expertpower

OPTIMIZING PUMP OPERATION & LIFESPAN USING SATEC ANALYZERS

Background

Rotating loads account for about 60-70% of power consumption worldwide. SATEC solutions help to optimize pump operations through advanced measurement and insightful data analysis.

The Role & Types of Pumping Systems:

There are three primary pump types to be considered:

1. Positive-Displacement
2. Centrifugal
3. Axial-Flow (including multiple subcategories)

In large industrial facilities (such as water utilities, factories, etc.) a great deal of information can be obtained by performing relatively simple measurements. These could indicate problems which should be addressed before major failures occur, often resulting in considerable expenses.

Monitoring 3-Phase Induction Motors

Most pumps are powered by 3-phase induction motors, each characterized by distinct operational parameters which warrant close monitoring. The motor plate, a valuable resource, provides the nominal electrical parameters (designed and tested) for motor operation, as set by the manufacturer.

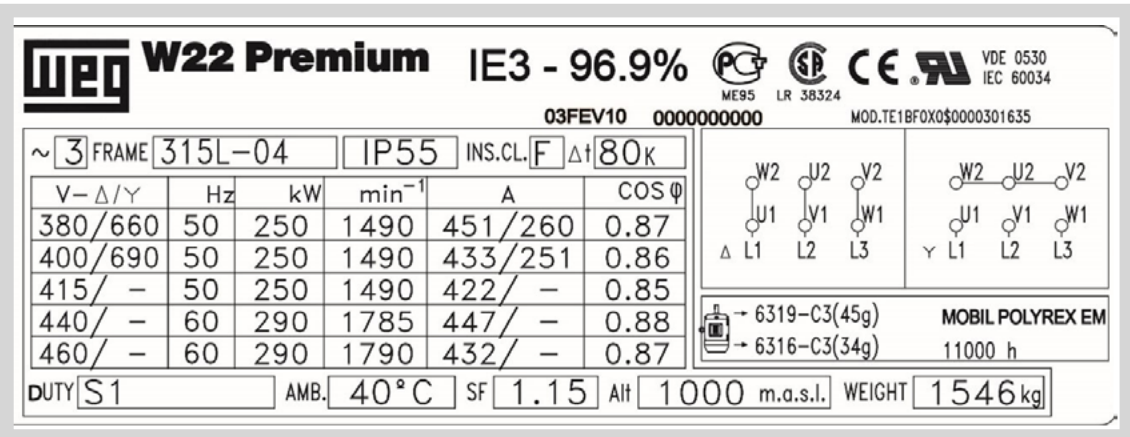


Image 1: motor plate sample

This includes information such as the required wiring configuration (delta or wye connection) and voltage requirements. Understanding these parameters helps to set appropriate thresholds for effective monitoring.

Critical Parameters for Monitoring

Overload

The current example, calculated by frequency and voltage, the motor's rated (nominal) power is 250KW. In this case, a threshold can be set in PAS to generate an alert in case the motor exceeds its rated power, since it can cause overheating and subsequent catastrophic failure due to insulation degradation and breakdown. Note: In order to avoid excessive/unwarranted alerts, it is recommended to program a setpoint at 10% above rated power, with a 60-second operate delay.

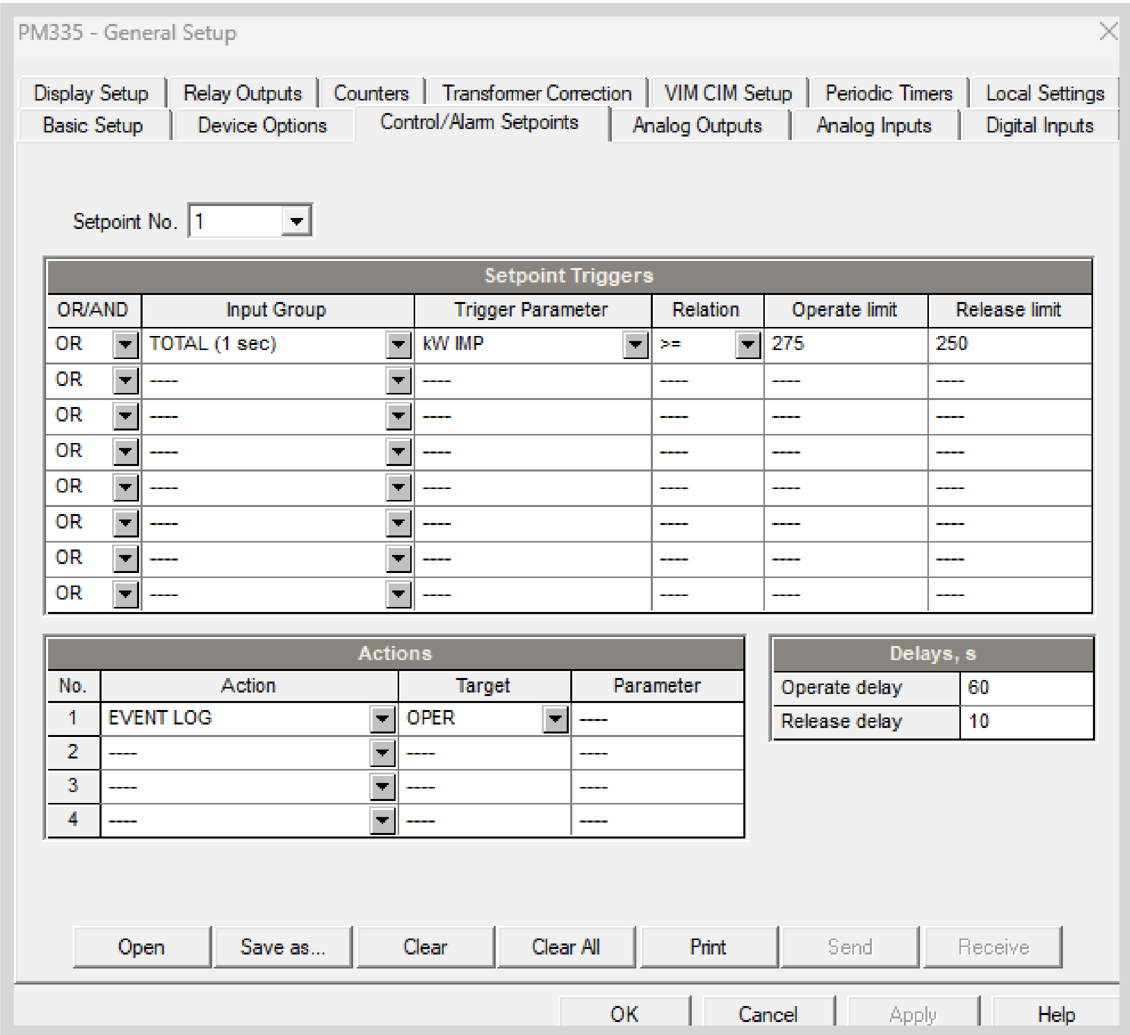


Image 2: configuring an overload setpoint in the PRO PM335

Overcurrent

Overcurrent analysis is significantly enhanced by placing dedicated analyzers, such as those offered by SATEC, the PRO Series and the PM180, which calculate ½ and 1 cycle values for both starting current and inrush current. Inrush current, which frequently exceeds nominal current by a factor of six and exhibits a transient nature, may trigger insulation deterioration. A surge of inrush current, along with heightened mechanical torque, could potentially set off critical failures of motors and pumps. This has substantial adverse impact on the lifespan of equipment.

