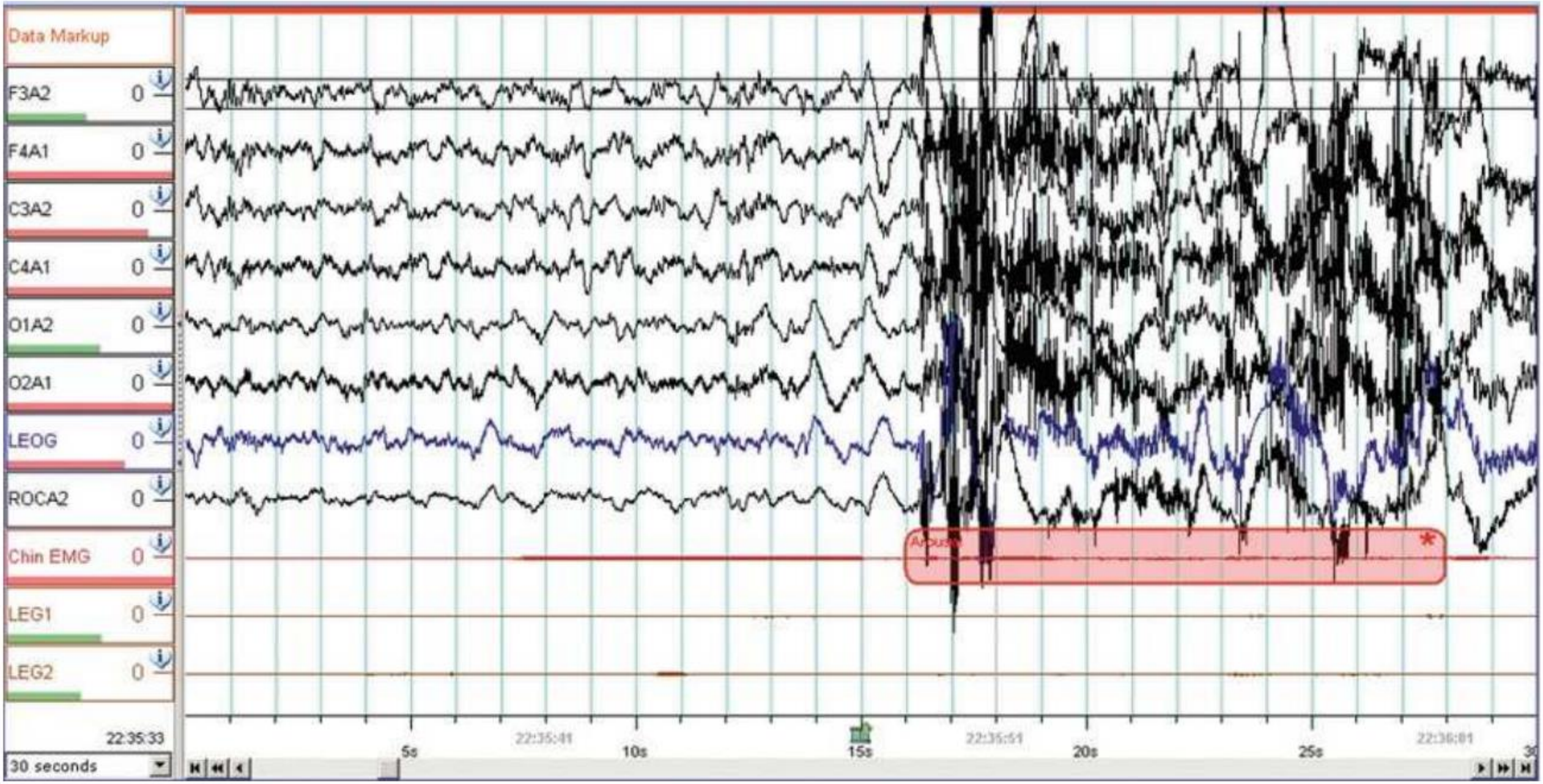


Figure 13.18A–B Slow eye movement in N2 epoch following a major body movement: A: N2 epoch shows a major body movement in second half that continues in first half of B.

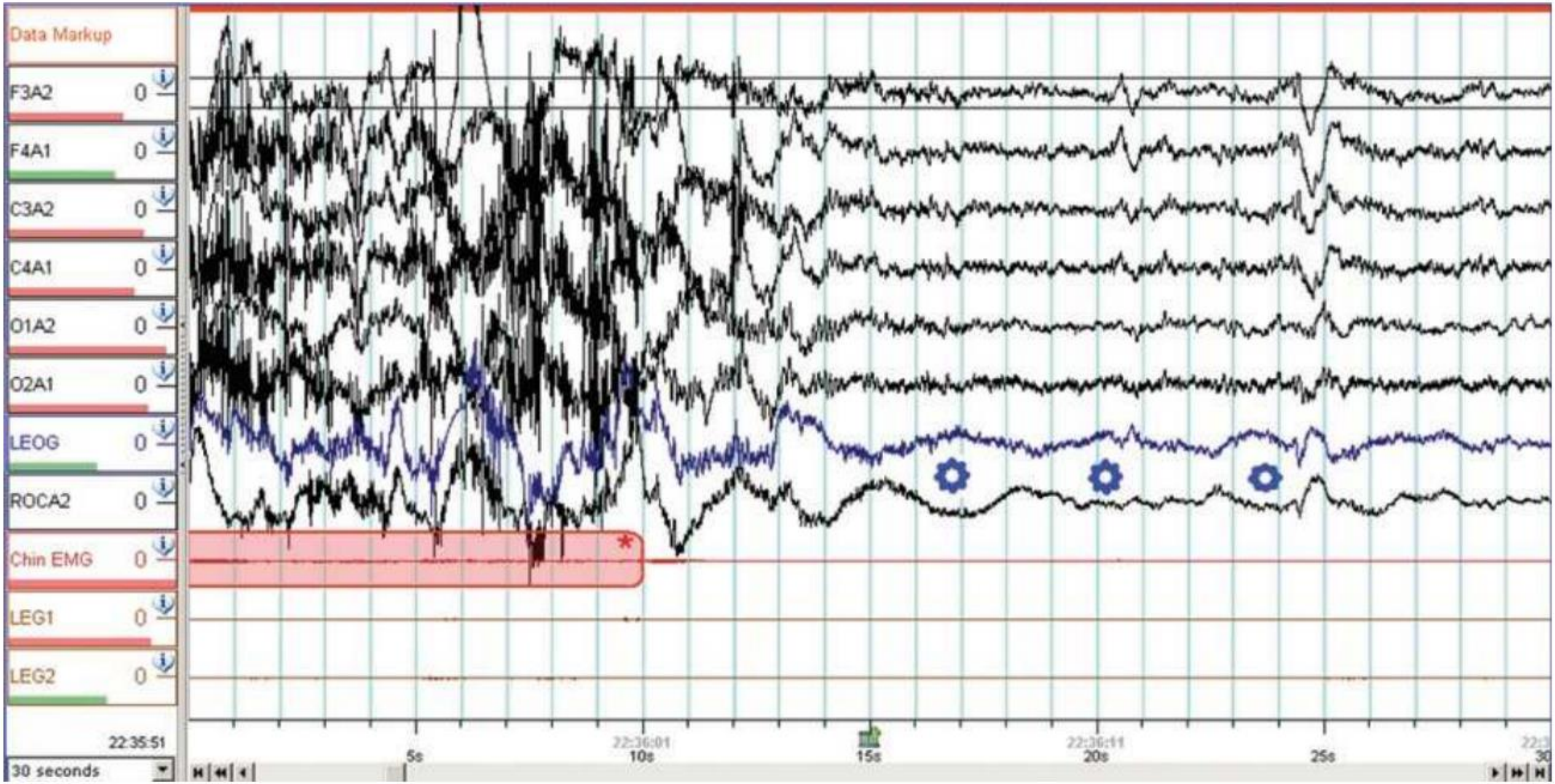


Figure 13.18B After the major body movement, slow eye movements are seen (starred). A will be scored as N2 while B will be scored as N1.

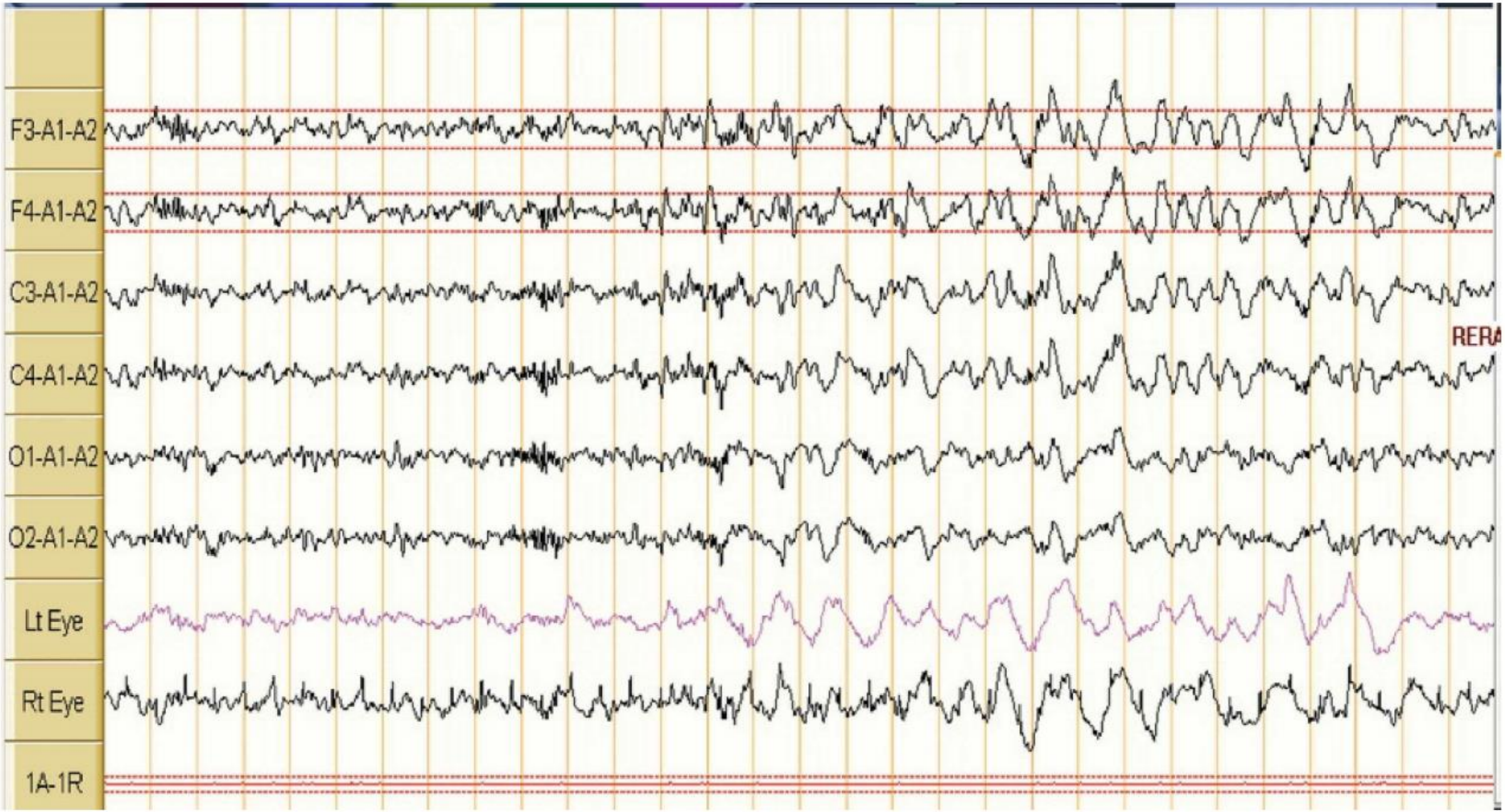


Figure 13.19 Shifting from N2 to N3: N2 sleep may shift to N3. If the epoch has delta waves less than 6 seconds, continue with N2. If the epoch has delta waves for at least 6 seconds, change the scoring to N3. In this epoch delta activity is seen in more than 20% (6 seconds) of epoch, hence, this will be scored as N3.

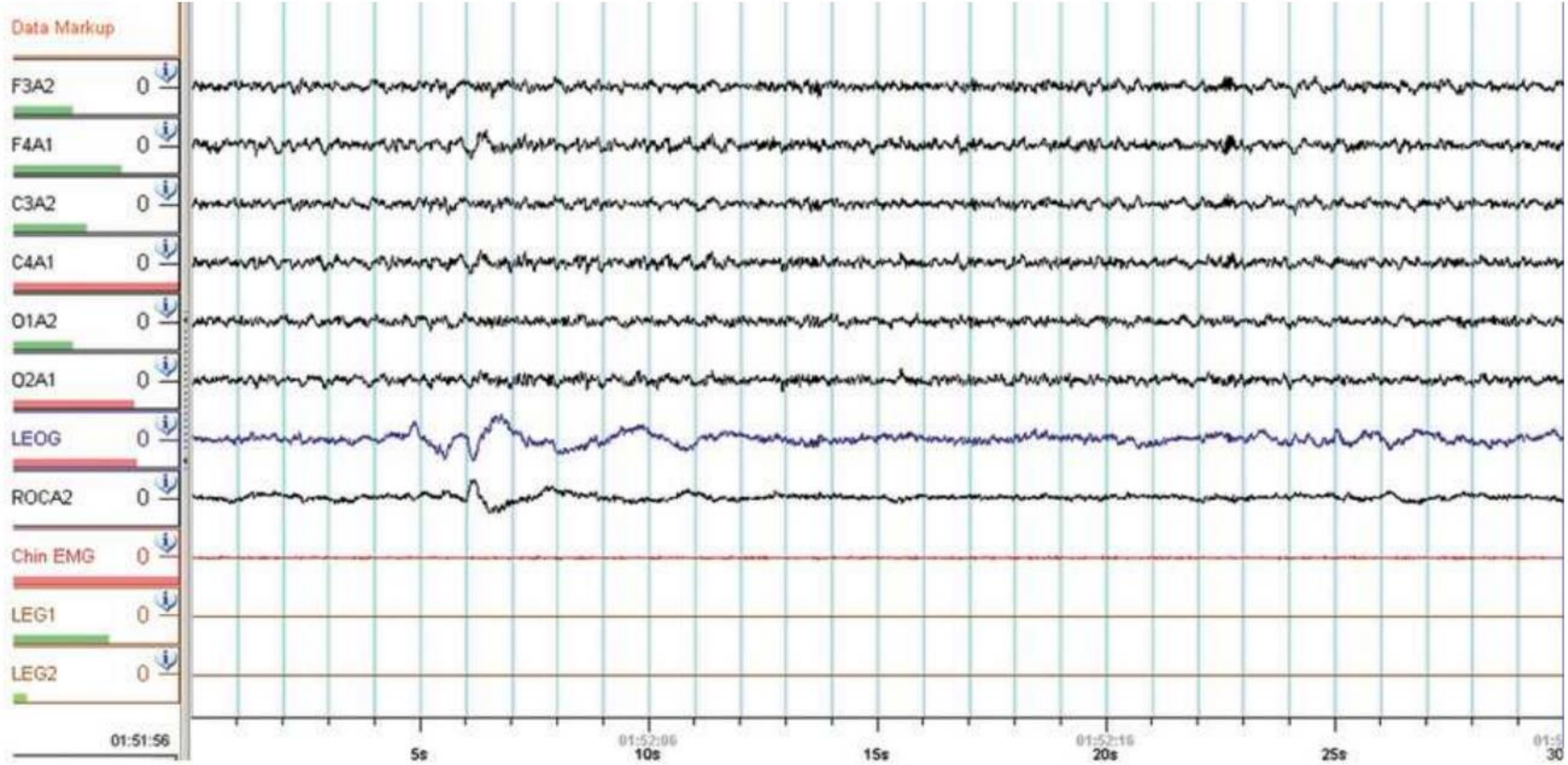


Figure 13.20 A Shift from N2 to REM: If the epoch has waveforms characterizing REM for more than 15 seconds, score as REM, otherwise continue scoring N2 In this epoch see the rapid eye movements and sawtooth waves hence this will be scored as REM. Previous epoch was N2.

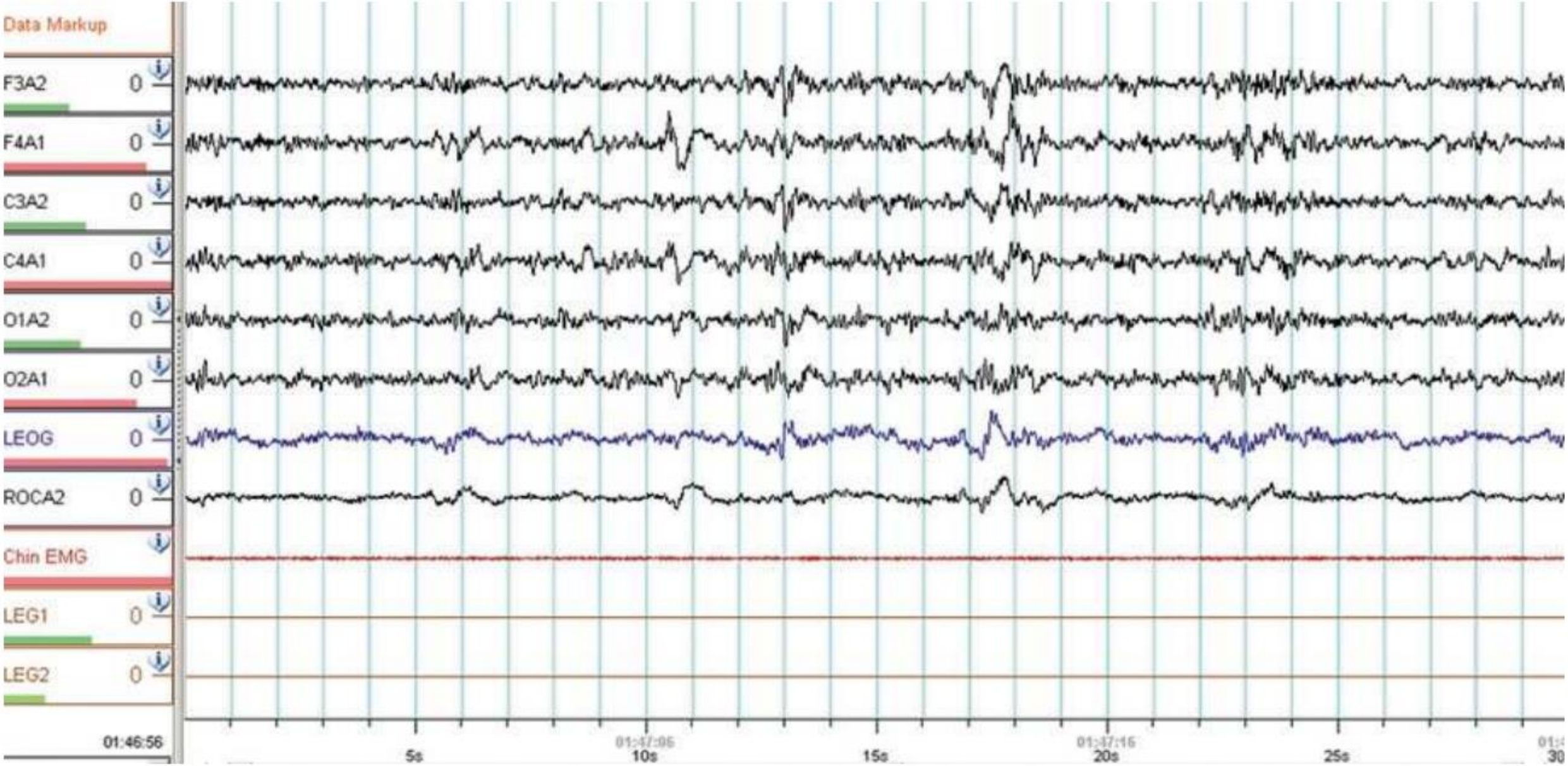


Figure 13.20 B1–B4 Shift from N2 to REM: Sometimes EEG makes it difficult to differentiate between N2 and REM. In such cases, scoring depends upon chin tone. Start scoring REM if an epoch shows lowering of chin tone for more than 15 seconds, does not have K complex or spindle and subsequent epochs can be scored as REM. In this series of epochs also appreciate that all the features of REM (Figure 13.24) do not appear simultaneously. In this series, EEG and EOG changes appeared first and chin tone lowered much later. Since B4 has all the criteria for REM, this will be scored as REM and previous epochs will be scored as N2.

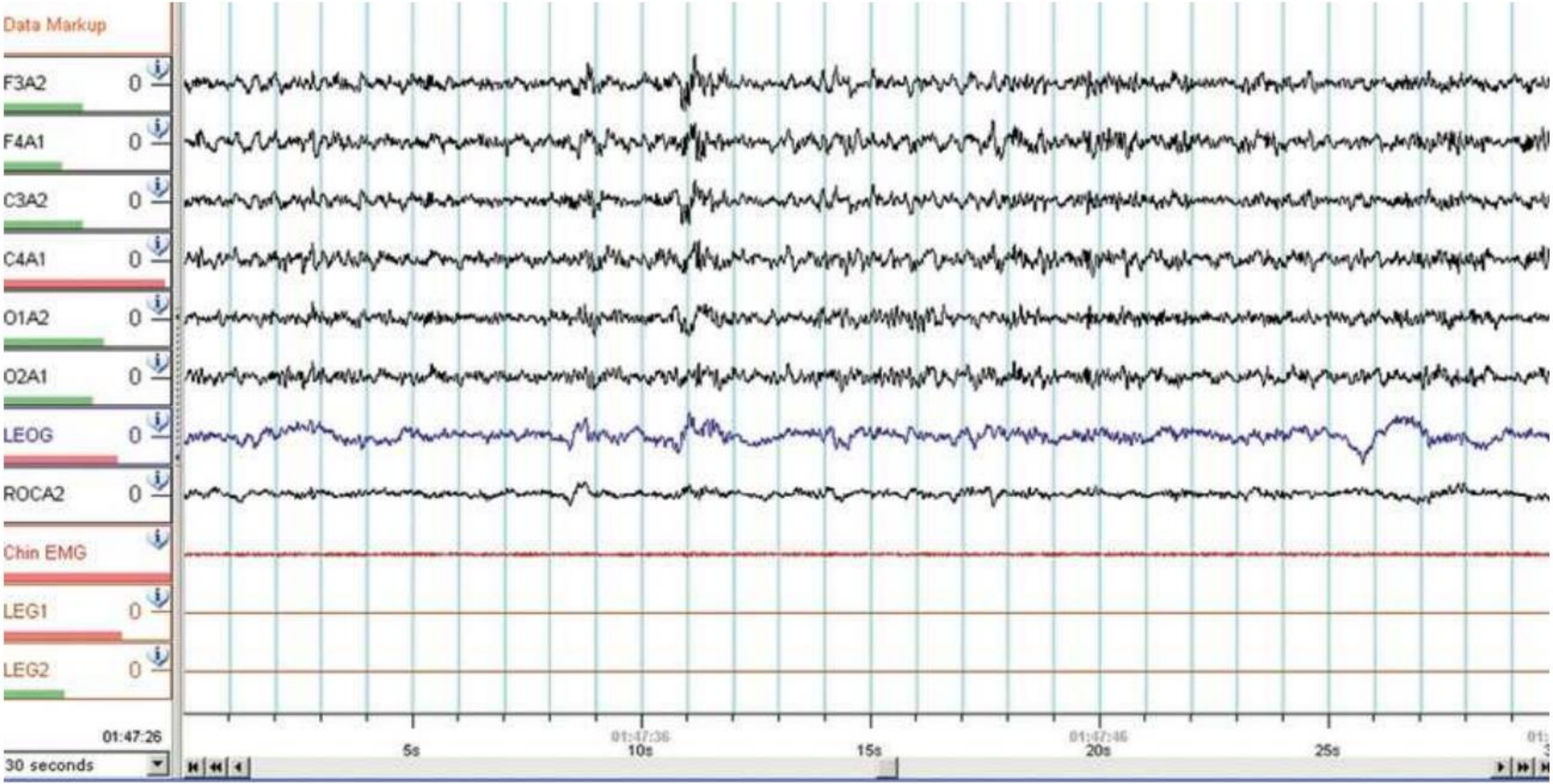


Figure 13.20 B2 Shift from N2 to REM.

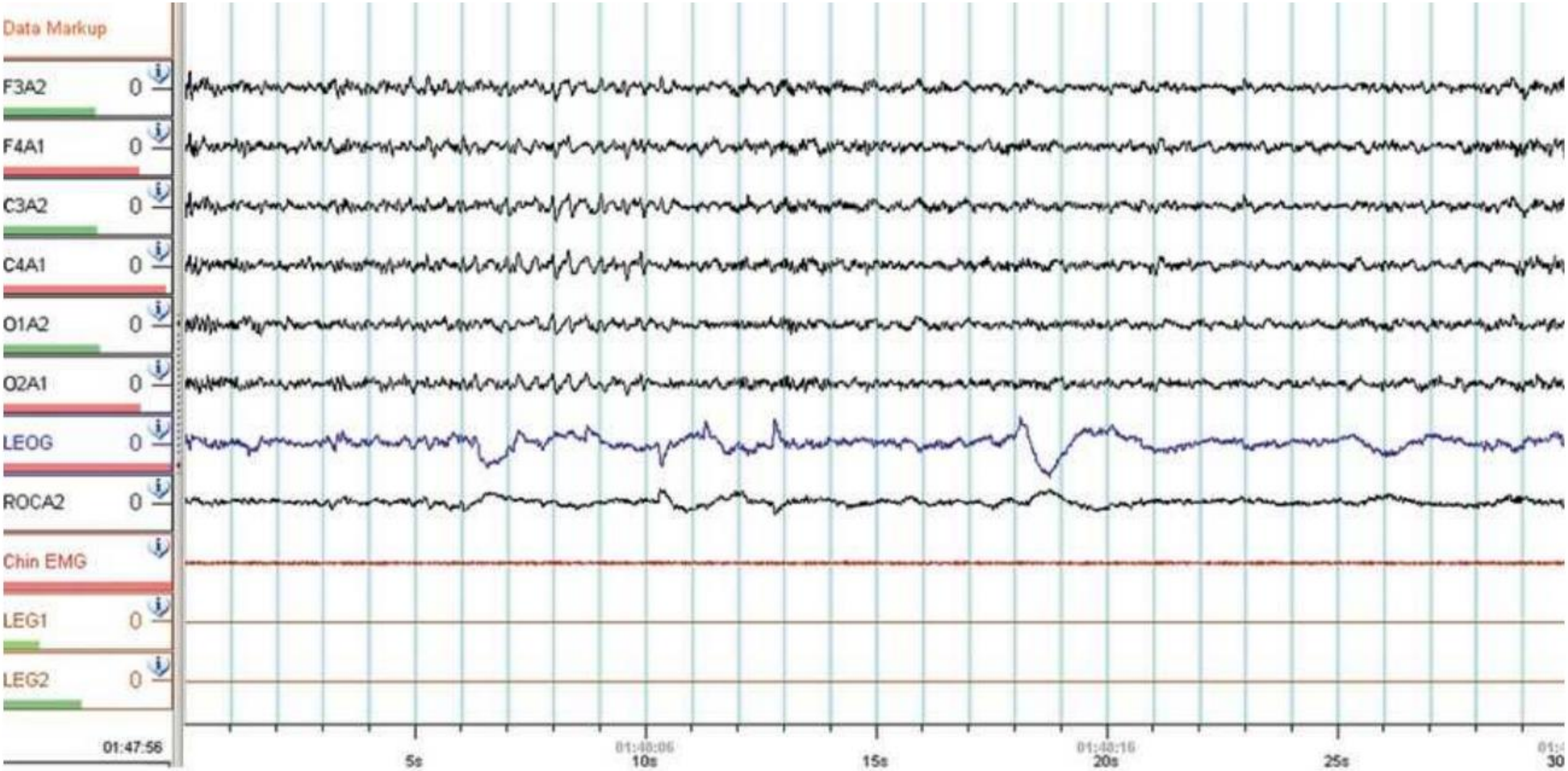


Figure 13.20 B3 Shift from N2 to REM.

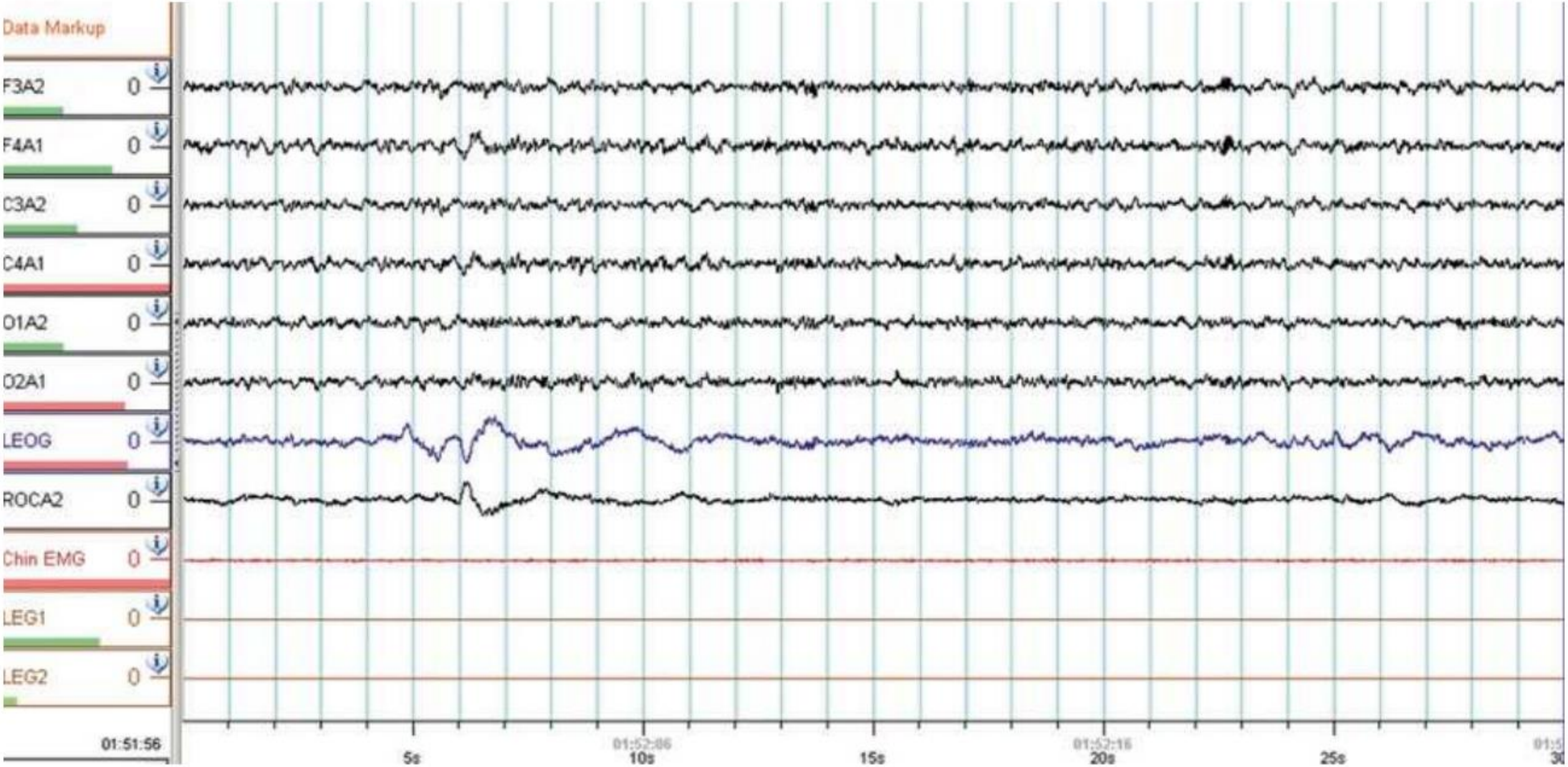


Figure 13.20 B4 Shift from N2 to REM. B4 has all the criteria for REM. This will be scored as REM, and previous epochs will be scored as N2.

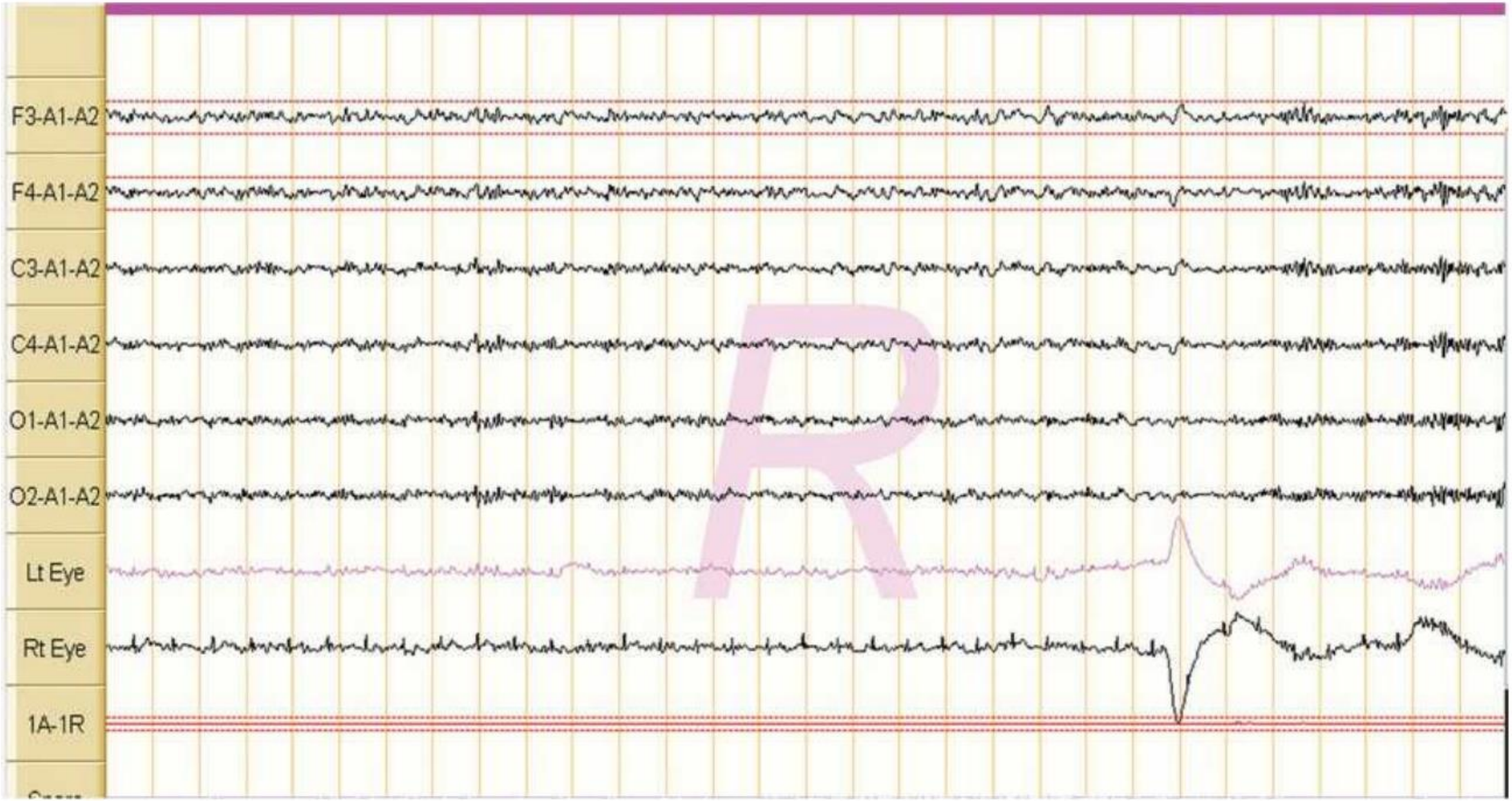


Figure 13.20 C Shift from N2 to REM: Even if the chin tone drops in N2, continue scoring N2 till the last epoch where spindle is seen. Subsequent epoch may be scored as REM, if it has all the characteristics of REM. In this epoch though chin tone is low and rapid eye movement is seen in second half, still this will be scores as N2 as spindles are seen all over the epoch.

