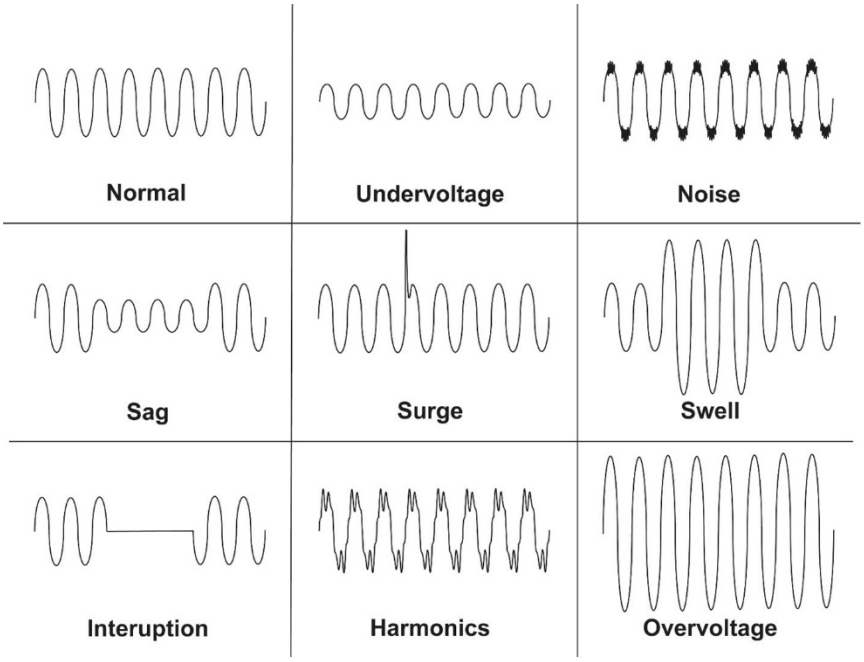
9 Types of Power Quality Conditions

Every electrical service will experience disturbances. Power is rarely perfect, and the following power-quality issues are the root causes of 99% of the problems integrators and end-users must deal with. The good news is that more than 80% of all power-related problems fall into the surge category, which are the easiest to eliminate and TPD has the products to solve! The other power quality issues that surge protection cannot fully address (voltage fluctuations) are handled by the TPD voltage regulator: the TPD-VR. Once you take care of both surge protection and voltage regulation, very few issues remain.

Power really isn't that complicated. There are only nine categories, with only eight being event of concern. Six of them are easy to fix but surges are associated with all eight events. Once you address surges and voltage stability, there's almost nothing left to cause symptoms.



Below is a breakdown of each of the nine events, how common they are, what equipment they affect, and which product solves them.

1. **Normal Voltage**
When voltage is at a perfect sine wave.
How common is it? Rare. This is what the utility tries to deliver but rarely can.
Product needed: None. This would be ideal.

2. **Undervoltage (Long Duration Low Voltage)**
When voltage slowly drifts low for seconds/minutes.
This can be caused by the following: Utility loading, long feeders, HVAC startup.
How common is it? Moderate
Symptoms that suggest undervoltage:

- Damaged LEDs, control processors, audio gear, HVAC

Solution: Voltage regulation (TPD-VR)

3. **Noise (EMI/RFI)**
When high-frequency chatter is on the sine wave.
This can be caused by the following:

- Motors
- VFDs
- Switching power supplies

How common is it? Very common, nuisance behavior
Symptoms that suggest noise:

- Flicker
- Processor lockups
- Weird network behavior

Solution:

- TPX surge protection with enhanced UL 1283 EMI/RFI filtering
- Voltage regulation (TPD-VR) helps as a secondary layer.

4. **Sag (Short Drop in Voltage)**
When there is a sudden dip in voltage for cycles or seconds.
This can be caused by the following:

- Motor starts
- HVAC
- Well Pumps
- Elevators

How common is it? Very common
Symptoms that suggest voltage sag:

- Flicker
- Reboots
- LED dropout

Solution:

- Voltage regulation (TPD-VR) to stabilize the dip.
- Surge protection helps with the accompanying transient.