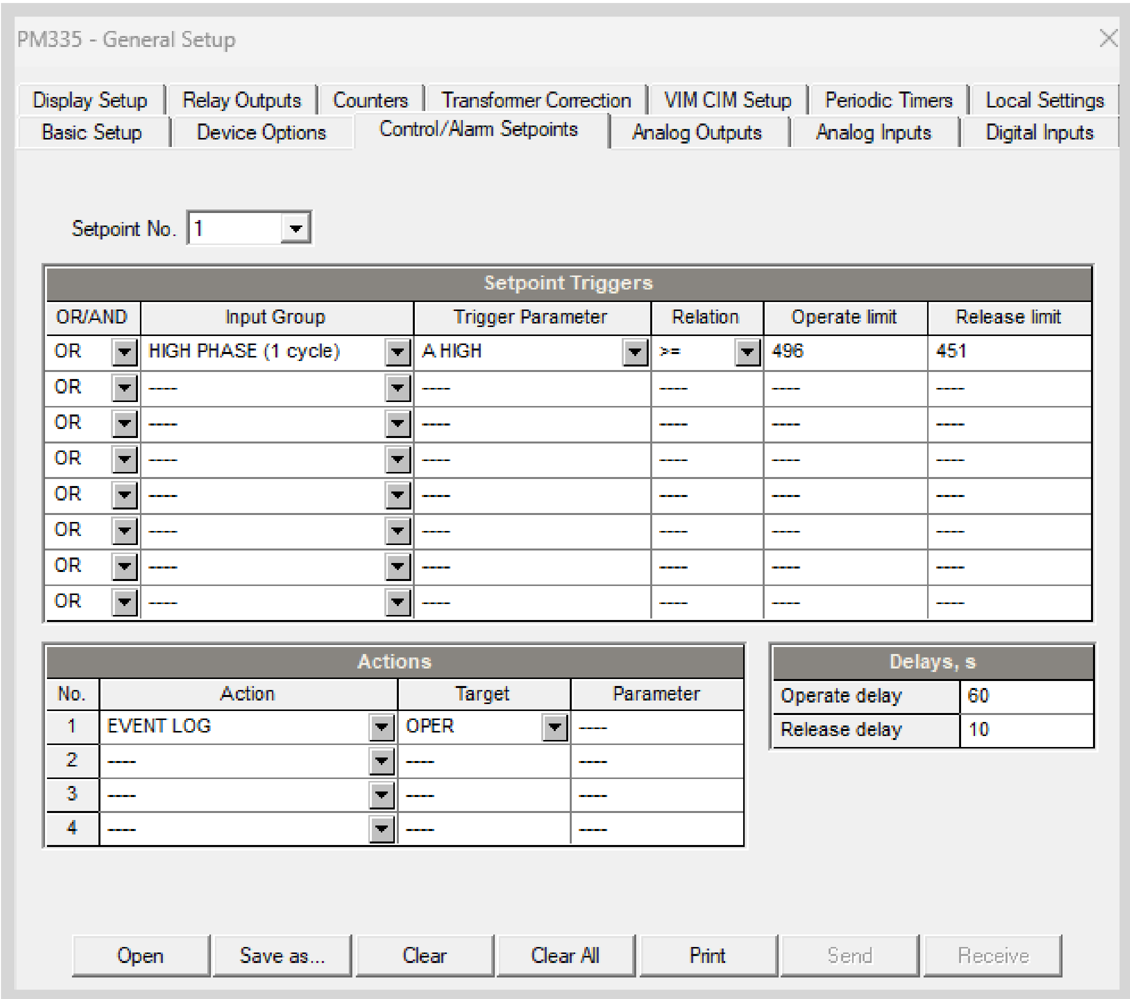


Image 3: configuring an overcurrent setpoint in the PRO PM335

Monitoring Overcurrent in Inrush Current

Utilizing the PRO Series or the PM180 analyzers, the user can capture motor startup current waveforms. The Operating limit can be strategically set slightly above anticipated inrush currents, in order to avoid false triggers from normal starting currents. The release limit aligns with the motor's rated current. For example, if I_n = 451A, the estimated inrush current is I_{Inrush} ~ 2750A (six times the nominal current).

Additionally, an embedded relay offers options by generating alarms or safeguarding equipment when connecting to the circuit breaker's shunt trip mechanism.

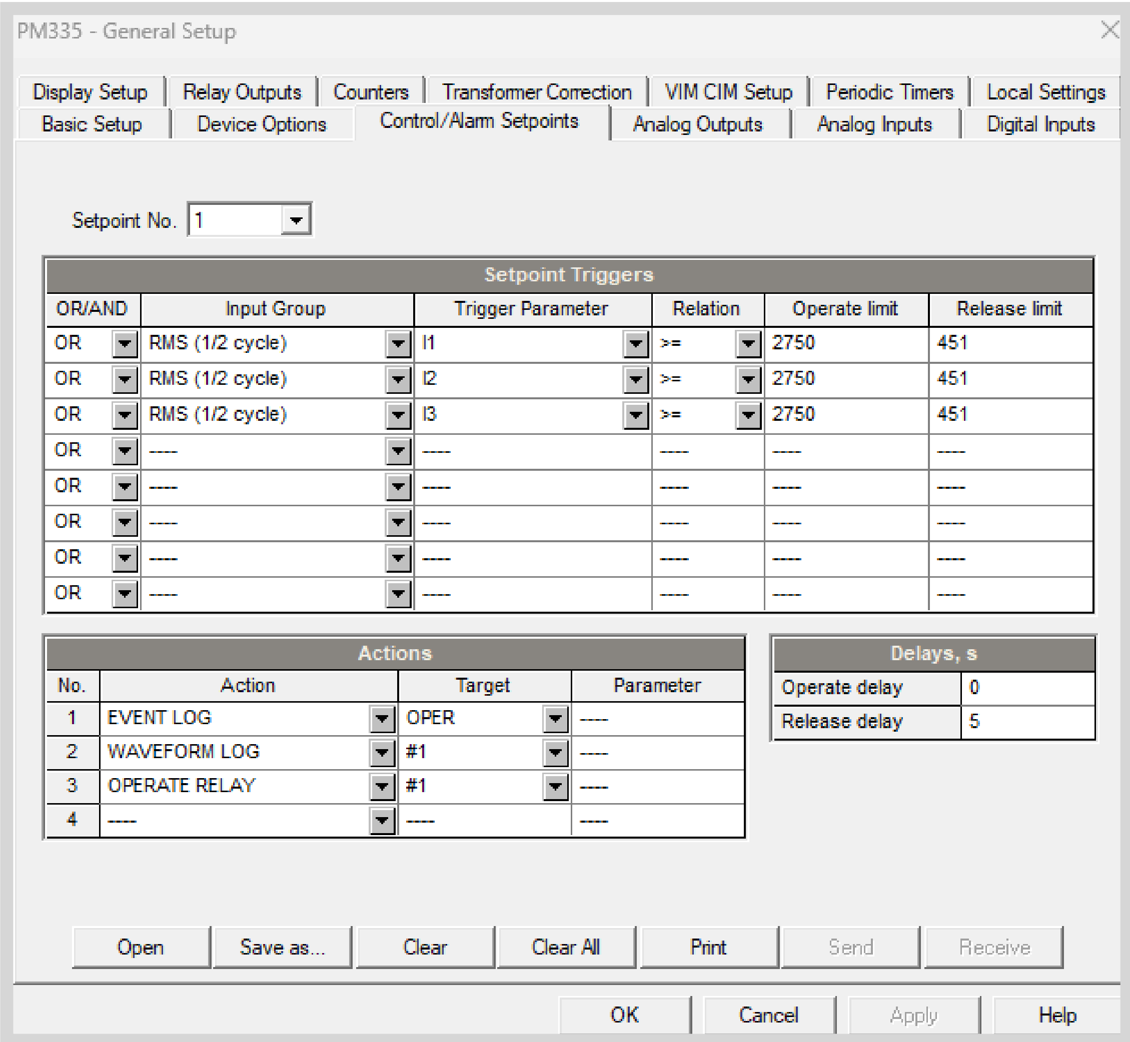


Image 4: configuring an inrush current setpoint in the PRO PM335

Current & Voltage Unbalance

Three-phase motors are naturally balanced loads, ideally distributing the load equally across each phase during normal operation. However, real-world scenarios often introduce minor imbalances. Systematic tracking of the current unbalance rate flags potential problems. This metric not only highlights efficiency concerns, but also unveils more serious problems such as motor and pump vibrations.

