Tech Corner

Automatic Ventricular Sensitivity Control (ASC)

MicroPort™
CRM

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AVAILABILITY

This function is available on all MicroPort ICDs.

DEFINITION

The ASC is an essential of sensing used in MicroPort Implantable Cardiac Defibrillators to ensure appropriate sensing for all ventricular rhythms at all rates. It dynamically adapts the sensitivity to the changing endocardial signal in an attempt to detect each and every R wave.

What does the ventricular ASC do?

The automatic sensitivity control optimizes arrhythmia detection and avoids late detection of T-waves and over-detection of wide QRS waves. The device automatically adjusts the sensitivities based on the initial ventricular endocardial sensed amplitude, except in the event of arrhythmia suspicion and paced rhythms where pre-defined sensitivities are used. Basically the ASC applies a lower sensitivity when T wave is likely to occur and a higher sensitivity afterwards.

DESCRIPTION OF THE FUNCTIONING

The programmable ventricular sensitivity setting determines the minimum signal sensing threshold to trigger a ventricular detection. To accommodate larger signals, the ICD uses an automatic ventricular sensitivity control as described below. The minimum value allowed is 0.4 mV, but ranges up to 4.0 mV in 0.2 mV increments. The as-shipped value is 0.4 mV. Proper sensing of arrhythmia detection can be assessed through induction of tachycardia or fibrillation in the hospital setting.

Automatic ventricular sensitivity control during the arrhythmia suspicion

A phase of fast arrhythmia suspicion starts as soon as one RR interval is detected above the Fast VT/VF rate. The sensitivity applied after the 500 ms period is then the programmed sensitivity for all subsequent cycles, as long as the arrhythmia suspicion phase has not ended.

The arrhythmia suspicion phase ends when a slow rhythm majority is found (6 RR intervals below the Slow VT rate out of 8).

Automatic ventricular sensitivity control: Post-V sensing

When sensing a spontaneous ventricular event, the leading edge endocardial amplitude is measured during 64 ms and the ventricular sensitivity is automatically set according to this measurement until the next ventricular event. Thus the ventricular sensing threshold depends on the sensed R wave amplitude:

R wave amplitude > 6.2 mV

In this case, the ventricular sensing threshold is set as follow:
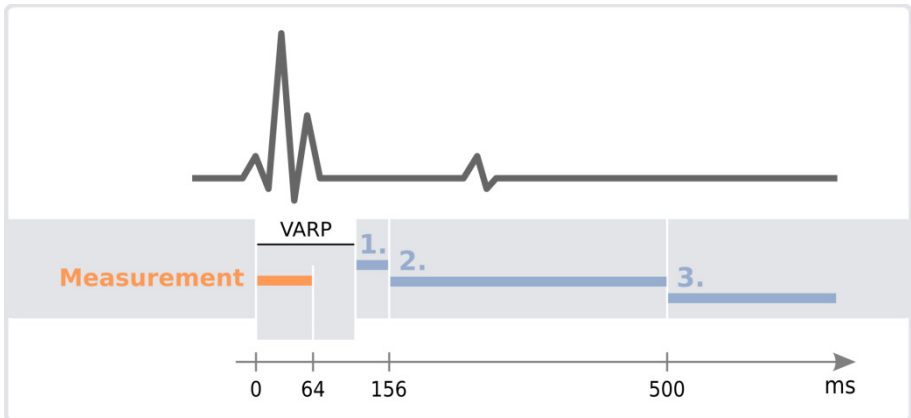
The sensitivity is set:	
1.	At 3.1 mV (= ½ of 6.2 mV) for the first 156 ms following the start of the amplitude measurement
2.	Then decreases to 1.5 mV (= ¼ of 6.2 mV) between 156 and 500 ms following the start of the amplitude measurement
3.	At 1.0 mV (or the programmed sensitivity if the value is higher) from 500 ms following the start of the amplitude measurement until the next cardiac cycle. If one RR interval is sensed in the Fast VT/VF zone, the ventricular sensitivity is set to the programmed sensitivity, not 1.0 mV (unless this is the programmed value)
VARP	Ventricular Absolute Refractory Period of 125 ms (fixed period of 95 ms + 30 ms that can be retriggered in the event of detection within this 30 ms period)

