ST/AR

ST segment and arrhythmia monitoring

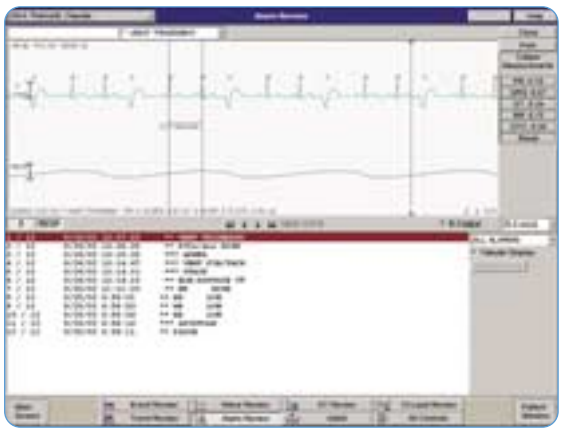
ST/AR is a powerful algorithm designed for ST segment and arrhythmia analysis from multiple ECG leads. The arrhythmia monitoring algorithm processes ECG signals from single or multiple leads for real-time arrhythmia detection on adult, pediatric, and neonatal patients. The ST segment algorithm analyzes up to 12 leads of ST segment changes in adult patients.

Leadership in ST and arrhythmia monitoring

Nearly three decades ago, Philips introduced its first real-time computerized arrhythmia monitoring system – and continues to build upon proven measurement and monitoring expertise, continually enhancing performance and functionality of our best-in-class and innovative measurements and algorithms.

The ST/AR algorithm is integrated in a wide range of Philips ECG monitoring systems – from our high-end patient monitors to telemetry to the central station – to support clinicians' decision making.

IntelliVue Information Center ST Review with superimposed waveforms for quick analysis of ST change.



Alarm Review showing beat labels and arrhythmia identification with tabular display of selected alarm group. Additional features for arrhythmia assessment include electronic calipers for measuring intervals, strip recordings, and printed reports.

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Arrhythmia Analysis

The ST/AR algorithm provides real-time arrhythmia detection with innovative features such as a highly sophisticated algorithm that combines multiple ECG leads for the detection of QRS complexes; applies a dual independent filtering system; and combines feature extraction and template matching for greater precision in the classification of QRS complexes. ST/AR is a ventricular oriented algorithm; however, the algorithm is also capable of detecting a number of atrial arrhythmia such as SVT and atrial fibrillation with variable ventricular response (indicated as irregular heart rate).

QRS detection

- Patented process for continuous monitoring of ECG signal quality across all leads, ensuring an optimal, uninterrupted QRS detection
- Two independent digital filters: one for the enhancement of the QRS detection and the other for QRS classification
- User-adjustable minimum detection threshold for monitoring ECG signals with large P or T waves, low amplitude complexes, and other difficult ECG complexes can be set at the Information Center

Arrhythmia analysis with beat labels and user-adjustable QRS detection.

QRS classification

- Combination of feature extraction and template matching increases precision in classifying QRS complexes
- Multiple beats are examined as a group for classification based on adaptive expert rules
- Up to 16 templates for each ECG channel are used to capture ECG morphology for beat classification

Paced processing

- Innovative algorithm for processing both single and dual chamber pacemakers
- Patented algorithms provide pace pulse analysis and pace beat classification

Rapid learning

ST/AR features a fast learning algorithm, requiring only 15 beats for recognition of the dominant rhythm. Templates are continuously adapted to the patient's QRS morphology for arrhythmia analysis. During the learning phase, the detection of asystole or ventricular fibrillation is active for immediate notification of the most life threatening arrhythmias.