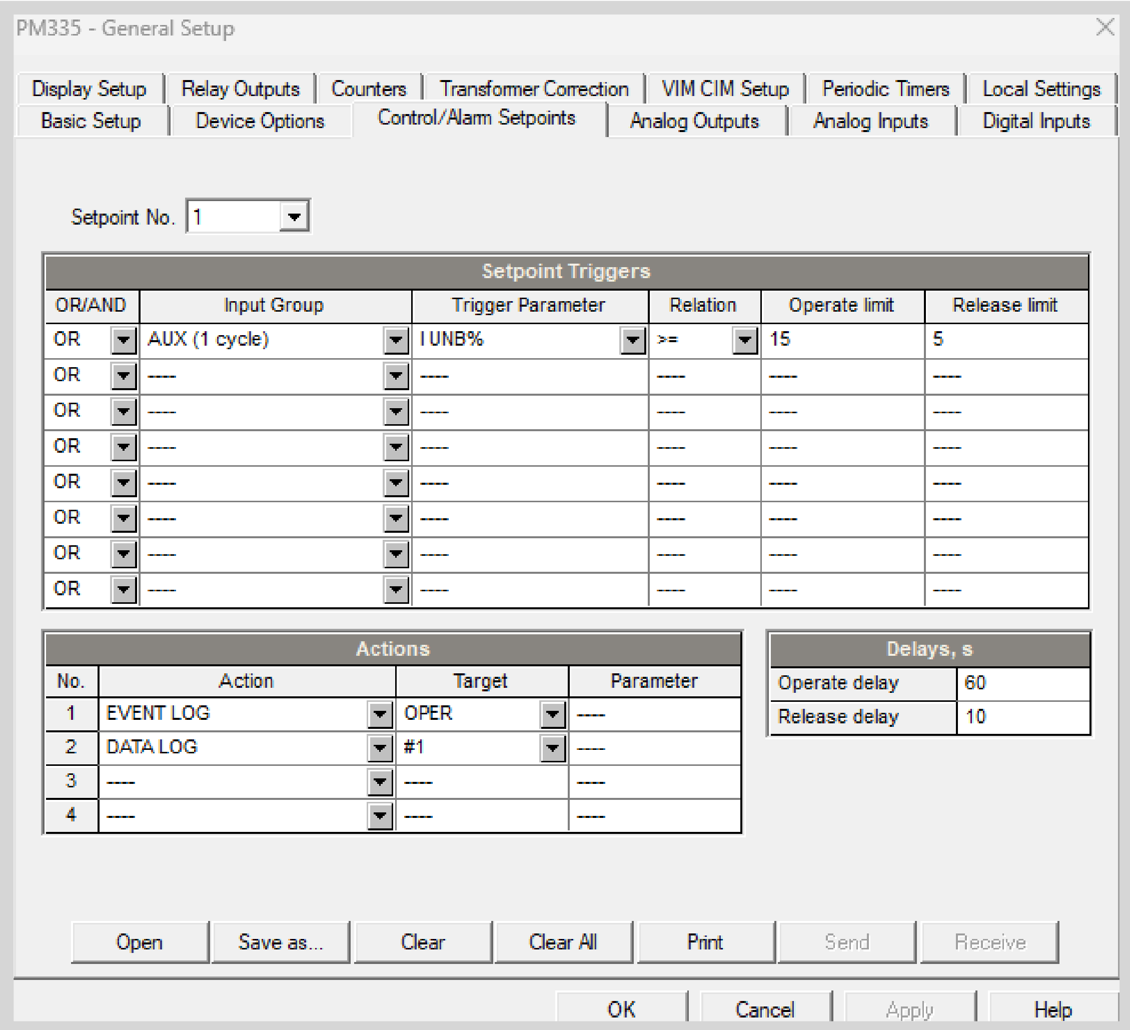


Image 5: configuring a current unbalance setpoint in the PRO PM335

Unusually high current unbalance, particularly in the absence of corresponding voltage unbalance, could signify a phase or winding fault. To augment analysis diverse setpoints can be configured for voltage unbalance as well, expanding fault detection capabilities.