Example 1: Automatic Ventricular Sensitivity Control when the R wave amplitude is measured at a value = 10 mV
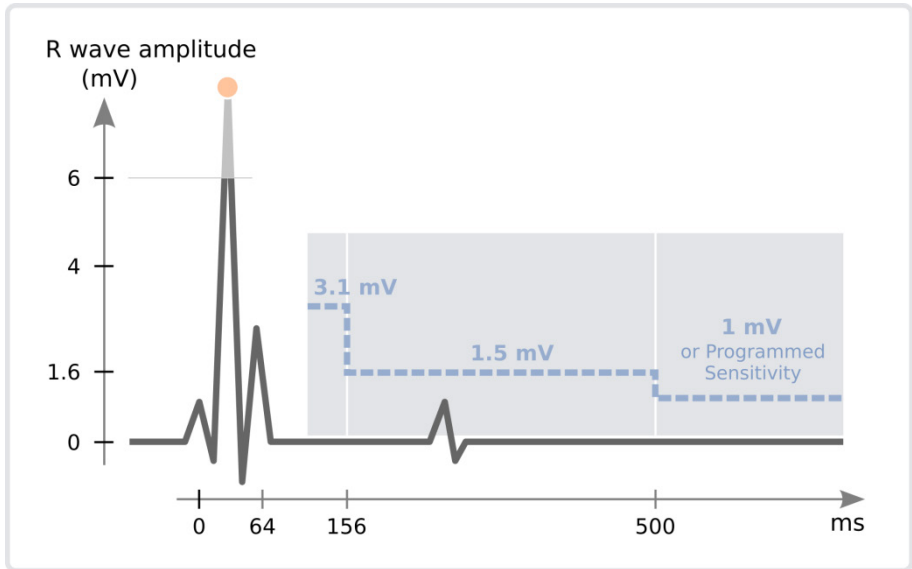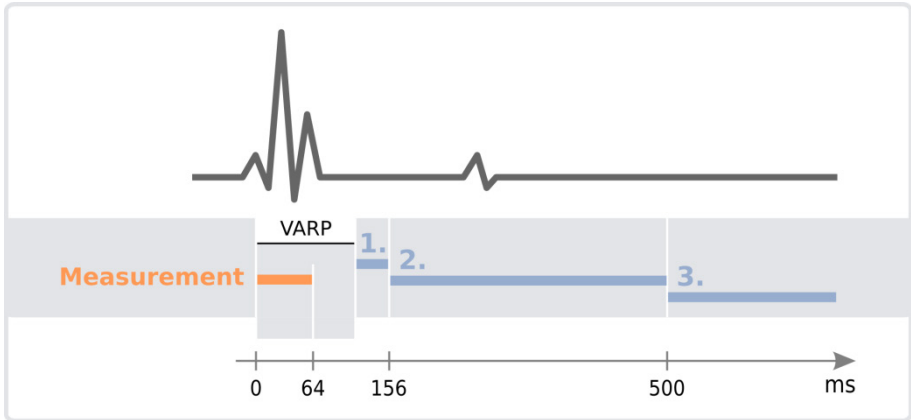

Figure 3: R wave amplitude > 6.2 mV

	Description
1.	When the R wave amplitude is measured ≥ 6.2 mV, the sensitivity is set at **3.1 mV** for 156 ms following the start of the amplitude measurement
2.	The sensitivity is set at **1.5 mV** between 156 and 500 ms following the start of the amplitude measurement
3.	The sensitivity is set at **1.0 mV** (or the programmed sensitivity if the value is higher) from 500 ms following the start of the amplitude measurement until the next cardiac event. If one RR interval is sensed in the Fast VT/VF zone, the ventricular sensitivity is set at the programmed sensitivity, not 1.0 mV (unless this is the programmed value).