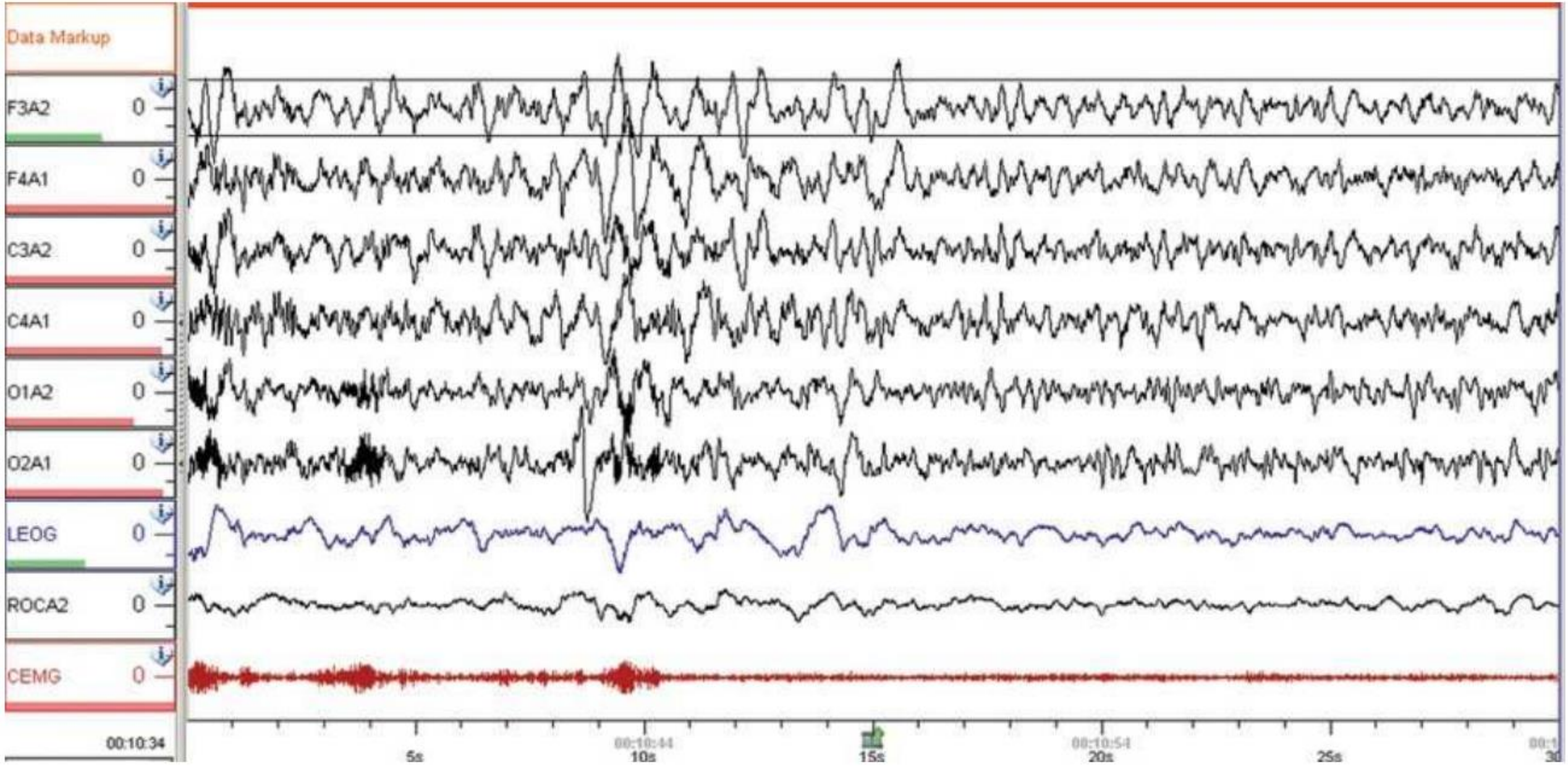


Figure 13.21A Appearance of N3: Score N3, if an epoch has slow wave for at least 6 seconds. Slow wave activity is best seen in frontal derivations, having a peak-to-peak amplitude of 75 μV and frequency of 0.5–2 Hz. These are also known as delta waves. Unlike N2, for scoring of N3, it is immaterial whether delta waves are present in first half or the second half of the epoch (sensitivity 12.5 μV/mm).

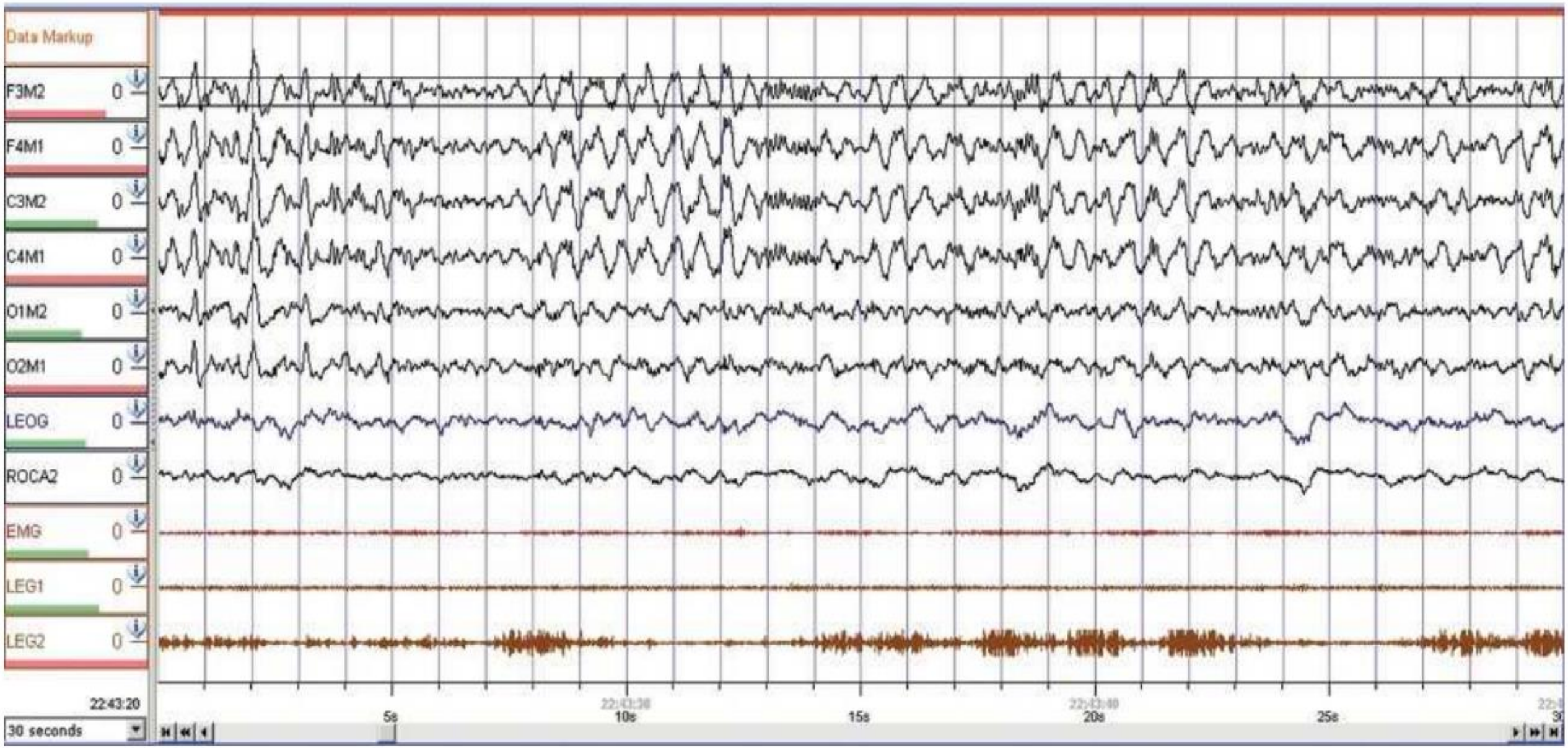


Figure 13.21B Sleep spindles in N3: Sleep spindles may persist along with delta waves. In this case, epoch should be scored as N3 (sensitivity 12.5 μV/mm).

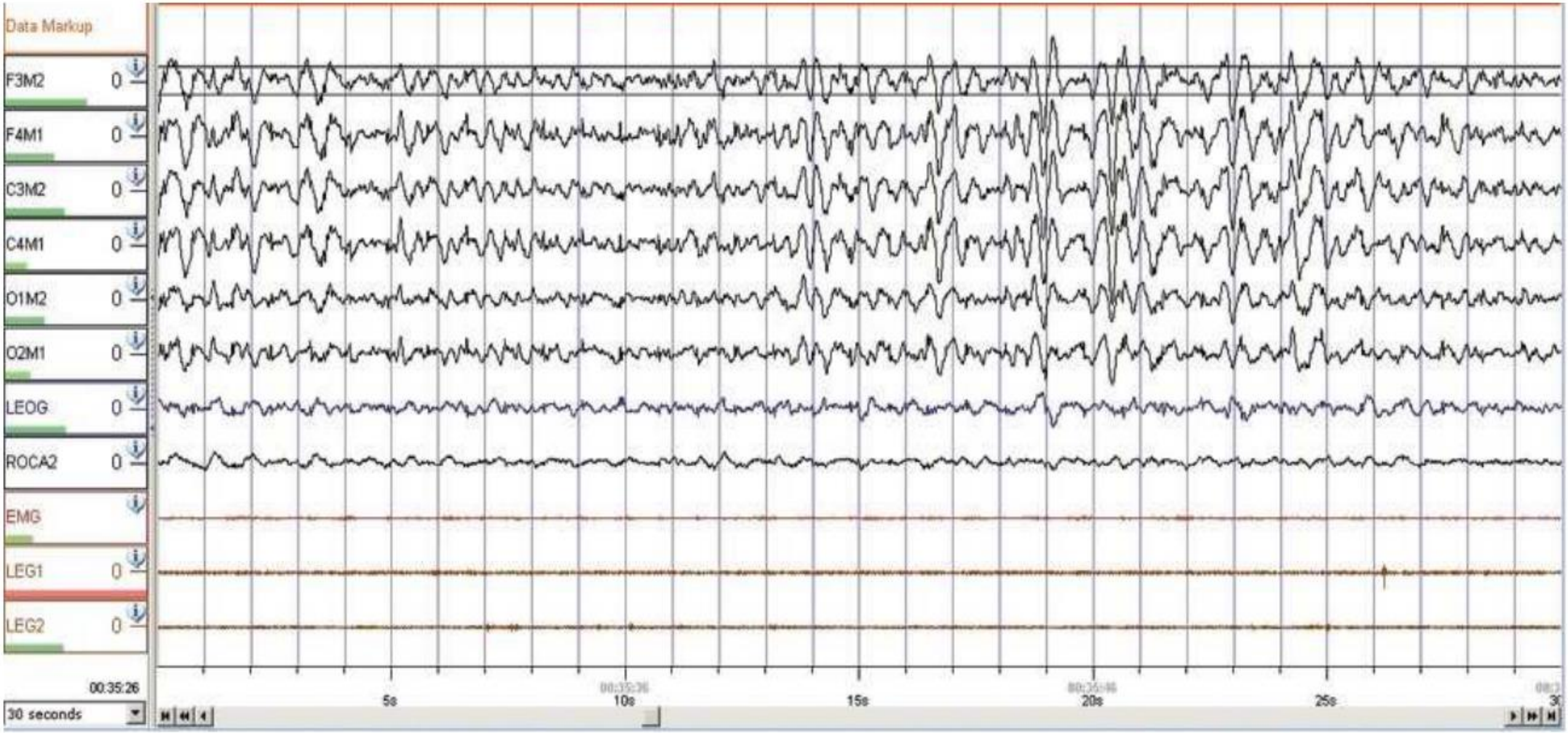


Figure 13.22 K complex as delta: When K complexes have characteristics of delta waves and are present in more than 20% epoch, epoch should be scored as N3.

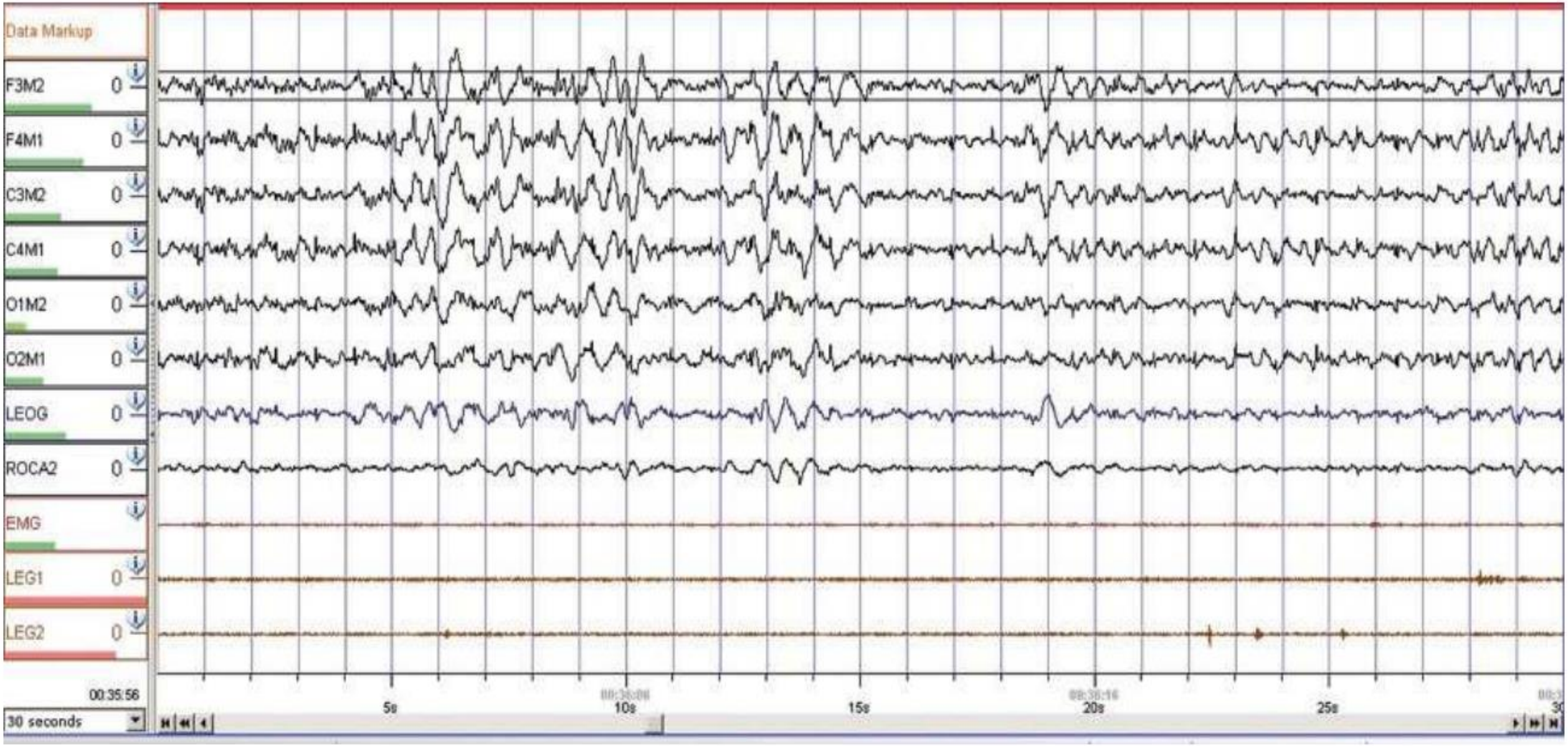


Figure 13.23A–B N3 to REM transition: A: This epoch shows N3 in most of the part, hence it will be scored as N3.

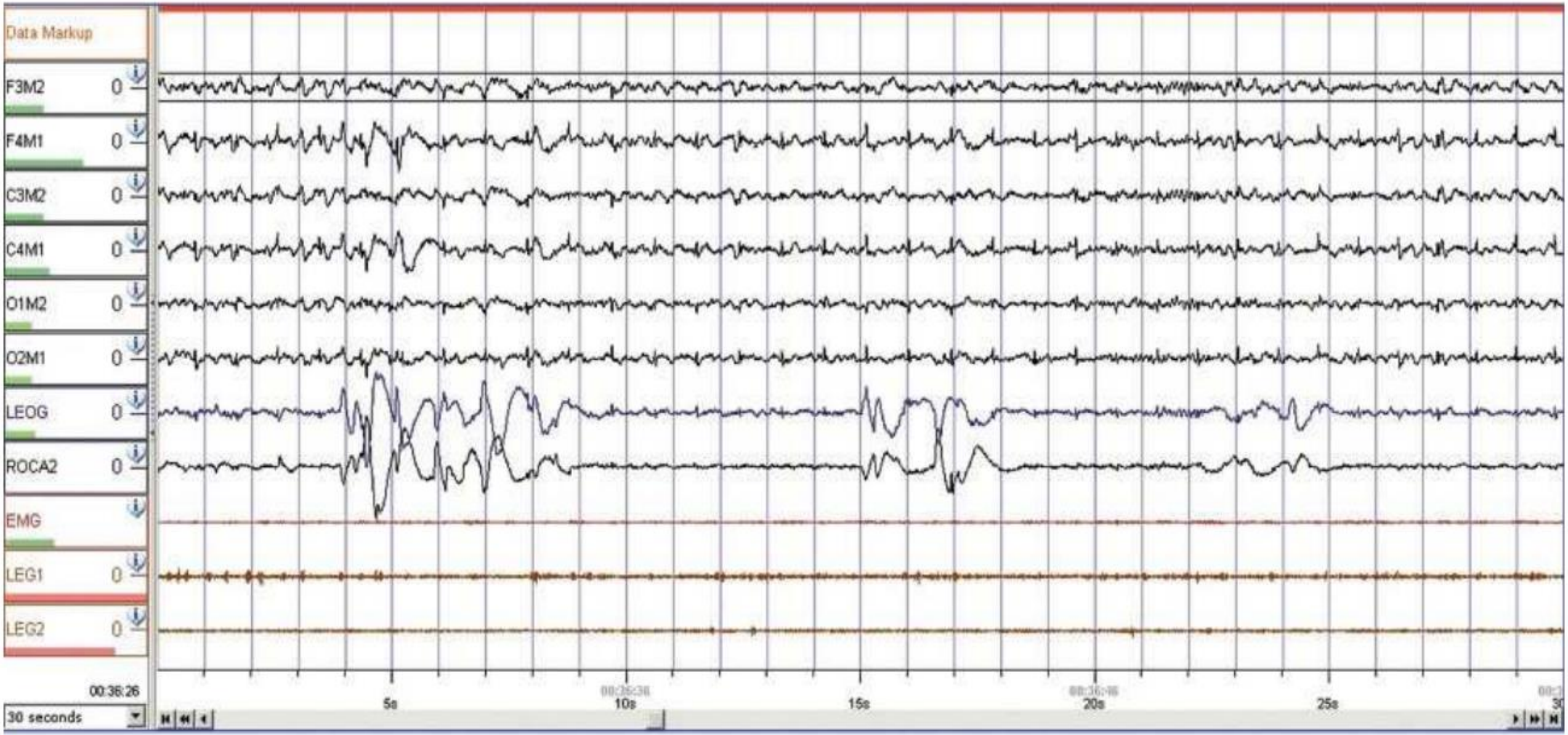


Figure 13.23B This epoch has all characteristics of REM, hence, it will be scored as REM.

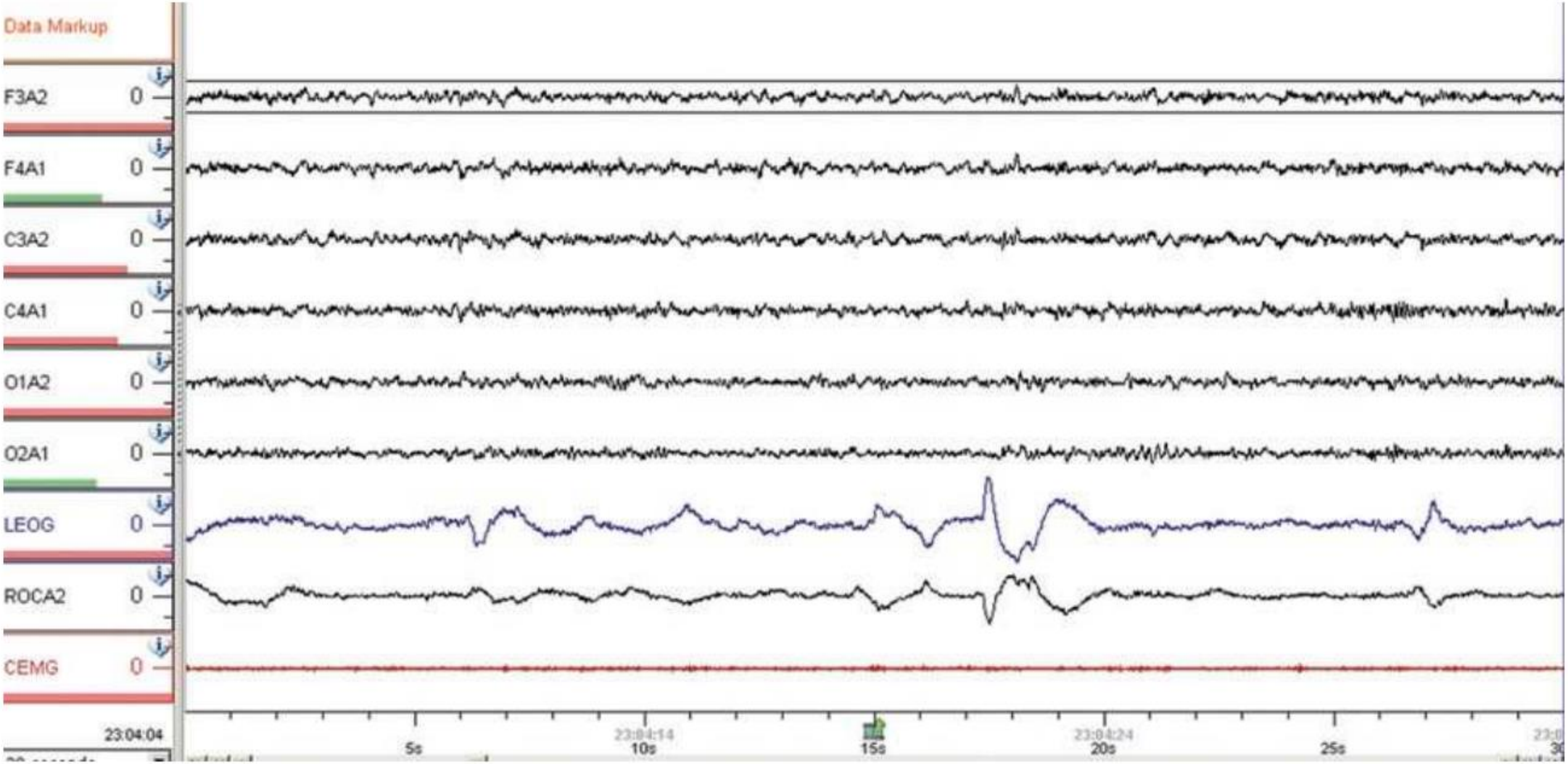


Figure 13.24 REM sleep: Score as REM if the epoch shows all three features of REM-low voltage mixed frequency activity, low chin tone and rapid eye movements (usually lasting less than half a second) for at least 15 seconds.

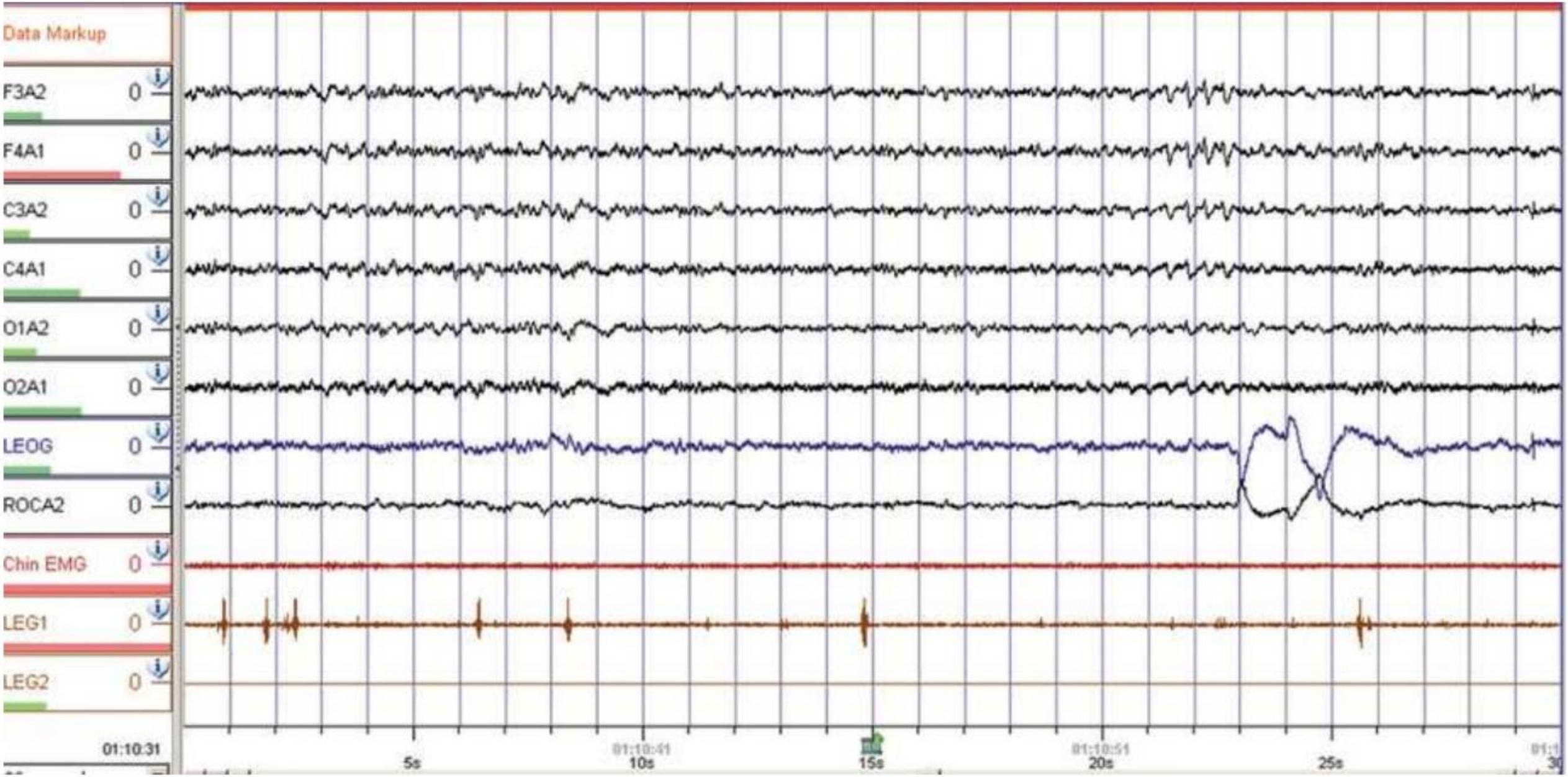


Figure 13.25 Sawtooth waves in REM: Sawtooth waves characterize REM. They are triangular waves with sharp top and appears serrated. They have frequency of 2–6 Hz and maximum amplitude is seen in central derivations. They are usually associated with rapid eye movements.

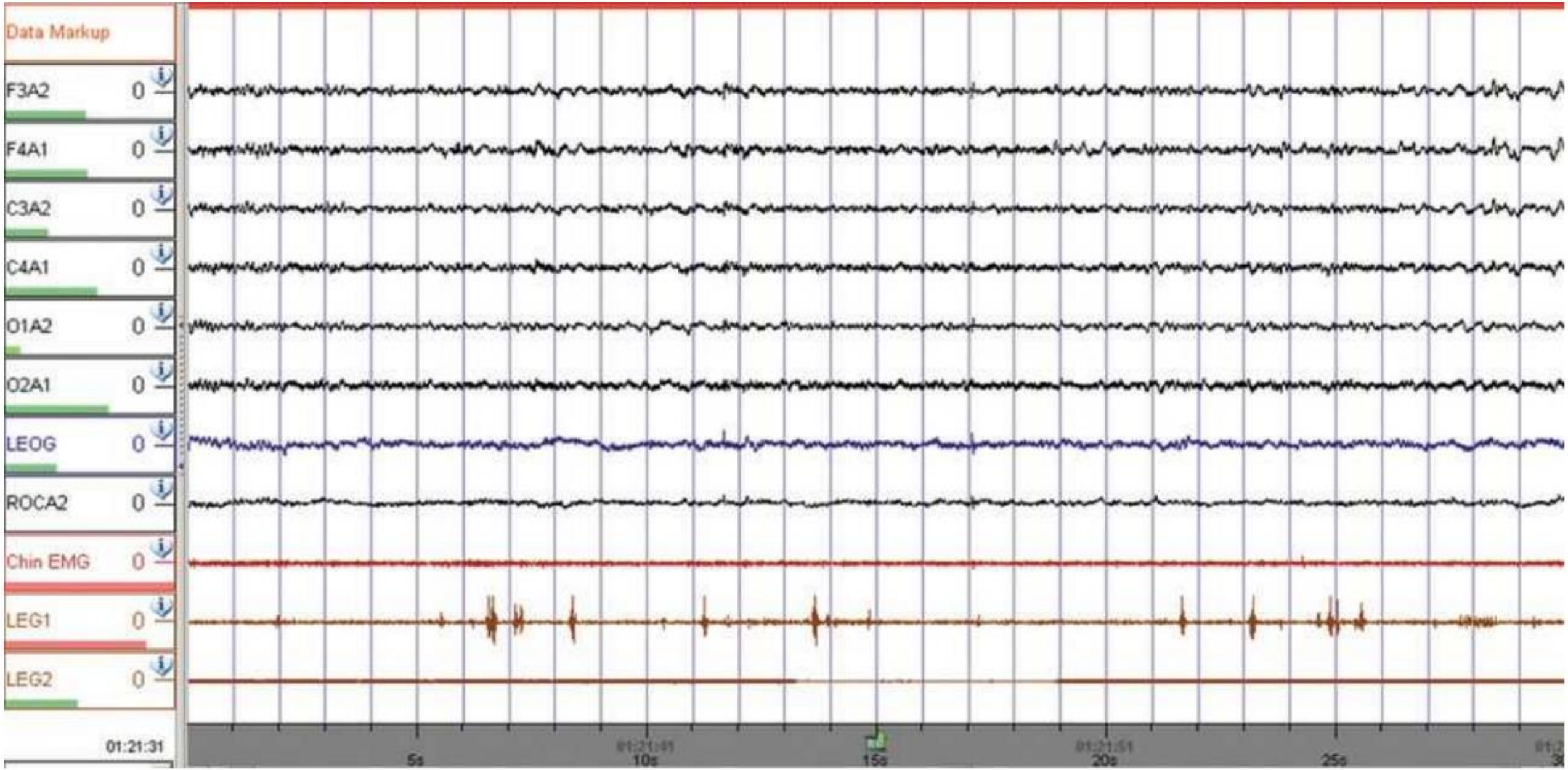


Figure 13.26 Transient muscle activity in REM: REM is characterized by transient muscle activity, which is less than 0.25 seconds in duration along with low EMG tone. This may be seen in any of the derivations (limb, chin, EOG, EEG) depending upon which muscle is involved. In this epoch transient activity is seen in Leg 1.