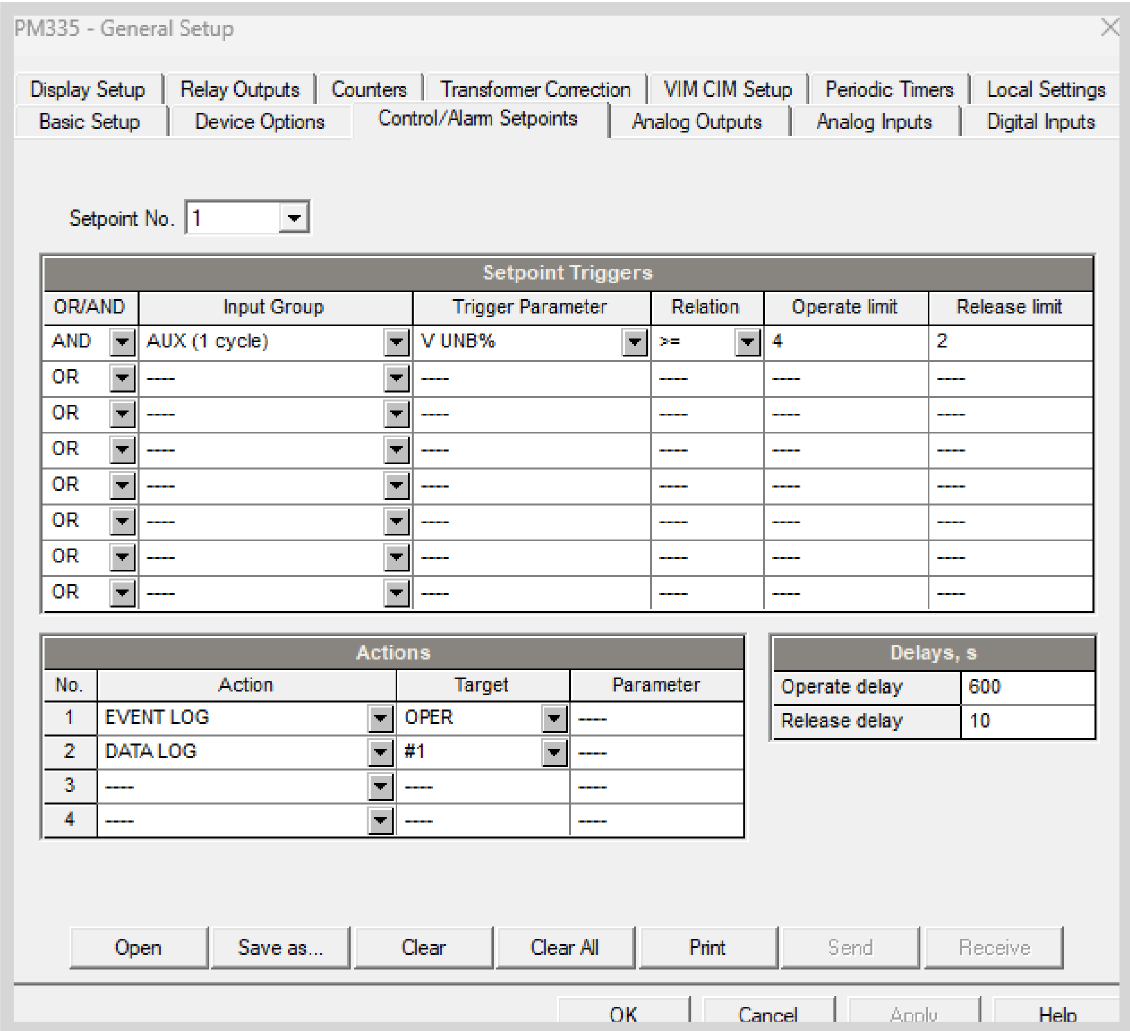


Image 6: configuring a voltage unbalance setpoint in the PRO PM335

Undervoltage

Pumps and electric motors exhibit sensitivity to undervoltage conditions. When voltage decreases below a certain threshold, torque experiences a quadratic reduction.

One solution could be to configure a setpoint 10% below nominal voltage, not coupled with any time delay. This approach is recommended due to the immediate and direct impact of undervoltage conditions on equipment performance.

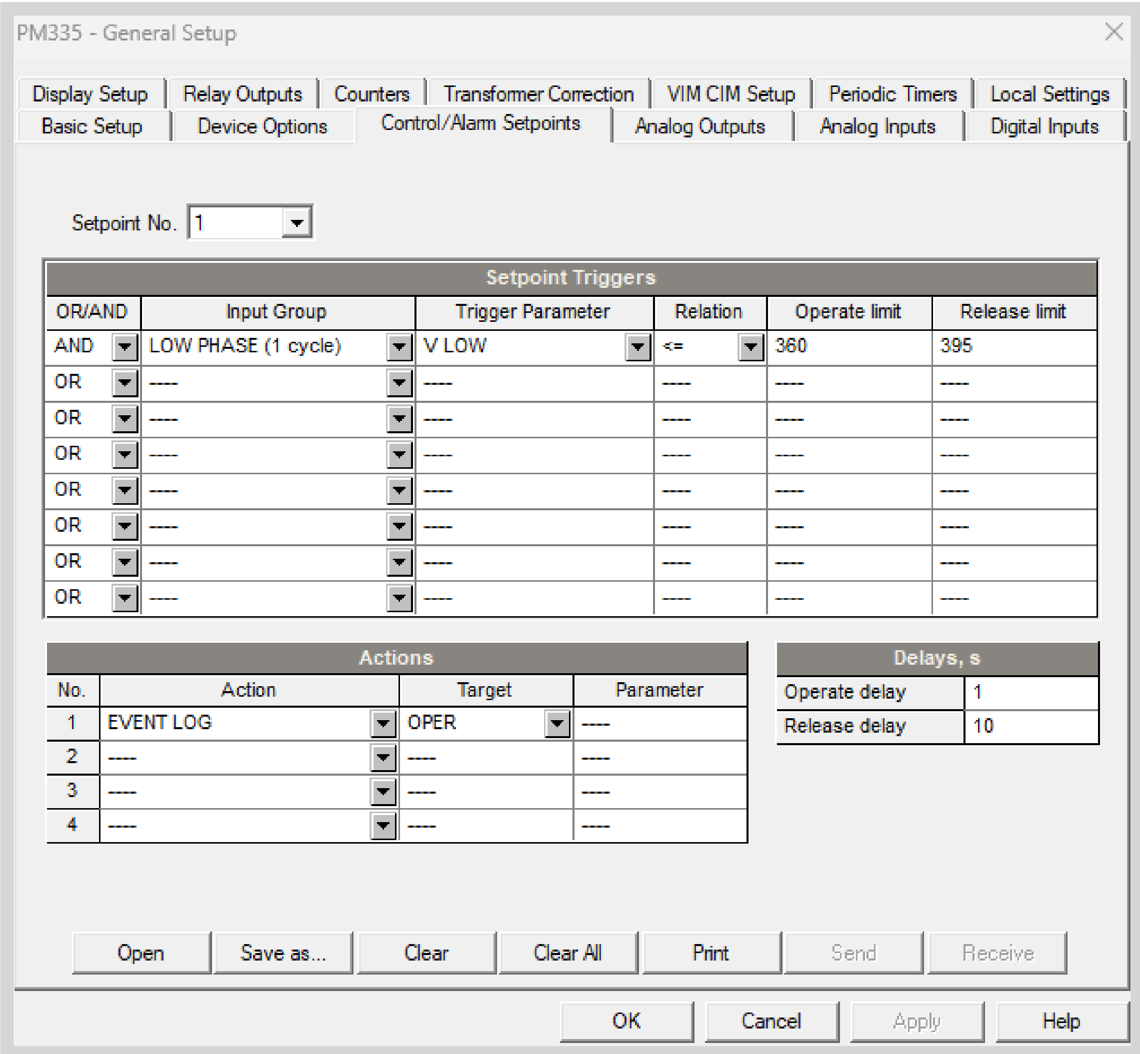


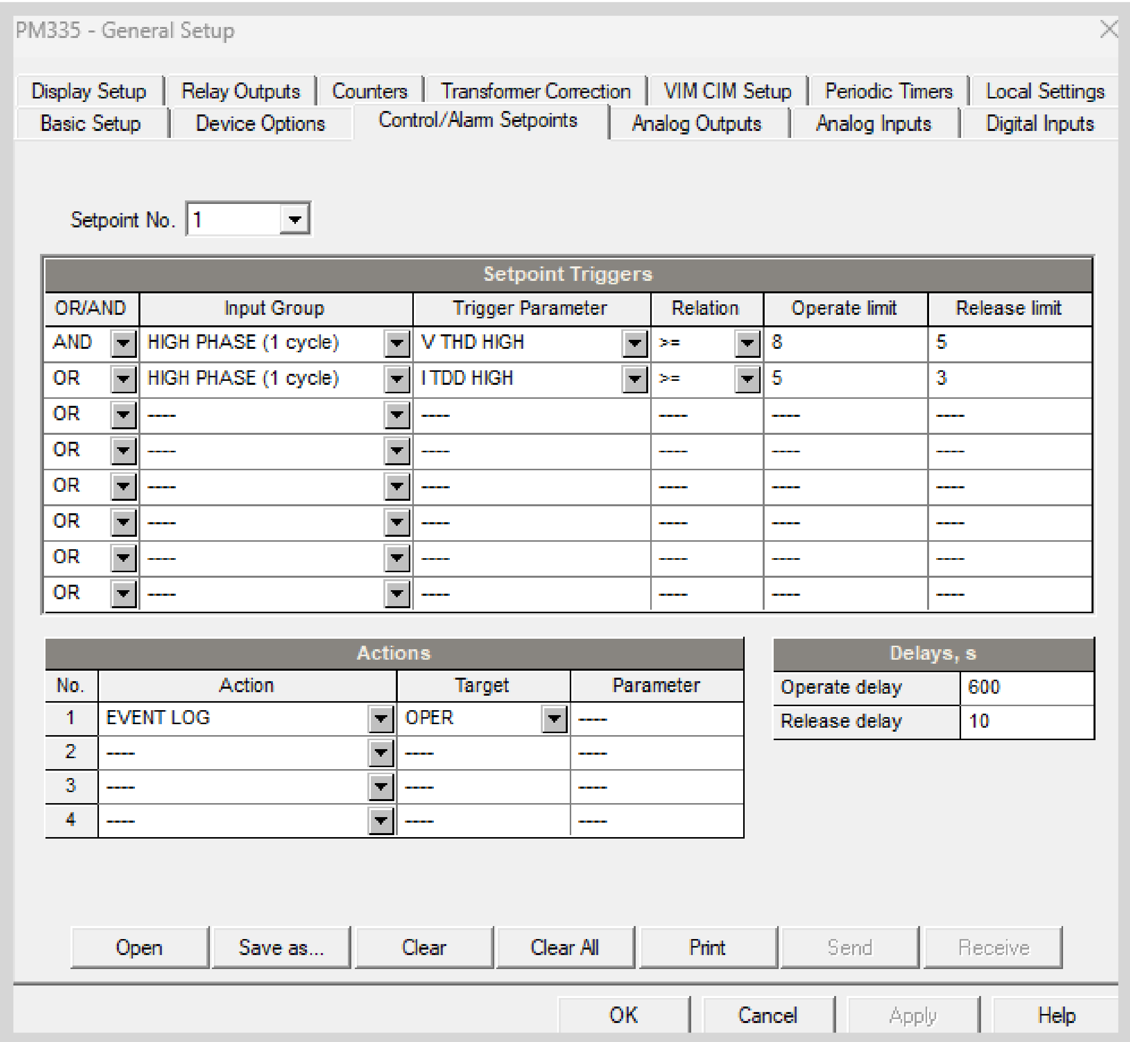
Image 7: configuring an undervoltage setpoint in the PRO PM335