4 mV ≤ R wave amplitude ≤ 6.2 mV

In this case, the ventricular sensing threshold is set as follow:

The sensitivity is set:	
1.	Between 1/4 and 1/2 (coefficient varies linearly from 1.6 to 6.2 mV) of the measured amplitude for 156 ms following the start of the amplitude measurement
2.	At 1/4 of the measured amplitude between 156 and 500 ms following the start of the amplitude measurement
3.	At 1.0 mV (or the programmed sensitivity if the value is higher) from 500 ms following the start of the amplitude measurement until the next cardiac event. If one RR interval is sensed in the Fast VT/VF zone, the ventricular sensitivity is set at the programmed sensitivity, not 1.0 mV (unless this is the programmed value)
VARP	Ventricular Absolute Refractory Period of 125 ms (fixed period of 95 ms + 30 ms that can be retriggered in the event of detection within this 30 ms period)

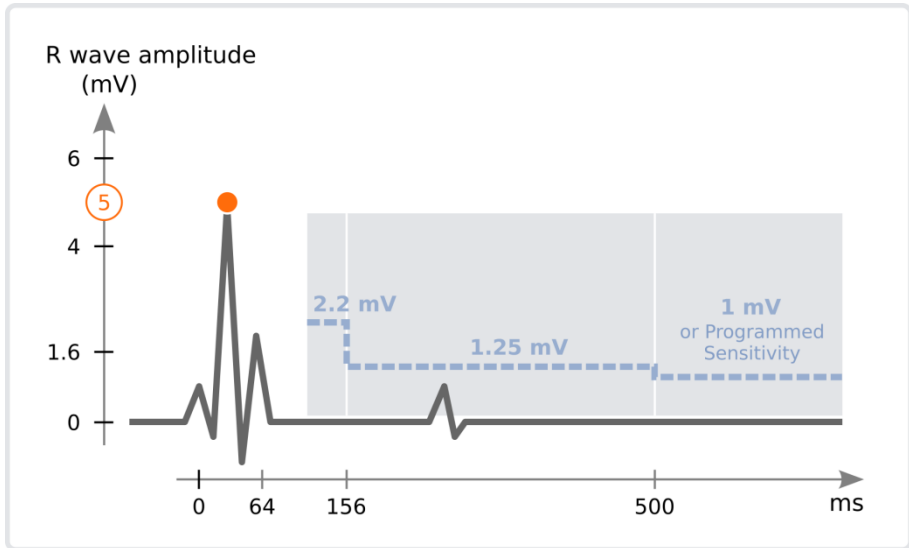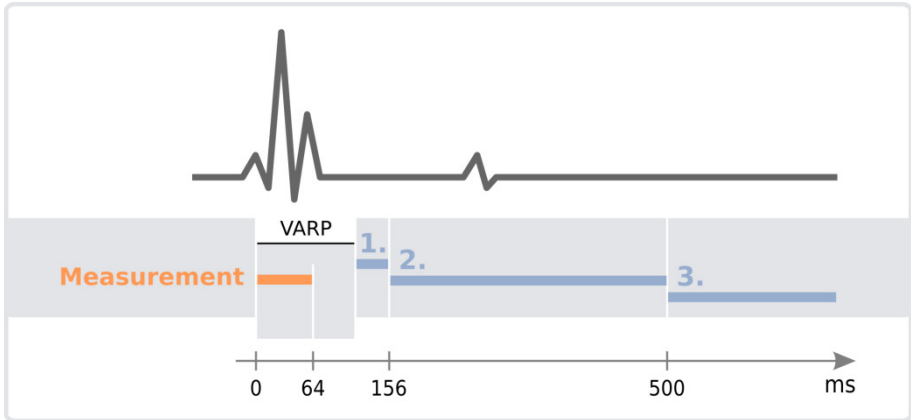**Example 2:** Automatic Ventricular Sensitivity Control when the R wave amplitude is measured at 5 mV

