ION8600 Sag/Swell Module

The PowerLogic™ ION8600 Sag/Swell module monitors voltage inputs for disturbances, which are defined as one or more of the inputs straying above a high limit (swells) or below a low limit (sags or interruptions). When it detects a disturbance, the Sag/Swell module provides information about the entire disturbance; in addition, it breaks up the disturbance into discrete components, or *sub-disturbances*, to provide for a more detailed analysis.

NOTE

The modifications described in this document are specific to the ION8600 meter.

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Introduction

The primary application for the Sag/Swell module is voltage quality monitoring and analysis. The module monitors voltage inputs for disturbances, which are defined as one or more of the inputs straying above a high limit (swells) or below a low limit (sags or interruptions). When it detects a disturbance, the Sag/Swell module provides information about the entire disturbance; in addition, it breaks up the disturbance into discrete components, or *sub-disturbances*, to provide for a more detailed analysis.

Sag/Swell Module in the ION8600

The Sag/Swell module in the ION8600 meter has been modified to operate a blade-powered meter in a similar manner as an auxiliary-powered meter. It now records outage duration and voltage level when the blade powered meter turns off (i.e. a true 3-phase outage). Typically, an auxiliary-powered meter records all outages as sags because the meter is still powered up when the supply voltage goes down. An outage on a blade-powered meter will cause the Sag/Swell module to respond in a similar manner.

NOTE

The modifications described below are for the ION8600 meter only.

Method of Operation

The outage duration is calculated upon start-up and is registered in the *DistDur* output register. Outage duration is calculated as the time between the start of the sag (just before the outage) and when the meter powered up again. The startup time is considered a fixed constant when calculating the outage time. The end of the outage is considered to be the time when there is enough power present for the internal power supply to turn the meter on.

- The voltage level is assumed to be 0 (zero) volts and a 0 value is registered in the *DistV1Min, DistV2Min, DistV3Min*.
- The *DistV1Engy, DistV2Engy, DistV3Engy* record 100%, lacking energy.
- *DistV1Avg, DistV2Avg, DistV3Avg* output register values are reset to zero after the power cycle and operate normally until the disturbance has finished.
- All other outputs are treated the same as they would during any other sag condition.

For more detailed information, see the *Sag/Swell* module description in the online *ION Reference*.

If there is a power outage:

If the disturbance duration is negative or it is less* than the meter startup time (approximately 6 seconds), then disturbance duration = meter startup time in seconds.

Otherwise, the disturbance duration = disturbance - meter startup time **

* caused by a backward time sync.
** includes forward time sync value.

Sag/Swell Configuration

The Sag/Swell data recorder provides details of power quality events. It is located through the following folder path on the meter's program:
Advanced Configuration > Power Quality > Sag/Swell/Transient Detection.
These data recorders, by default, log the following ION output register values:

Sag/Swell Logging

Sag/Swell Log			
DistDur	DistV2Engy	DistV1Engy	DistV3Engy
DistV1Min	DistV3Min	DistV2Min	DistNominal
DistV1Max	DistV3Max	DistV2Max	SwellLim
DistV1Avg	DistV3Avg	DistV2Avg	SagLim

Power quality configuration is provided by a number of modules, depending on your meter type: the Sag/Swell module, the Transient module, and numerous EN50160 frameworks, some of which include the Mains Signalling Evaluation modules. Sag/Swell module settings are provided below.

Sag/Swell Module Settings

The Sag/Swell module monitors voltage waveforms for sags and swells (i.e. ITI [CBEMA] Type 2 and Type 3 disturbances). It then reports each disturbance's magnitude and duration. The Sag/Swell module can also detect sub-disturbances during a Sag/Swell event.

Settings are as follows:

Setup Register	Function	Default
Swell Lim	This is the magnitude above which a voltage deviation is considered a swell.	106
Sag Lim	This is the magnitude below which a voltage deviation is considered a sag.	88
Change Crit	This is the amount a voltage signal must change during a disturbance to be considered a new sub-disturbance.	10
Nom Volts	This is the nominal power system voltage (used for all Power Quality functions).	0 [1]
EvPriority	The priority assigned to Sag/Swell and Transient module events (0 to 255, 255 is highest).	0 [2]

[1] The primary power system voltage is sometimes different than the PT Primary setup register value (i.e. when the PT Primary is used to indicate winding ratio rather than primary voltage).