THD & TDD - Harmonic Indicators

THD (Total Harmonic Distortion) and TDD (Total Demand Distortion) are significant because they offer harmonic detection within induction motors. These parameters are measured as a percentage relative to the 50Hz/60Hz 1st harmonic.

While characteristic thresholds which are specific to motor-related issues are currently unavailable, established standards such as IEEE 519 or EN50160 can be employed. These values are typically measured at facility settings, presenting an opportunity to install a power quality (PQ) analyzer if it is not already implemented. Collaboration with the facility's electrical engineer(s) is advised to facilitate setup.

The impact of harmonics extends beyond motor overheating, potentially impacting the entire system. Elevated frequencies lead to heightened turn-to-turn voltage, while working torque experiences reduction, necessitating vigilant analysis and management.



Setpoint Triggers					
OR/AND	Input Group	Trigger Parameter	Relation	Operate limit	Release limit
AND	HIGH PHASE (1 cycle)	V THD HIGH	>=	8	5
OR	HIGH PHASE (1 cycle)	I TDD HIGH	>=	5	3
OR	----	----	----	----	----
OR	----	----	----	----	----
OR	----	----	----	----	----
OR	----	----	----	----	----
OR	----	----	----	----	----
OR	----	----	----	----	----

Actions			
No.	Action	Target	Parameter
1	EVENT LOG	OPER	----
2	----	----	----
3	----	----	----
4	----	----	----

Delays, s	
Operate delay	600
Release delay	10

Image 8: configuring a THD/TDD setpoint in the PRO PM335

Flow & Efficiency Analysis

Using the PRO Series analyzers, equipped with an on-board analog input, we connect to a 0/4-20mA flow meter. This configuration enables the device to trigger alerts when efficiency deviations are detected, facilitating swift corrective action.

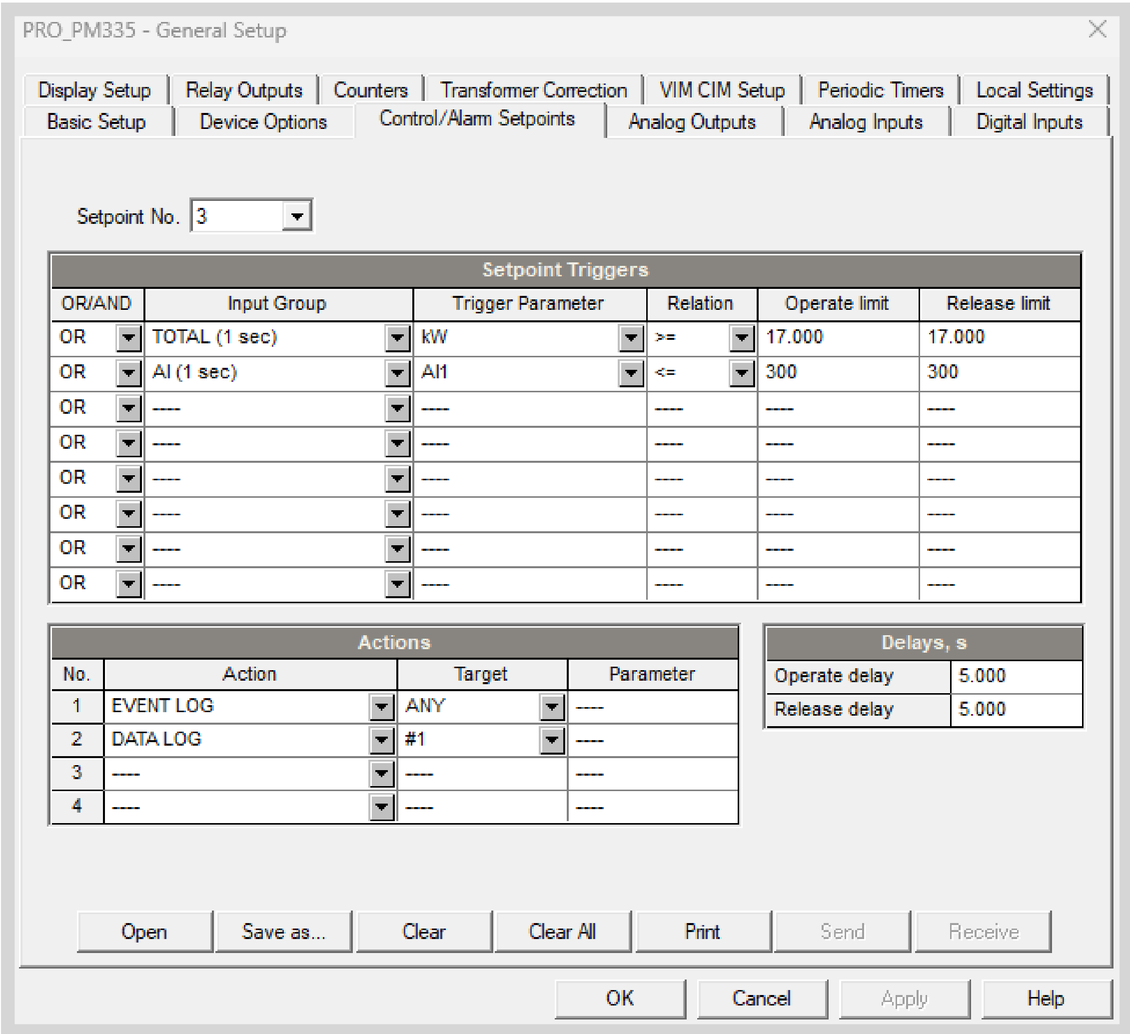


Image 9: configuring setpoints for flow efficiency monitoring in the PRO PM335

Reviewing the pump's performance curve reveals the correlation of flow with rated power. This curve is also useful for monitoring motor temperature through a PT1000/100 sensor.