Figure 2: R wave amplitude = 5 mV

Description	
1.	When the R wave amplitude is measured at 5 mV, the sensitivity is set at **2.2 mV** (since the coefficient varies linearly from 1.6 to 6.2 mV) of the measured amplitude, for 156 ms following the start of the amplitude measurement
2.	The sensitivity is then set at **1.25 mV** (= 1/4 of the measured amplitude) between 156 and 500 ms following the start of the amplitude measurement
3.	The sensitivity is set at **1.0 mV** (or the programmed sensitivity if the value is higher) from 500 ms following the start of the amplitude measurement until the next cardiac event. If one RR interval is sensed in the Fast VT/VF zone, the ventricular sensitivity will be set at the programmed sensitivity, not 1.0 mV (unless this is the programmed value).

1.6 mV ≤ R wave amplitude ≤ 4 mV

In this case, the ventricular sensing threshold is set as follow:

The sensitivity is set:	
1.	Between 1/4 and 1/2 (coefficient varies linearly from 1.6 to 6.2 mV) of the measured amplitude for 156 ms following the start of the amplitude measurement
2.	At 1/4 of the measured amplitude between 156 and 500 ms following the start of the amplitude measurement
3.	At the programmed ventricular sensitivity from 500 ms following the start of the amplitude measurement until the next cardiac event
VARP	Ventricular Absolute Refractory Period of 125 ms (fixed period of 95 ms + 30 ms that can be retriggered in the event of detection within this 30 ms period)

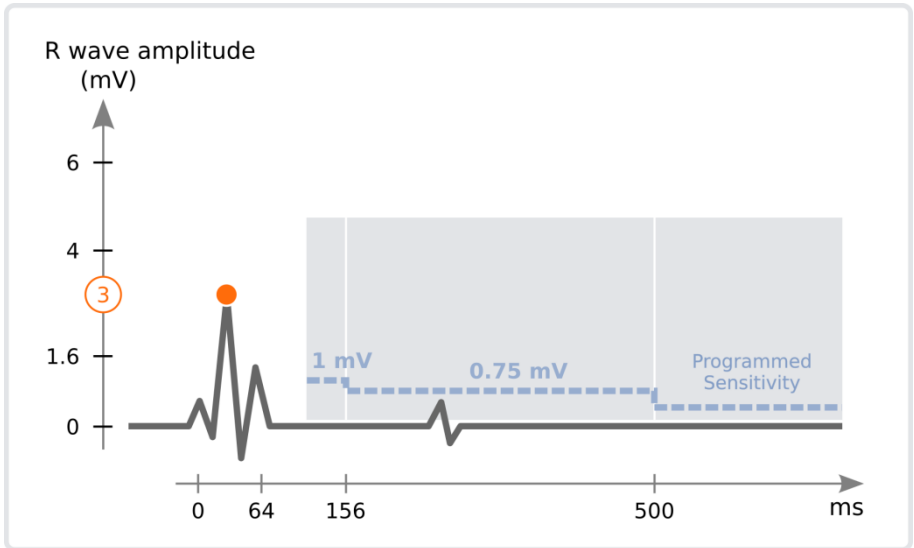**Example 3:** Automatic Ventricular Sensitivity Control when the R wave amplitude is measured at 3 mV:

Figure 1: R wave amplitude = 3 mV

	Description
1.	When the R wave amplitude is measured at 3 mV, the sensitivity is set at **1 mV** (since the coefficient varies linearly from 1.6 to 6.2 mV) of the measured amplitude, for 156 ms following the start of the amplitude measurement
2.	The sensitivity is then set at **0.75 mV** (= 1/4 of the measured amplitude) between 156 and 500 ms following the start of the amplitude measurement
3.	At the **programmed ventricular sensitivity** from 500 ms following the start of the amplitude measurement until the next cardiac event

