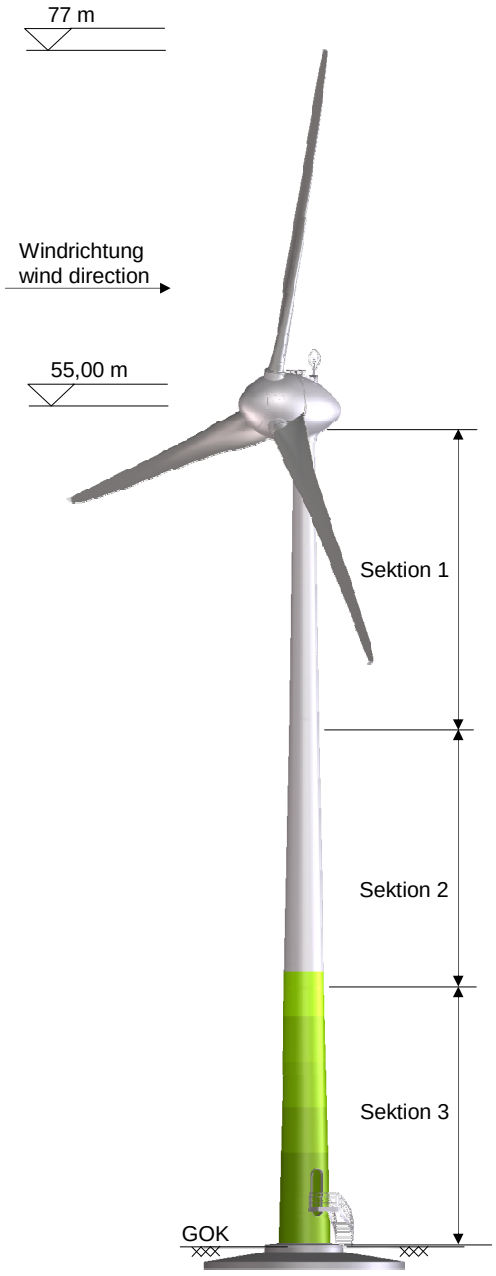
ENERCON ENERGY FOR THE WORLD	Gewichte und Abmessungen *Weights and Dimensions* E-44/S/54/3K/01	Page 1 of 1



Gesamthöhe ab Gelände *Total height from territory*	77 m
Nabenhöhe ab Gelände *Hub height above ground*	55,00 m
Turmlänge *Tower height*	53,95 m
Bauart / *Design*	Stahlturm / *steel tower*
Windzone WZ (DIBt)	———
WTGS Class (IEC 61400-1)	IEC IA[1]
Anzahl der Sektionen / *Number of sections*	3 + Fundamentkorb / *3 + foundation basket*

	Länge *length*	D_{oben} $diam_{top}$	D_{unten} $diam_{bottom}$	Gewicht weight
	m	m	m	to
Sektion 1 / *section 1*	19,92	1,332 / 1,488[3]	1,805	ca. 12
Sektion 2 / *section 2*	17,00	1,805	2,41	ca. 16
Sektion 3 / *section 3*	17,03	2,41	3,30 / 3,576 [3]	ca. 29
Fundamentkorb / *foundation basket*	1,50	3,576[3]	3,656[3]	ca. 3.3
Gesamtgewicht Turm / *total weight tower*				ca. 60

[1] Typenprüfung vorhanden /*Certification Report available*
[2] Typenprüfung in Arbeit/ *Certification report in process*
[3] Flanschaußendurchmesser / *outside flange diameter*

Document information:			
Author/ date:	TC / 13.3.2006		
Department:	WRD	Translator / date:	-
Approved / date:	MKR / 13.3.2006	Revisor / date:	
Revision / date:	1 / 18.01.2011	Reference:	D0178657-0.docx

Fundamentdatenblatt
für geotechnische Nachweise
Foundation data sheet
for geotechnical calculations

Turmtyp: **E-44/S/44/2K/01**
tower type:

Typenklasse: Windzone IV (DIBt- Richtlinie)
type class: WTGS class IA (IEC- /NVN- /EN- Richtlinie)

Fundamenttyp: **Flachgründung - Kreisfundament**
mit Auftrieb - Ø 15,20m

foundation type: ***shallow foundation – circular foundation***
with buoyancy - Ø 15.20m

Statikdatum: 19.07.2007 / Rev. 1.0
static date:

1041503
TYPENPRÜFUNG Geltungsdauer
5 Jahre/Wiedervorlage bis 30. Sep. 2012

Datum: 14.08.2007
date: Rev. 1.0

In bautechnischer Hinsicht geprüft.
Siehe Prüfbericht vom 06. Sep. 2007
München
TÜV SÜD Industrie Service GmbH
Prüfamt für Baustatik für Fliegende Bauten
und für Windenergieanlagen
Der Prüfer: Der Sachverständige:

ENERCON GmbH
Dreekamp 5
D – 26605 Aurich / Germany
www.enercon.de

Author: Dipl.-Ing. (FH) J. Laschke
Approved: Dipl.-Ing. (FH) M. Schade

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

Document information:			
Author/ date:	JLA / 14.08.2007		
Department:	WRD-K	Translator / date:	-
Approved / date:	MSCH / 14.08.2007	Revisor / date:	-
Revision / date:	1.0 / 14.08.2007	Reference:	WRD-04-FDB_E-44_S_44_2K_01_FlmA_Rev1.0-ger.doc

- **Lasten an der Fundamentunterkante für geotechnische Nachweise**
  (inkl. Eigengewicht Fundament und Bodenauflast γ = 18 kN/m³ im Trockenzustand)
  Loads at the bottom of foundation for geotechnical calculations
  (Incl. dead weight foundation and soil weight γ = 18 kN/m³ for dry conditions)

Lastfall *Load case*	F_{xy} [kN]	F_z [kN]	M_{xy} [kNm]	M_z [kNm]
DLC 1.0	164	-4006 mit Auftrieb / *with buoyancy*	6635	-
		-6637 ohne Auftrieb / *without buoyancy*		
DLC 6.1	331	-3944 mit Auftrieb / *with buoyancy*	13215	-619
		-6575 ohne Auftrieb / *without buoyancy*		
DLC 6.2	431	-3960 mit Auftrieb / *with buoyancy*	17675	686
		-6591 ohne Auftrieb / *without buoyancy*		

alle Lasten mit Teilsicherheitsbeiwert γ_F = 1,0
All loads with partial safety factor γ_F = 1,0

- **Aufzunehmende Bodenpressung / *Minimum required bearing pressure***
  Der anstehende Baugrund muss mindestens eine Bodenpressung von σ = **102 kN/m²** aufnehmen können.
  Minimum required bearing pressure is σ = 102 kN/m².

- **Drehfedersteifigkeit / *Rocking spring stiffness***
  Für die elastische Fundamenteinspannung zwischen Fundament und Baugrund ist eine Mindestdrehfedersteifigkeit von $k_{\varphi,dyn}$ **= 12.000 MNm/rad (dynamischer Bodenkennwert)** und $k_{\varphi,stat}$ **= 1.500 MNm/rad (statischer Bodenkennwert)** einzuhalten.
  The minimum value of rocking spring stiffness for clamping between foundation and soil must be $k_{\varphi,dyn}$ = 12.000 MNm/rad (dynamic soil parameters) and $k_{\varphi,stat}$ = 1.500 MNm/rad (static soil parameters).

  Die erforderlichen dynamischen Steifemodule ($E_{oed,dyn}$) ergeben sich in Abhängigkeit von Fundamentgeometrie und Querdehnzahl.
  The minimum values of dynamic modulus of stiffness ($E_{oed,dyn}$) are calculated in dependence on foundation geometry and Poisson's ratio.

  Für Kreisfundamente gilt:
  For circular foundations:

$$k_\varphi = \frac{8 \cdot G \cdot r^3}{3 \cdot (1 - \nu)}$$

  daraus folgt:
  Resultant:

$$E_{oed,dyn} = k_\varphi \cdot \frac{3}{4} \cdot \frac{1}{r^3} \cdot \frac{(1+\nu) \cdot (1-\nu)^2}{1 - \nu - 2 \cdot \nu^2}$$

  G = Schubmodul / shear modulus

  r = Radius / *radius*

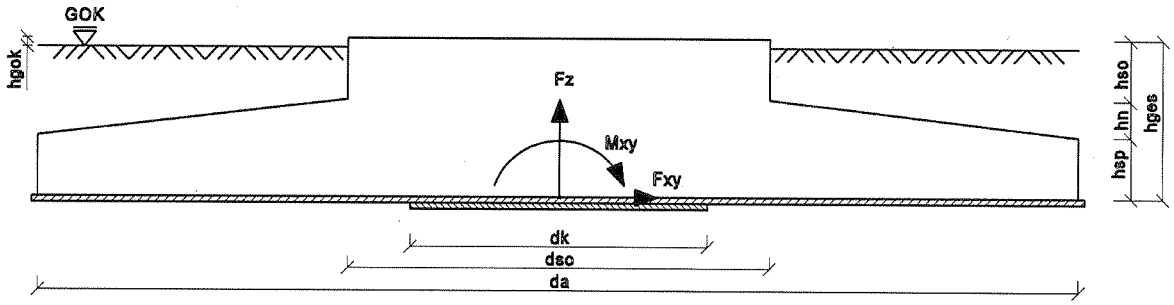
  ν = Querdehnzahl / *Poisson's ratio*

- **Zulässige Schiefstellung / *Permissible tilting***
  Maximal zulässige Schiefstellung infolge Baugrundsetzung in 20 Jahren.
  Maximum allowed tilting due to settlement of the foundation soil in 20 years.