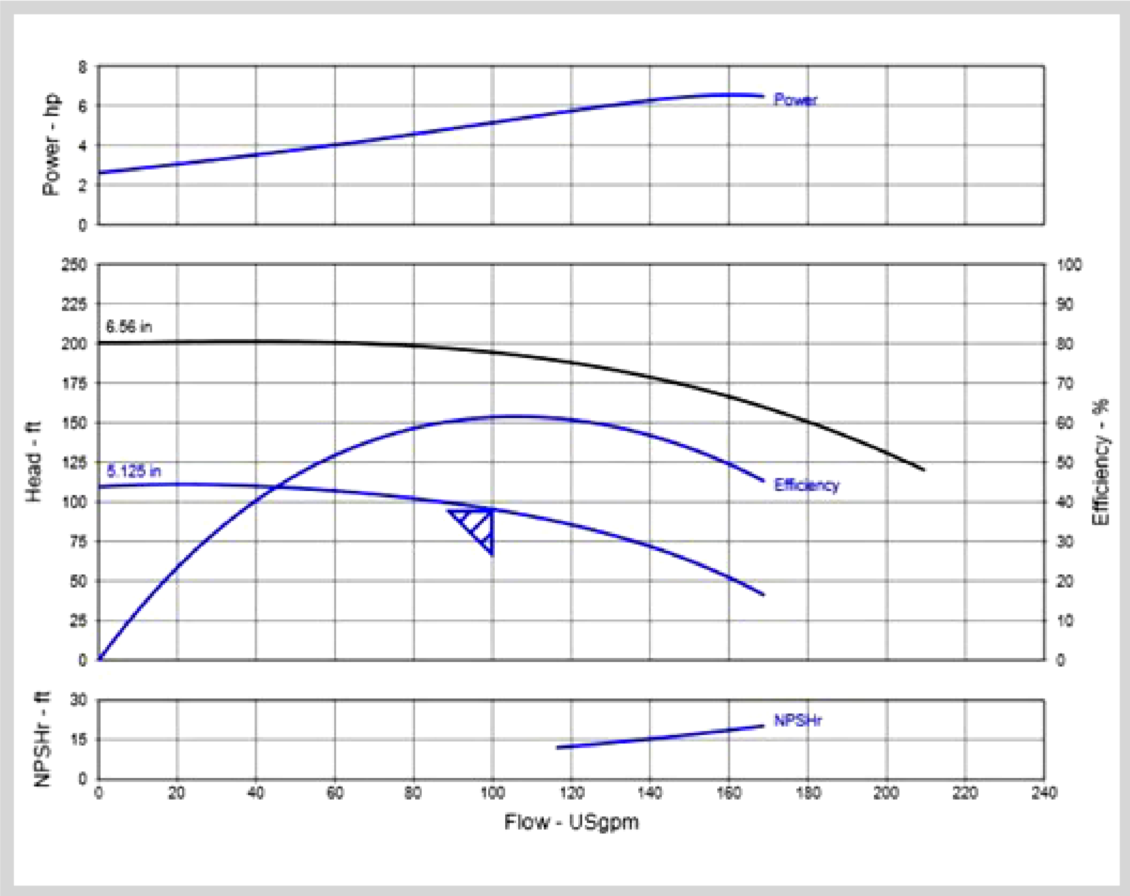


Image 10: pump performance curve

Enhancing Value with Expertpower

Expertpower (SaaS) offers an additional layer of value by sending notifications to users (via email) when significant events occur. This feature substantially aids in Predictive Maintenance, leading to cost reduction and extending the lifespan of the system.

Users can conveniently access a comprehensive record of events through the Event Log page. Below is a brief workflow which details the setup of a setpoint (SP) in Expertpower.

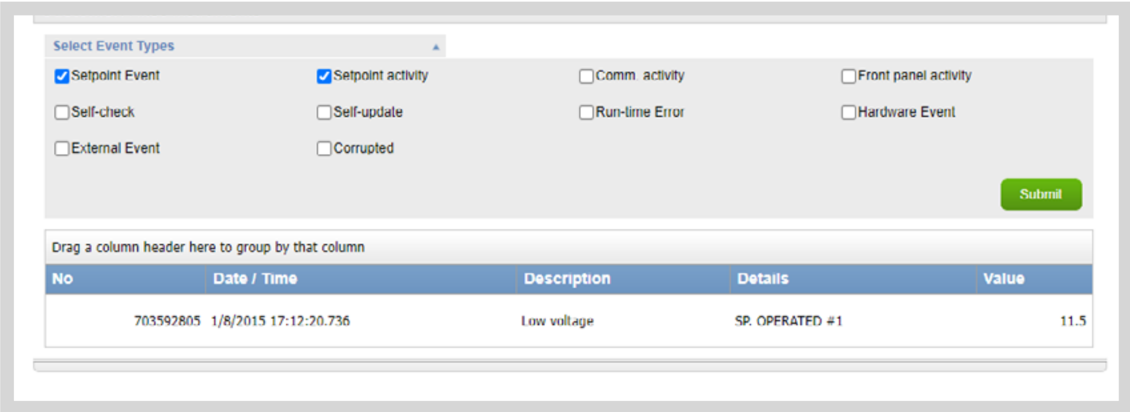


Image 11: configuring an Expertpower event log

Creating Analyzed Events for Notification

The presented solution involves generating an **Analyzed Event** for each flagged occurrence. Following this, specific conditions are set, as depicted below:

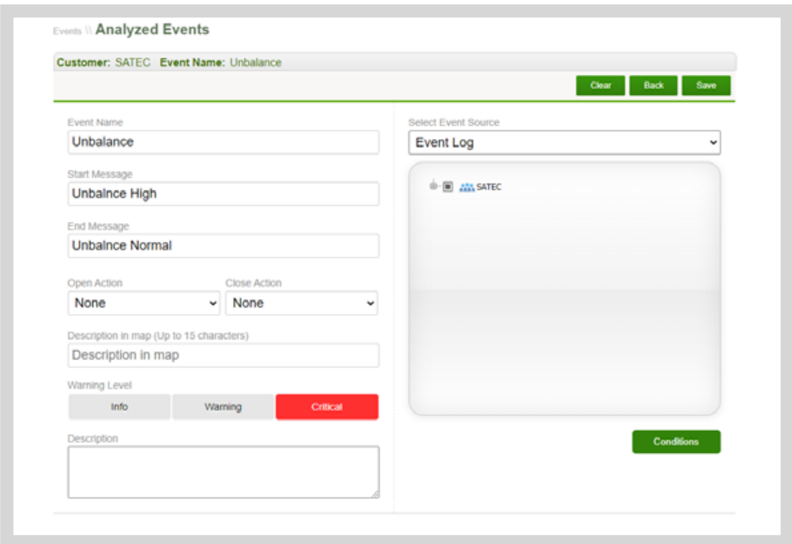


Image 12: configuring Expertpower Analyzed Events

Configuring Device Events

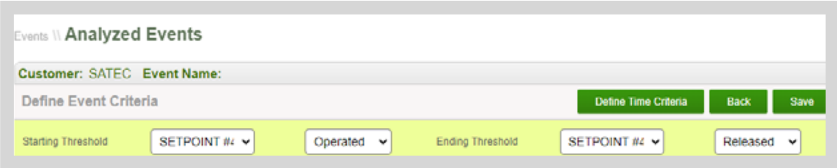


Image 13: configuring an analyzed events

Following this, event settings are configured for the various devices.