[2] The *EvPriority* setup register value must be greater than the Event Log Controller module's *Cutoff* value to enable Sag/Swell events. Set *EvPriority* to zero (0) to disable Sag/Swell events.

You may need to change *Swell Lim* and *Sag Lim*, but most applications are served by the default values entered into these registers. The *Change Crit* setup register does not need to be changed for normal operation.

NOTE

If the Sag/Swell module's *Nom Volts* setup register is set to zero, all Sag/Swell module functions are disabled. *Nom Volts* is typically set when the meter is put into service. If *Nom Volts* has not been set, enter a value for your system's nominal voltage (i.e. 120, 277, or 347). The value you enter will also be used by the Transient module and in all EN50160 compliance calculations with the ION8600.

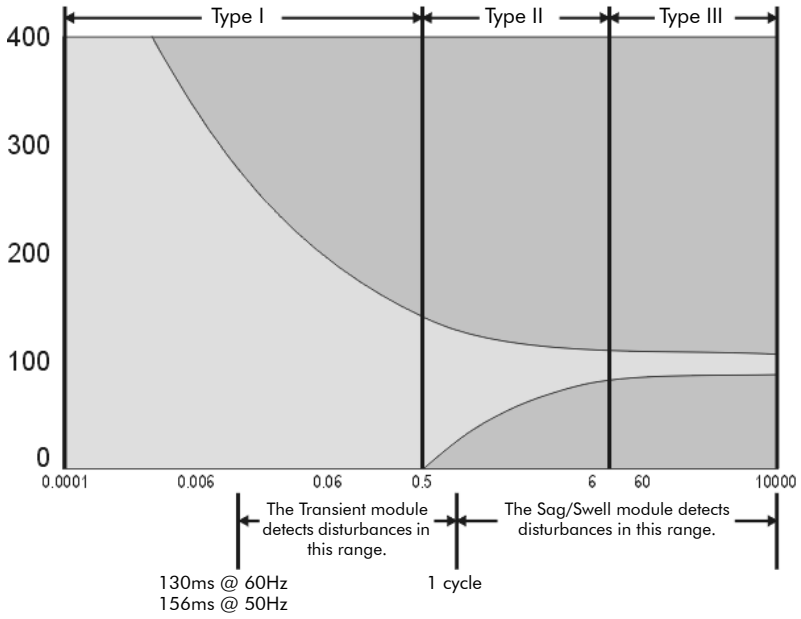
Detailed Module Operation

A major concern about disturbances in power quality is the adverse effect sags and swells can have on electrical equipment. These effects can range from a momentary disruption in operation to permanent damage, all of which can be expensive.

The severity of a sag or a swell in voltage is determined by a combination of how large it was and how long it lasted. A piece of equipment may be able to tolerate a large, but short duration disturbance in voltage. Likewise, it may be able to tolerate a disturbance that is small but longer in duration.

Power Tolerance Curves

The ITI (CBEMA) curve is a power tolerance curve that describes what types of disturbances electrical equipment can typically ride through, and what types can cause equipment failure or damage. It plots the magnitude of the disturbance (in percentage) on the Y-axis and the duration of the disturbance on the X-axis. Disturbances that fall within the envelope defined by the upper and lower curve are typically not harmful to electrical equipment; disturbances that fall outside the envelope may disrupt or damage the equipment.