  $\Delta s \leq 3{,}0$ mm/m

Fundamentgeometrie
Geometry of foundation

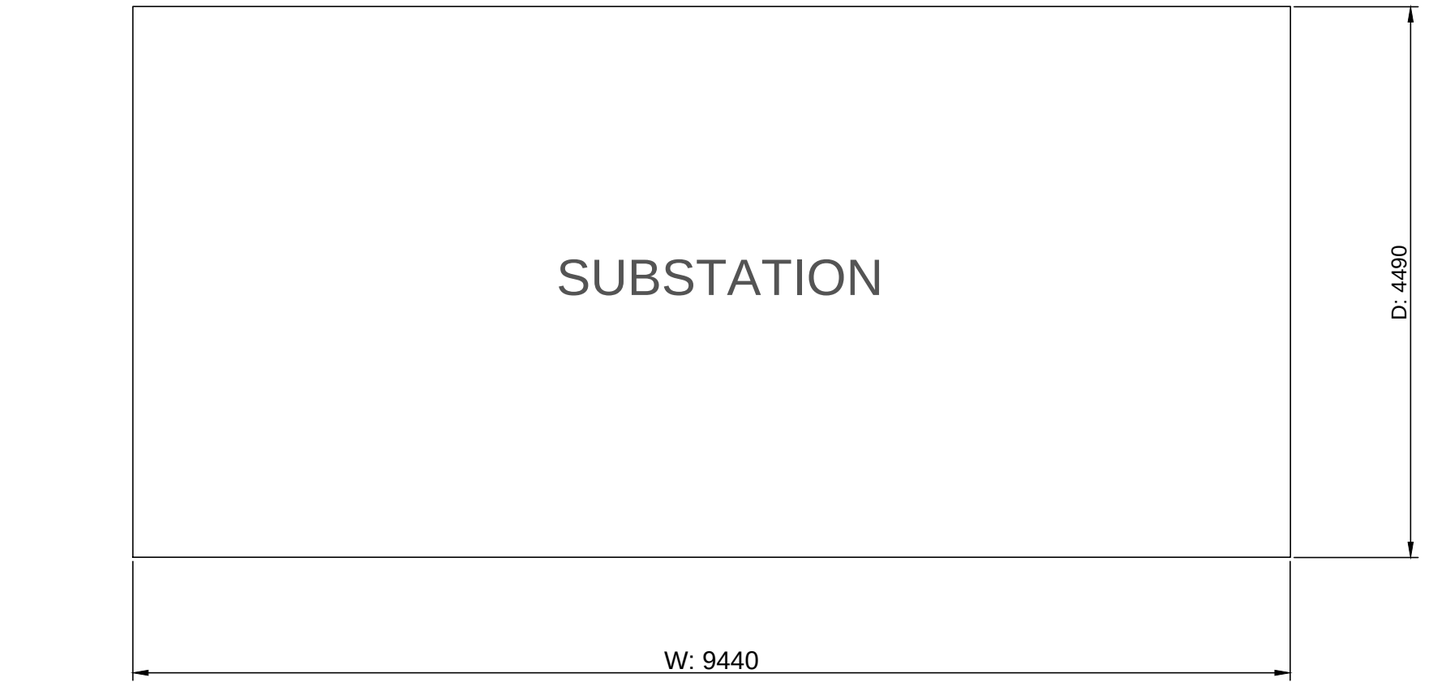
Außendurchmesser *outer diameter*	da	15,20 m
Sockeldurchmesser *base diameter*	dso	5,00 m
Fundamenthöhe *foundation height*	hges	1,60 m
Sockelhöhe *base height*	hso	0,60 m
Höhe Spornneigung *inclination of plinth*	hn	0,40 m
Spornhöhe *height outside diameter*	hsp	0,60 m
Differenz Fundamentoberkante - GOK *difference top of foundation – top ground surface*	hgok	0,15 m
Durchmesser der kompressiblen Einlage *diameter of soft compressive layer*	dk	2,90 m
Betongüte und Volumen *concrete class and volume*	C 25/30	155 m³
Betonstahl und Gewicht *reinforcement steel and weight*	BSt 420 S (A)	18,1 t
Betonstahl und Gewicht *reinforcement steel and weight*	BSt 500 S (A)	17,5 t