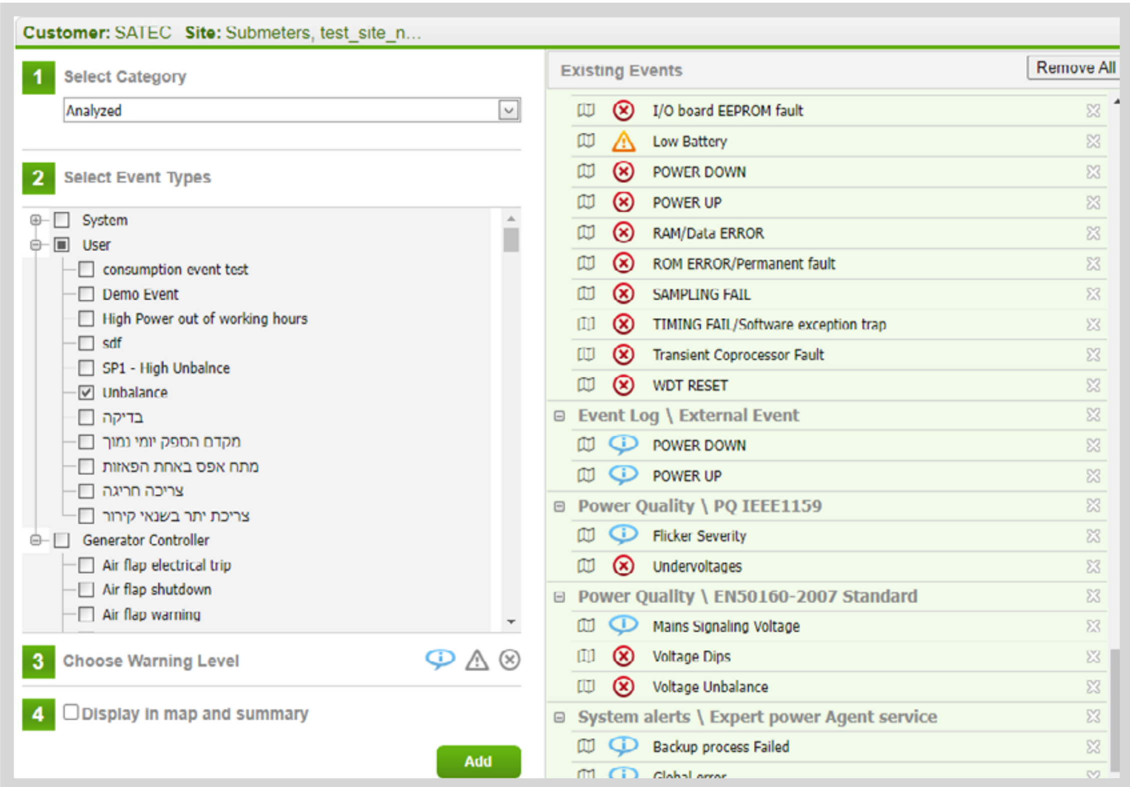


Image 14: configuring event settings

Once configured, the system ensures immediate email notifications when these events take place.

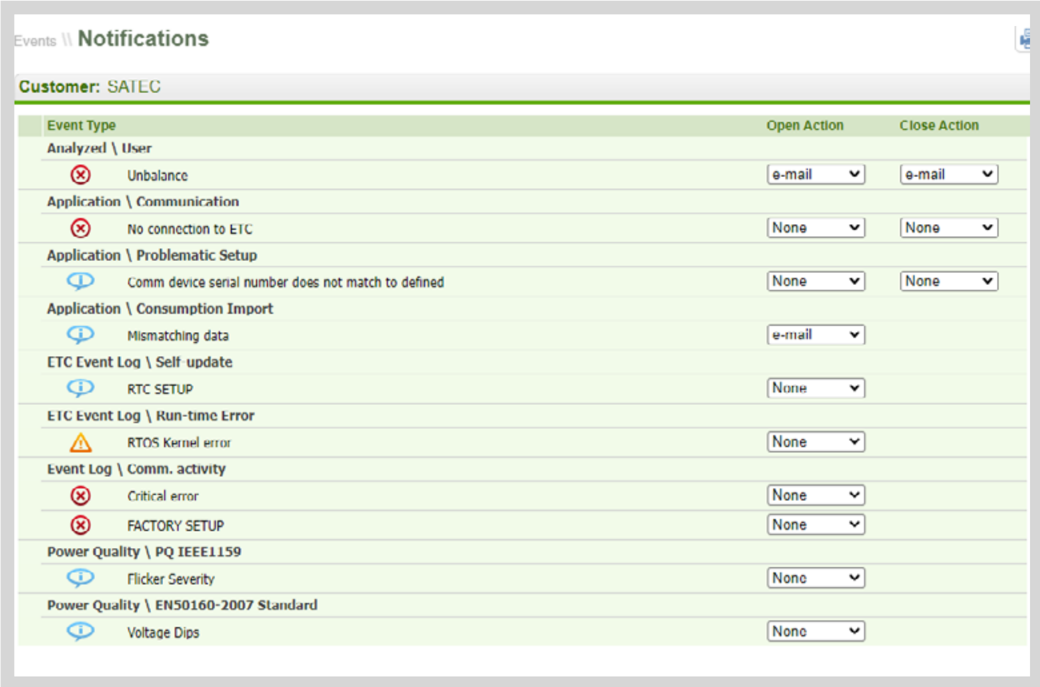


Image 15: configuring notifications

Comparing Similar Pumps or Stations

To do so, within Expertpower navigate the path MANAGER > DASHBOARD > ANALYSIS > COMPARISON. Here, users can conduct a comparative analysis of similar pumps or motors with regard to their energy consumption.

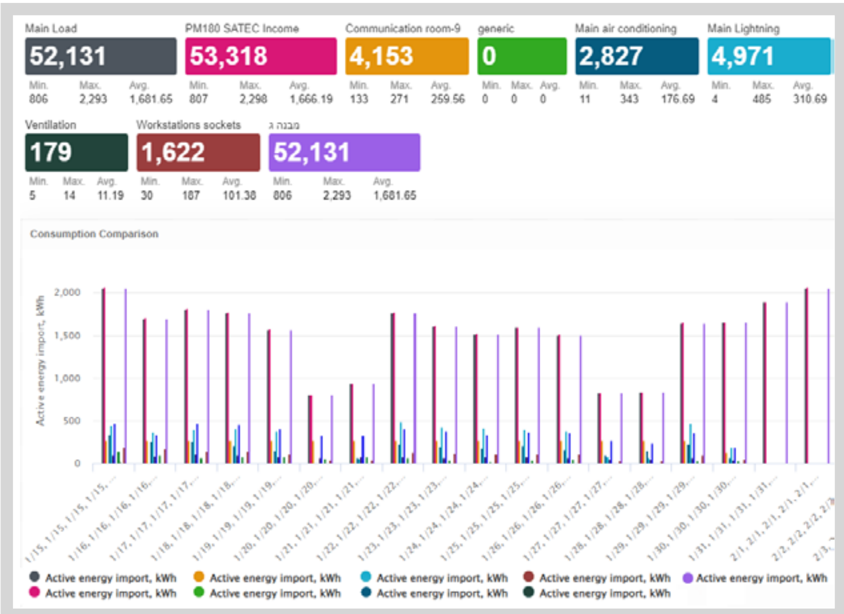


Image 16: graphic comparison

Thorough Analysis and Energy Visualization

In this module, the user gains insight into the pump's energy usage through the Detailed View & Heat Map. This enables assessment of consumption patterns, enhancement of energy efficiency, and prompt identification of the optimal load utilization.

