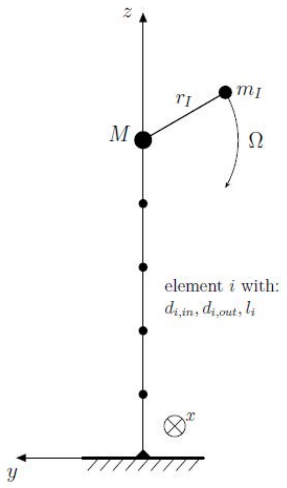

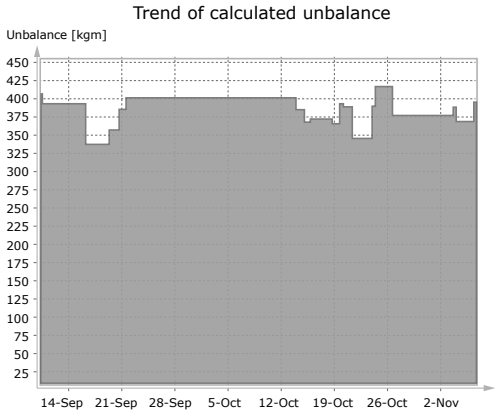

Blade Unbalance Calculator

Unbalance estimation without loss of availability

Mechanical unbalance of a wind turbine is typically specified to G16 tolerance[1)], which can cause significant forces on the drivetrain and the tower. In practice, a much better tolerance can be achieved, and often is, but this is not a requirement. In addition, unbalance can change over time due to blade erosion/damage, and ingression of moisture into the structure of one or more blades. To correct this, operators must arrange for mechanical balancing of the turbines, which requires access to the blades and the consequent loss of availability.

To optimise the on-site work, some method of identifying those turbines in need of attention would be useful. Although mass unbalance provides a clear 1/rev signal, on a wind turbine this is complicated by: variable speed operation; natural frequency of the tower and aerodynamic imbalance – also 1/rev but principally an axial force.

The Blade Unbalance Calculator for Bachmann Monitoring's CMSSTD software, which drives the CMS modules, provides calculated mass unbalance results for your rotor, without stopping the turbine. This allows you to identify those turbines which require mechanical balancing.

The mechanical balance is calculated by a model-based algorithm using basic build data. The model is built once and is valid for all the similar turbines on your farm. Using real-time information from a 2D MEMS sensor in the centre of the nacelle, the output from the module is a measure of mechanical unbalance (in kgm). With the addition of an extra position sensor on the main shaft the module will also identify the angular location of the required correction mass.

You can also confirm whether a rotor 1/rev results from aerodynamic or mechanical effects, thus allowing you to plan the appropriate corrective action for a time that suits you. There is also full visibility of whether turbine balance is degrading.

With Bachmann Monitoring's 20 years of Condition Monitoring experience underpinning this software and the diagnoses it provides, you can be confident that you will have better knowledge of the state of your turbine rotor thanks to the Blade Unbalance Calculator.

1) For a 30 t rotor revolving at 20 rpm, G16 is equivalent to an unbalance of ~230 kgm

Blade Unbalance Calculator	
Pre Requisites	
Controller Application	CMSSTD V1.05 or higher
Hardware	2 analog inputs for (GIO212 or AIC21x)
Motion sensor	Mems Sensor placed close to centre of nacelle
Positioning	One axis parallel to shaft in axial direction One axis perpendicular to shaft in transverse direction
Mathematical model	To build the model, the following inputs are required: • Height of tower • Thickness of wall • Material properties (Youngs modulus and density) • Mass of nacelle • Mass of rotor • Measured first natural frequency of tower • Measured tower damping (only required for optional phase measurements)
Phase relation (optional)	Position detector fitted to main shaft for detecting the rotor position
Evaluation	
Axial vibration	Indicates aerodynamic imbalance
Mass imbalance rotor	Results generated only in specific speed range Displayed in kgm
Position/phase mass unbalance (optional)	Calculated with reference to the zero point of the rotor position

Order Code		
Item	**Item-No.**	**Description**
CMSSTD V1.05 Download	00032041-00	CMS Standard Software for M1 controller used to drive condition monitoring modules, including configuration tools. From this version also includes plug ins for various extensions to the basic condition monitoring capabilities.
CMSSTD + GIO Runtime License	00032042-63	Allows the CMSSTD software to run with a GIO212 module, to drive data acquisition and analysis.
CMSSTD + AIC Runtime License	00032043-63	Allows the CMSSTD software to run with a AIC206 or AIC214 module, to drive data acquisition and analysis.
CMSUNB Plugin Runtime License	00032047-63	Blade Unbalance Calculator-Plugin allows the calculation of balance quality of the rotor, and distinguishes between mass unbalance and aerodynamic unbalance. This RT license must be stored on the controller in addition to the CMSSTD RT.
MEMS Sensor fitting kit	00032187-00	Kit of parts for installation of 2D mems sensor
Zero Position Sensor fitting kit	00026838-00	Sensor BMF00C7 (M12-PS-C-2-S4)
	00026841-00	Magnet BAM TG-MF-006
CMSUNB Tower Model	On request	Mathematical model required to generate inputs to the CMSUNB plug-in configuration

Related Modules		
Item	**Item-No.**	**Description**
AIC214	00028808-00	Analog measuring module for Condition Monitoring; 9x Input IEPE; 3x Input IEPE /±10V; 24bit; 0.1%; >95dB dynamic range; 20µs sample time; 1x INC HTL; 300kHz; A,A/B/N; 512MB measured data ring buffer; real-time continuous output of values
GIO212	00020620-00	Universal Input / output module; 12x analog inputs ±10V ±20mA Pt TE; 16bit; analog outputs ±10V 20mA; 14bit; digital inputs DI 5V/24V, 125kHz, sink/source, Counter; digital outputs 24V/100mA, 10kHz, highside/lowside/ pushpull, PWM; DI/AI Filter configurable; 100µs scanning und refresh time; Value monitoring; insulated
AIC212	00014151-00	Analog measuring module for Condition Monitoring; 9x Input ICP; 3x Input ±10V; 18bit; 0.1%; >95dB dynamic range; 20µs sample time; 1x INC HTL; 36kHz; A,A/B/N; 128MB measured data storage
AIC206	00031353-00	Analog measuring module for Condition Monitoring; 4x Input IEPE; 24bit; 0.1%; >95dB dynamic range; 20µs sample time; 1x INC HTL; 300kHz; A,A/B/N; 512MB measured data ring buffer; real-time continuous output of values