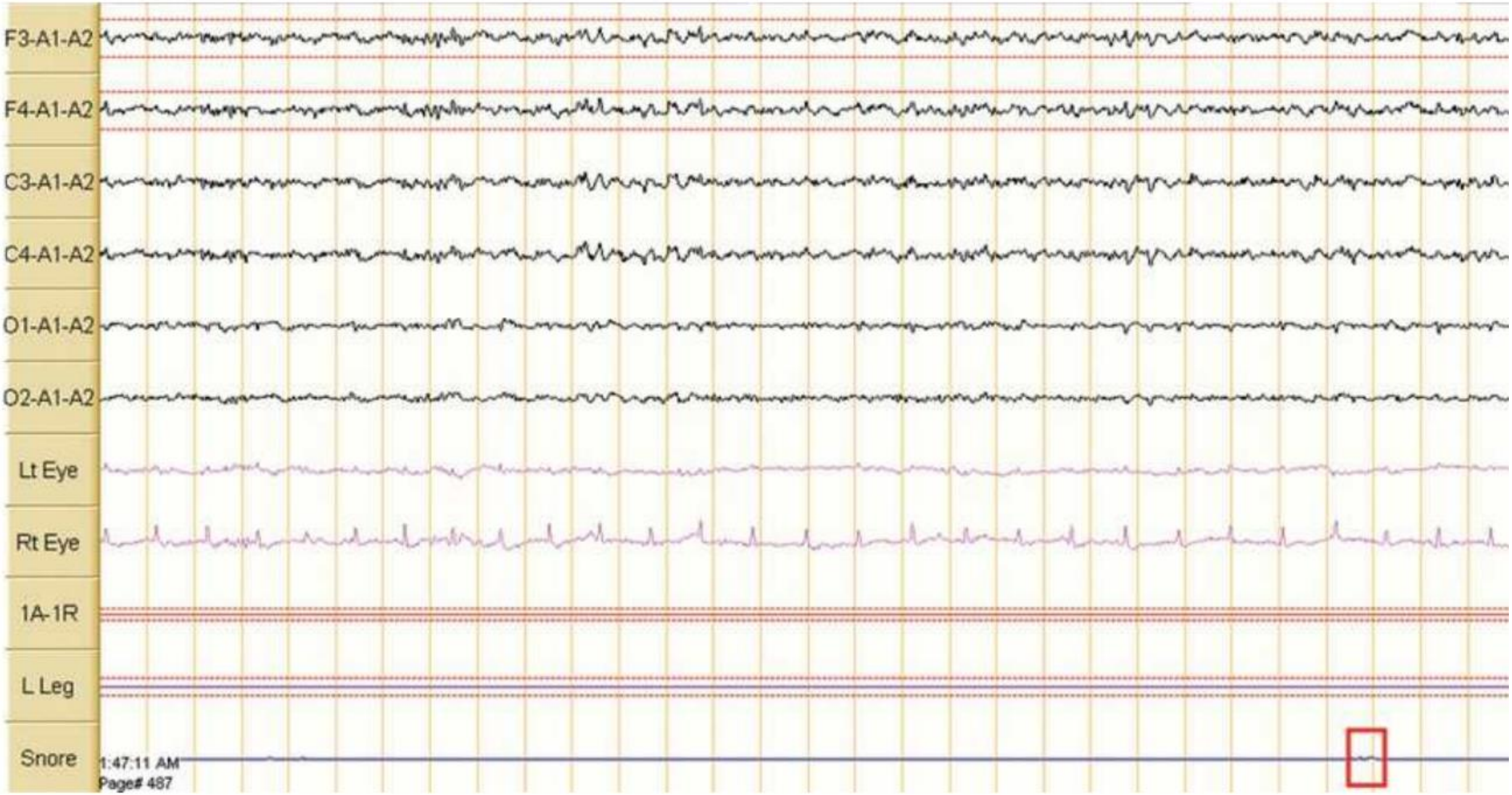


Figure 13.27 A-B Scoring REM: A: Once a epoch of REM is found, subsequent epochs should be scored as REM, even in absence of rapid eye movements unless interrupted by any other sleep stage. However, the epochs must have EEG and EMG characteristic of REM as described in Figure 13.24.



Figure 13.27 B In between epochs of REM, epochs of N2 may appear. If an epoch has spindle of K complex even if preceding and following epochs can be scored as undisputed REM, score as N2 if sleep spindles or K complex is seen, score as N2. In this epoch spindle is seen in first as well as second half.

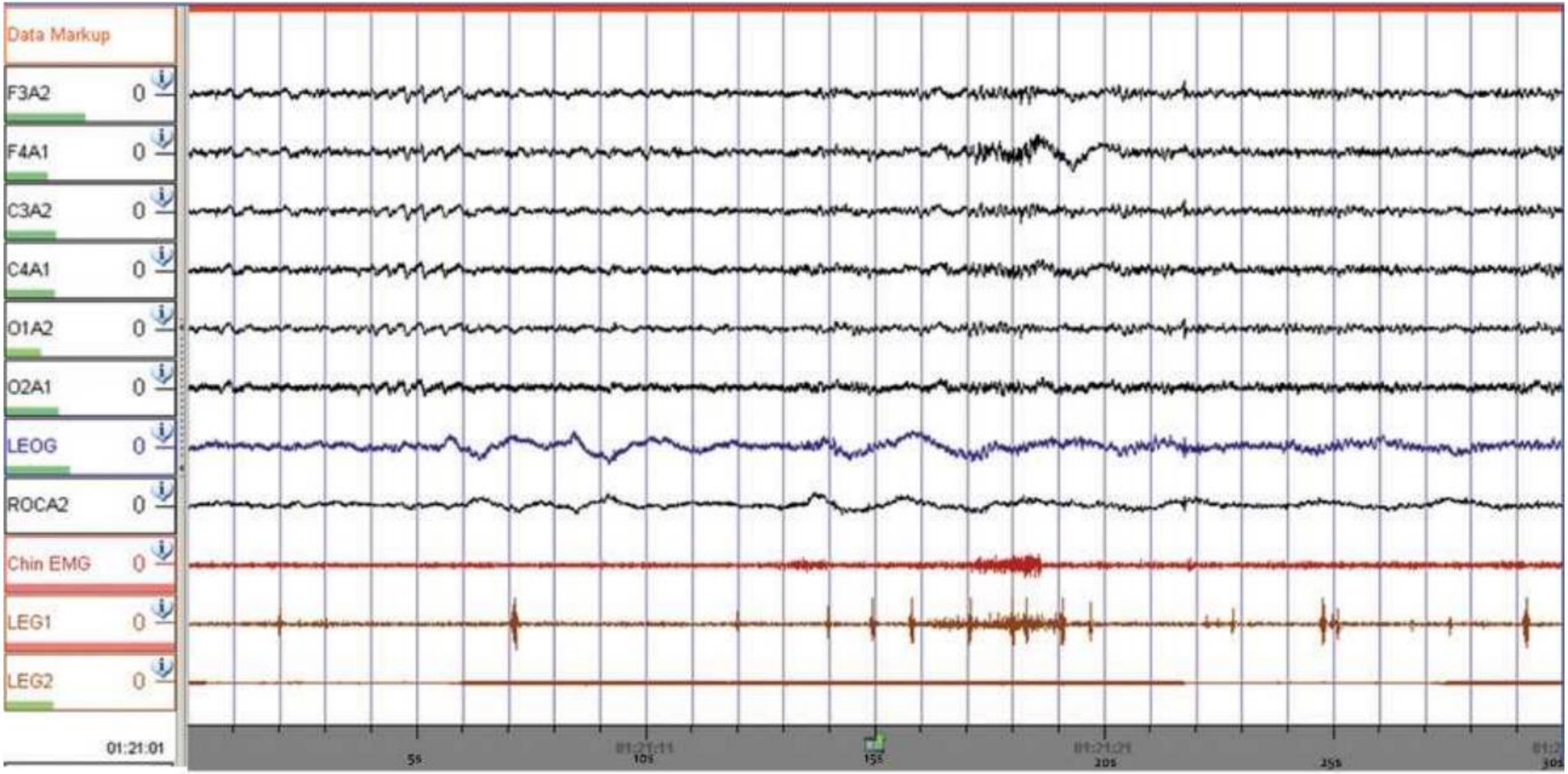


Figure 13.28 Chin tone transiently increasing in REM: If chin tone increases during REM epoch change of scoring depends upon the duration of high tone. If it is less than half the epoch continues scoring REM, however, if it is seen in more than half the epoch, change the score to N1, if other characteristics of N1 are seen or to wake if all characteristics of wakefulness are seen. In this epoch, chin tone increased for more than a second, but lowers down, and is followed by slow eye movements; hence subsequent epoch will be scored as N1. However, in this epoch, REM characteristics are present in more than 50% of epoch, hence, it will be scored as REM.

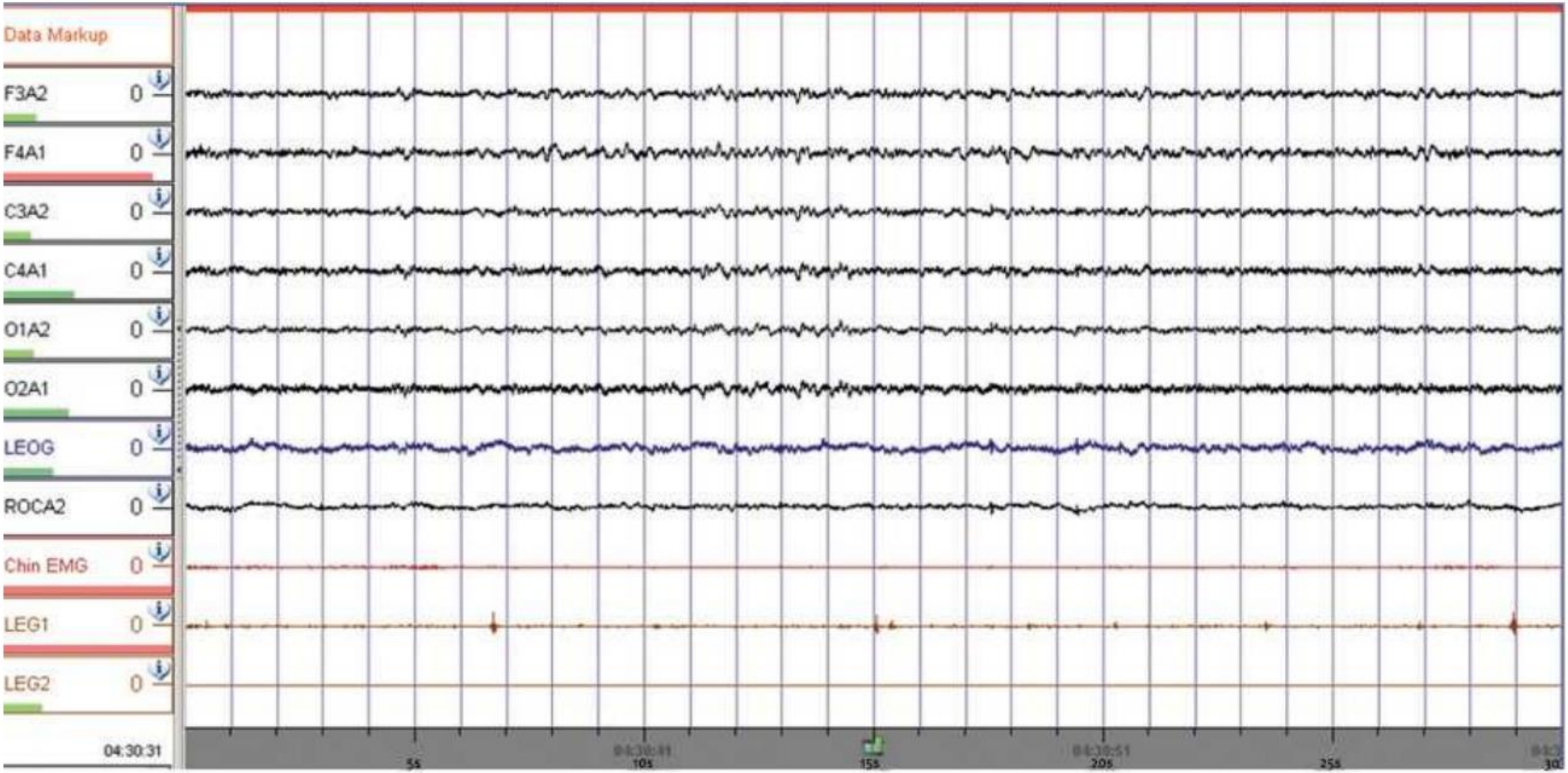


Figure 13.29A-F Arousal in REM: Arousal in REM is scored if the EEG changes suggest arousal (Figure 13.14) along with increased chin tone for at least for 1 seconds. Change to W if EEG and Chin EMG suggestive of arousal persist for more than half the epoch. A: Epoch showing REM.

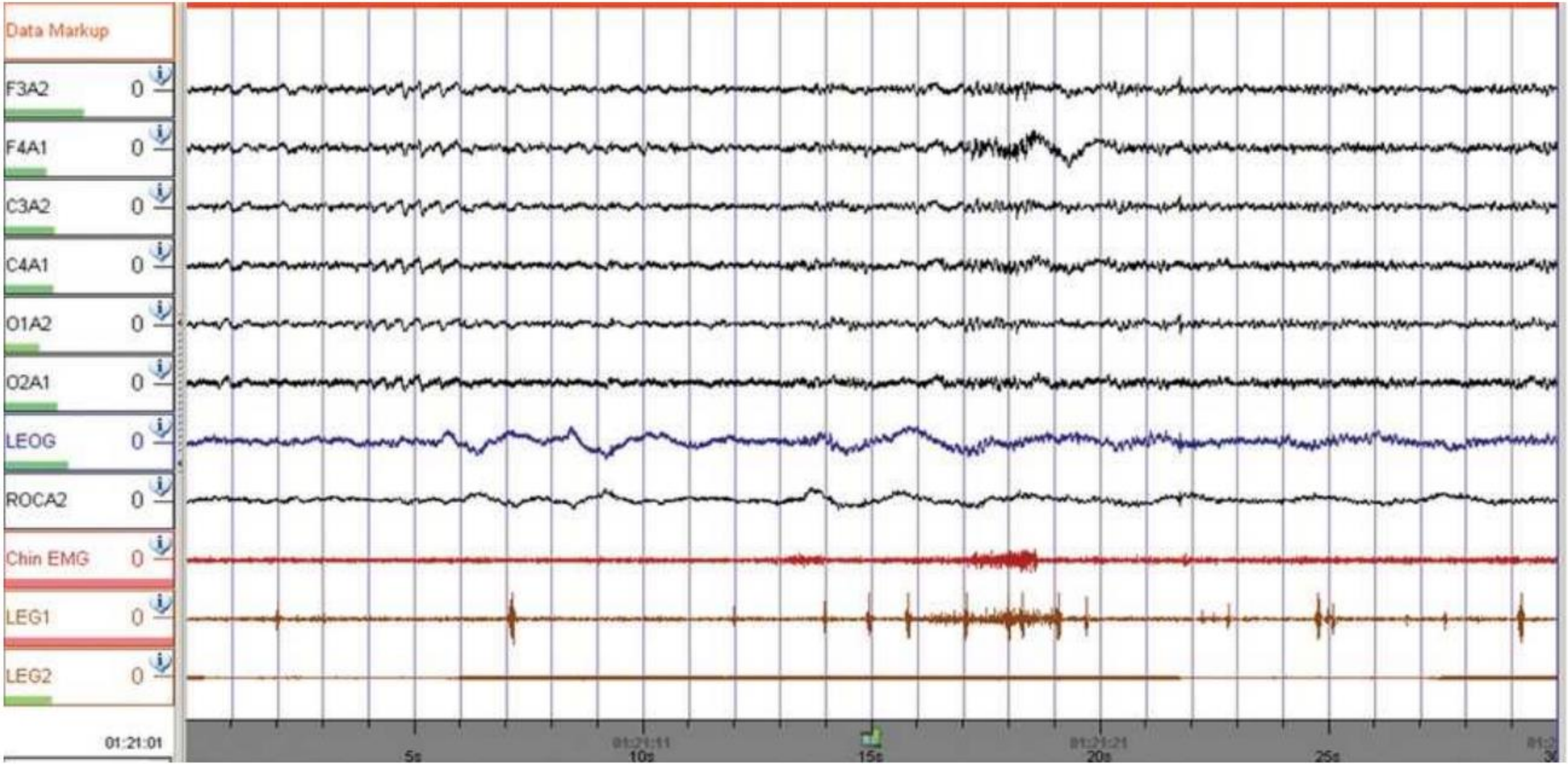


Figure 13.29B Scored as N1 SEM are seen and tone is increased for most of the epoch.

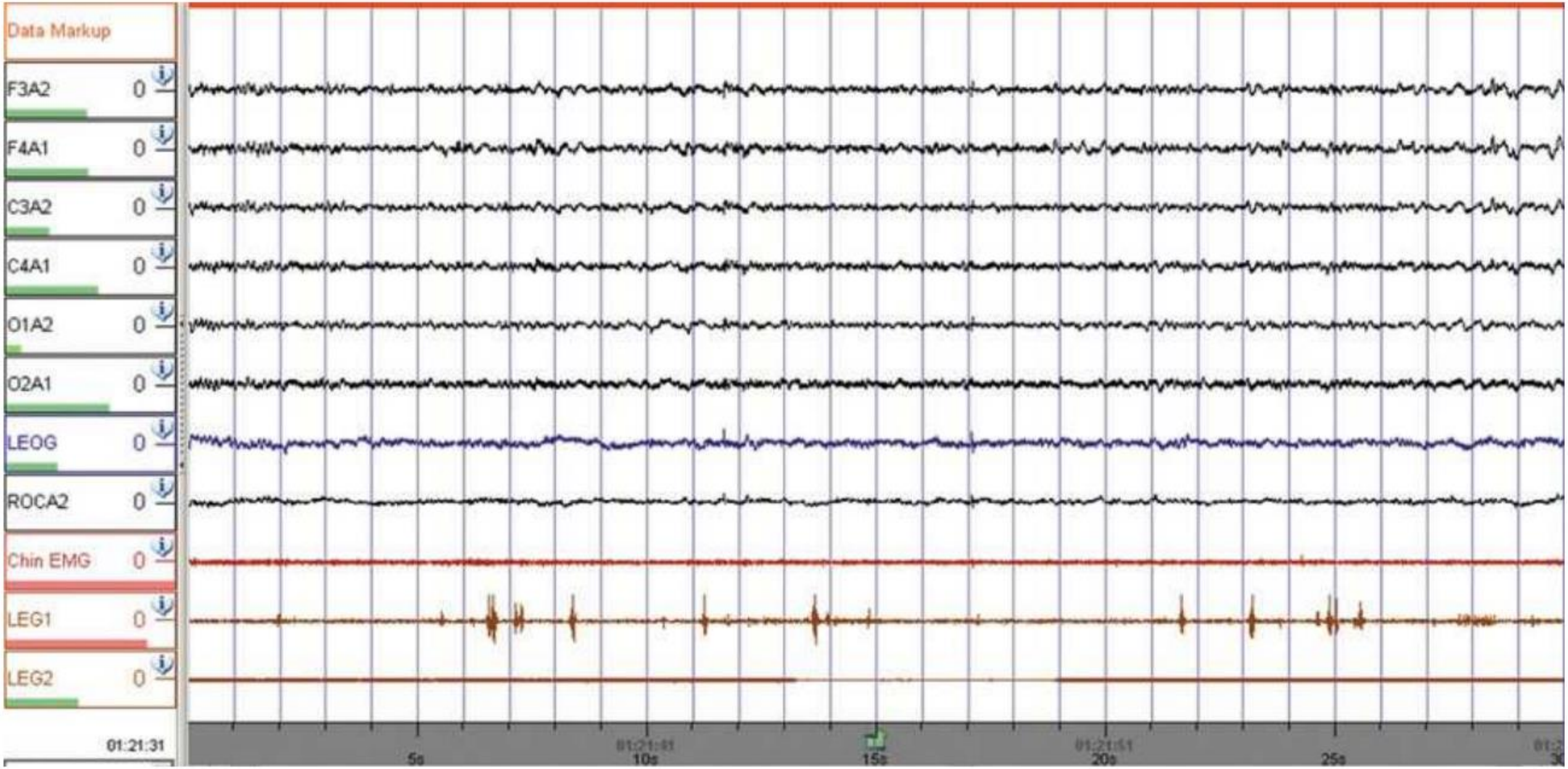


Figure 13.29C Following epoch will be scored as N1 as chin tone is still high.

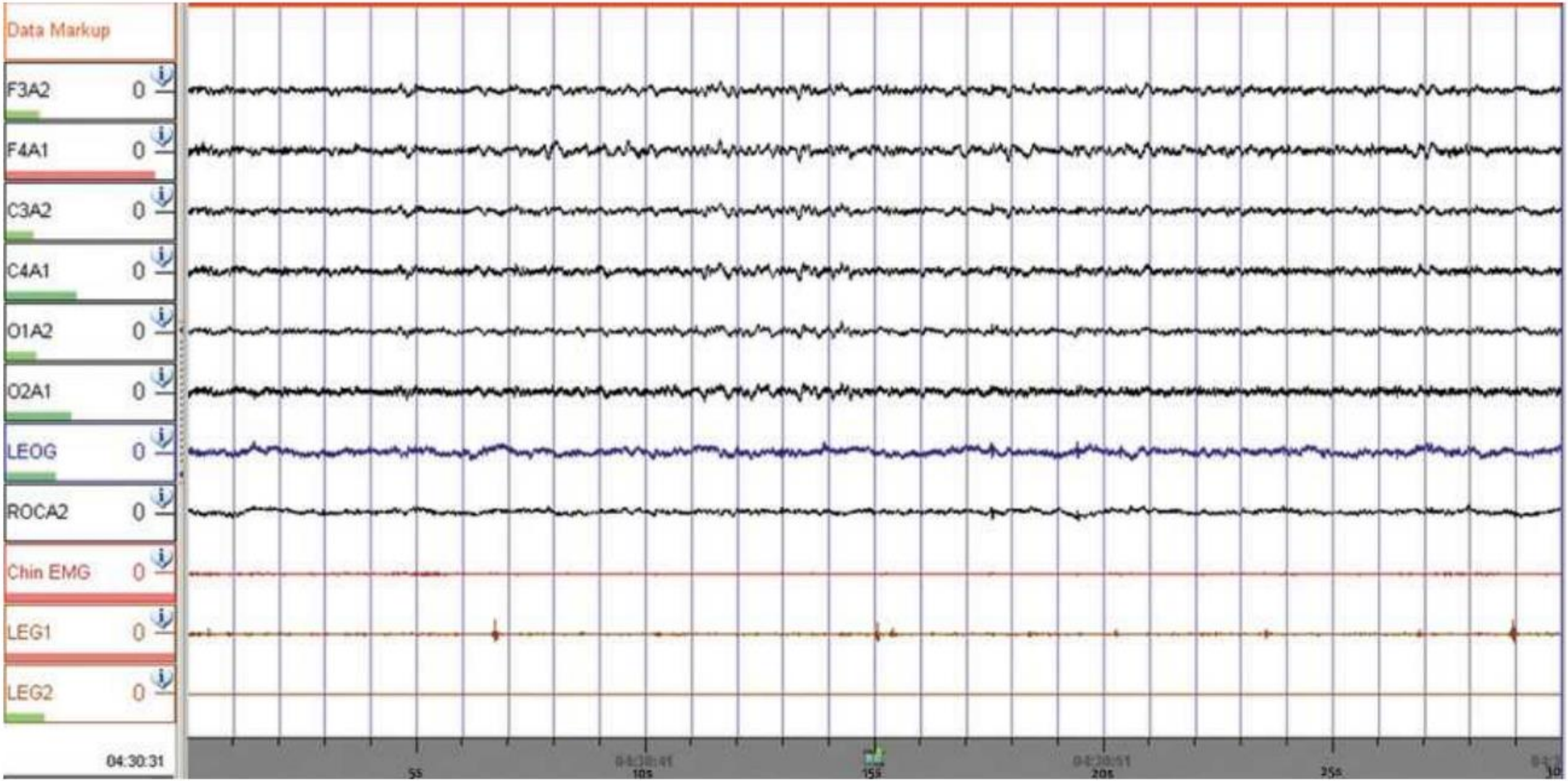


Figure 13.29D Scores as REM as chin tone drops.

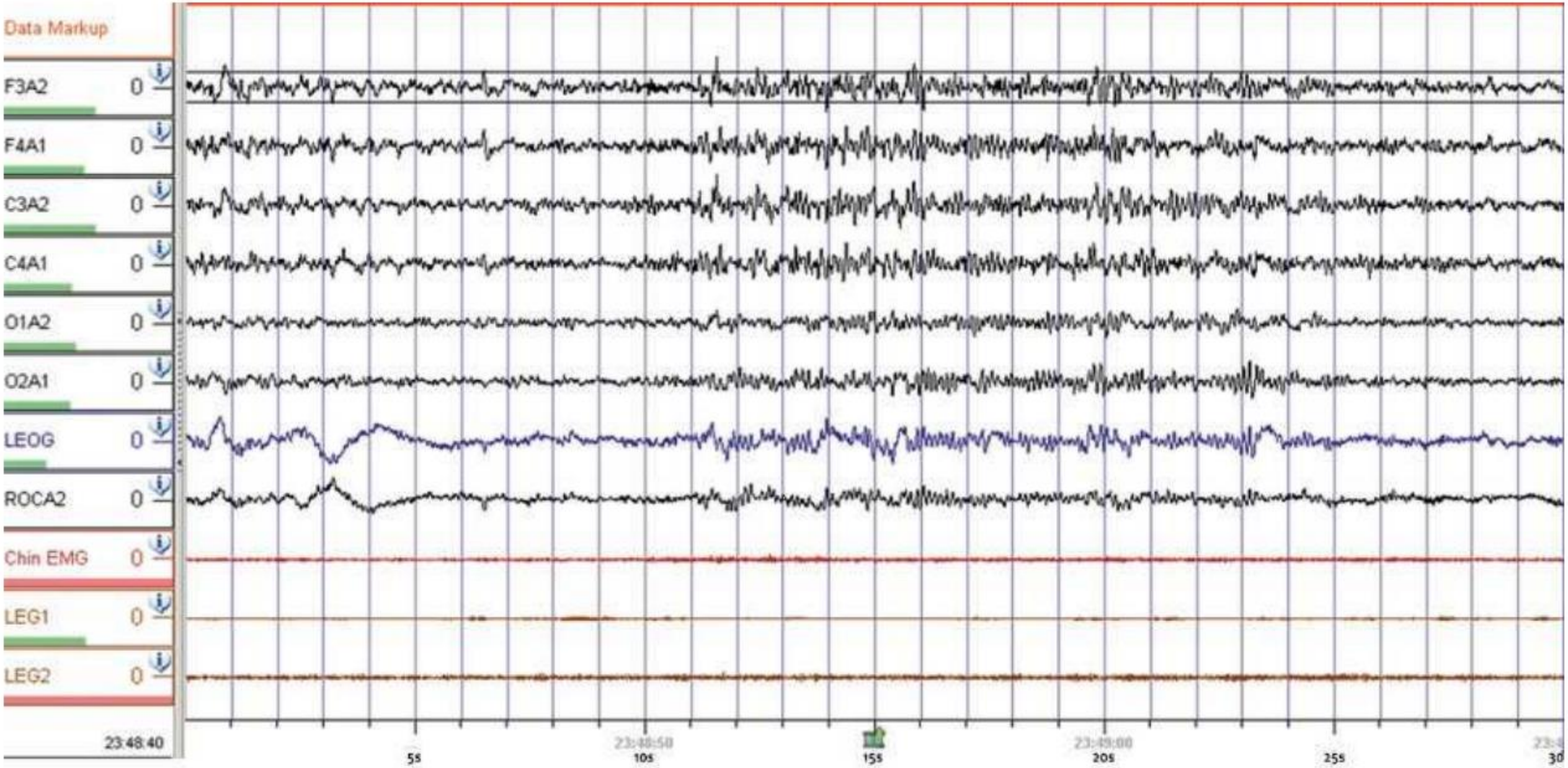


Figure 13.29E This epoch will be scored as wake as chin tone is high in more than 50% epoch and alpha waves also appeared.

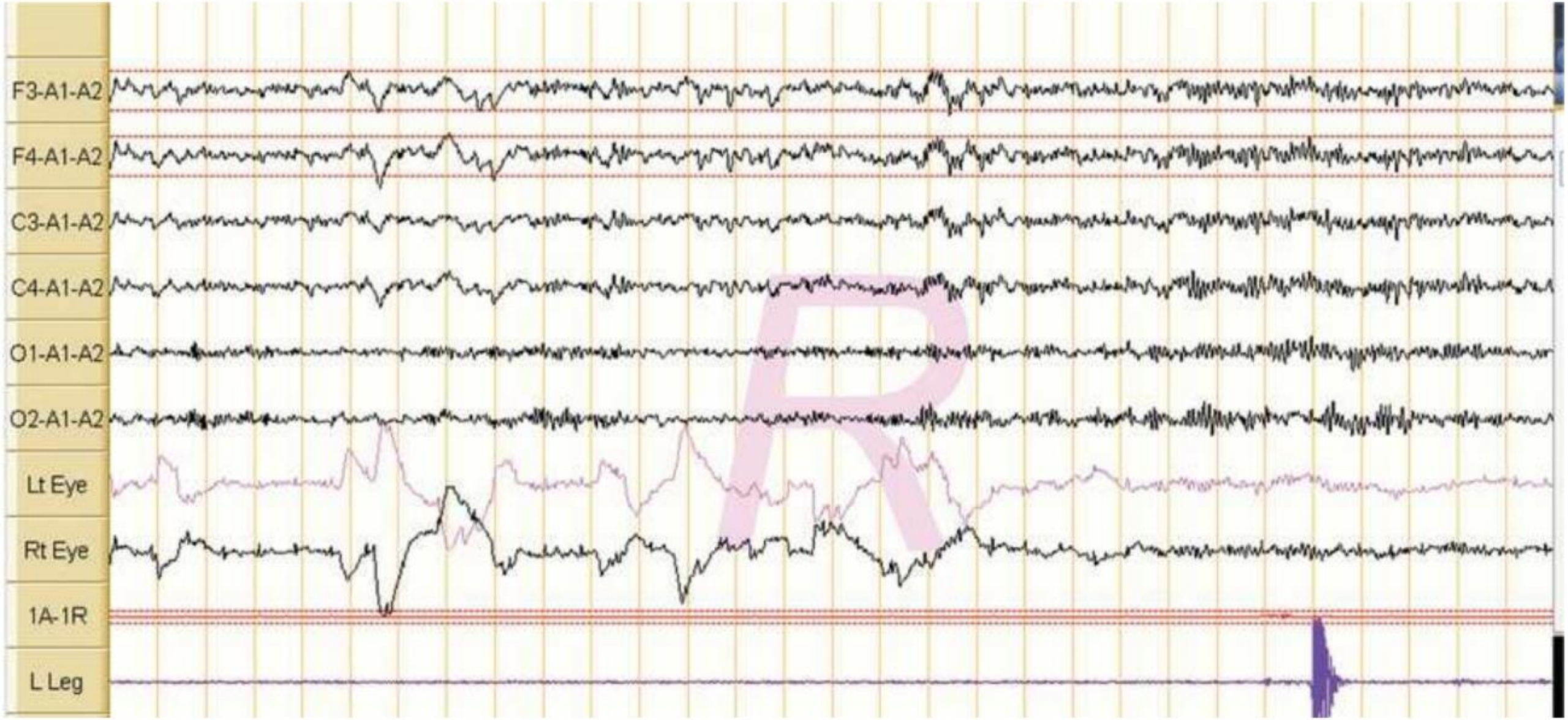


Figure 13.29F Though alpha is seen during REM, but chin tone does not increase and hence, arousal will not be scored.

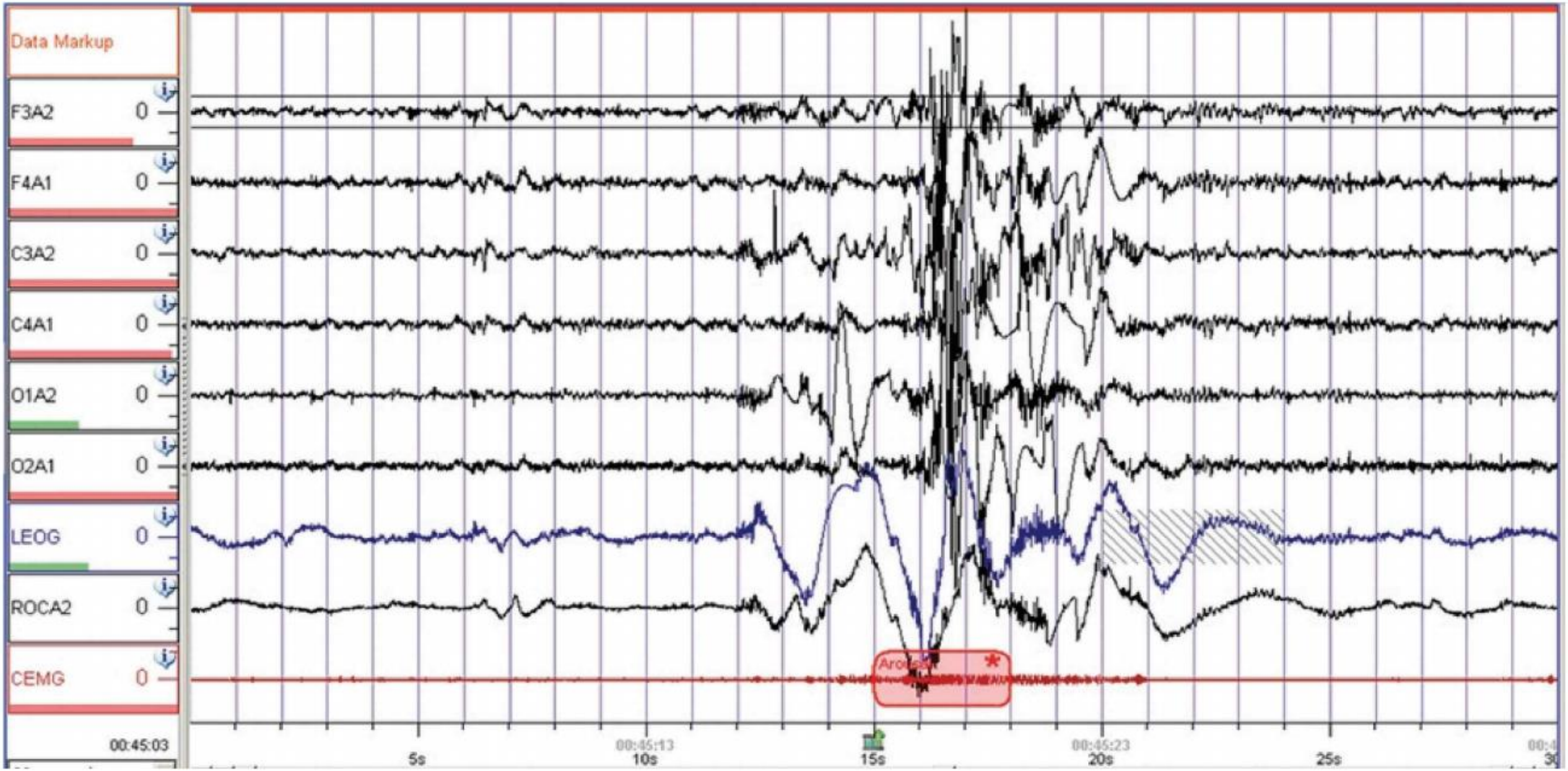


Figure 13.30A-B Arousal in REM: If following arousal, chin tone again goes low and slow eye movement are not seen, continue to score REM A: Lowering of chin tone after arousal and SEM not seen hence scored as REM.