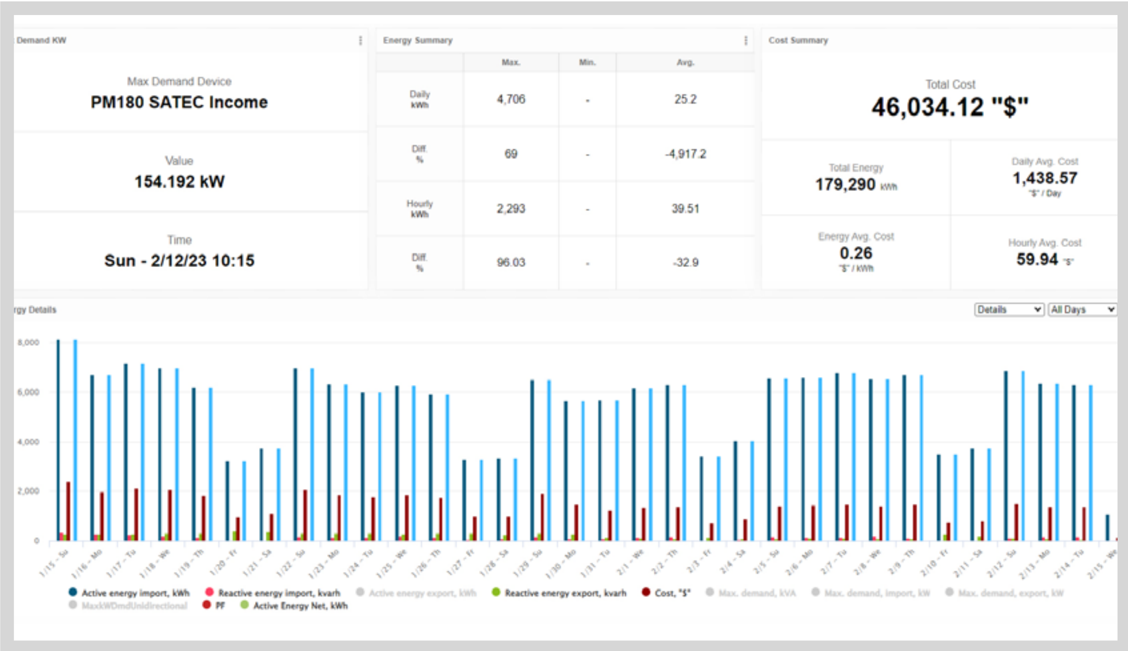


Image 17: financial analysis

Weekly Distribution, kWh

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Avg.
00:00 - 01:00	149	168	146	134	133	168	161	151.29
01:00 - 02:00	154	159	135	126	132	162	160	146.86
02:00 - 03:00	149	158	128	121	134	159	159	144
03:00 - 04:00	147	125	131	122	133	159	154	138.71
04:00 - 05:00	151	123	126	120	131	154	158	137.57
05:00 - 06:00	147	126	126	122	129	157	158	137.86
06:00 - 07:00	237	193	178	181	175	155	155	182
07:00 - 08:00	364	288	286	261	270	163	158	255.71
08:00 - 09:00	440	337	335	335	342	160	158	301
09:00 - 10:00	488	368	368	374	346	163	161	324
10:00 - 11:00	498	385	380	389	373	174	164	337.57
11:00 - 12:00	504	398	386	393	402	166	163	344.57
12:00 - 13:00	506	398	385	396	397	174	160	345.14
13:00 - 14:00	516	404	397	408	400	176	162	351.86
14:00 - 15:00	506	416	399	411	405	179	166	354.57
15:00 - 16:00	489	412	401	403	398	178	162	349
16:00 - 17:00	492	397	393	406	393	180	168	347
17:00 - 18:00	473	382	373	379	359	174	164	329.14
18:00 - 19:00	401	330	308	343	289	172	157	285.71
19:00 - 20:00	254	219	203	211	204	170	157	202.57
20:00 - 21:00	195	164	167	143	142	167	155	161.86
21:00 - 22:00	181	150	155	145	144	162	155	156
22:00 - 23:00	176	152	137	136	139	162	153	150.71
23:00 - 24:00	172	148	136	135	135	160	152	148.29
Avg.	324.54	266.67	257.46	258.08	254.38	166.42	159.17	

Image 18: consumption heat-map

Strategic Overview with Executive Dashboard

The Executive Dashboard enables effortless monitoring of pumping loads. It facilitates simple comparison for energy efficiency initiatives, such as upgrading motors from EFF2 to EFF3 and EFF4. As a result, users can consider replacing or optimizing pumps to enhance overall efficiency.

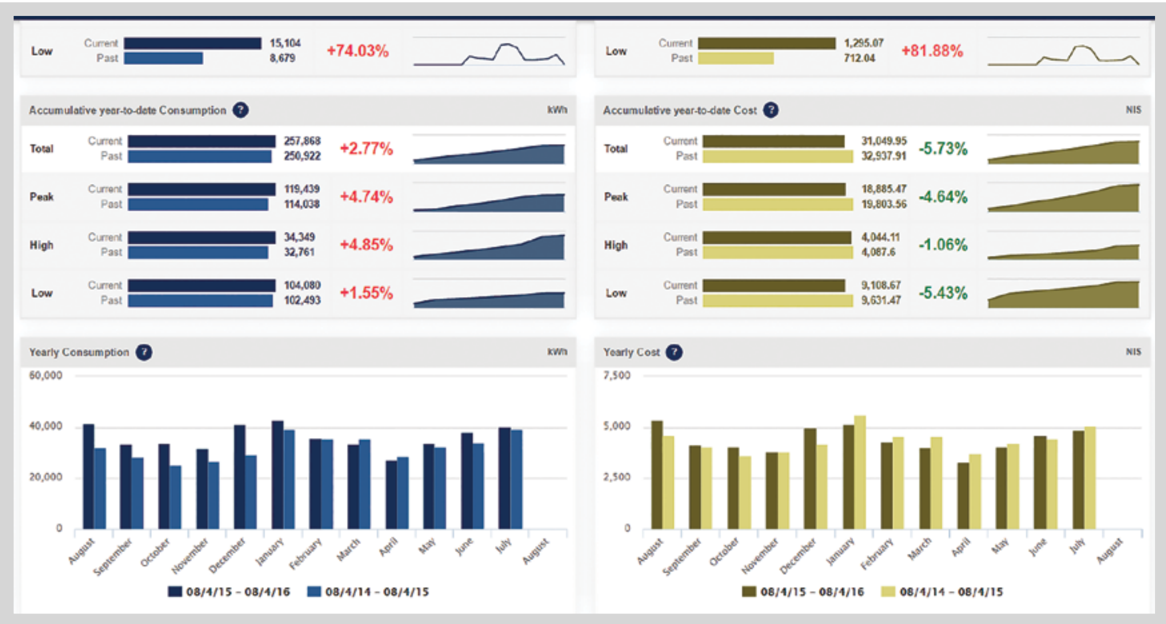


Image 19: executive dashboard

Conclusion

Further to the steps indicated above, users can enhance energy management, minimize equipment malfunctions, and boost production efficiency. This applies regardless of the pump's specific application.

Examples of potential pump applications include (but are not limited to) the following:

Water Utilities: Pump motors are indispensable to water treatment and distribution systems. They extract, treat, and deliver water to homes and businesses.

HVAC Systems: Pump motors in HVAC systems circulate coolants or refrigerants to regulate indoor temperatures.

Agriculture: Pump motors are vital to irrigation systems, ensuring that crops receive adequate amounts of water for optimal growth.

Oil and Gas Industry: Pumps drive fluid transfer in refineries, pipelines, and drilling operations.

Construction: Powerful pumps transfer liquid concrete at controlled rates in concrete pumps.

Wastewater Treatment: Pumps transport sewage to purification facilities for treatment.

Marine Industry: Pumps handle bilge pumping activities, ballast control, and cooling systems on ships and boats.

Mining: Pumps drain mines and transport mineral-laden slurry during extraction.

Food and Beverage Industry: Pumps transport liquids for processing in food and beverage production.

Chemical Manufacturing: Pumps transfer chemicals between processing stages in chemical plants.