

Raum Energy 3.5 kW Wind Turbine Brake Operation Rev 1.0

This memo describes the operation of the brake system of the 3.5kW wind turbine. Braking is critical for safe operation of all wind turbines. At some wind speed, every wind turbine must reduce the wind load on the tower and blades - this is also known as “furling”.

The Raum 3.5kW wind turbine system has been optimized to balance the maximum allowed wind load on the tower with maximized power output. To do this, we have designed the turbine to have three operational modes: Normal Mode, High Wind Mode, and Parked Mode.

Normal Mode

This is the mode the wind turbine system will be in the vast majority of the time. The wind turbine will operate in this mode until the inverter senses a wind gust above approximately 54 km/h (34 mph). The wind speed that the system switches between Normal Mode and High Wind Mode will vary based on elevation, atmospheric pressure, temperature, humidity, among other factors. *Note that what you believe the wind speed is two meters (six feet) off the ground can be far different on top a wind turbine tower!*

Considering there are 8766 hours in a year, the number of hours the machine will spend in Normal Mode is well above 8000 hours a year. In Class 3-4 wind sites, which cover the majority of the Canadian Prairies as well as the mid-West of the United States, it is close to 8600 hours. Those days where it is most windy, with wind gusts above 50 km/h (30 mph), is exactly the time the system needs to protect itself and will transition to High Wind Mode. This is when the customer will notice the braking action.

High Wind Mode

Once wind gusts of approximately 54 km/h (34 mph) are sensed, the brake is engaged and the turbine stops. The inverter will load the turbine much harder, thus slowing the turbine RPM down while still producing power, but at lower levels, typically in the 300W to 1000W range. This action can be likened to tapping the brakes as your car goes downhill. If after a minute the RPM stays below a predetermined level, the system will transition back to Normal Mode. If the RPM increases, the High Wind Mode will remain active.

In this scenario, three things can happen:

1. The wind dies down and the system reverts back to Normal Mode.
2. The wind remains gusty but generally not increasing. This will cause the system to remain in High Speed Mode, maybe for hours. High Wind Mode is active in wind speeds of approximately 54 km/h (34 mph) to roughly 80 km/h (50 mph). Again, the actual wind speeds that correspond to High Wind Mode vary with location and atmospheric parameters.
3. The wind speed continues to increase, thus causing the system to transition to Parked Mode.

Parked Mode

Once wind gusts of approximately 80 km/h (50 mph) are sensed, the brake is engaged and the turbine stops. The inverter will delay one hour before releasing the brake. Upon release from Parked Mode, if the RPM indicates the winds are still above approximately 80 km/h, the system will enter Parked Mode for another hour. This transition between High Wind Mode and Parked Mode will continue until the wind storm dies down, which may be most of the day. Typically, only 1% of the time the system will be in Parked Mode, or roughly 100 hours out of 8766 hours in a year.

Summary

The Raum Energy 3.5kW wind turbine system is a high-performance energy machine. Proper braking not only insures safe operation, but optimizes long-term energy from the system. Controlling wind turbines requires advanced control systems, intimate knowledge of the nature of wind, and detailed analysis and optimization of the major components in the system. Once a customer understands the intricate dance between blade RPM, generator loading, inverter logic and the wind driving the system, the amazing technology of small wind turbines will be apparent.