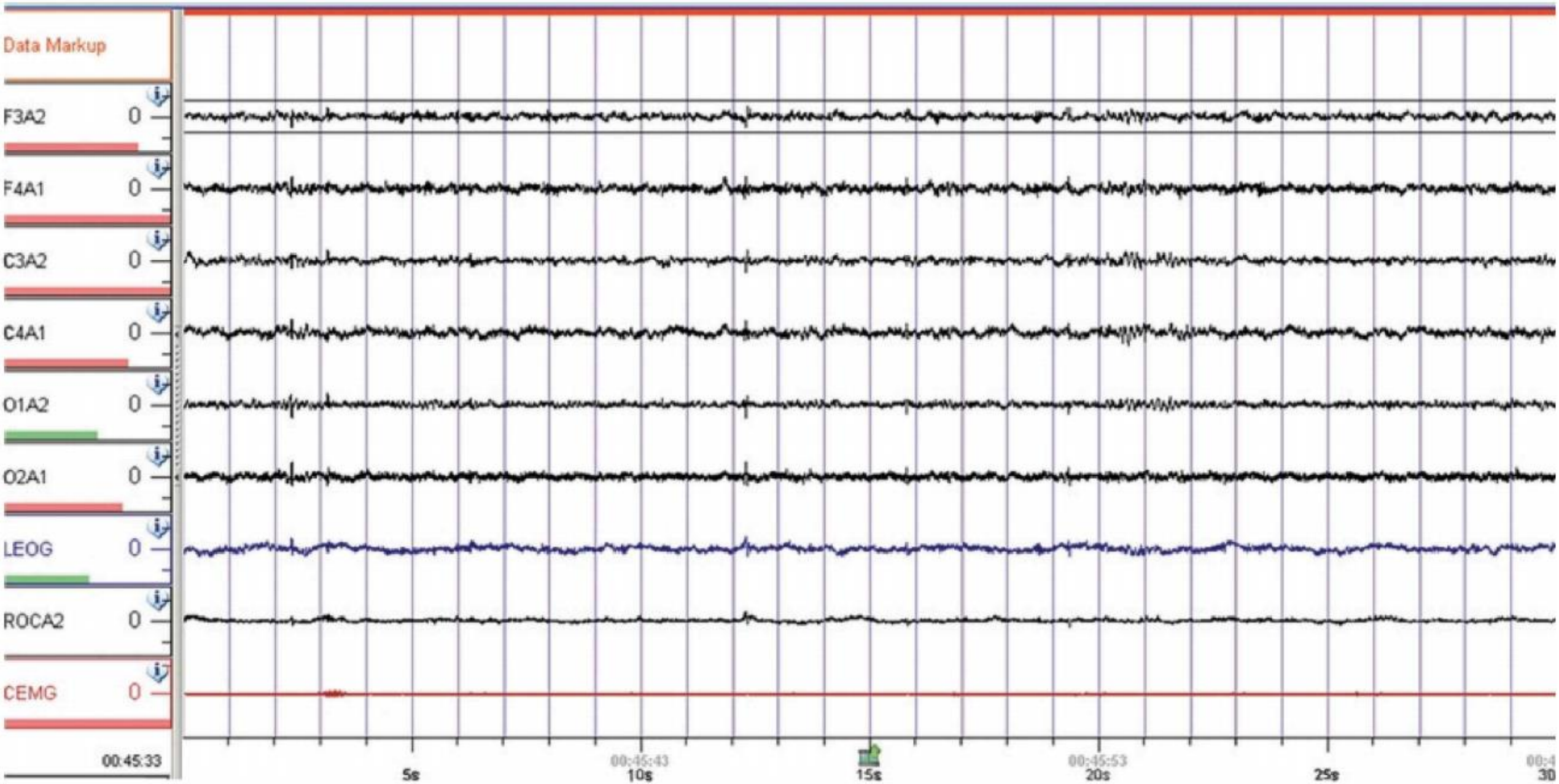


Figure 13.30B This epoch show lowered tone in absence of SEM hence scored REM.

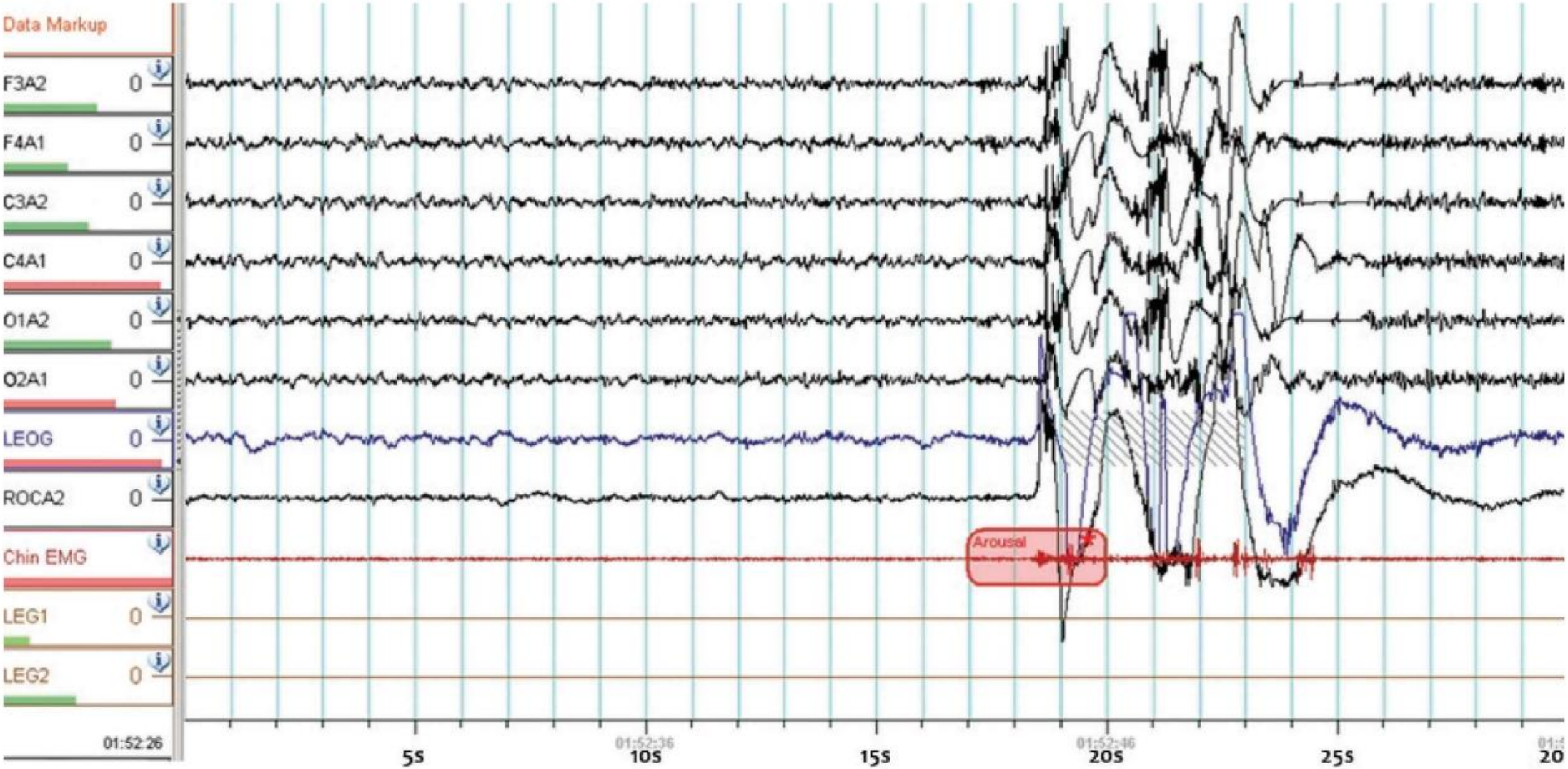


Figure 13.31A-B REM to N1: If an arousal during REM is followed by slow eye movements, score the epoch with SEM as N1. A: Arousal in later part of epoch.

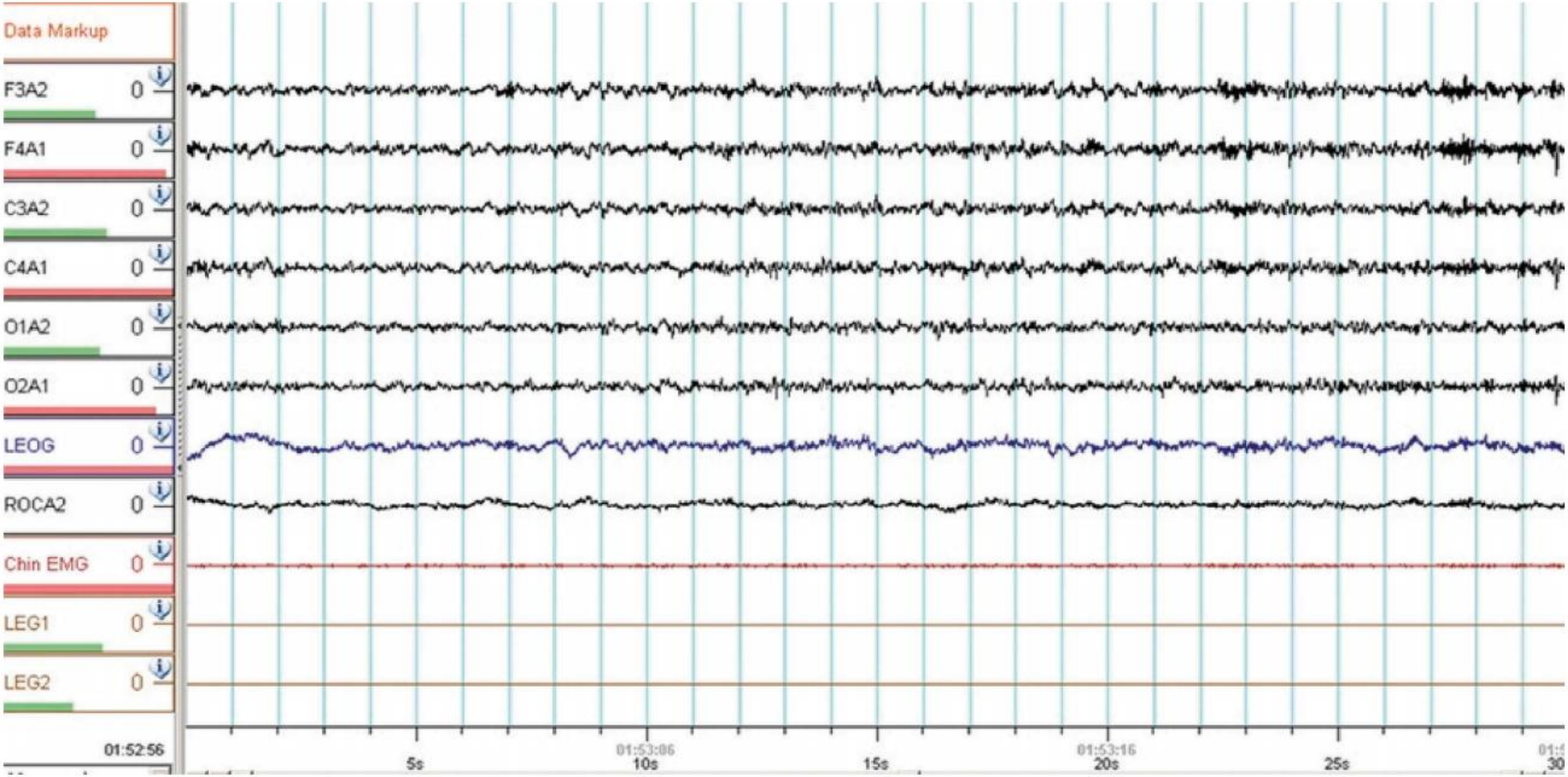


Figure 13.31B Slow eye movements in the initial parts of the epoch. Continue to score N1 till another sleep stage (N2 or REM) appears.

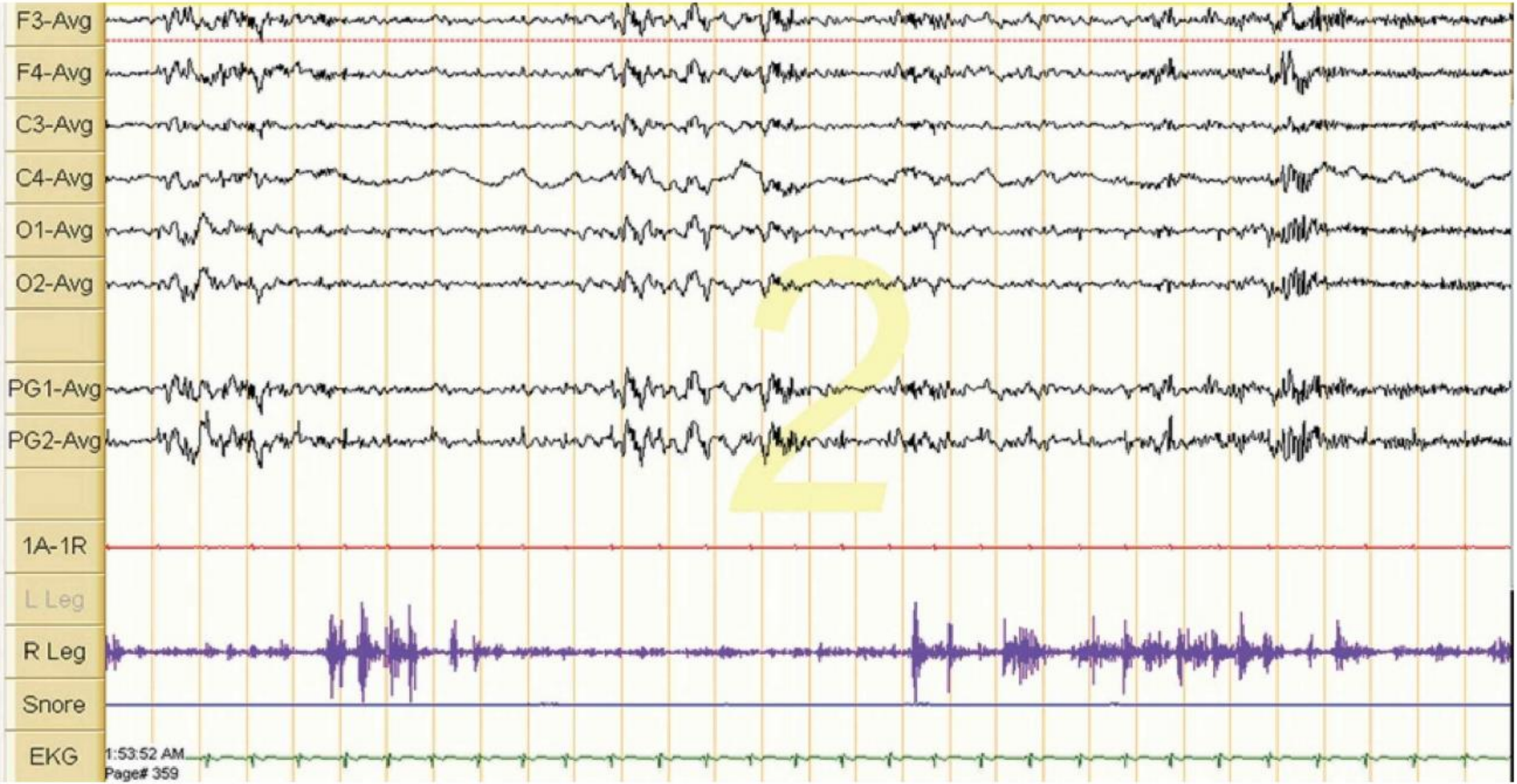


Figure 13.32 REM to N2: Change scoring from REM to N2, if K complex or sleep spindle is seen in the first half of the epoch. If it is seen in the latter half of the REM epoch, score present epoch as REM and subsequent epoch as N2 even in presence of low chin tone.

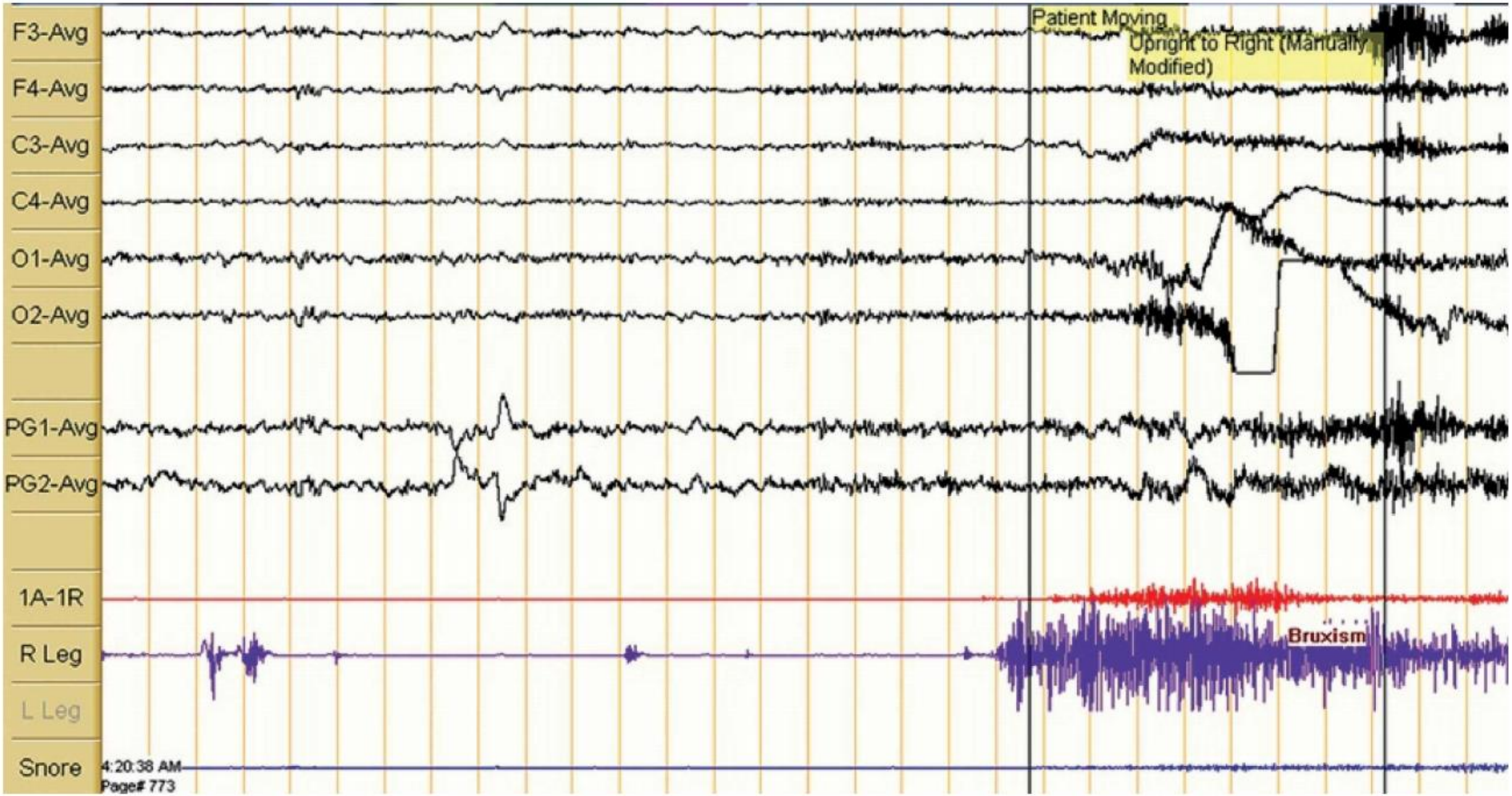


Figure 13.33 Movement during REM: If a major body movement makes the EEG and RMG findings indiscernible in an epoch, but previous and subsequent epochs are REM, score present epoch as REM. This epoch shows a minor movement and REM occupies more than 50% of epoch, hence scored as REM.

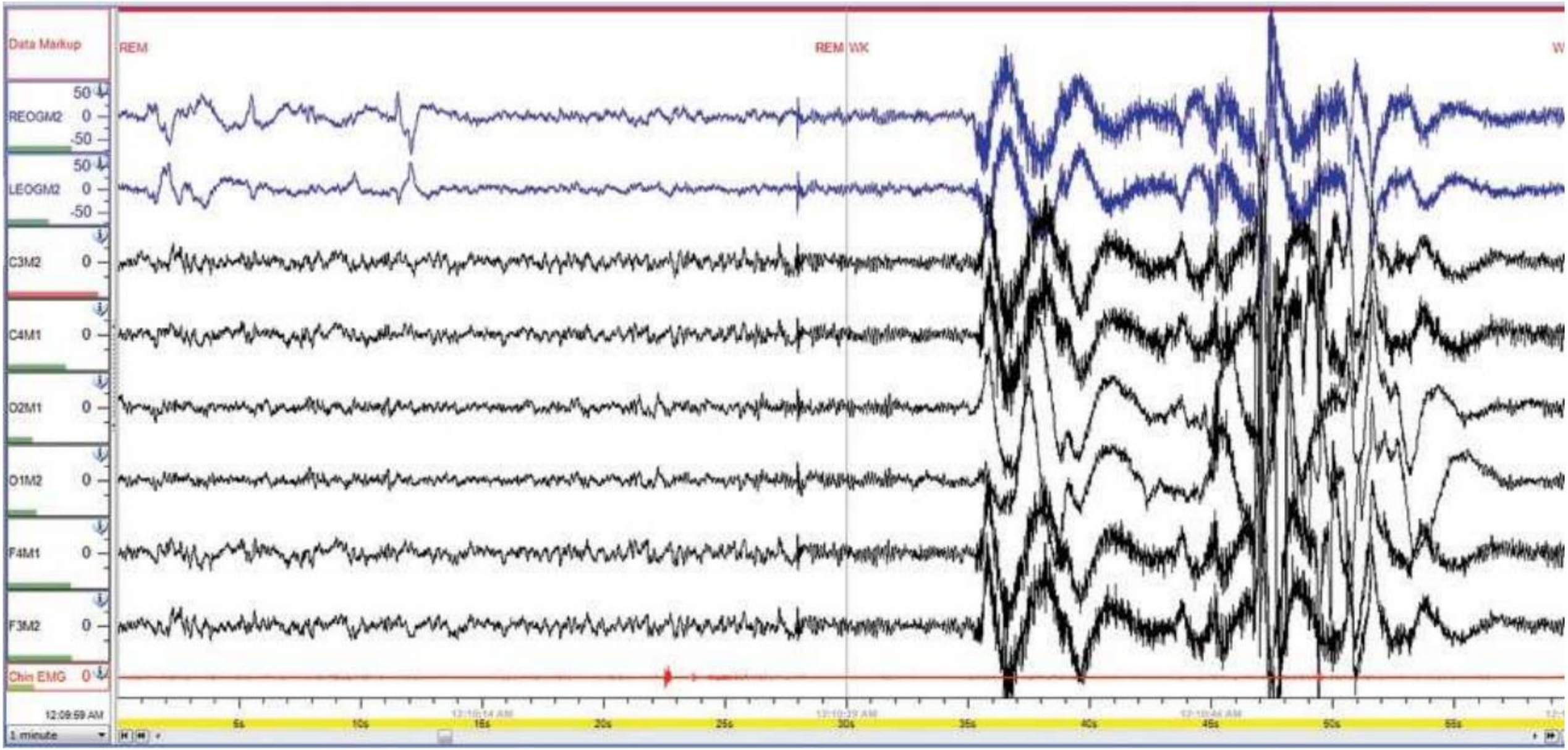


Figure 13.34 Major movement during REM: If an epoch of major body movement during REM is followed by slow eye movements in an epoch, both epochs (with movement and SEM) should be scored as N1

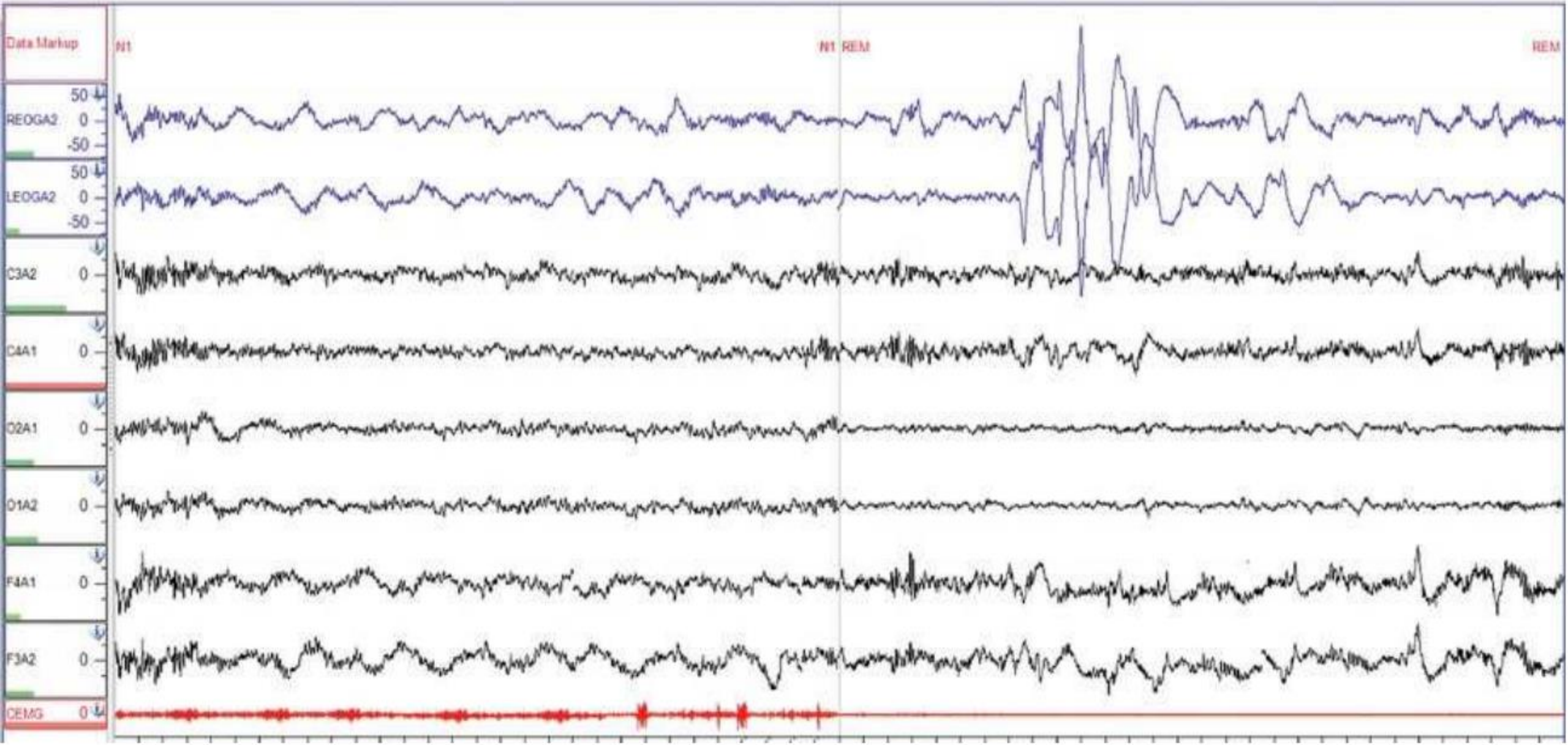


Figure 13.35 N1 to REM: If an epoch following N1, shows characteristics of REM, score as REM.



Figure 13.36 Alpha during REM: Alpha may also be seen during REM, however, alpha during REM is usually 1–2 Hz slower than waking alpha.

Respiratory events

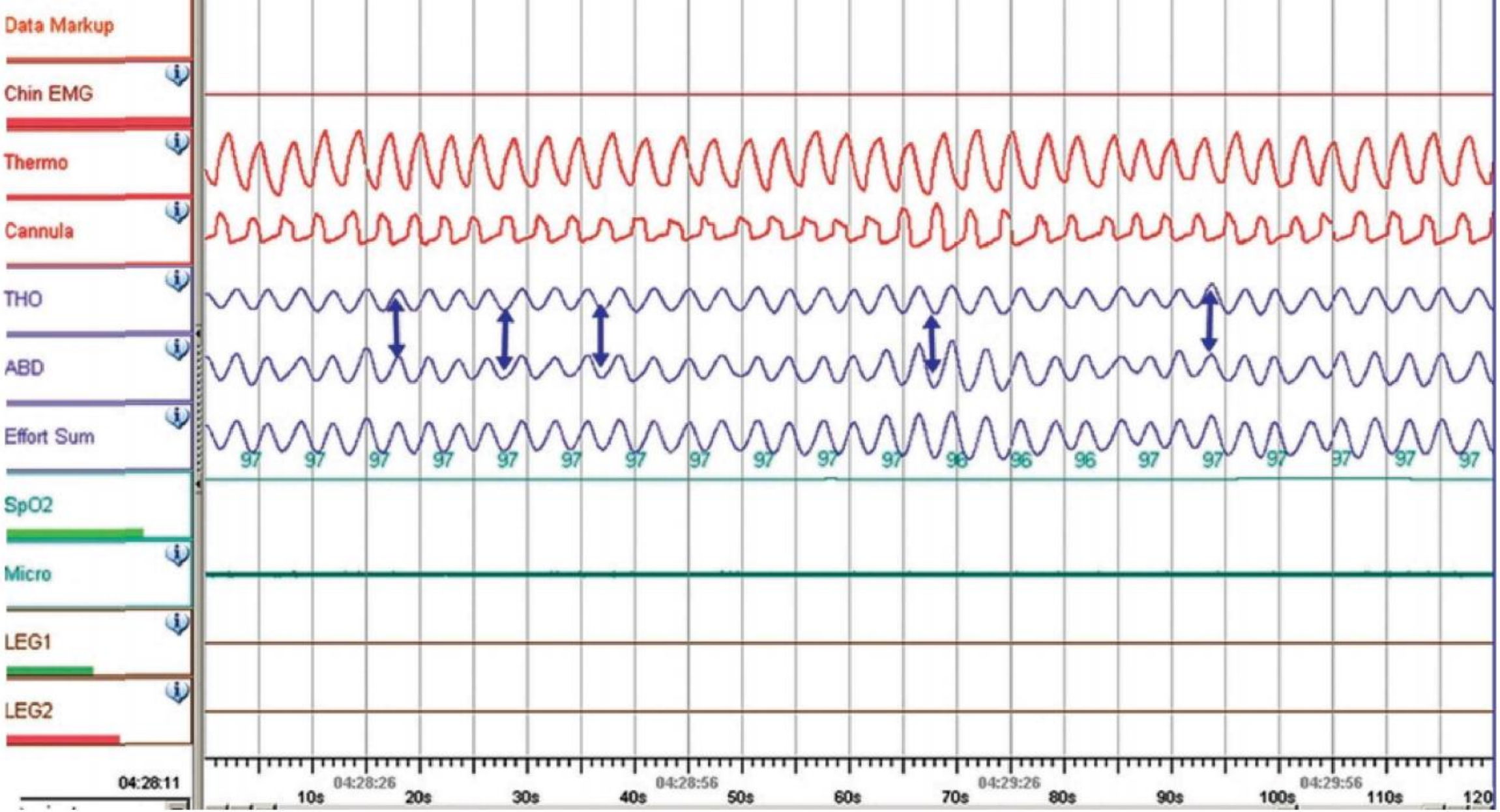


Figure 13.37A Normal Respiration during sleep: 2 min epoch showing normal respiration. See that flow in the thermistor and cannula is regular, rhythmic, and has equal amplitude across the epoch. Chest and abdomen RIP belts show in phase movement and effort sum (RIP-Sum) does not show any change in amplitude. Oxygen saturation is maintained throughout the epoch and microphone does not show any signal.