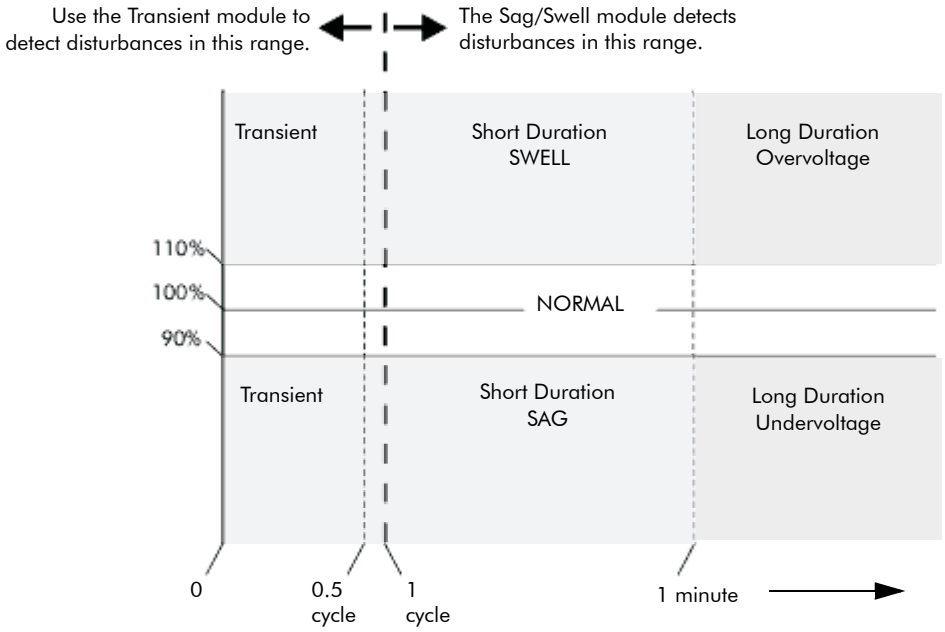
NOTE

The start of the transient detection window depends on the meter's sampling rate. See your device's documentation.

CBEMA is not the only power tolerance curve available. ANSI Standard C84.1 also defines a curve that places an upper and lower bound on voltage excursions of different durations. Both of these curves are available in the data log plotters in the Vista software. If you plot the magnitude and duration of the sub-disturbances detected by the Sag/Swell module, you can overlay either of these curves, or a custom power tolerance curve to see if equipment might be affected by the sub-disturbance.

Disturbance Categories as Defined by IEEE

The IEEE 1159 standard categorizes a wide range of electrical disturbances according to their typical duration and magnitude. The categories that are addressed by the Sag/Swell module include short-duration variations and long-duration variations. The figure below summarizes these categories:



The highlighted areas indicate changes in the input that were less than the *ChangeCrit* setup register. In these cases, there was no new sub-disturbance.

Sags and swells are described as short-duration variations; under and overvoltages are described as long-duration variations. When the voltage drops below 10% of the nominal voltage, it is called an interruption.

As a disturbance progresses, it will likely move through several of these categories. It isn't until the voltage has returned to the normal parameters that the disturbance can be categorized. Even then, a single disturbance often cannot be categorized because there were many variations. To address this, the *ChangeCrit* setup register allows you to break the disturbance into sub-disturbances.