Alarm structure

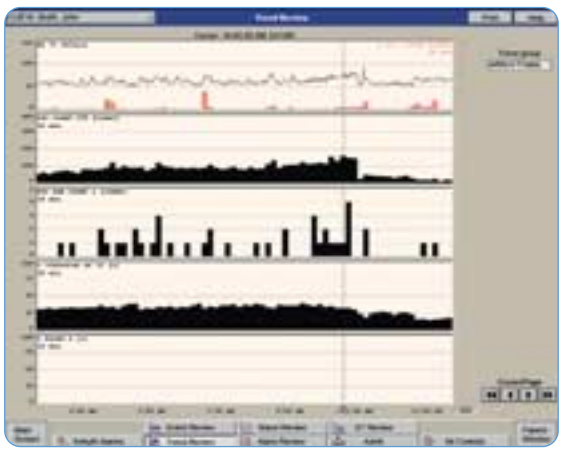
- Identification of 22 alarm conditions
- Alarm conditions are classified into multiple groups, with announcement of only the highest priority alarms in each group, helping to reduce redundant alarms
- User-defined limits for a number of alarm conditions, including pause, asystole, and ventricular tachycardia
- User-adjustable SVT alarm and irregular heartbeat alarm for detection of atrial fibrillation
- Low-priority alarms can be disabled although these events continue to be trended

Neonatal arrhythmia monitoring

ST/AR arrhythmia algorithm is specifically designed for neonatal ECG characteristics, such as narrow QRS and higher heart rate. Clinicians can define a set of alarm limits specifically for neonates. Filters and noise handling are optimized for neonatal ECG signals and adaptive expert rules are used for classification of neonatal ECG waveforms

Trended data

Arrhythmia and event information generated by the ST/AR algorithm is available for comprehensive trending. These events can be used to document rhythm stability prior to transfer or discharge. This information can also be used to correlate with other trended vital signs for monitoring patients progress and response to treatment. For example, combining physiological parameters such as ventricular arrhythmia events and ST segment trends can be used to determine the root cause of the arrhythmia and support clinical decision making.



Trend Review application displays selected arrhythmias, such as PVC rate, as well as other physiological parameters for clinical correlation.

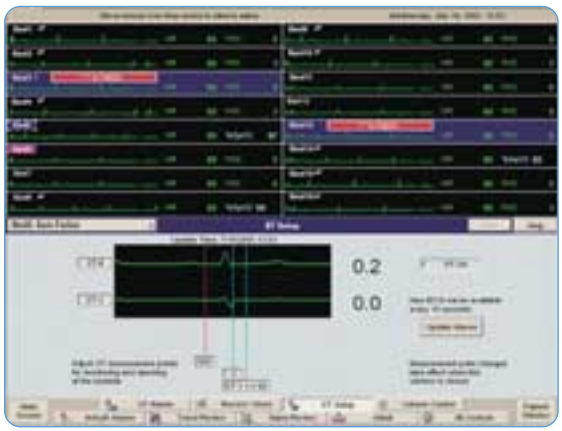
Arrhythmia performance summary

Average Performance Measures	AHA	MIT-BIH
QRS detection sensitivity (%)	99.80	99.66
QRS detection positive predictivity (%)	99.87	99.86
PVC detection sensitivity (%)	95.96	94.25
PVC detection positive predictivity (%)	98.34	96.38
PVC detection false positive rate (%)	0.16	0.27

Results of validation testing of the ST/AR arrhythmia algorithm for PVC performance against two publically available reference databases sponsored by the American Heart Association (AHA) and Massachusetts Institute of Technology/Beth Israel Hospital (MIT-BIH). *Source: ST/AR Arrhythmia Performance application note: 4522 981 82421*

ST Segment Analysis

The ST segment algorithm documents changes in ST segment in adult patients that can be indicative of the severity and duration of myocardial ischemia. Since many ischemic episodes are silent or painless, continuous monitoring of ST segment changes can provide the earliest warning of ischemic events.



Computerized ST segment analysis uses advanced algorithms to detect and evaluate ST segment changes.