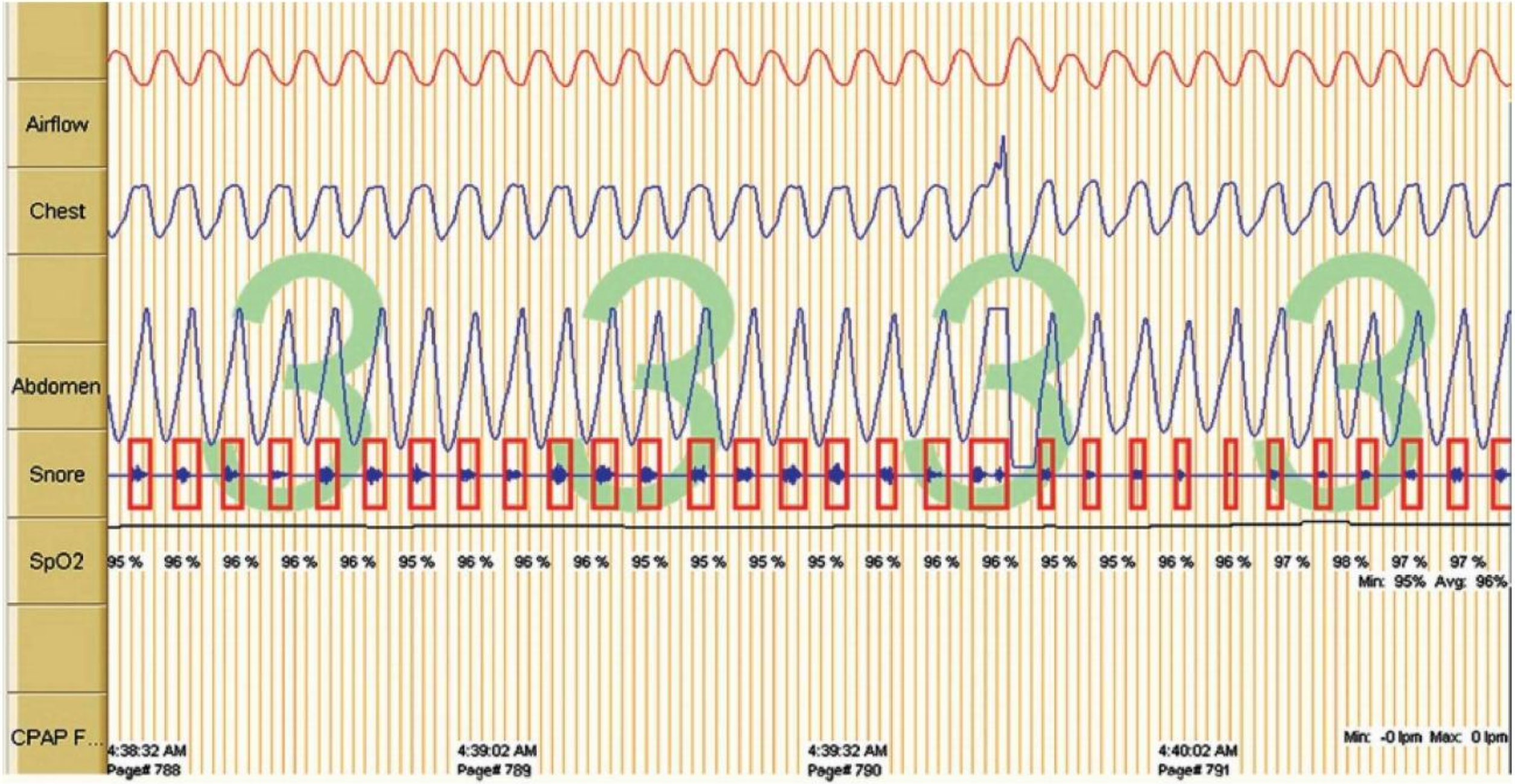


Figure 13.37B Snoring without sleep related breathing events: Tracing showing snoring (microphone channel) without the hypopnea or apnea.

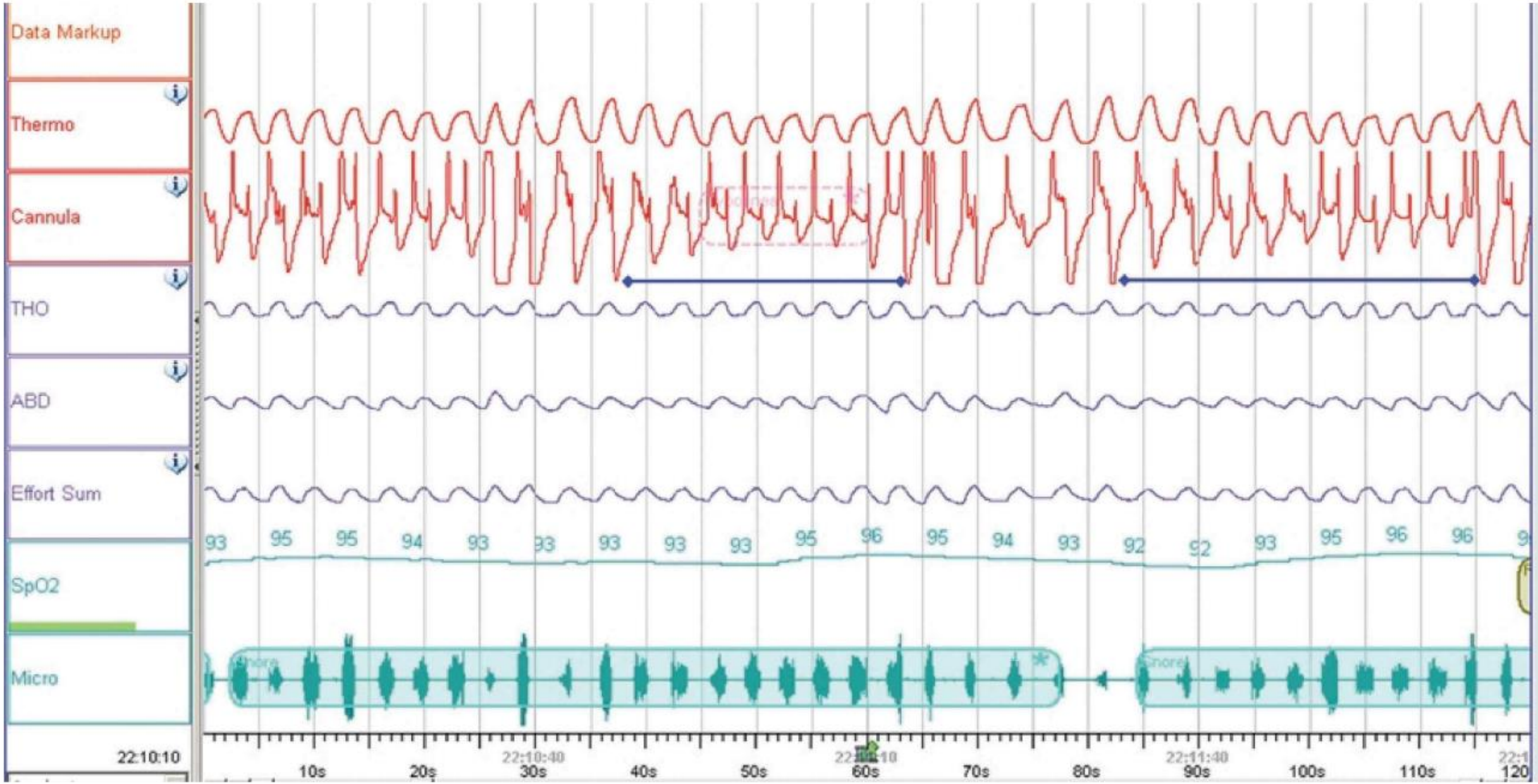


Figure 13.38A Hypopnea is characterized by at least 30% reduction in the amplitude of nasal airflow (pressure transducer) with retained signals in thermistor and regular breathing effort (chest and abdominal belts) and desaturation in oximetery channel (3% or 4% depending upon the criteria followed). Duration must be at least 10 seconds (Blue lines). In this epoch regular snoring is also visible.

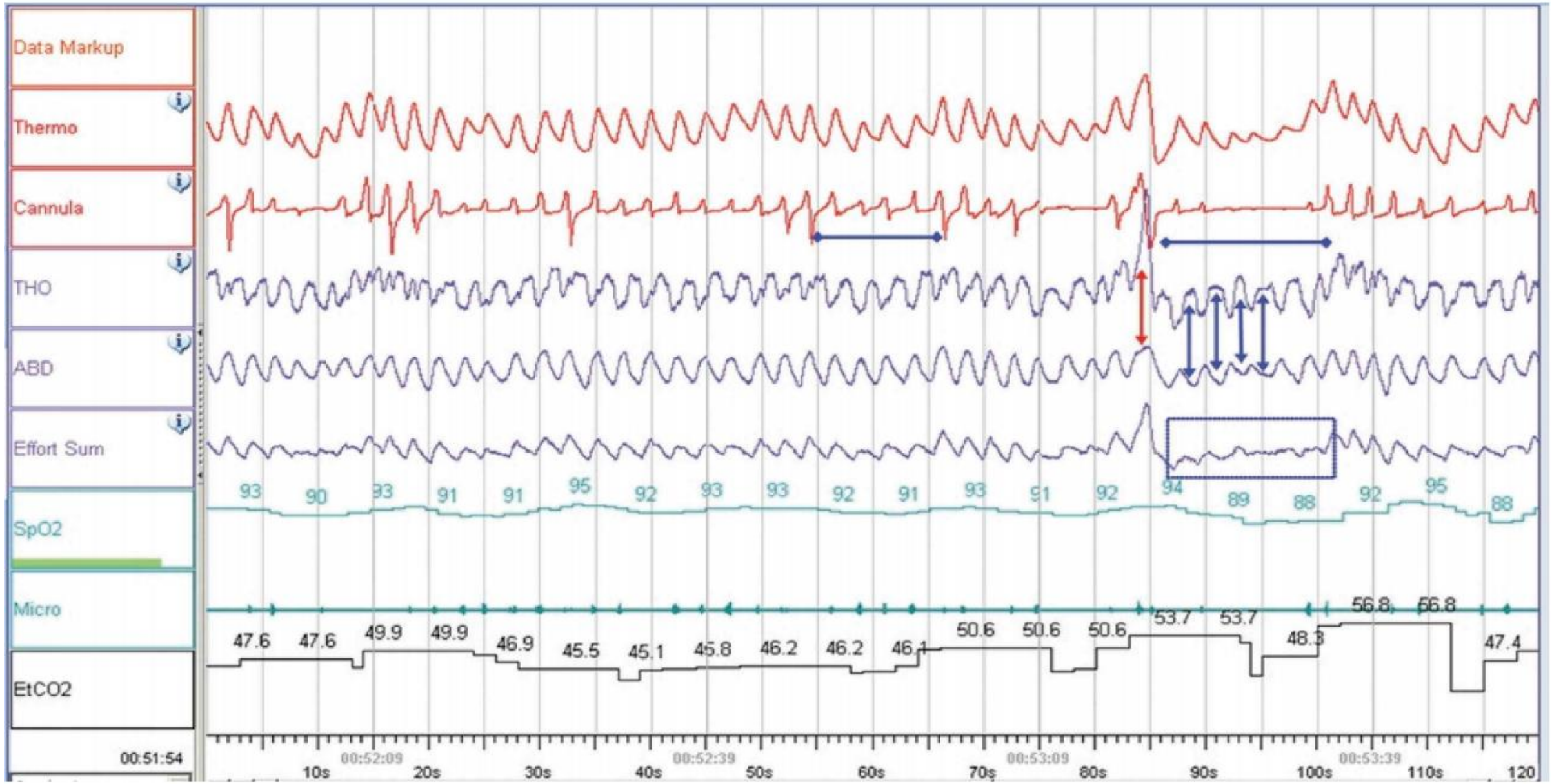


Figure 13.38B Hypopnea is characterized by at least 30% reduction in the amplitude of nasal airflow (pressure transducer) with retained signals in thermistor and regular breathing effort (chest and abdominal belts) and desaturation in oximetery channel (3% or 4% depending upon the criteria followed). Duration must be at least 10 seconds (horizontal blue arrows). In this epoch regular snoring is also visible. Also see in-phase breathing (red arrows)) during normal breathing and paradoxical breathing (blue vertical arrows) and reduction in effort-sum (box).

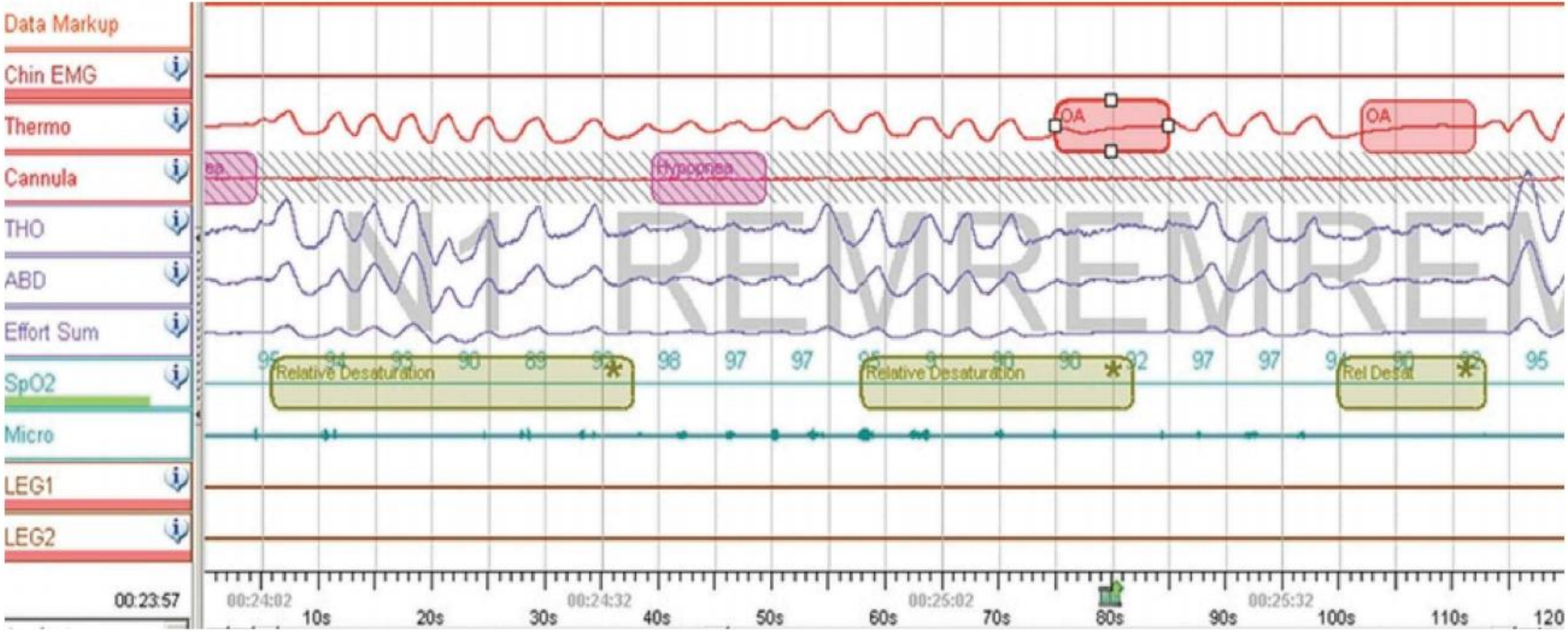


Figure 13.38C Hypopnea and apnea during pressure transducer malfunction: In case of malfunction of pressure transducer, hypopnea and may be diagnosed using signals from RIP belts. During Hypopnea sum of Chest and abdominal belts show paradoxical movement followed by desaturation with reduction in effort-sum signals, whereas in apnea, signals from thermistor as well as effort-sum are flat.

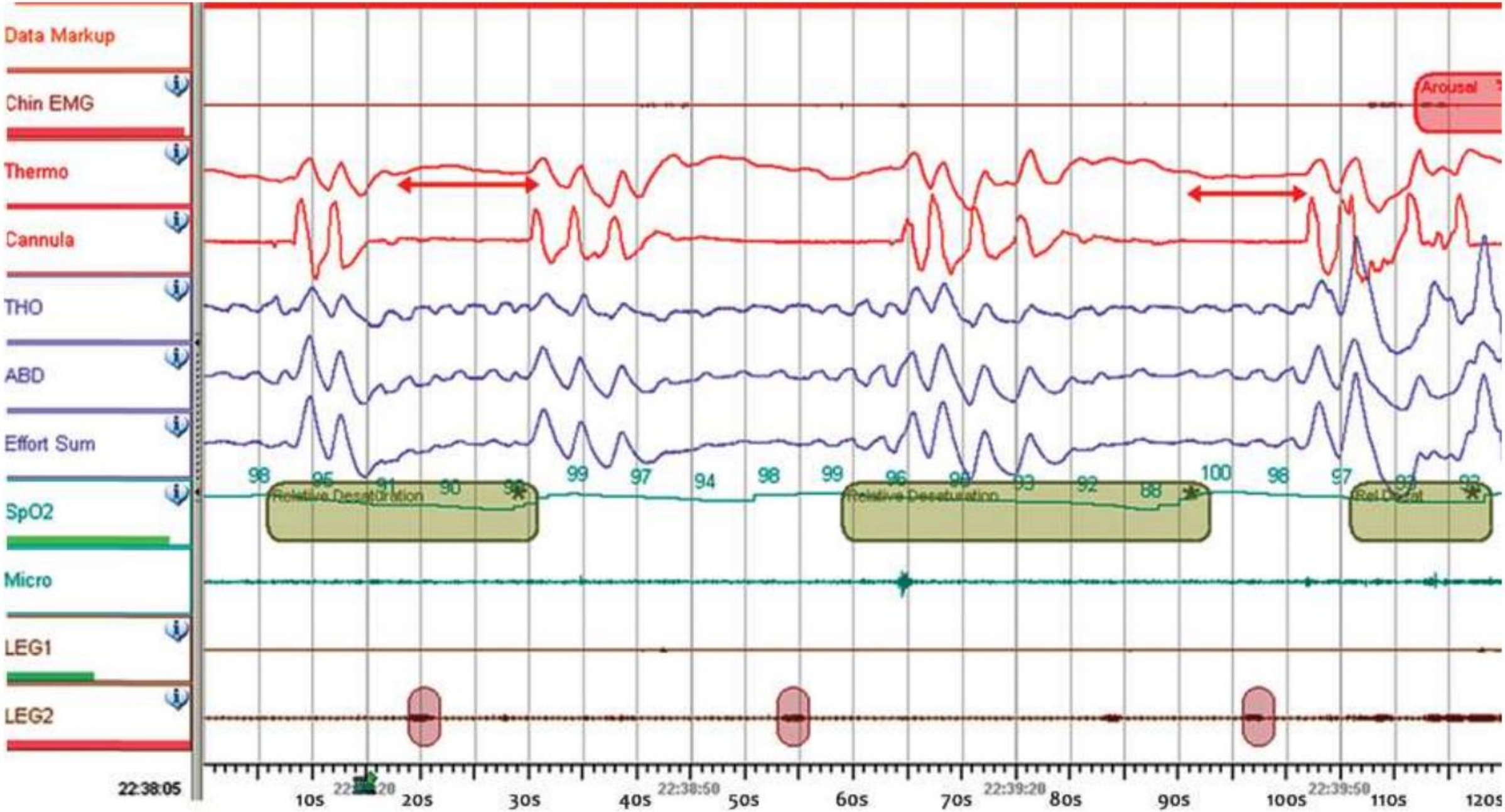


Figure 13.39 Obstructive sleep apnea: If a part of hypopnea meets criteria for apnea (Figure 13.39: Red arrows), score the event as apnea. Note that in the latter part thermistor signals showing flattening, hence this will be scored as apnea.

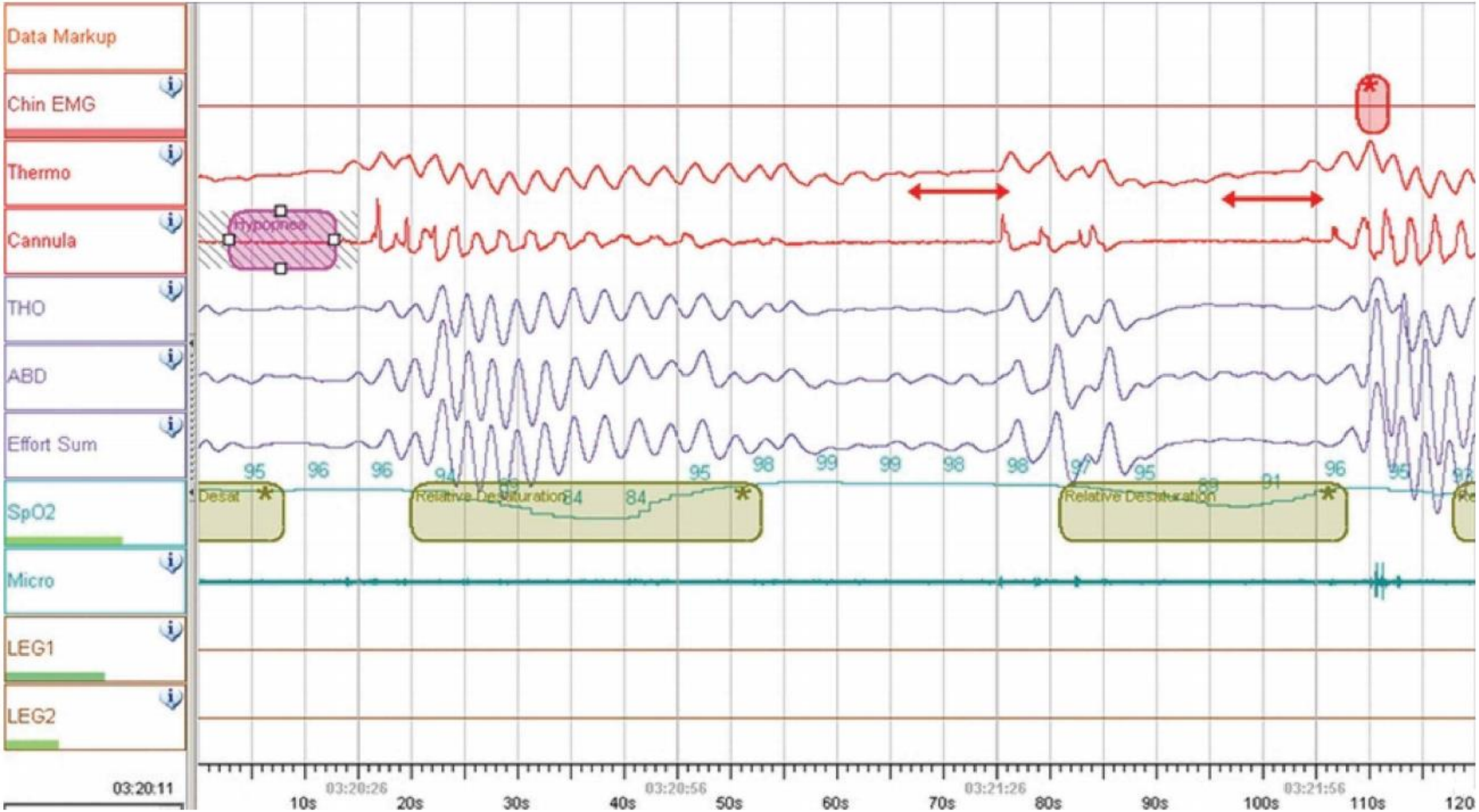


Figure 13.40 Obstructive sleep apnea: If a part of hypopnea meets criteria for apnea (Figure 13.39: Red arrows), score the event as apnea. Note that in the latter part of thermistor signals showing flattening, hence this will be scored as apnea.

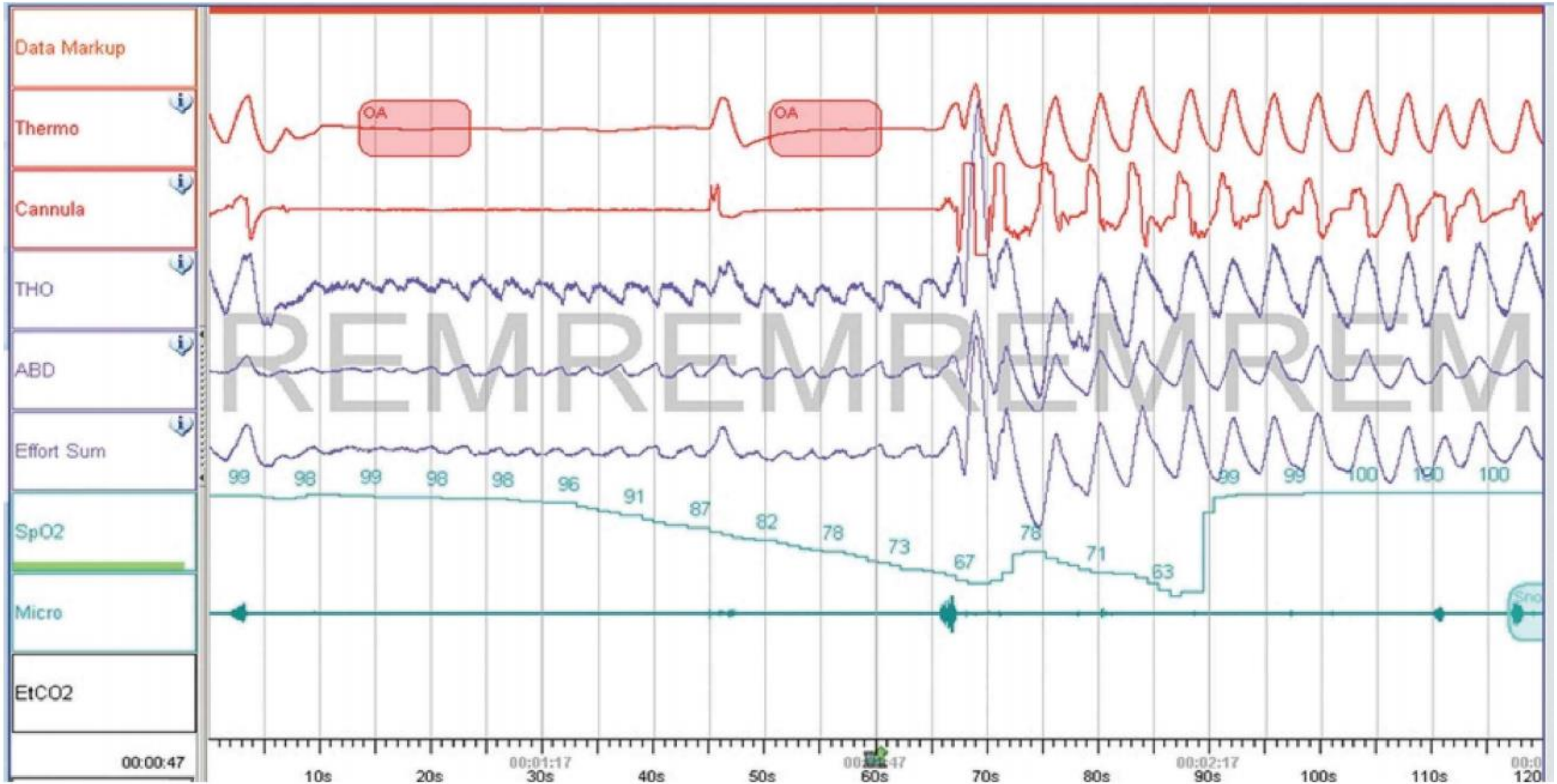


Figure 13.41 Obstructive sleep apnea: Obstructive apnea is characterized by absence of signals (for at least 10 seconds) in thermistor and pressure transducer. There is usually reduction of signals in RIP belts and effort-sum followed by hyperpnoea (belts) and subsequent desaturation. However, desaturation is not necessary to diagnose OSA. In this epoch you can appreciate paradoxical breathing (movement of chest and abdomen in opposite phase) during apnea.

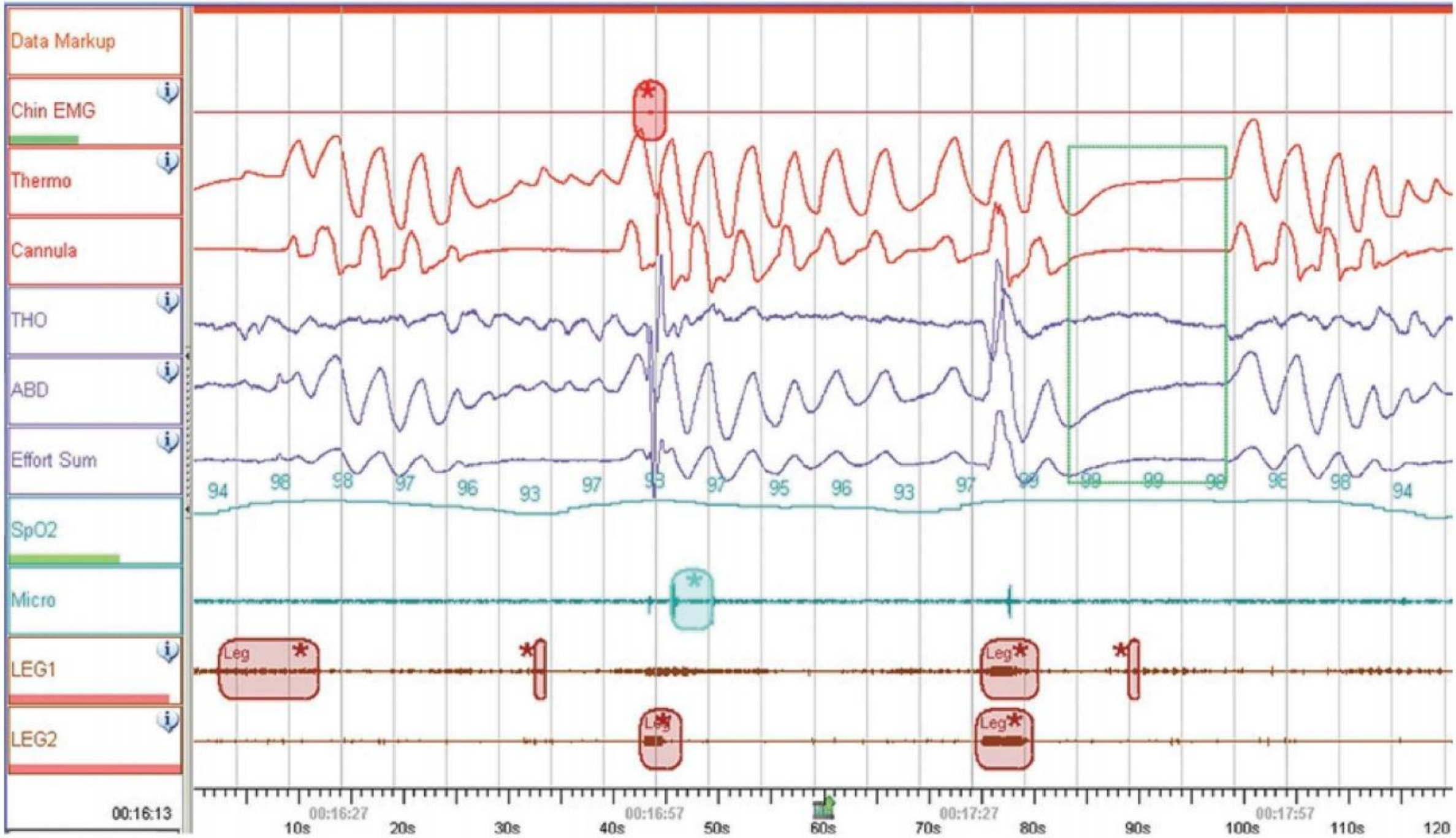


Figure 13.42 Central sleep apnea is diagnosed with absence of flow and effort signals for at least 10 seconds. In this epoch central sleep apnea can be seen (Green Box).

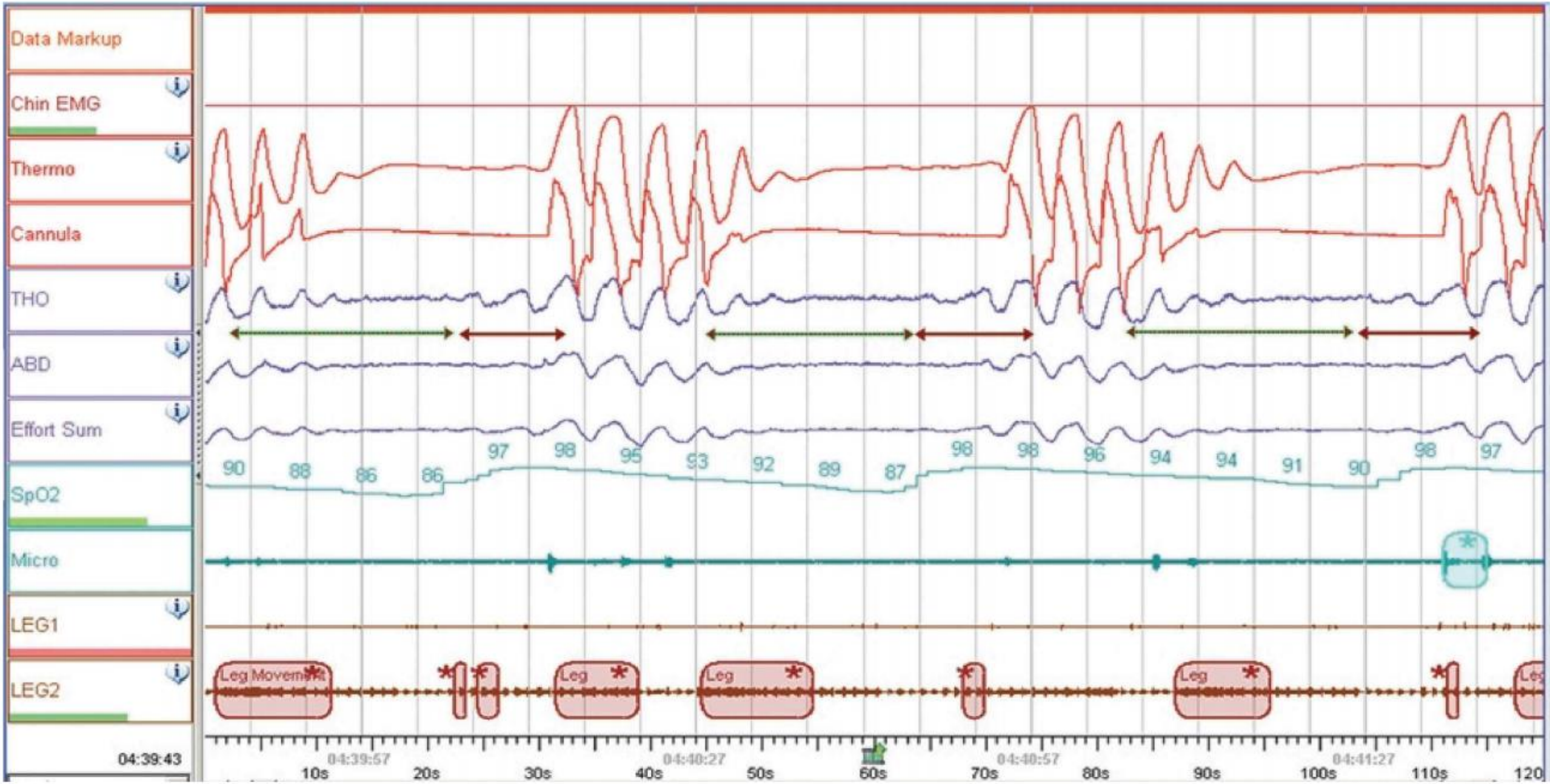


Figure 13.43 Mixed apnea: Initial part of the apnea meets criteria for central sleep apnea (Green arrows) and latter half that of obstructive sleep apnea (Maroon Arrows). In this epoch chest resumes movement before apnea terminates in flow signals.