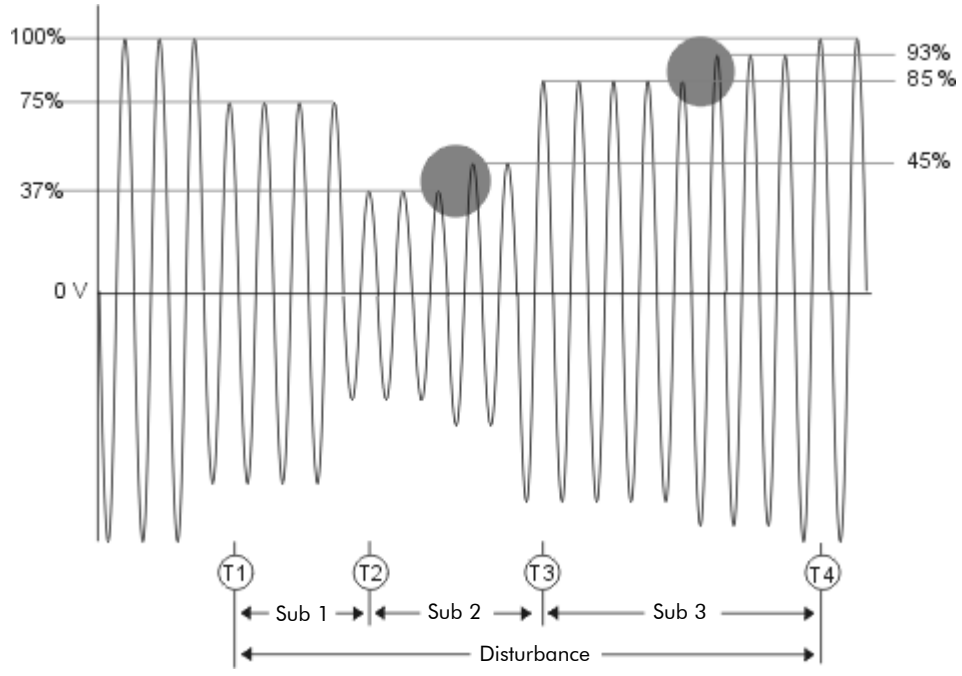
Disturbance Sub-Divisions

Within a complex disturbance, the voltage may fluctuate before returning to within the limits defined by the *Swell Lim* and the *Sag Lim* setup registers. Disturbances such as these cannot be plotted on a Magnitude vs. Duration graph since there can be many different magnitudes throughout the disturbance, each one sustained for a different duration. To address this, the Sag/Swell module breaks the disturbance up into sub-disturbances so that each part of the disturbance can be recognized and analyzed independently. During a disturbance, if the voltage on an input changes by more than the amount specified in the *ChangeCrit* register, the corresponding *SubTrig* output register will pulse, marking the beginning of a new sub-disturbance.

NOTE

The Sag/Swell module uses RMS values. Thus, in each case, it takes a full cycle for a disturbance or a sub-disturbance to be detected.

The highlighted circles indicate changes in the input that were less than the *ChangeCrit* setup register. In these cases, there was no new sub-disturbance. This diagram shows a sag disturbance on the *V1* input. In this example, the nominal voltage is 120V, the *ChangeCrit* setup register is set to 10% of nominal voltage, and the *Sag Lim* is set to 94% of nominal voltage.



T1 This is the beginning of the disturbance as well as the beginning of the first sub-disturbance. At this point, the output registers are:

- *DistState* = ON
- *DisStart* pulses
- *SubV1Trig* pulses
- *SubV1Avg* = Not Available (it was the period of normal operation)
- *SubV1Dur* = Not Available (it was the period of normal operation)

T2 This is the beginning of the second sub-disturbance because the voltage has changed by more than 10% of nominal. At this point, output registers are:

- *DistState* = ON
- *SubV1Trig* pulses
- *SubV1Avg* = average magnitude of sub-disturbance 1
- *SubV1Dur* = duration of sub-disturbance 1

T3 This is the beginning of the third sub-disturbance because the voltage has changed by more than 10% of nominal. At this point, output registers are:

- *DistState* = ON
- *SubV1Trig* pulses
- *SubV1Avg* = average magnitude of sub-disturbance 2
- *SubV1Dur* = duration of sub-disturbance 2

T4 This is the return to normal operating parameters (within the Swell and Sag Limits). At this point, output registers are:

- *DistState* = OFF
- *Distend* pulses
- *SubV1Trig* pulses
- *SubV1Avg* = average magnitude of Sub-disturbance 3
- *SubV1Dur* = duration of Sub-disturbance 3

Responses to Special Conditions

The following table summarizes how the Sag/Swell module behaves under different conditions.

Condition	Response of Output Registers
When the module is first created	All numeric and Boolean output registers are N/A.
If *V1*, *V2*, *V3*, *V1 Delta*, *V2 Delta* or *V3 Delta* is not linked	All numeric and Boolean output registers related to that input are N/A.
If *V1, V2, V3, V1 Delta, V2 Delta or V3 Delta* is N/A	All numeric and Boolean output registers related to that input are N/A.
If the *Enable* input is OFF	All numeric and Boolean output registers are N/A.
After the module is re-linked or its setup registers are changed	All numeric and Boolean output registers are N/A.
When the device is powered up (either the first time, or after a shutdown)	All numeric and Boolean output registers are N/A until the inputs are evaluated.