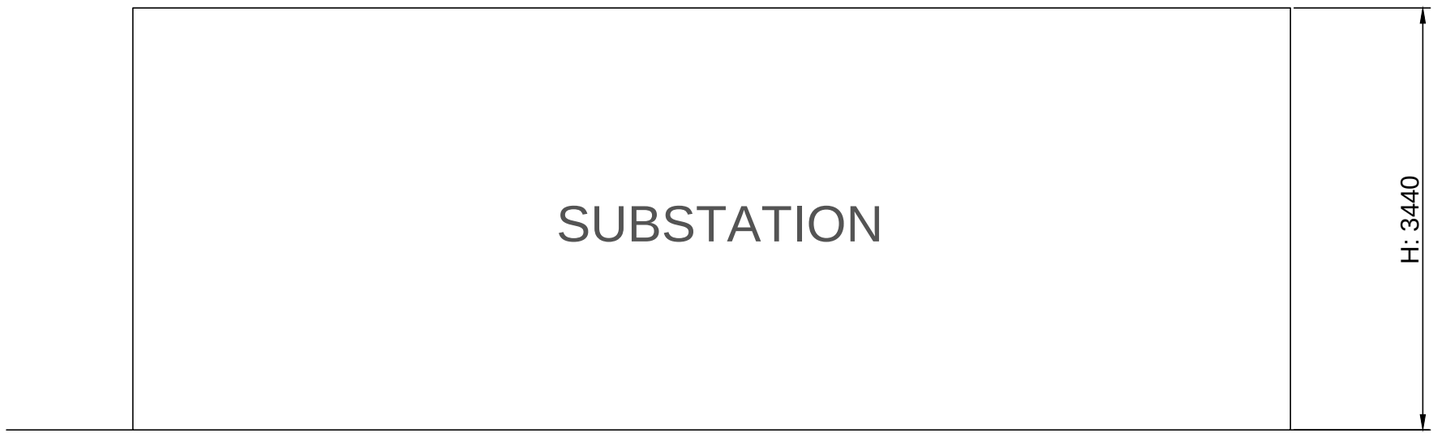


Bemerkungen / *Remarks*

- Die angegebenen Lasten sind ausschließlich für geotechnische Nachweise zu verwenden.
  The stated loads are only used for geotechnical calculations.
- Dieses Dokument wurde auf Anfrage bzw. für einen bestimmten Auftrag verschickt. Der Empfänger wurde nicht registriert! Der Empfänger wird bei Änderung nicht automatisch informiert!
  This document has been sent on request on a certain order. The receiver has not been registered! The receiver will not be informed automatically in case of alterations!
- Weitergabe und Kopien an Dritte sind nur mit schriftlicher Zustimmung der ENERCON-Konstruktionsabteilung erlaubt.
  Circulation or copies are only enabled by written agreement from ENERCON design department.

Proposed Substation Unit





PROJECT: 1 no. 500kW Wind Turbine		
LOCATION:		
Title: Substation Housing Dimensions		
Site ID:	DWG 003	Scale 1: 50 A3
Date: 23/04/2014		Created by: MK
Date: 23/04/2014		Checked by: CM
Date: 23/04/2014		Approved by: KT

entrust planning for renewables

ENERCON space and auxiliary power requirements for wind farm control or substation buildings

Table of contents

1 Introduction

The ENERCON SCADA SYSTEM communicates with both operator and wind turbines to enable the monitoring of wind turbines and the analysis of operating data. The system centralises the monitoring function and its reliability plays an important role within the operation of the wind farm. The necessary hardware devices of the ENERCON SCADA System such as SCADA PC or FCU shall be located in the SCADA room of the wind farm, which must fulfil certain technical and ambient conditions.

This document describes ENERCON's space and auxiliary requirements for a control building provided by the electrical works contractor (EWC). The purpose is to ensure that the building's design is sufficient for a proper installation and secure operation of the ENERCON SCADA equipment.

The information in this document must be adhered to by the EWC for planning purposes. The EWC being the contracted party providing planning, design and execution of all civil and electrical installations of the substation employed by the wind farm operator or wind farm owner.

In any case, the building design must be agreed during the planning phase with the ENERCON project management electrical works (PM-EW) project engineer.

Please note that beside the SCADA PC not all of the listed SCADA devices in this document are mandatory for the wind farm operation. These are project specific and may be included or excluded during the project planning phase, depending on grid code, utility or wind farm operator requirements.

2 Definition of terms

CLC: Close Loop Control (optional). Project specific application development.

CT: Current transformer

EWC: Electrical Works Contractor

FCU: Farm Control Unit (optional). [1]

GDA: Grid Data Acquisition (optional). [1]

PDI: Process Data Interface (optional). [1]

PQM: Power Quality Meter. (Optional). Permanent metering system for voltage and current monitoring, event-triggering and harmonics analyses as part of the FCU.