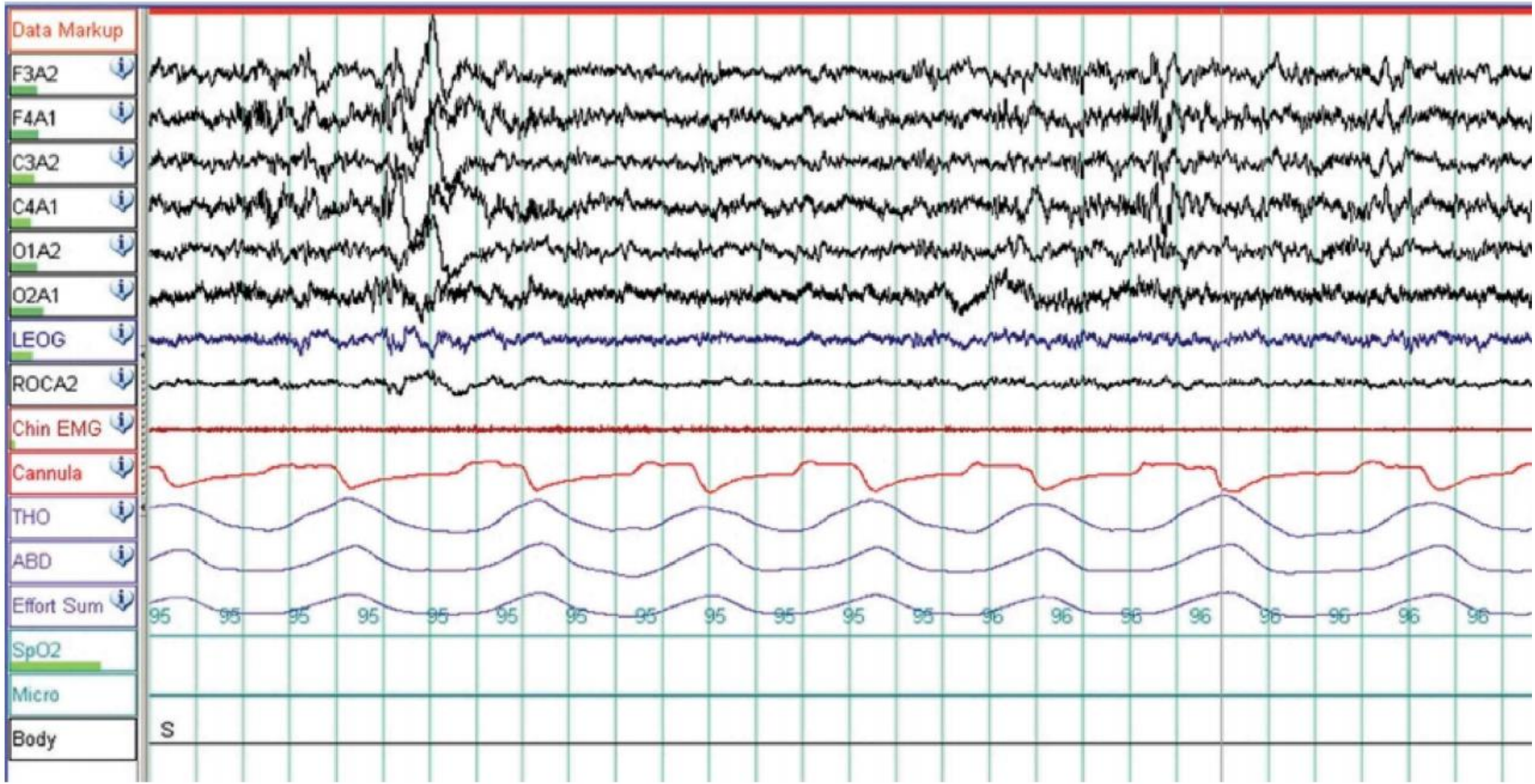


Figure 13.44A-B Respiratory event related arousal: A series of breaths with flattened waveform showing increased efforts to breath for at least 10 seconds and associated with an arousal. These breaths do not meet criteria for hypopnea. A: All the breaths in the nasal cannula have nearly equal amplitude.

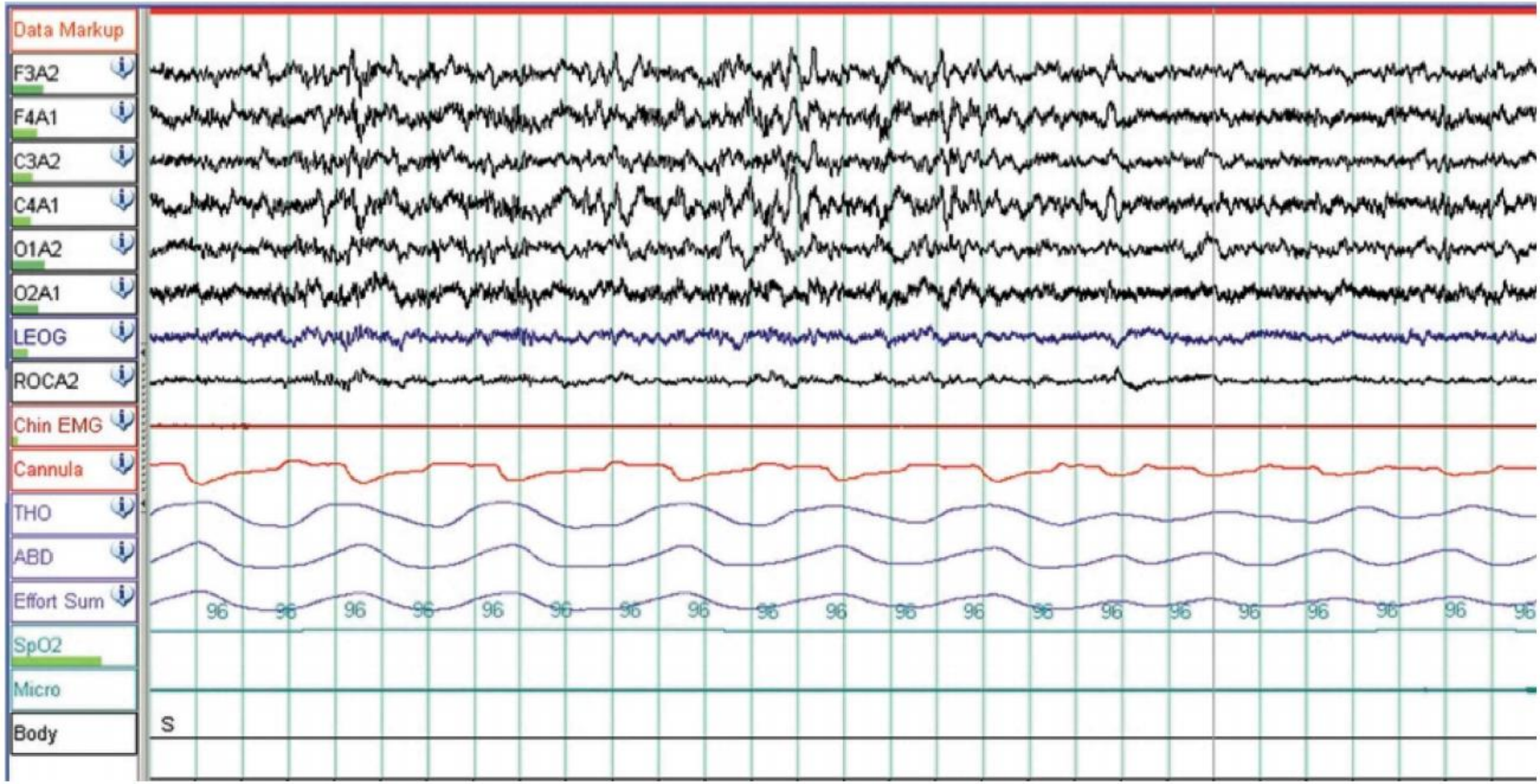


Figure 13.44B Progressive flattening of the nasal cannula tracing.

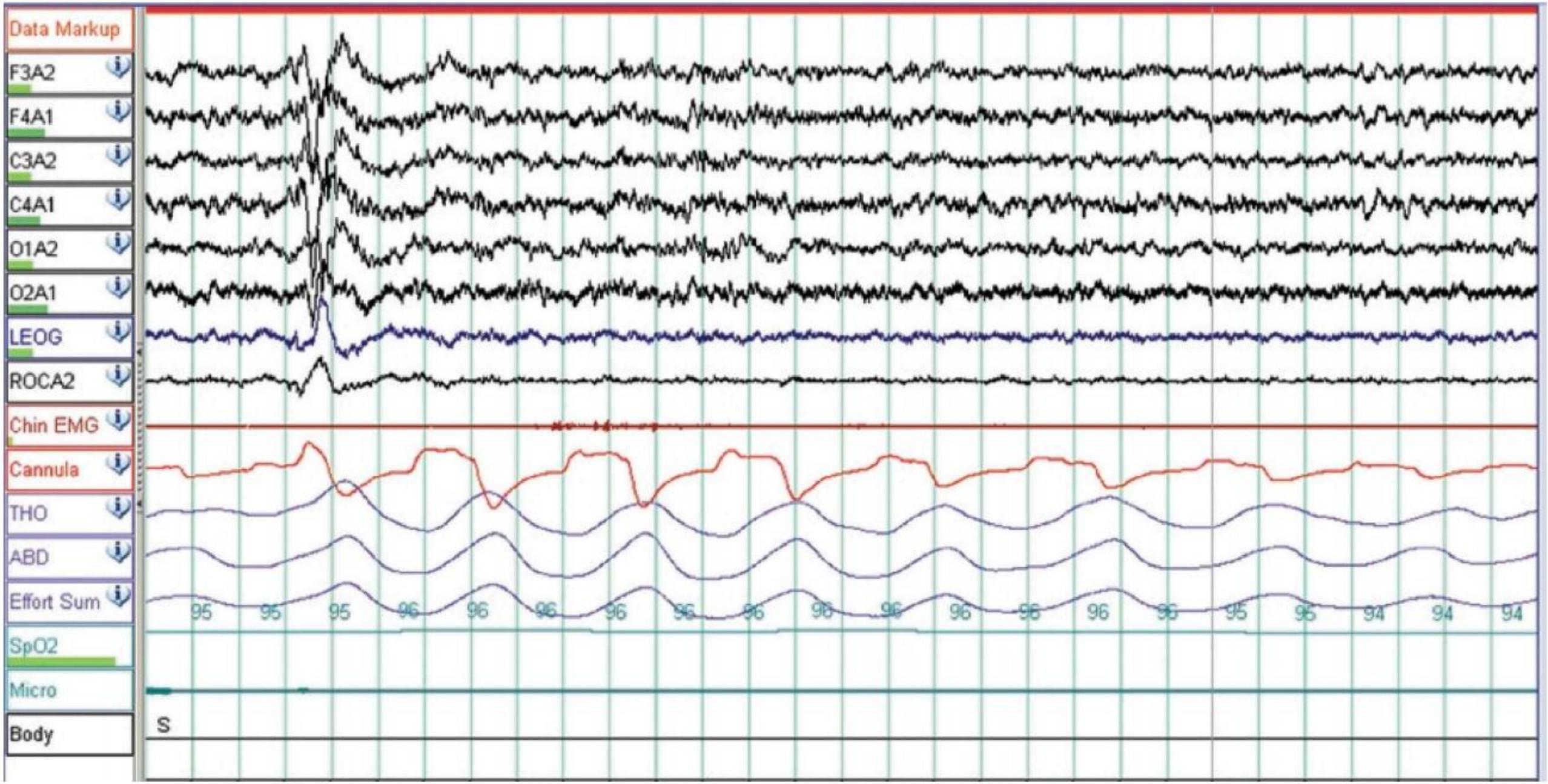


Figure 13.44C Normal amplitude of respiration appears with an arousal, later part of epoch shows progressive flattening.

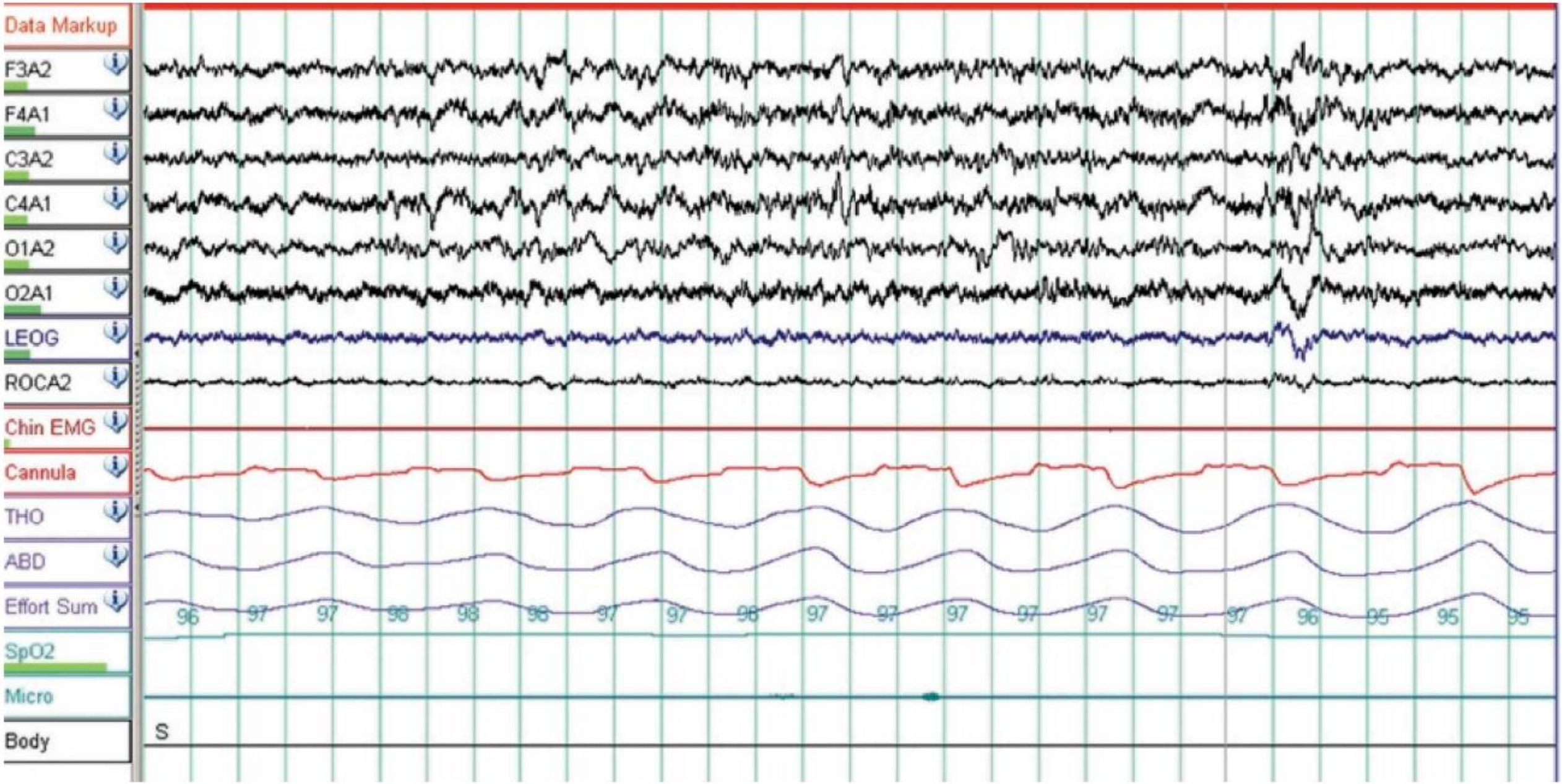


Figure 13.44D Normal amplitude appears with an arousal. See in all epochs, oxygen desaturation does not fulfill criteria for the hypopnea.

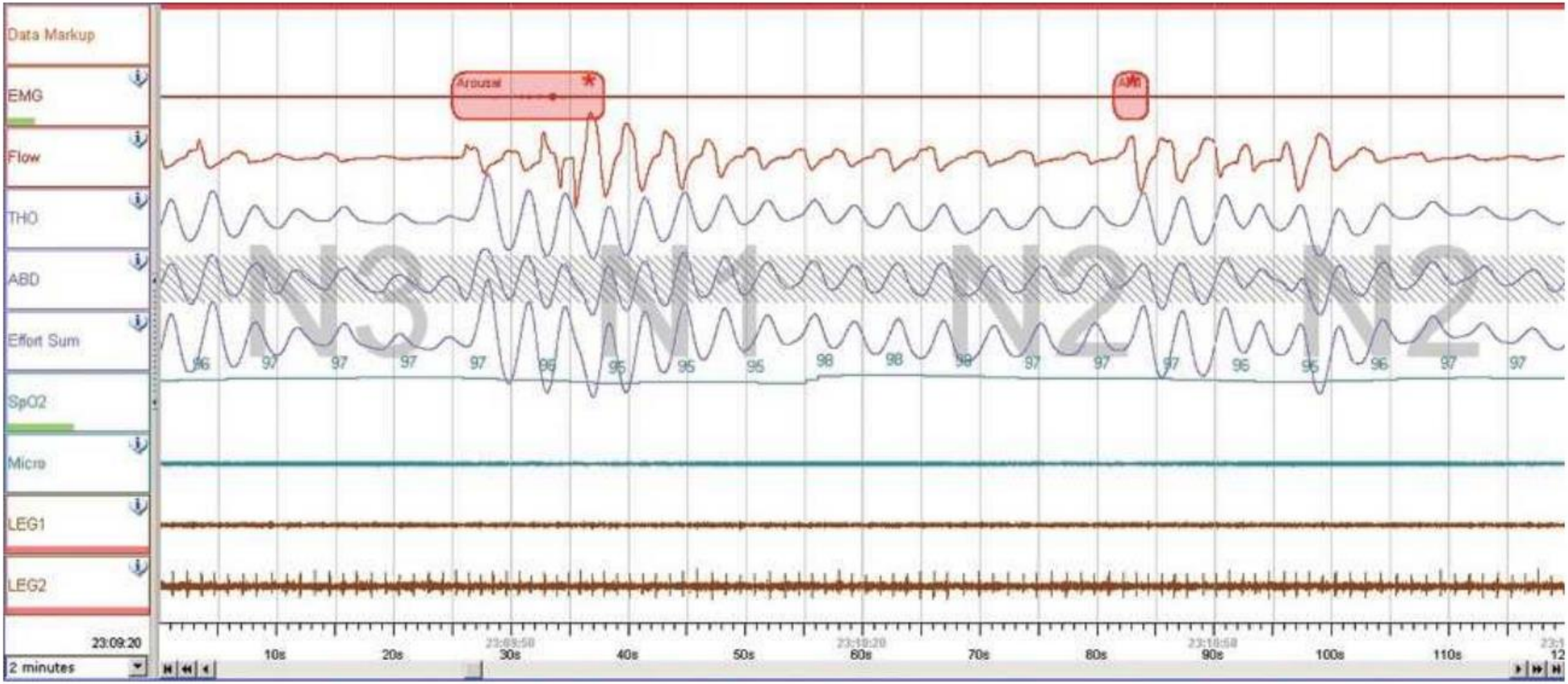


Figure 13.44E RERA as appears in 120 min epoch.

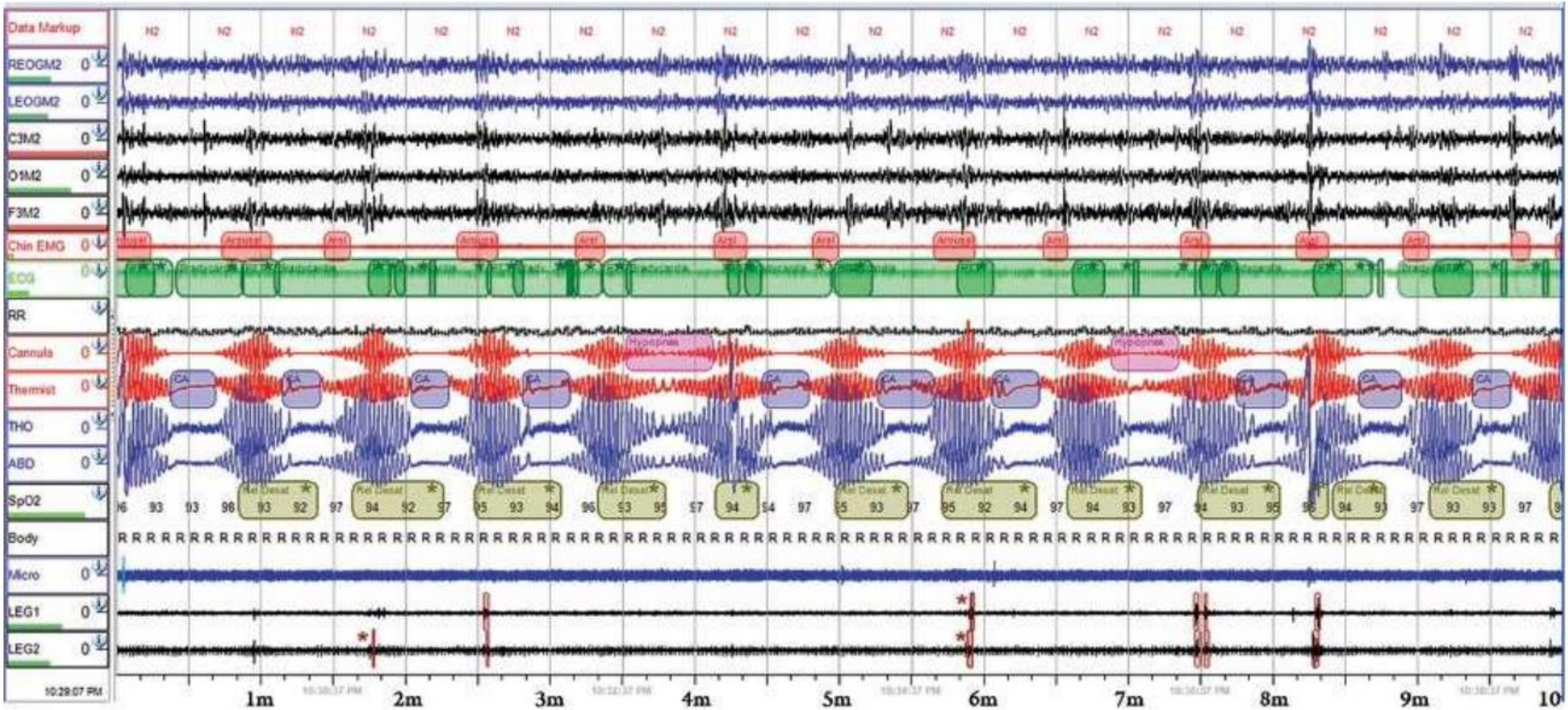


Figure 13.45A Cheyne–Stokes breathing: A: Cheyne–Stokes breathing is characterized by three or more central apnea/hypopnea that are separated by crescendo-decrescendo pattern of breathing and this cycle lasts at least 40 seconds. In addition central apnea/hypopnea index should be at least 5. In addition, crescendo-decrescendo breathing should be present at least 2 hours of total sleep time.

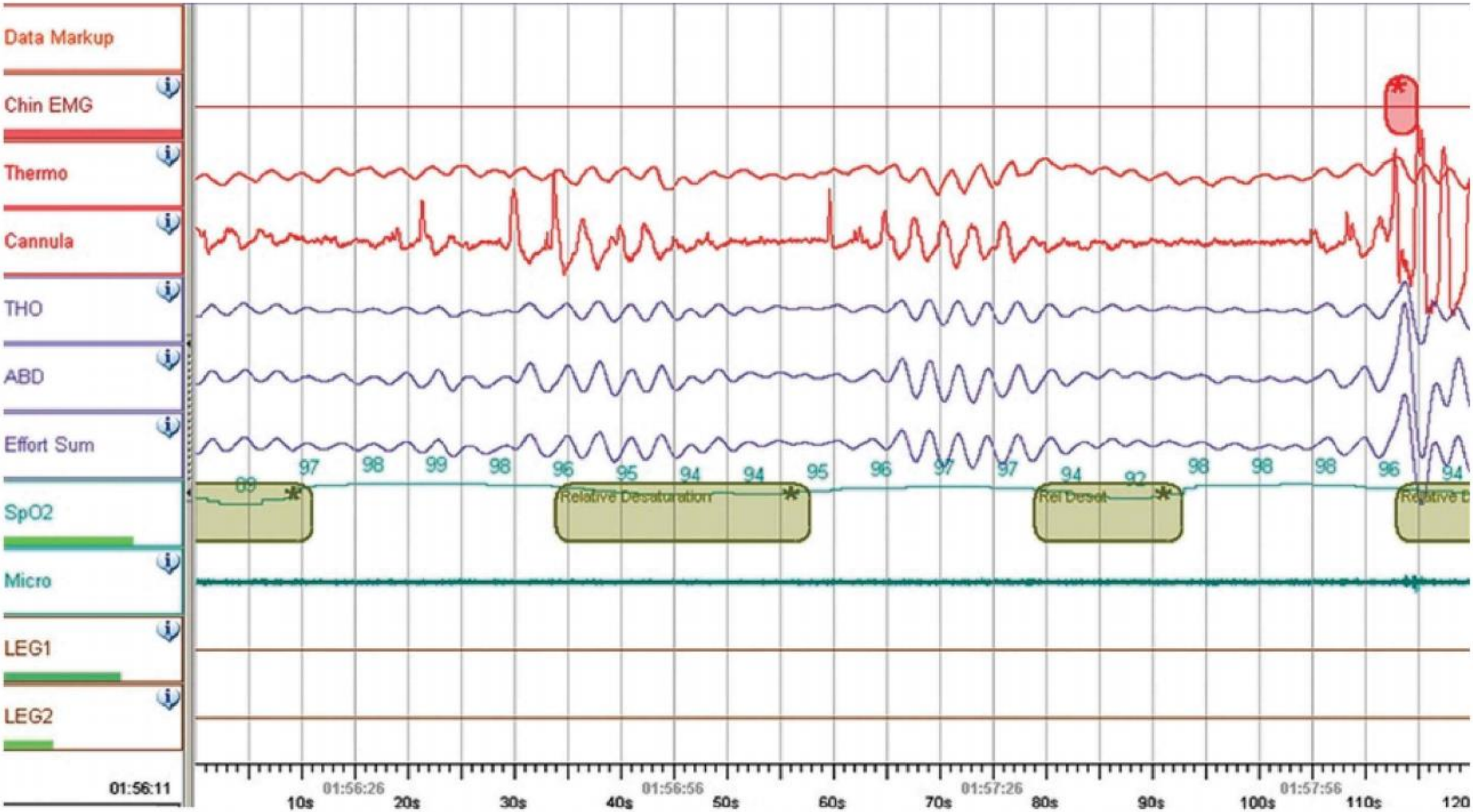


Figure 13.45B This breathing pattern seen in obstructive sleep apnea should not be confused with CSB.

Leg Movements

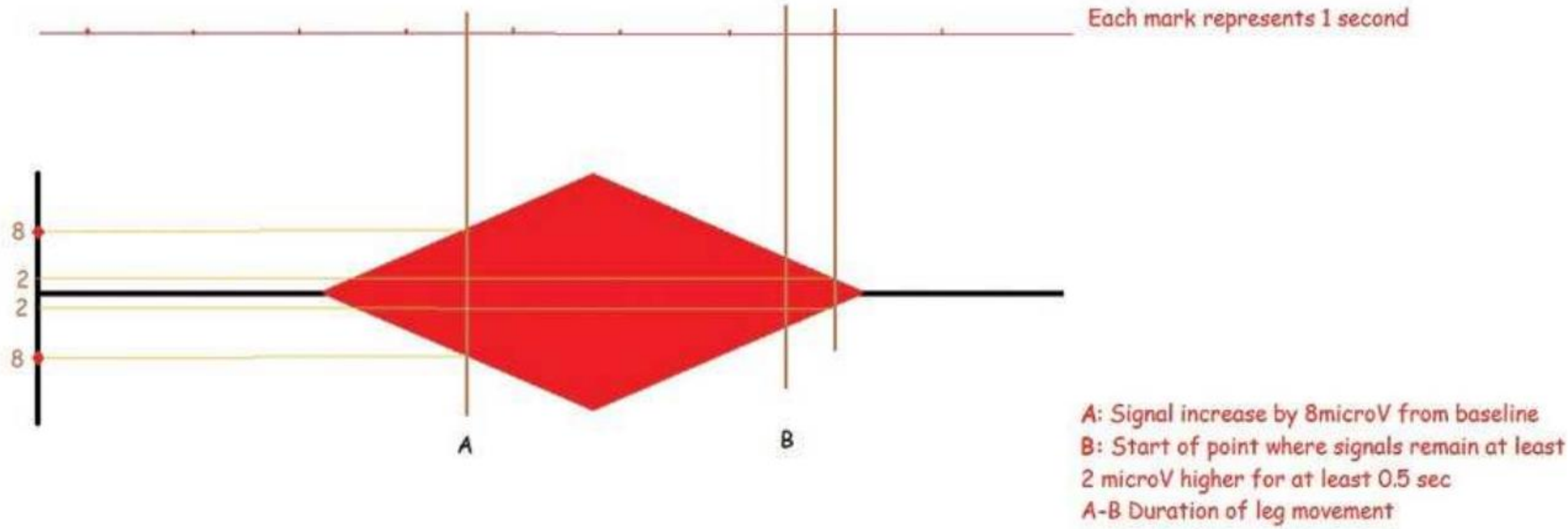


Figure 13.46 Leg movement: To be considered as movement, leg EMG must rise at least 8 μV above the baseline EEG and should last between 0.5 to 10 seconds. End point of leg movement is marked where EMG remains elevated by at least 2 μV for at least half a second.

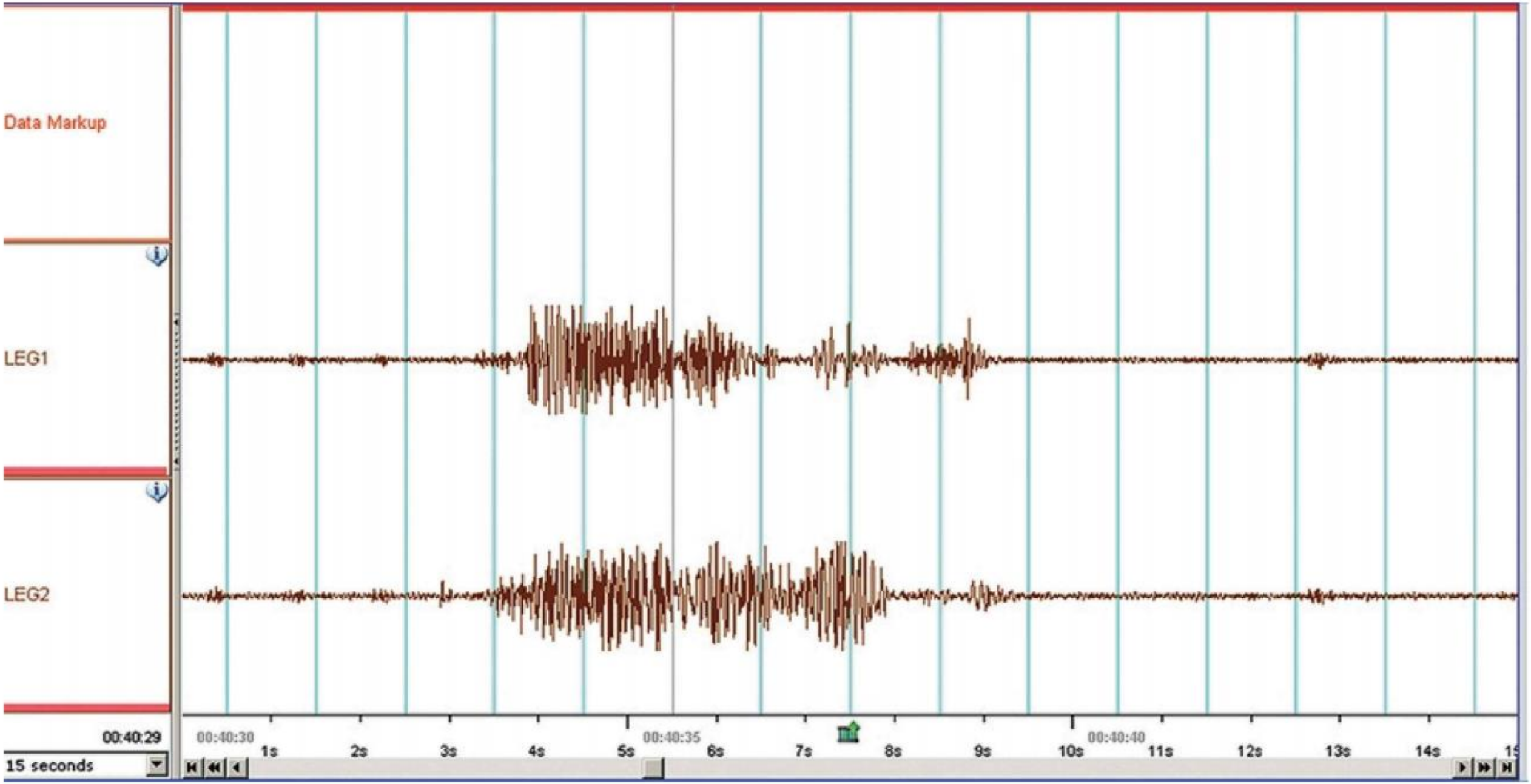


Figure 13.47 Leg movement: Leg movements in two limbs that are separated by less than 5 seconds are considered as one movement.