R wave amplitude < 1.6 mV

In this case, the ventricular sensing threshold is set at the programmed ventricular sensitivity until the next R sensed event. There is no dynamic adjustment of the sensitivity setting following an intrinsic event of such low amplitude.
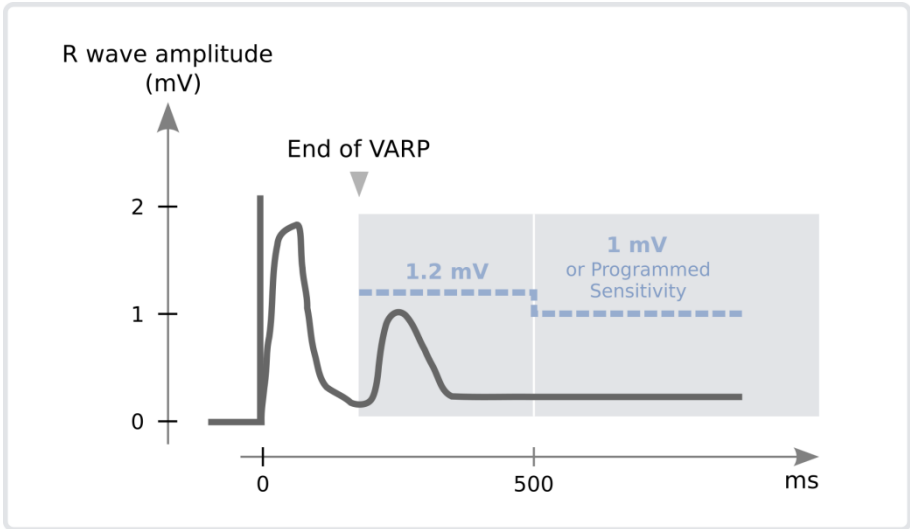
AUTOMATIC VENTRICULAR SENSITIVITY CONTROL: POST-V PACING

When pacing, there is no initial endocardial signal to measure. Therefore a programmed value is arbitrarily selected. To reduce the likelihood of T-wave oversensing or potential double-counting due to long conduction issues, the automatic ventricular sensitivity functions as follows:

- For the first 500 ms following the paced event, the ventricular sensing threshold is set at the programmed ventricular sensitivity increased by the "V margin post-V pacing" parameter. This parameter is a value, in mV, which is the augmentation of the minimum sensitivity setting. This value is programmable from 0.0 to 2.0 mV in 0.2 mV increments.

- After 500 ms, the ventricular sensing threshold is set to 1 mV (or the programmed ventricular sensitivity value if higher). If one RR interval is sensed in the Fast VT/VF zone, the ventricular sensitivity will be set at the programmed sensitivity, not 1.0 mV (unless this is the programmed value).

Example: Automatic Ventricular Sensitivity Control after ventricular pacing

Automatic Sensitivity Control post-ventricular pacing

Description	
1.2 mV[1]	Here the programmed ventricular sensitivity = 0.4 mV and the V margin post-V pacing parameter = 0.8 mV[1]: therefore the sensitivity is set at [0.4 + 0.8] = **1.2 mV** for the first 500 ms following the paced event
1 mV (or prog. sensitivity)	After 500 ms, the ventricular sensing threshold is set to **1.0 mV** (or the programmed sensitivity if the value is higher).

[1] *as-shipped value*

WHAT YOU MUST REMEMBER

Post spontaneous R wave

The ventricular sensing threshold is automatically adapted during the 500 ms following the ventricular sensing in order to avoid over-detection of wide QRS waves and late detection of T-waves. 500 ms after the R wave sensing 1 mV sensing threshold will be applied except if:

- fast arrhythmia is suspected
- the measured R wave is smaller than 4 mV

In these cases the sensing threshold is the programmed ventricular sensitivity.

In the event the measured R wave is smaller than 1.6 mV the programmed ventricular sensitivity is applied.

Post-ventricular pacing

The ventricular sensing threshold is the programmed ventricular sensitivity plus the ventricular post pacing margin during the first 500 ms. Then the ventricular sensing threshold is 1 mV except if fast arrhythmia is suspected. In this case the sensing threshold is the programmed ventricular sensitivity.

Refer to user's manual furnished with the device for complete instructions for use (www.microportmanuals.com).