RCD: Residual Current Device

RTU: ENERCON Remote Terminal Unit. [1]

SAI: SCADA Application Interface. (Optional). Project specific I/O interface.

SCADA: ENERCON Supervisory Control and Data Acquisition System. It is mandatory for the monitoring of the wind farm. [1]

SCADA System: The ENERCON SCADA$_1$ SYSTEM is used for data acquisition, remote monitoring, open-loop and closed-loop control for both individual wind turbines and wind farms. It enables the wind farm operator and ENERCON Service to monitor the operating state and to analyse saved operating data. [1]

SCADA Devices: In this document meant as the group of SCADA PC, FCU, GDA, PDI and PQM as part of ENERCON SCADA System. [1]

SCADA PC: The SCADA PC is the hardware for operating the wind farm SCADA System. One PC in a 19” cabinet will be provided in each individual wind farm. [1]

SCADA room: Room in the control building dedicated for the ENERCON SCADA System.

Splice box: Terminal connection box for the connection of the fibre optic communication cables. The numbers of splice boxes depend on the design of the wind farm’s fibre-optic cabling.

UPS: Uninterruptible power supply.

VT: Voltage transformer

[1] Supplementary documentation available on request

3 General requirements

For the SCADA room design the following general requirements have to be taken into account:

- Climate: The room must be air-conditioned and temperature-controlled to maintain min. 5°C and max. 40°C and avoid humidity above 85%.
- Light: Sufficient light for normal working and maintenance must be provided. All lights must be designed as emergency lighting.
- Free from high voltage (>1kV) equipment. Access for ENERCON personnel must be guaranteed at all times. High voltage equipment must not be installed in the SCADA room or in the access routes to the SCADA room.
  NOTE: Exceptions to be agreed with the responsible ENERCON PM-EW Manager in agreement with local health and safety regulations and operation procedures.
- In front of each cabinet a working-space of 1.5m must be available.
  NOTE: Exceptions to be agreed with the responsible ENERCON PM-EW Manager in agreement with local health and safety regulations and local norms.
- The location of the exit door must guarantee direct and safe evacuation.
- Earthing: All SCADA devices listed in this document must be connected to the overall earthing system. Suitable connection points to the earthing system adjacent to the cabinets must be provided.

4 Room and dimensions

For the design of the SCADA room the, dimensions of the ENERCON SCADA devices, if necessary for the wind farm operation, to be installed in the SCADA room are as follows:

Equipment	Width (m)	Depth (m)	Height (m)	
SCADA PC	0.6	0.6	2.2	Free standing
Splice Box	0.3	0.2	0.4	Wall mounted
FCU	1.0	0.4	2.0	Wall fixed, floor-mounted
GDA	0.8	0.35	0.8	Wall mounted
PDI / SAI	0.6	0.3	0.6	Wall mounted
CLC	0.8	0.6	2.1	Wall fixed, floor-mounted
RTU	0.76	0.3	0.76	Wall mounted

Table 1: SCADA device dimensions

The orientation and position of the ENERCON SCADA devices must follow Figure 1: Floor plan SCADA devices and Figure 2: SCADA device installations, view A. - A