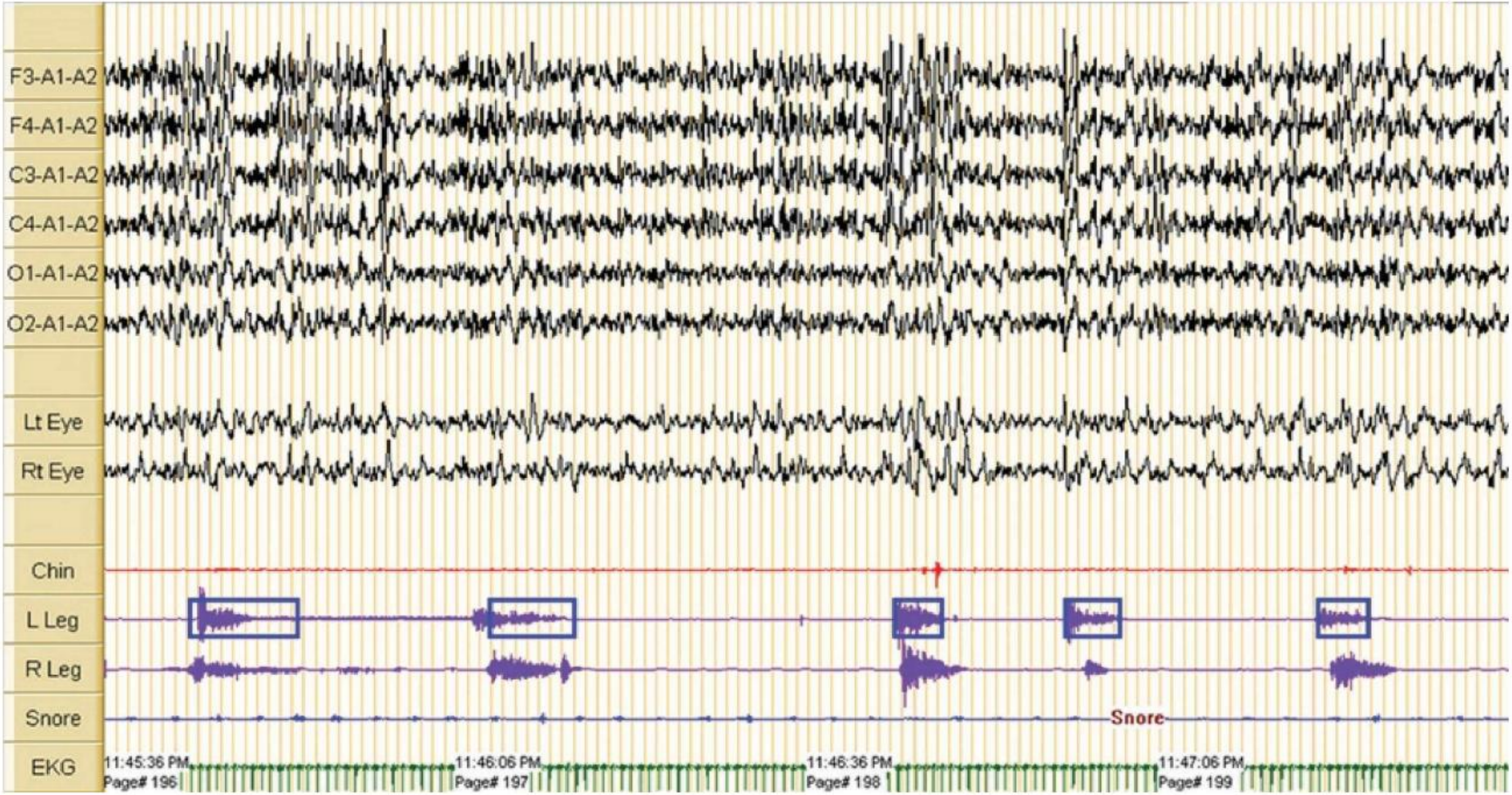


Figure 13.48A Periodic limb movement series: At least four or more leg movements where they are separated by at least 5 seconds and maxim by 90 seconds from each other are termed as leg movement series.

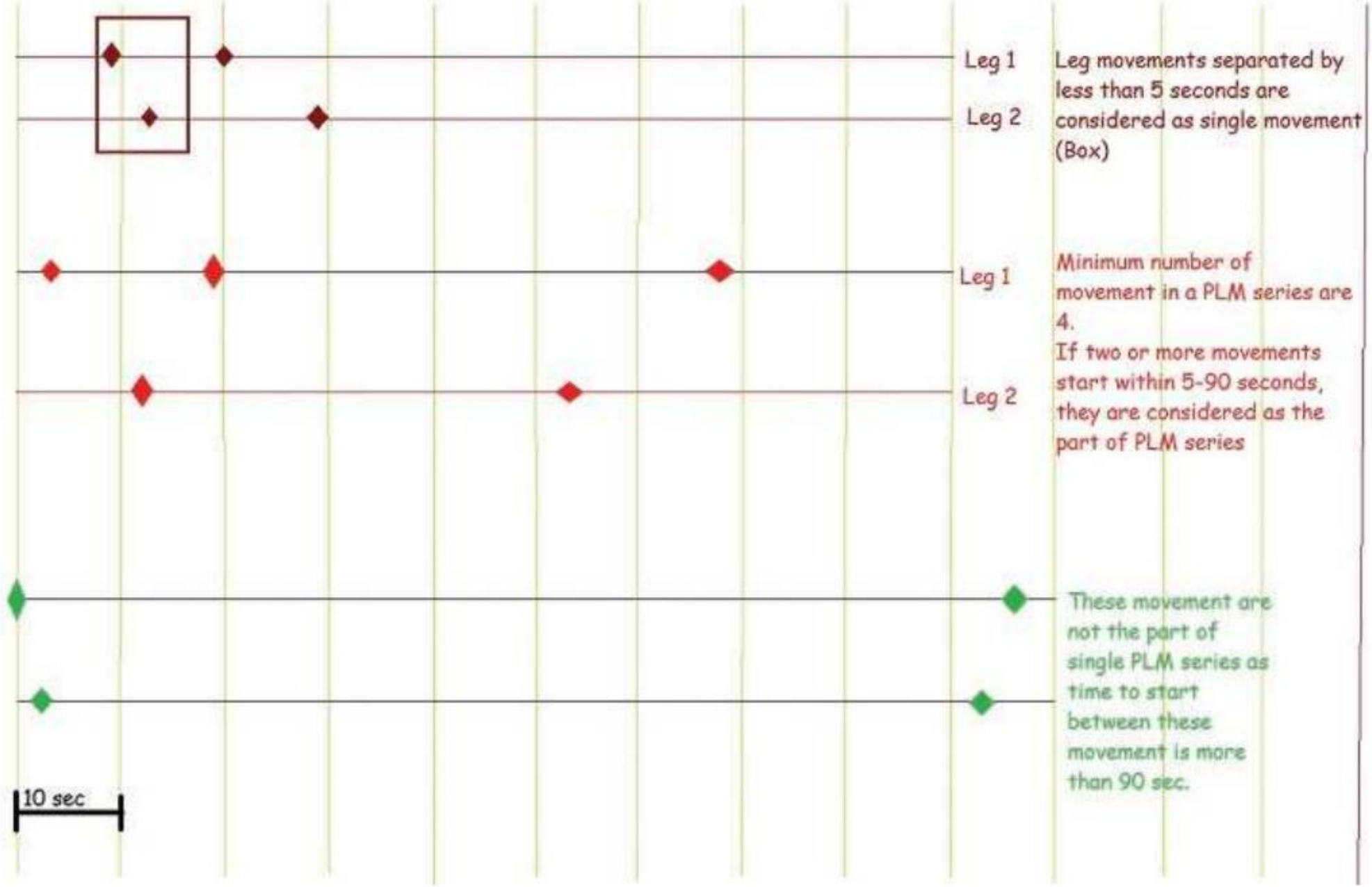


Figure 13.48B Periodic limb movement series: At least four or more leg movements where they are separated by at least 5 seconds and maxim by 90 seconds from other are termed as leg movement series.

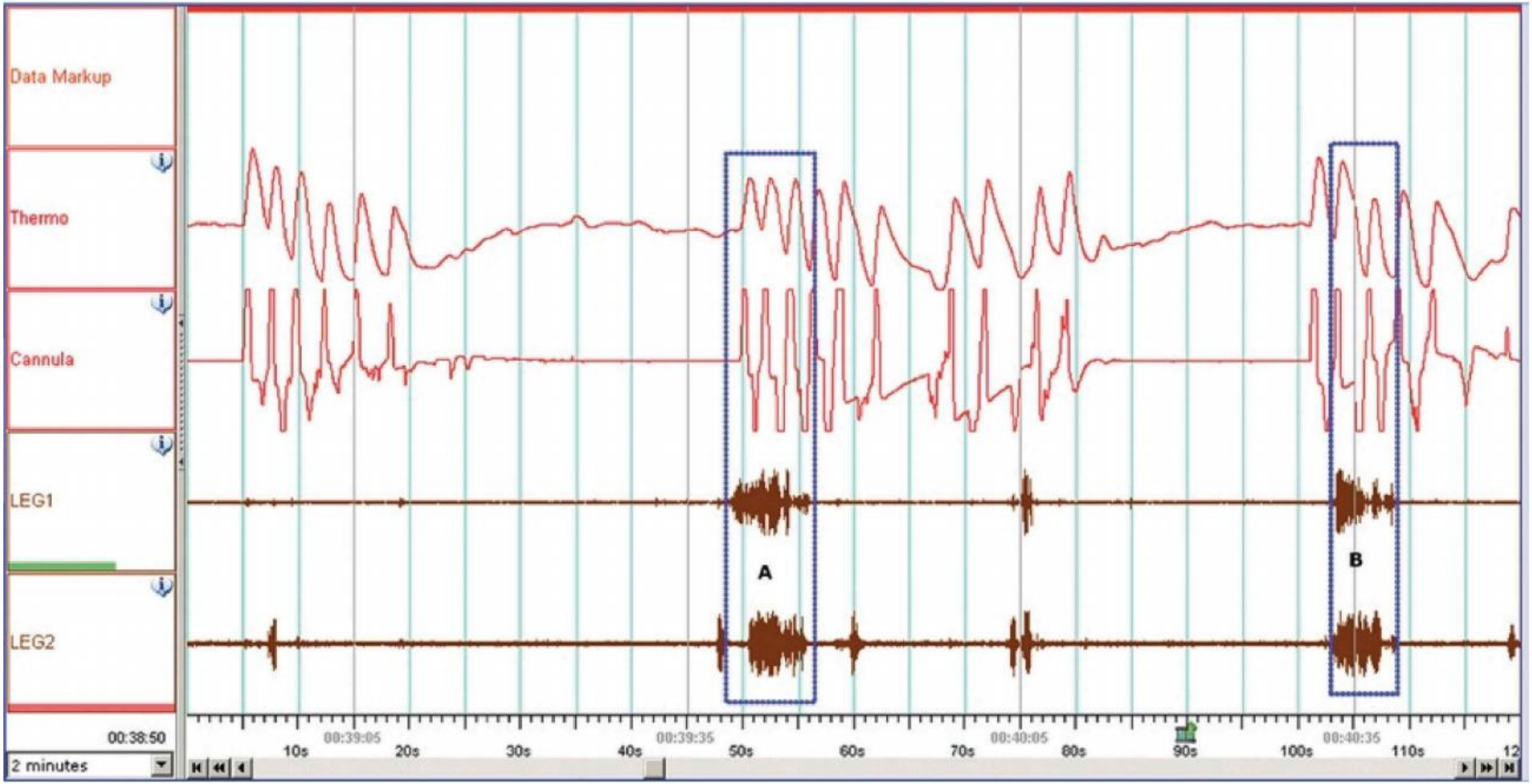


Figure 13.49 Leg movements associated with respiratory events: Leg movement preceding or following a sleep related breathing disorder event by 0.5 seconds is not considered as leg movement (A). However, if the start of leg movement is beyond 0.5 seconds, it is cored as leg movement (B).

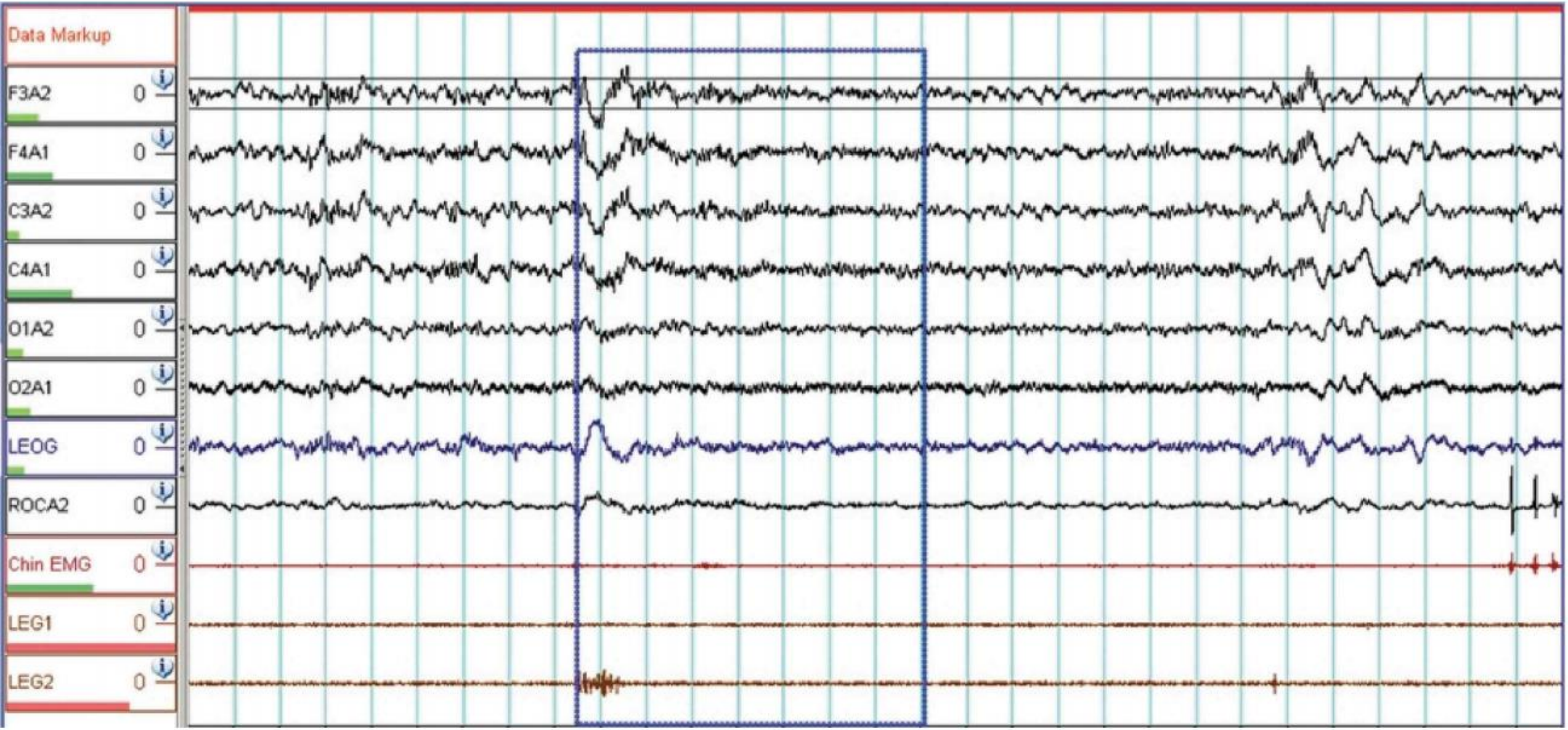


Figure 13.50 Leg movement related arousals: If a leg movement and an arousal is separated by less than half a second, they are considered associated with each other (box).

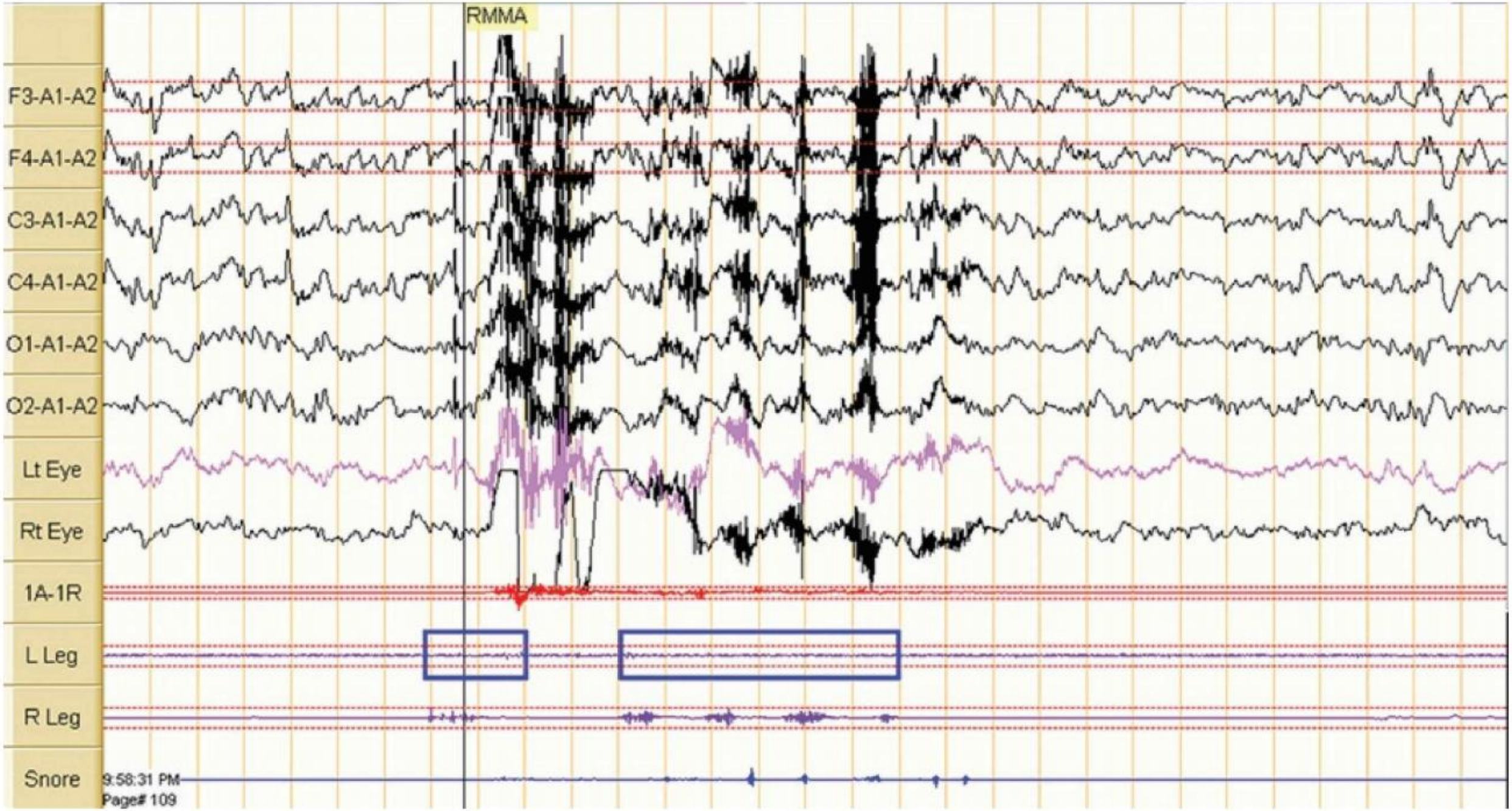


Figure 13.51 Bruxism: 2 seconds elevation in chin EMG suggesting sustained activity during bruxism.

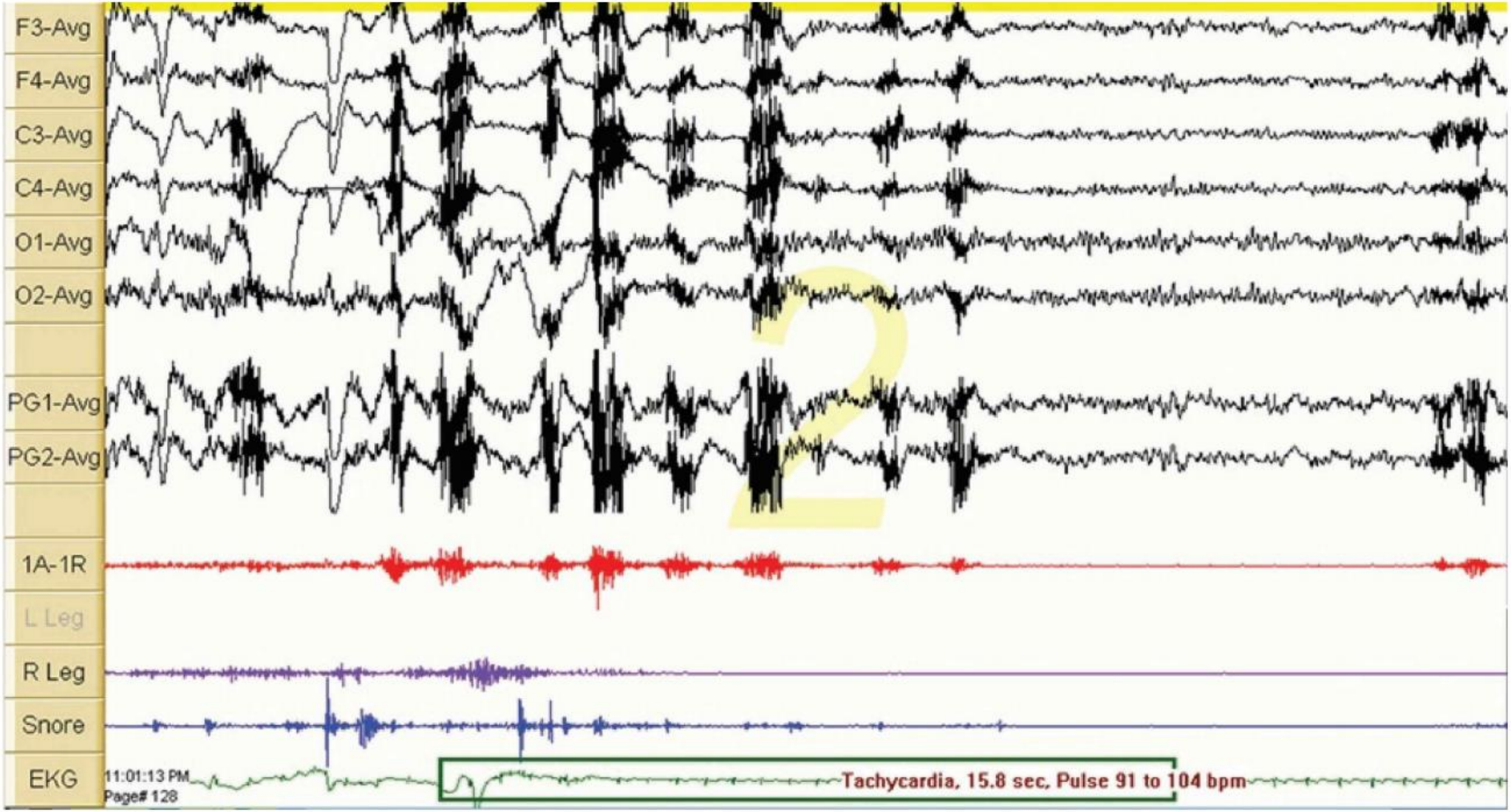


Figure 13.52 Bruxism: Phasic elevation in chin EMG suggesting bruxism. See the teeth grinding in microphone channel.

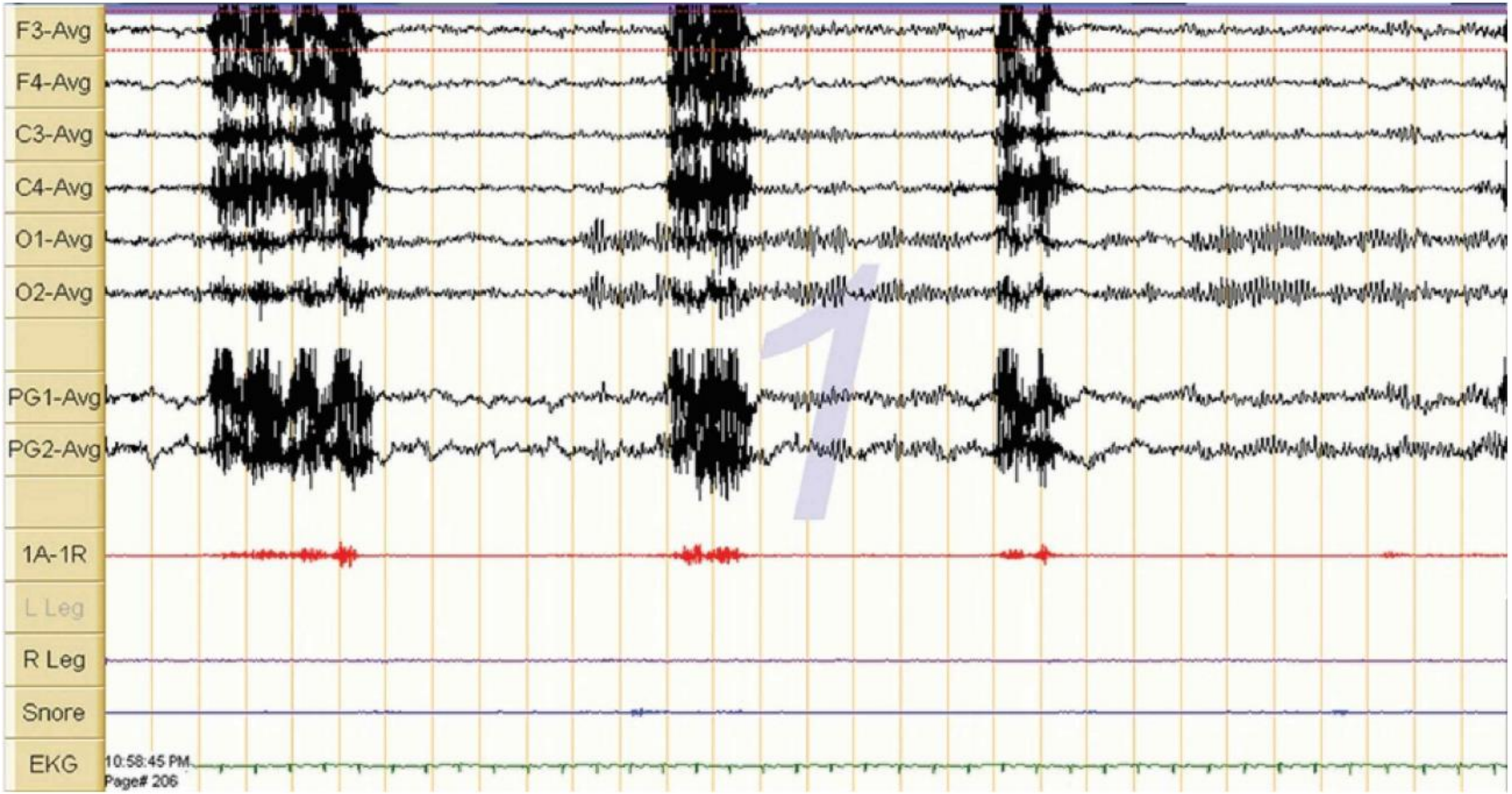


Figure 13.53 Three episodes of sustained bruxism: Three episodes are three seconds apart, hence they will be considered as separate episodes of Brixusm.

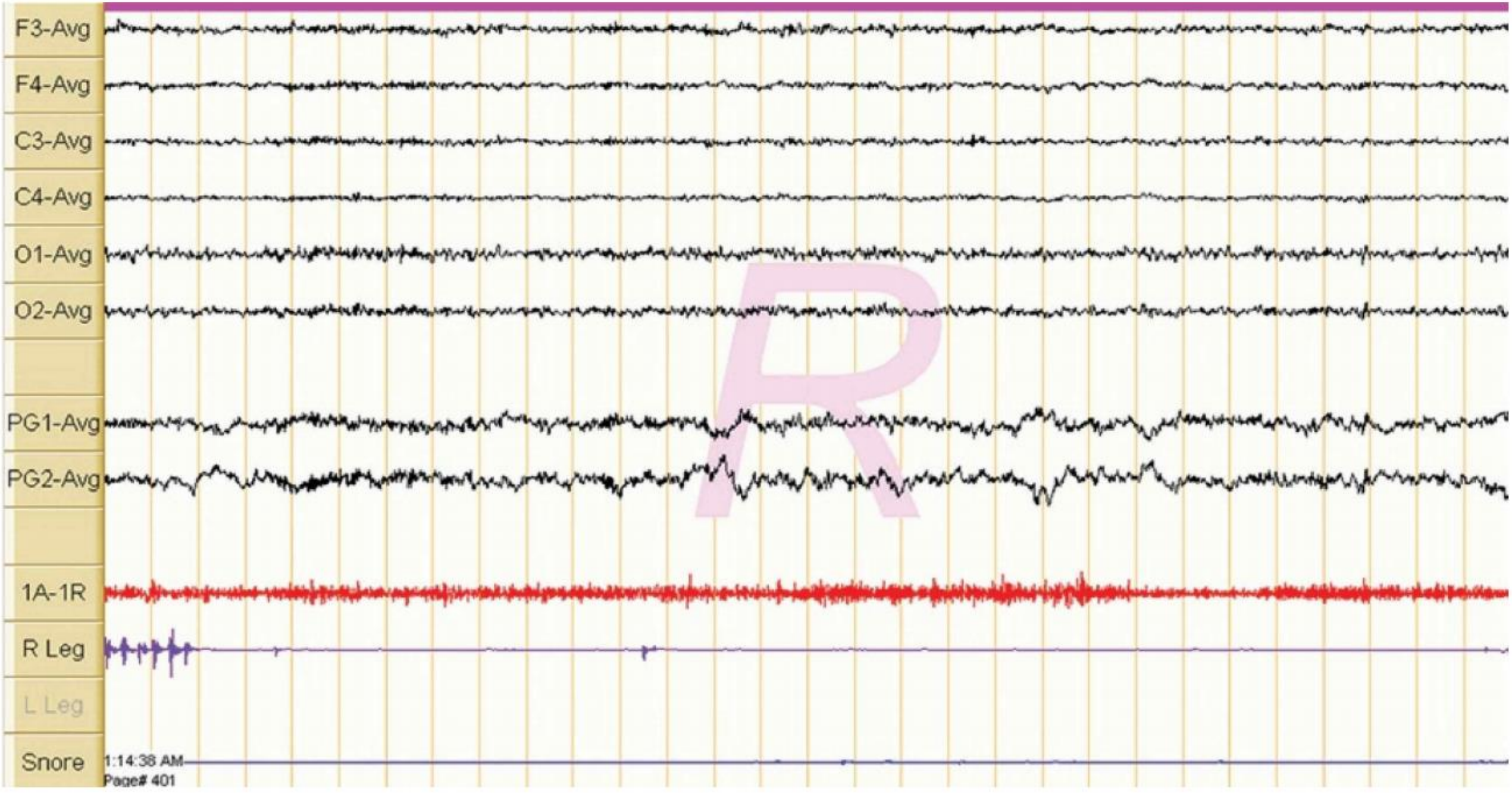


Figure 13.54A REM sleep without Atonia. Sustained muscle activity is seen in this epoch throughout (chin EMG: Channel 1A-1R).

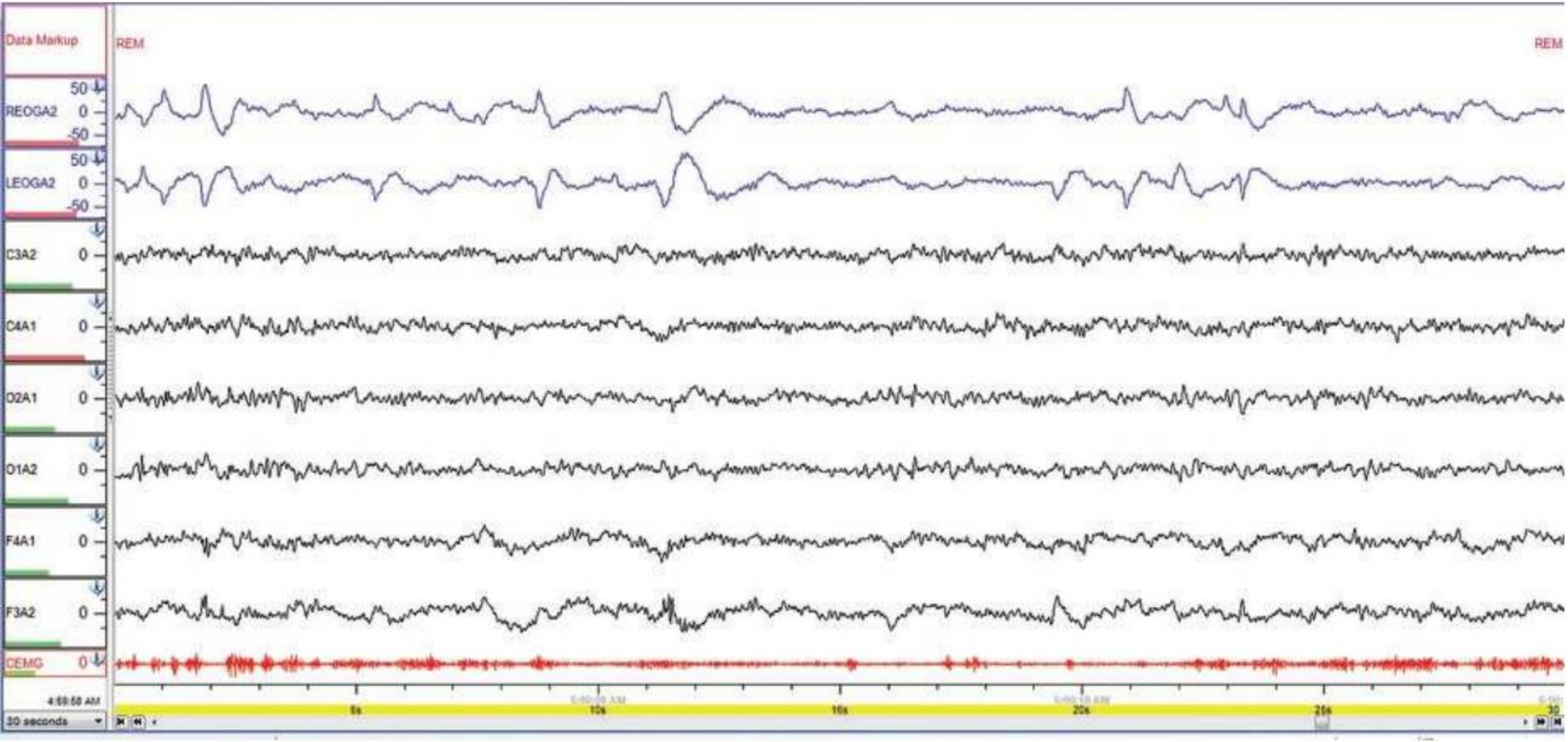


Figure 13.54B REM sleep without atonia: Most of epoch shows loss of muscle atonia in chin EMG during REM.