Clinical indicator

ST segment changes, especially prolonged changes, can be indicative of myocardial ischemia.
In patients with known coronary artery disease, asymptomatic changes in the ST segment could indicate transient myocardial ischemia. In high-risk non-cardiac surgical patients, ST segment changes are possibly an independent predictor of perioperative cardiac events.

The strength of Philips ST segment analysis

Philips provides ST segment analysis of up to 12 leads of ECG, for greater sensitivity and a more complete view of the heart. With this comprehensive set of measurements, areas of potential ischemia may be more easily identified.

COMPATIBILITY

ST Segment and arrhythmia measurements acquired via the ST/AR algorithm are fully integrated with other key parameters on these Philips patient monitors:

- IntelliVue
- CMS 2002
- V24 and V26
- M3 and M4
- Philips Telemetry system
- IntelliVue Information Center

Please ask your sales representative for details on compatibility.

Complexes used for ST measurement

Beat detection and classification information provided by the arrhythmia algorithm are used to eliminate beats that are ventricular in origin or ventricular paced beats from ST segment analysis. All other complexes are measured, including atrial paced complexes.

Median value

A unique algorithm for determination of median ST values filters erroneous ST segment measurements, which reduces false alarms.

Measurement points

Both the isoelectric point and the J-point are user-adjustable. ST measurement points are selectable at J+60msec or J+80msec.

Alarm detection

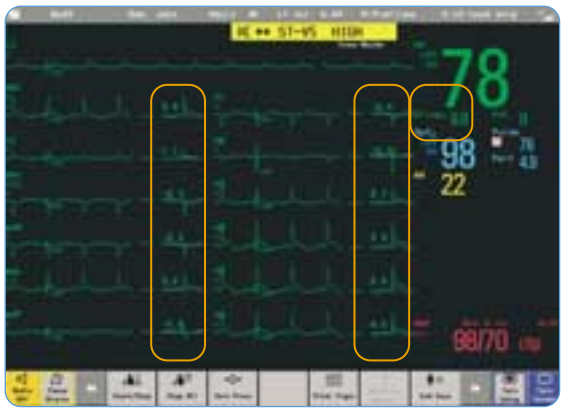
The ST monitoring algorithm supports detection of ST alarm conditions for each lead separately. ST alarms can be selected either as single- or multi-lead.

ST Index

ST Index is a unique calculation providing a single numerical indication of ST changes. The summation of the absolute values of V2, V5, and aVF is used in determining the ST index. These leads are selected for their sensitivity in anterior (V2), lateral (V5), and inferior (aVF) areas of the heart.

ST review

Individual ST values and associated waveforms may be trended for retrospective review. To facilitate the detection of ST changes, multiple ST waveforms may be selected for side-by-side comparison of different leads, or superimposed for comparison of the same lead.



IntelliVue bedside real-time 12-lead ECG with corresponding overlapping ST waveforms. Calculated ST Index is integrated on-screen with other real-time parameters.

Philips Commitment to Measurement Technologies

Philips is committed to providing best-in-class standard clinical measurements as well as innovative measurements to support clinicians' decisions at the patient's side.

Philips continues to build on its proven measurement expertise by:

- Maintaining and advancing the performance of existing, widely used standard-of-care measurements
- Investing heavily in research, development, and clinical validation of new, innovative parameters and algorithms
- Working with strategic partners to integrate next-generation measurements and technologies
- Providing interfaces to more than 100 third-party specialty measurement devices through the Philips VueLink module

References

Wang JY. Noise Stress Testing for Real-Time ST Segment Measurement Algorithms: A New Methodology. Computers in Cardiology, IEEE Computer Society Press, 2000;27:845-848.

Wang J, Yeo CL, Aquirre A. The Design and Evaluation of a New Multi-Lead Arrhythmia Monitoring Algorithm. Computers in Cardiology, IEEE Computer Society Press, 1999;26:675-678.

Yeo CL, Wang JY. Method and System for Providing Characterizations of Waveform Representations of Heart Function. US Patent 5,827,196, Oct. 27, 1998.

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