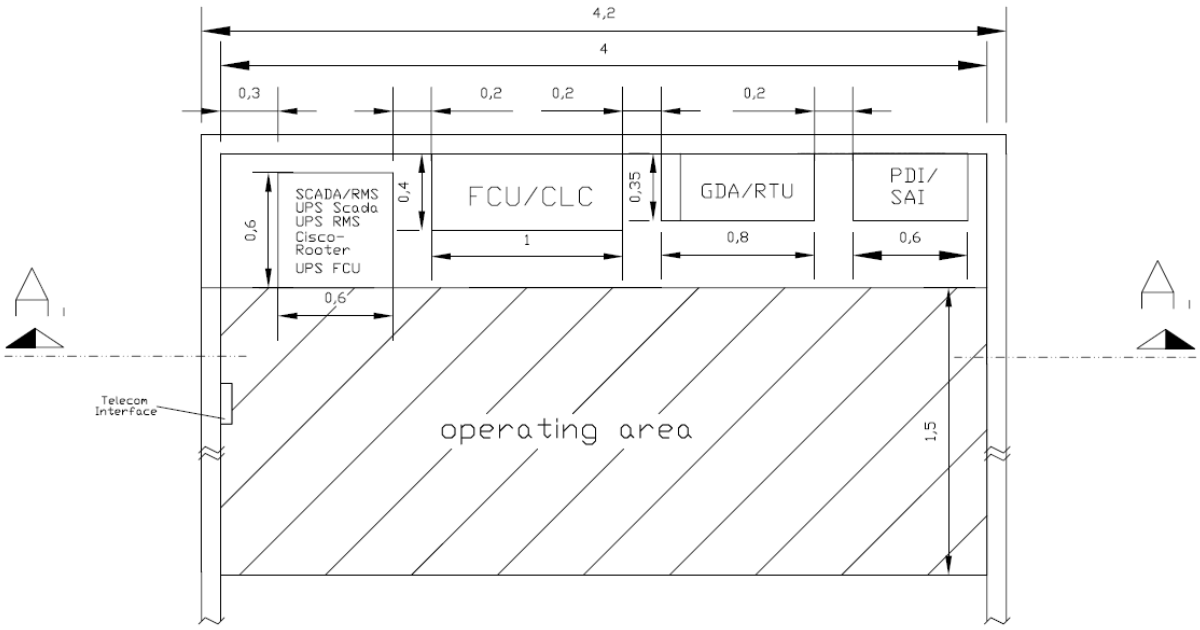


Figure 1: Floor plan SCADA devices

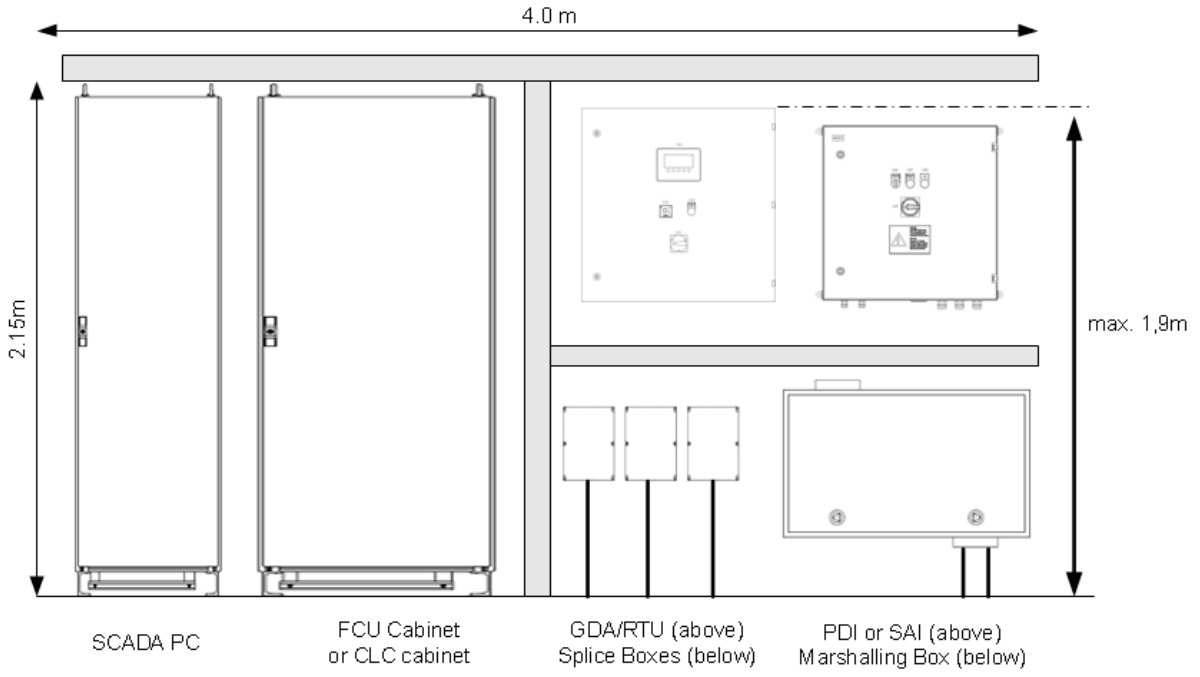


Figure 2: SCADA device installations, view A. - A

Note: Figure 2 shows the maximum number of ENERCON SCADA devices and their general orientation. The SCADA device which has to be installed depends on the requirements for signal exchange and controlling the wind farm as per the relevant grid code or connection conditions specified by the DNO or TSO.

Project-specific installation of meteorological or GPS sensors attached to the building may be necessary. For the electrical installation a 50mm opening underneath the ceiling (aprox. 2.2m) in a northerly direction must be provided. After installation of cabling the opening must be made fireproof and watertight by the responsible EWC

5 Input signals

The following voltage and current signals are requested for the different ENERCON SCADA devices:

Equipment	Current signal	Voltage signal
FCU	Redundant 2 x 3 phase xA/5A 3VA accuracy class 0.2 (or better)	Redundant 2x 3 phase 100V - 115V AC phase to phase, 0,2VA accuracy class 0.2 (or better)
GDA	1 x 3 phase xA/5A, 0,25VA accuracy class 0.2 (or better)	1x 3 phase 100V-115V AC phase to phase, 0,4VA accuracy class 0.2 (or better)
CLC	1 x 3 phase xA/5A, 1VA accuracy class 0.2 (or better)	1x 3 phase 100V-115V AC phase to phase, 0,1VA accuracy class 0.2 (or better)
PQM	1 x 3 phase xA/5A, 1VA accuracy class 0.2 (or better)	1x 3 phase 100V - 115V AC phase to phase, 0,1VA accuracy class 0.2 (or better)
RTU	1 x 3 phase xA/5A, 0,2VA accuracy class 0.2 (or better)	1x 3 phase 100V - 115V AC phase to phase, 0,1VA accuracy class 0.2 (or better)

Table 2: Input signals

NOTE:

“xA”: The primary current ratio must be chosen in accordance with the expected rated current of the wind farm, and needs to be confirmed in advance with the ENERCON PM-EW Manager.

For the FCU it is strongly recommended to provide redundant signals for both current and voltage by using another set secondary windings of both current and voltage transformers. This can assure a continuously supervision of the input signals. Please note that a redundancy is not mandatory for the FCU operation.

Protection-class instrument are strictly forbidden for measuring.

All SCADA devices have to be physically connected to the CT and VT’s. A converted signal transfer (e.g. 4-20mA or TCP) is not allowed. An external positioning of the integrated signal transducer is possible for the RTU only. If desired, this solution must to be agreed with the ENERCON EW-Manager at an early stage of the communication planning phase.

The FCU must be installed close to the CT’s and VT’s. A separation of the FCU measuring unit is not possible.

Burden:

The above-mentioned burden does not take into account the interconnection wiring from the VT/CT's to the SCADA devices. This must be considered and, if significant, added to the SCADA device burden with I^2 * R [Ω/m] * length [m] of connecting cable. In this respect ENERCON recommends to choose a burden between 5VA to 10VA. Please contact the ENERCON EW-Manager for support.

For planning of the CT burden please note the following: The load must be at least 25% of the CT burden in order to guarantee the accuracy class.

Example: CT burden = 10VA -> the load must be at least 2,5VA

For all device mentioned in Table 2 the measurement connection must follow the specifications of Table 3.

Measuring transformer	Cable
Voltage transformer	4 × ≥ 1.5 mm², shielded
Current transformer	**Variant 1:** 7 × ≥ 2.5 mm², max. 6 mm², shielded **Variant 2:** 4 × ≥ 2.5 mm², max. 6 mm², shielded

Table 3: Measuring transformer connection specification

6 Signal marshalling

All input or output signals, if any, must be terminated in a marshalling box provided by the EWC in the ENERCON SCADA room. ENERCON will connect the ENERCON SCADA devices to this marshalling box.

NOTE: Any external connection of auxiliary-supply, CT and VT signals or interface-signals to the marshalling box is not in the ENERCON scope of work. Sufficient fusing especially for the VT signals and short-circuitable termination points/terminals must be provided by the EWC. Only the delivery, installation, commissioning of the ENERCON SCADA devices and their associated communication devices up to the marshalling box are within ENERCON's scope of supply. For the avoidance of doubt, the planning, delivery and installation of the marshalling box is not in ENERCON's scope of supply.

All technical aspects of signal exchange must be agreed with the responsible ENERCON PM-EW Manager. A signal exchange list can be provided by ENERCON on request.

Please consider Figure 3: Metering VT and CT connection scheme indicating the expected VT and CT connections into the marshalling box:

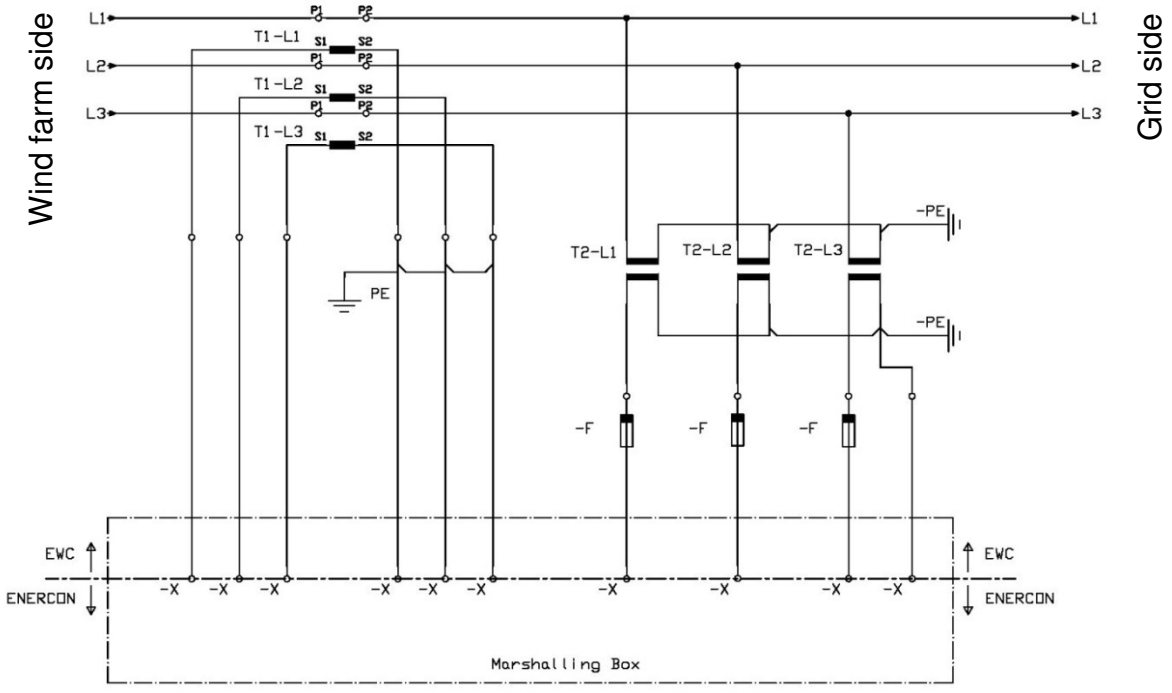


Figure 3: Metering VT and CT connection scheme

NOTE: For the avoidance of doubt, in addition to the signals shown in Figure 3, all other signals (to/from the ENERCON equipment) must be terminated in the marshalling box.

7 Auxiliary requirements

The following requirements regarding electrical supply must be adhered to by the EWC:

- Auxiliary supply for the FCU must be 230V AC (phase - neutral) 50/60Hz
- All other ENERCON SCADA devices need an auxiliary supply each: Single-phase 110V AC or 230V AC (phase - neutral) 50/60Hz.
- Circuits for power sockets must be fused separately from lighting circuits.
- All electrical circuits supplying ENERCON SCADA devices are requested NOT to be RCD (Residual Current Device) protected. Each device must be hard wired and not socket connected.
- General outlets and lightning must be RCD (30mA) protected.
- All ENERCON SCADA devices are internally protected by a circuit breaker type K10A MCB.
- All cabinets must be connected to an earthing bar using a 16mm² green/yellow-insulated earth cable.

For general auxiliary planning purposes please consider Table 4: Power consumption of SCADA devices showing the power consumption of the ENERCON SCADA devices in detail:

Equipment	Power consumption
SCADA PC	150W
SCADA Monitor	50W
SCADA - UPS	40W
SCADA Router	25W
GDA	100W
PD / SAI	50W
FCU / CLC	150W
FCU + UPS	project-specific
RTU	100W

Table 4: Power consumption of SCADA devices

8 Uninterruptible power supply (UPS)

8.1 General

The following equipment can be equipped with an internal UPS provided by ENERCON; where indicated as standard or as option:

- SCADA PC: 19" USV APC Smart-UPS® 750VA (SUA750RMI2U) (standard)
- GDA stand alone: SUA750I (optional)
- PDI stand alone: SUA750I (optional)
- PDI 19” version: Connected to 19” SCADA UPS (standard)
- RTU: Internal pre-installed 7Ah (standard) - (optional 26Ah)

8.2 FCU and CLC

The FCU and the CLC hardware require a UPS connection usually using the Substation UPS provided by the EWC. The following technical specifications must be taken into account:

UPS output: 230V 50Hz / 60 Hz
Fuses: See Table 4: Power consumption of SCADA devices and chapter 7 “Auxiliary requirements” of this document.

NOTE: Due to high inrush currents caused by the FCU, a “time delay type fuse” must be used for protection.

ENERCON also offers the option to supply a UPS for the FCU and the CLC. Please contact the Electrical Works Project Management – Application for planning details.

9 Telecom communication

For the communication between the wind farm ENERCON SCADA computer and the central SCADA computer located at the headquarters of ENERCON in Germany, a permanent TCP-IP-connection (static or dynamic IP-address) must be provided. As a backup, one analogue or mobile connection (3G, EDGE or UMTS) must be provided. The analogue must be realised by means of a dial-in connection. The Telecom-socket must be wall-mounted near to the ENERCON SCADA PC.

Please note that further documentation relating to “Wind Farm Connections” is available on request from ENERCON.

Legal notice

Publisher: ENERCON GmbH ▪ Dreekamp 5 ▪ 26605 Aurich ▪ Germany
Phone: +49 4941 927-0
Fax: +49 4941 927-109

Document details

Document no.:	Index	Date	Language	"Original" or "Translation of <Doc. no.>"
DC059	5	08.07.2010	Eng	Original
DC059	6	13.04.2012	Eng	Updates: RTU included and updates on burden specification