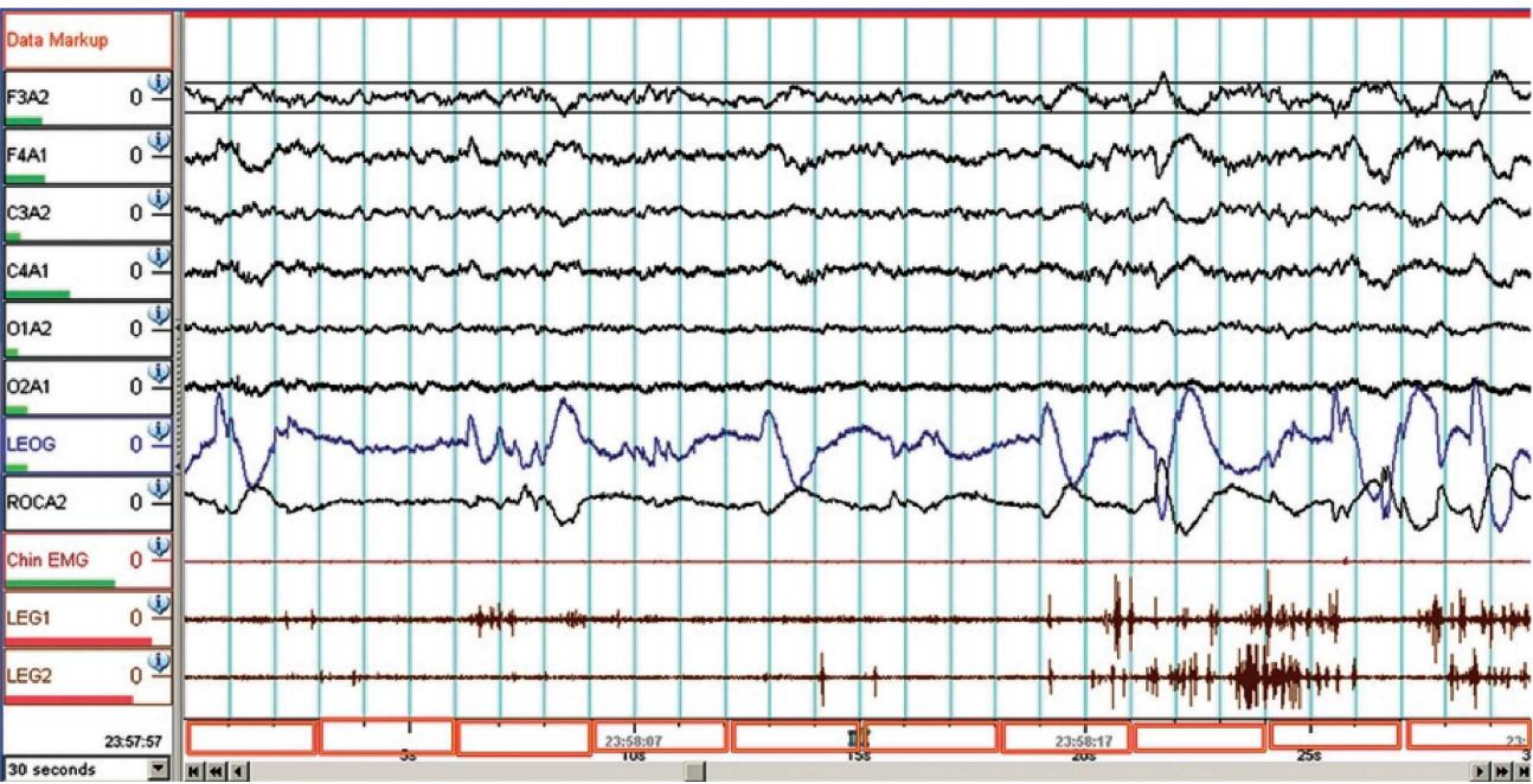


Figure 13.55 Excessive fragmentary transient muscle activity also suggests REMBD. It is scored by diving a 30 seconds epoch into 10 mini-epochs of 3 seconds duration each.

ECG events

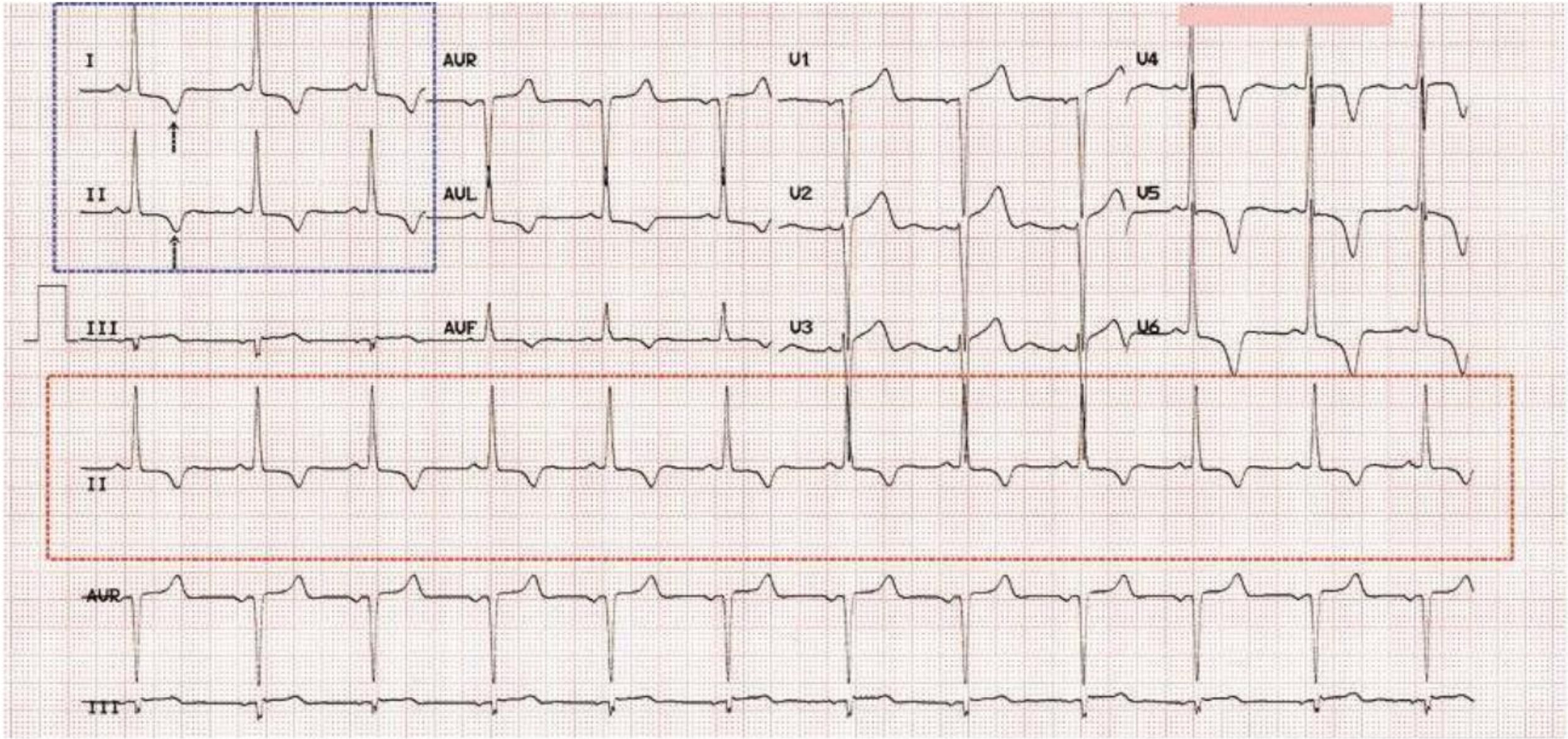


Figure 13.56 ECG-left ventricular hypertrophy: Asymmetrical T wave inversion in both derivations I and II (Blue box). Also see in the long run in Lead II (Red Box). In such cases, Physician's opinion must be sough as this may be seen in a number of non-life threatening conditions, e.g., Left ventricular hypertrophy as well as potentially life threatening conditions, e.g., Myocardial infarction. However, in myocardial infarction, inverted T waves are symmetrical.

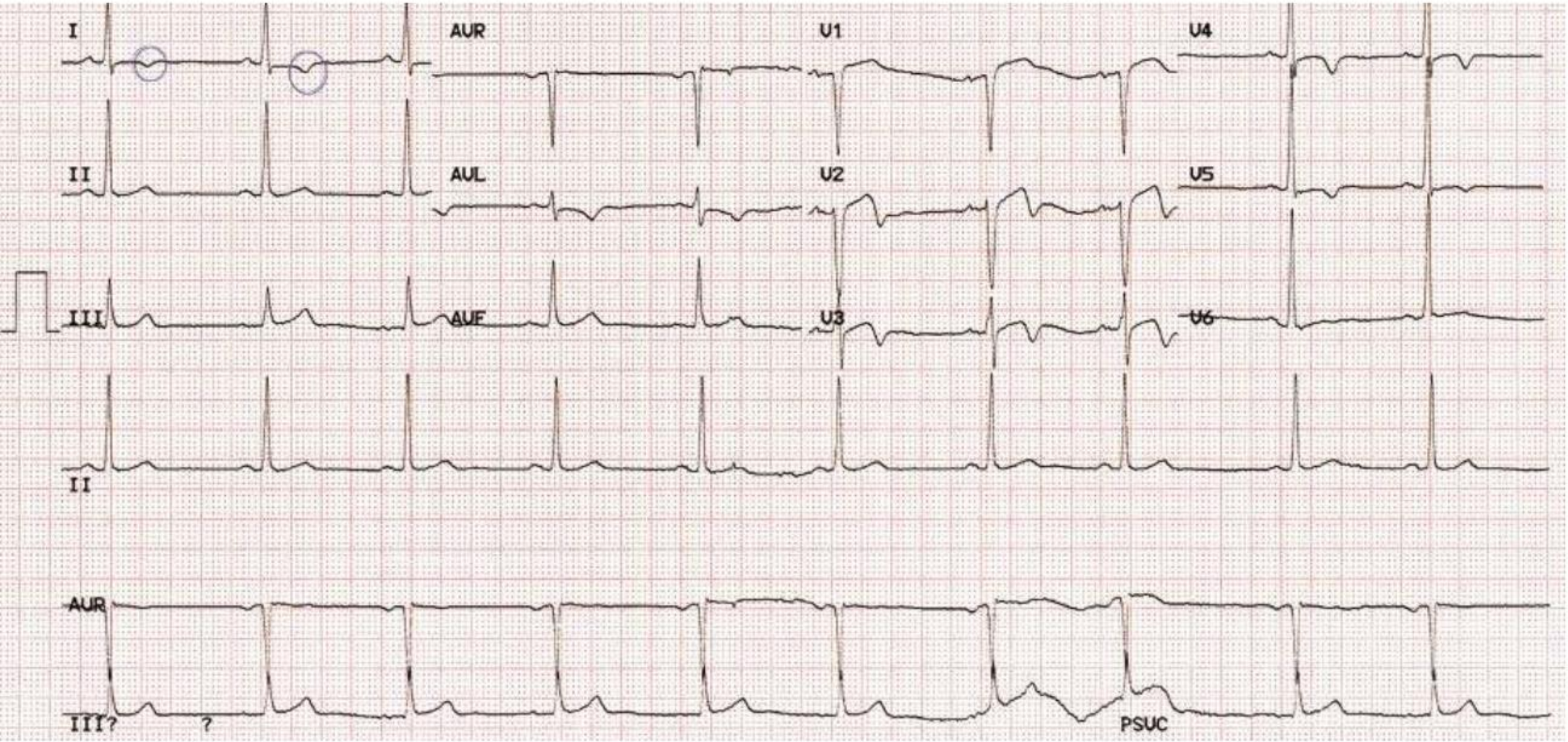


Figure 13.57 T wave inversion: Symmetrical T wave inversion is seen in lead I. in such cases opinion from a physician should be sought immediately and complete 12 derivations ECG must be obtained.

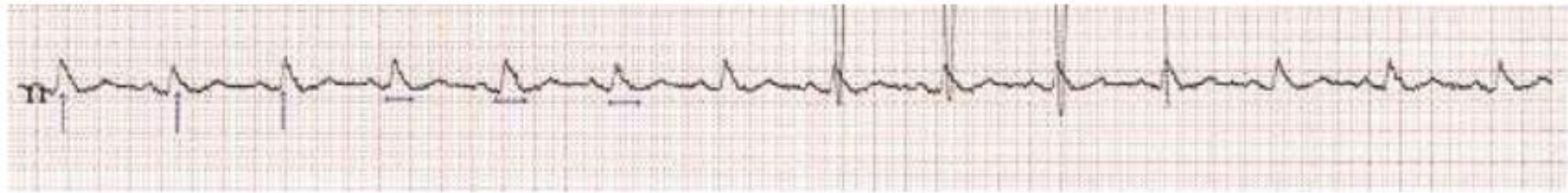


Figure 13.58 Wide QRS complex: This ECG shows wide QRS complex (arrows) (duration >120 msec; line segments) suggestive of bundle branch block.

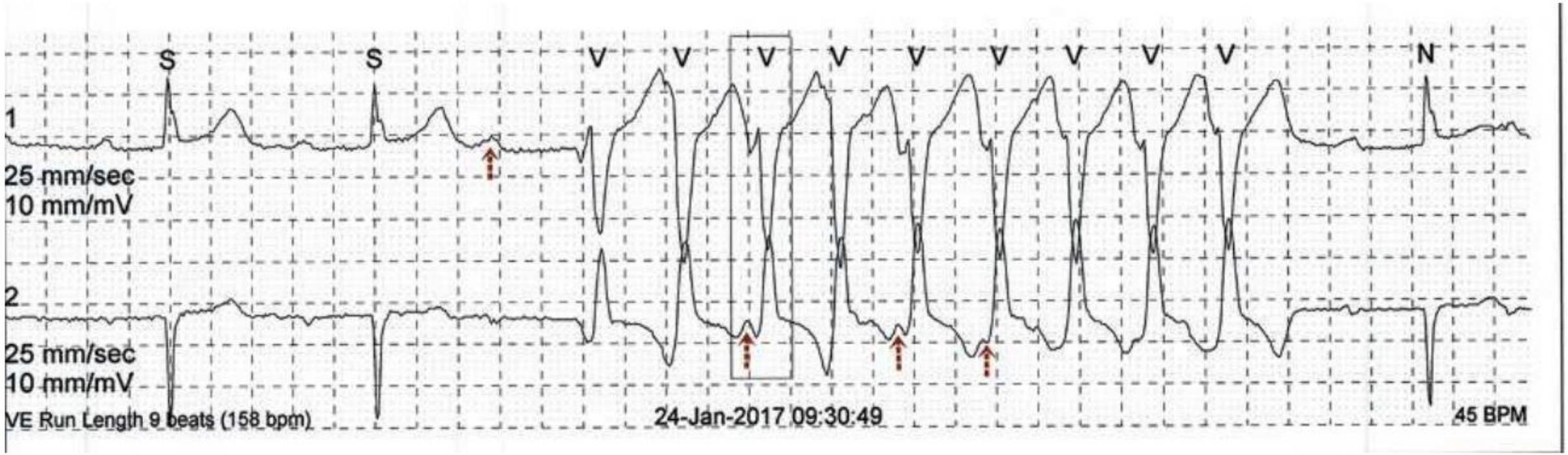


Figure 13.59 This ECG shows short lasting Ventricular Tachycardia. In this ECG, P wave (red arrows) is independent of QRS complex even during tachycardia. Such events are pathological and should be immediately reported to attending Physician.

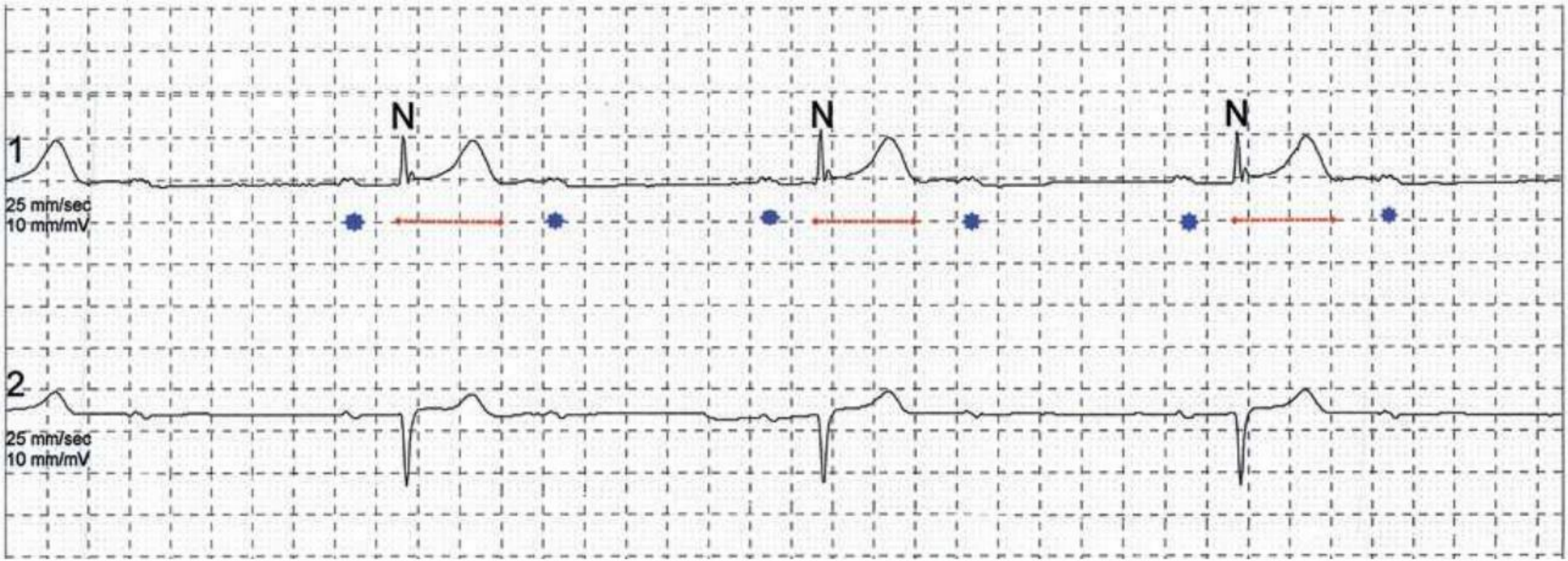


Figure 13.60 2:1 heart block: This ECG shows 2:1 AV block. QRS complex (redline segment) appears after every two waves (blue stars).

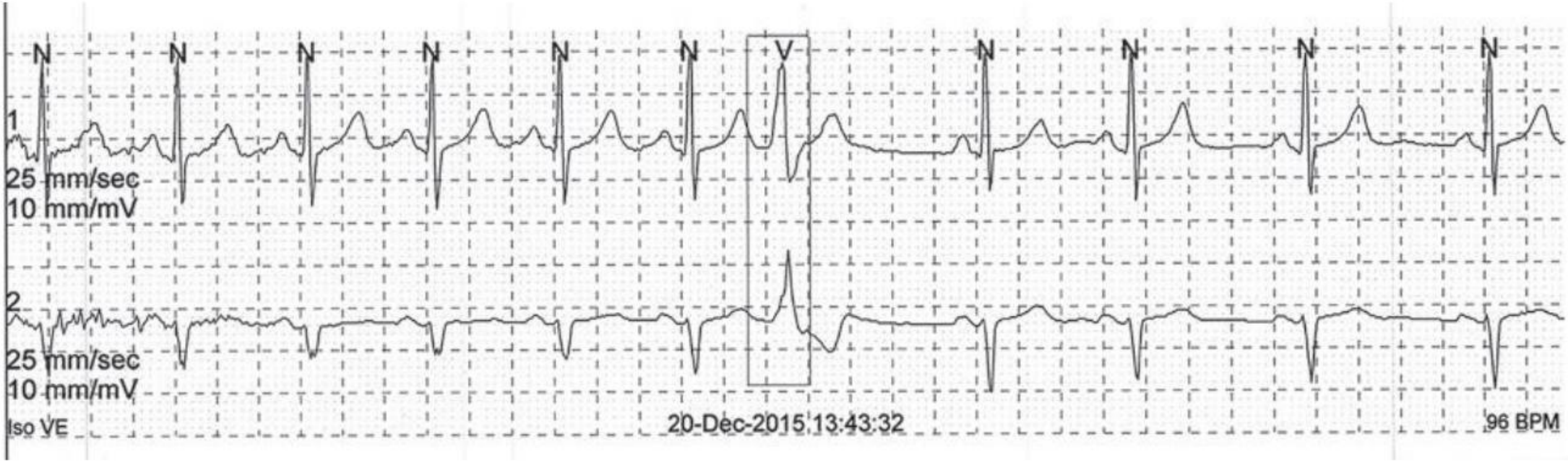


Figure 13.61 VPC: This ECG shows ventricular premature beat (marked in box as V) in between normal beats (Marked as N). Look that VPC lacks P wave, hence, ventricular in origin.

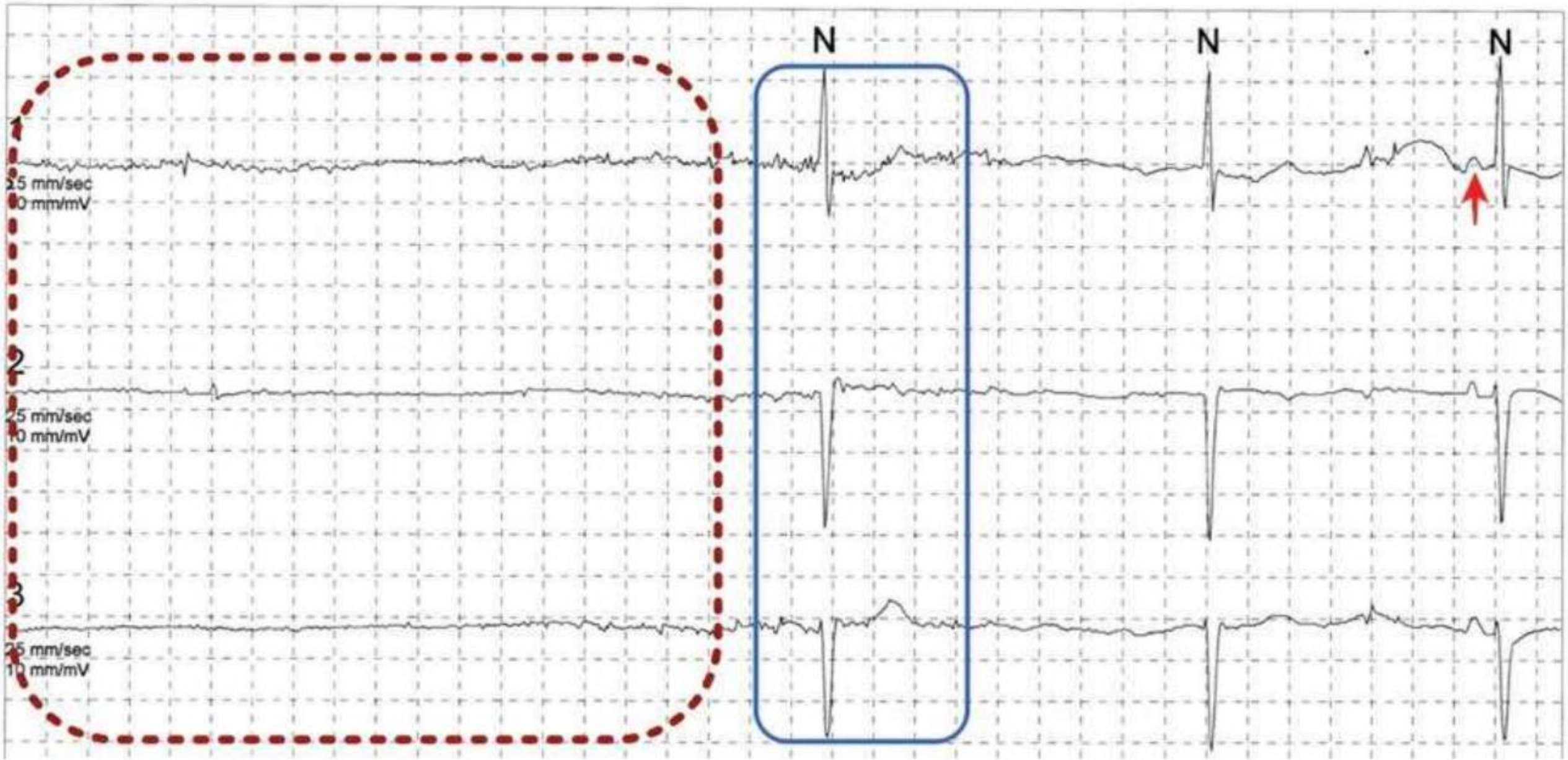


Figure 13.62 Asystole: This ECG shows cardiac asystole (Maroon box). The baseline is flickering giving appearance of AF. Asystole is followed by one QRS-T complex (Blue box), which is functional in origin and P wave is absent. Last beat is QRS complex is preceded by P wave (red arrow).

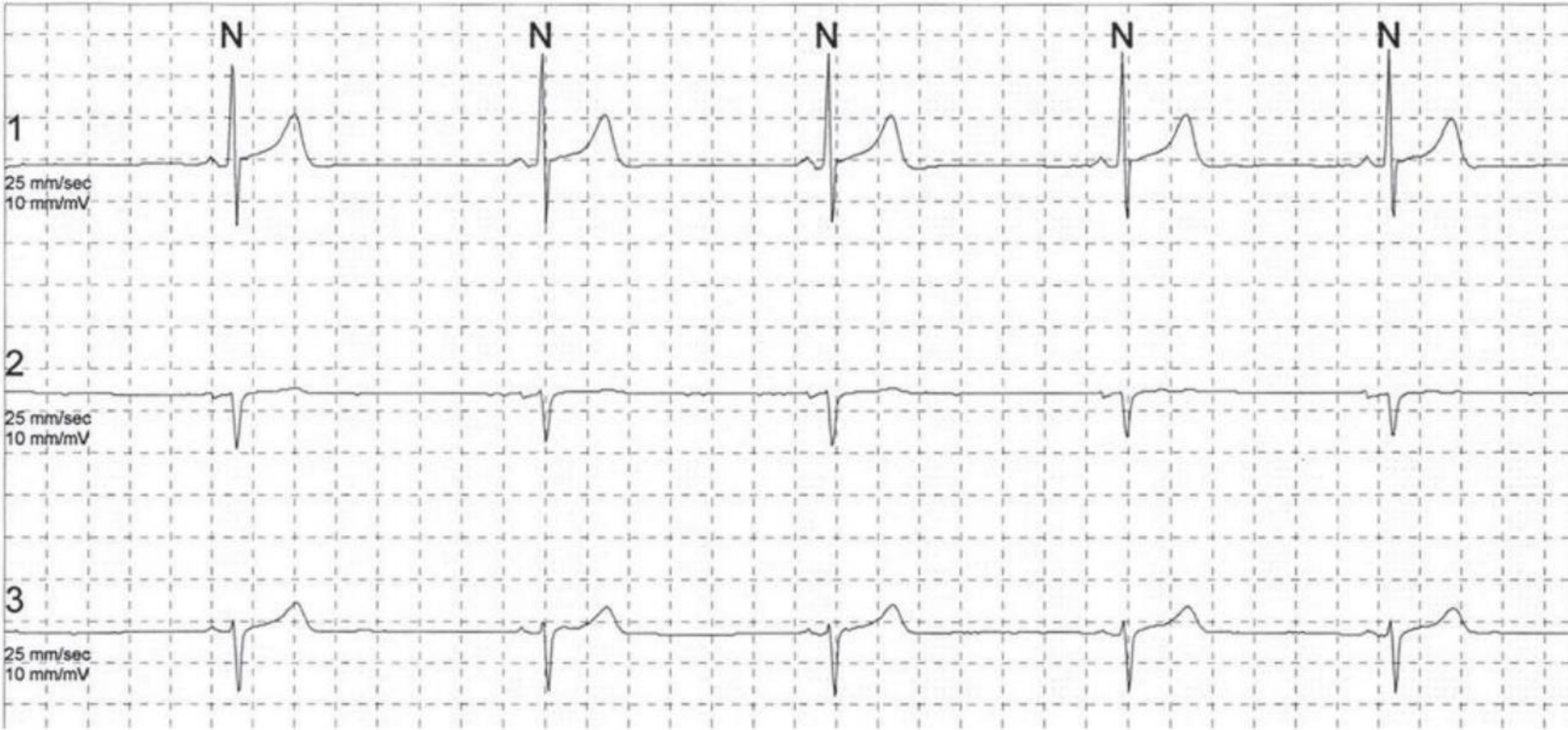


Figure 13.63 Bradycardia: This ECG shows sinus bradycardia with PQRST waves but they are widely placed. One big square of ECG represents 0.2 seconds duration. Heart rate is calculated by dividing 60 with the RR interval. In this case RR interval is 1.4 seconds. Hence, heart rate is 42/min..

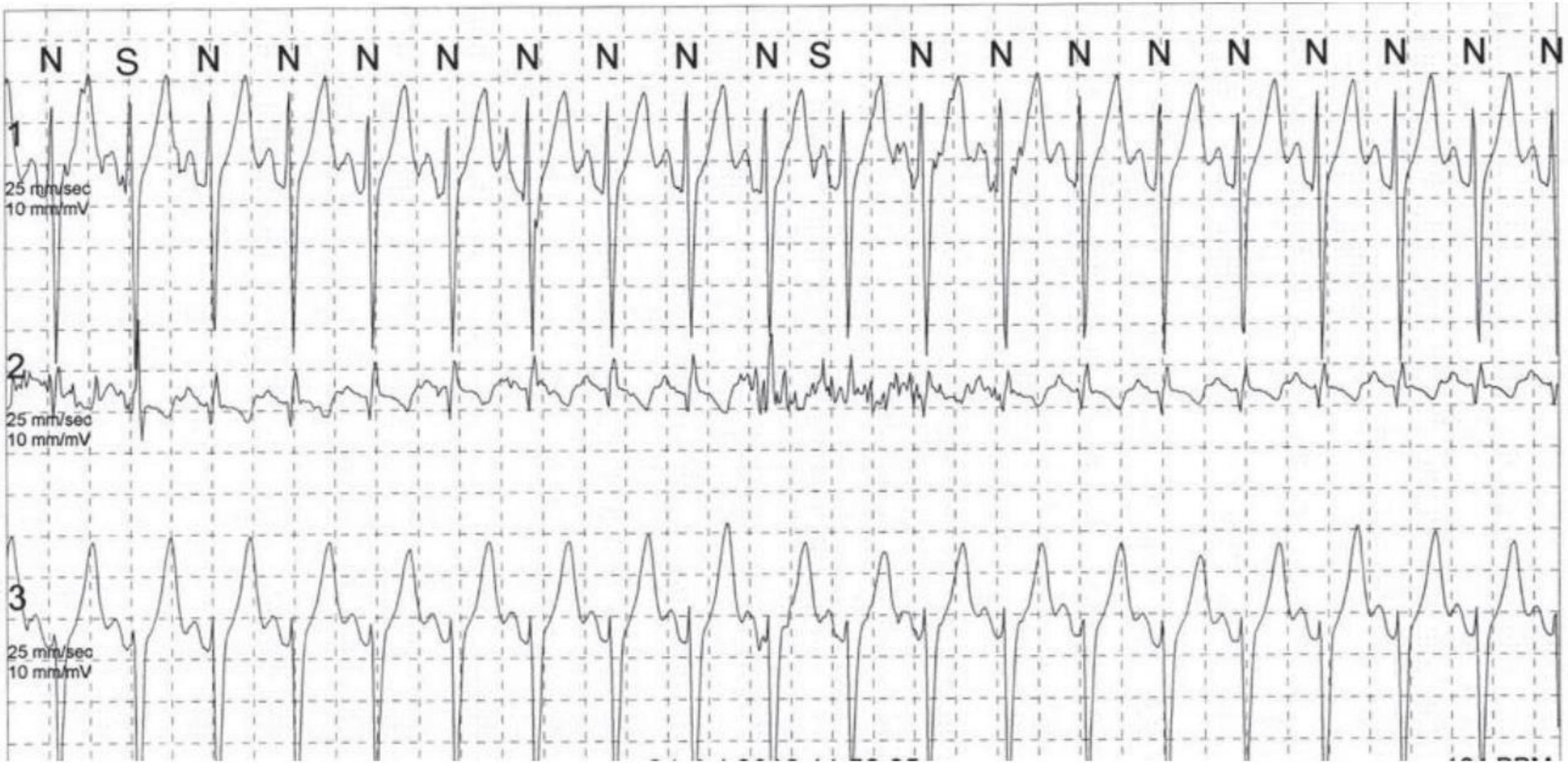


Figure 13.64 Tachycardia: This ECG shows sinus tachycardia with PQRST waves but they are closely placed. Heart rate is 150/min.



Figure 13.65 Grade 1 AV block: This ECG shows prolonged PR interval. If it is longer than 0.2 seconds, it is considered as AV block. This ECG shows PR interval of nearly 0.4 seconds which is equal duration throughout the strip and regular QRS complex following each P wave. Hence, this is first degree AV block.