5. **Surge or Transient Spike**
When a microsecond-level voltage spike occurs.

This can be caused by the following:

- Motors
- Switching
- Grid events
- Lightning

How common is it? Most common problem. Approximately 80% of all power complaints.
Symptoms that suggest voltage surges: flicker, processor failure, premature LED death, nuisance resets
Solution:

- TPX surge protection with enhanced UL 1283 EMI/RFI filtering

6. **Swell (Short Rise in Voltage)**
When voltage rises briefly above nominal.
How common is it? Moderate but equipment-damaging
Symptoms that suggest voltage swell:

- LED life reduction
- Failures in sensitive gear

Solution:

- Voltage regulation (TPD-VR) to absorb/regulate swells.
- TPX surge protection with enhanced UL 1283 EMI/RFI filtering to handle the spike that often pairs with a swell.

7. **Interruption**
When there is a momentary loss of power.
How common is it? Low to moderate
Symptoms that suggest interruption:

- Systems Reboots
- Memory losses

Solution:

- UPS or Battery Storage with 8mS or less to keep equipment operation without interruption or damage. Double conversion with zero transfer time can also be used for better protection against lockups.

8. **Harmonics**
When there is distortion of the sine wave shape.
This can be caused by the following:

- Large lighting loads
- VFDs
- Cheap switching supplies

How common is it? Less common but a bad problem to have.
Symptoms that suggest harmonics:

- Heat
- Buzzing

Solution:

- TPX surge protection with enhanced UL 1283 EMI/RFI filtering gives partial benefit.
- True harmonic filters only used in extreme environments.
- Voltage regulation helps stabilize but doesn't "fix" harmonics.

9. **Overvoltage (Long Duration High Voltage)**

Where there are long periods of excessive voltage.
This can be caused by the following:

- Utility problems
- Solar Storm/Flare issues

How common is it? Not common but highly destructive
Symptoms that suggest overvoltage:

- Total equipment failure
- LED burnout
- System lockups

Solution:

- Voltage regulation (TPD-VR) prevents sustained high voltages up to 160V.
- TPX surge protection with enhanced UL 1283 EMI/RFI filtering to handle fast spikes, not long-duration overvoltages.

Which Problems Happen Most Often?
If you take everything the industry sees across residential, commercial, and industrial sites you would see that surges cover 80–85% of all power quality issues.
This includes:

- LED flicker
- Processor lockups
- Motor-induced spikes
- Lightning-related transients
- "Ghosts and gremlins"
  All power and low voltage network systems need to be protected with applicable Suge Protection Devices.

2. Voltage fluctuations (sag/swell/undervoltage/overvoltage) cover approximately 10–15% of all power quality issues. This is where voltage regulation and the TPD-VR become essential.
3. Noise covers approximately 5–10% of all power quality issues. Noise is everywhere and easily handled by the filtering inside TPD surge products.
4. Harmonics cover approximately 1% of all power quality issues and is only a problem in unique operating environments.

Notes for Dealers

STEP 1 **Bonding & Grounding**
These are key elements to a comprehensive site wide Power Quality Program. The NEC requirements for grounding are clear and that ground is the common denominator for everything electrical. Even with perfect grounding, however, the following steps are still needed.

STEP 2 **Layered Surge Protection (Fixes ~80% of problems)**
Use TPX/TTLP at:

- Service entrance
- Subpanels / ATS
- Sensitive loads

Use low voltage TPD surge protection at:

- Low-voltage lines (CAT6, audio, control)

This eliminates the majority of flickers, lockups, and failures.

STEP 3 **Voltage Regulation (Fixes voltage stability problems)**
The TPD-VR corrects voltage at 8-microseconds and is 98% efficient, removing sag, swell, under-voltage and over-voltage. *The TPD-VR is the precision power layer for high-end equipment*.