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Bangladesh Wind Resource Testing

Mymensingh Tower Installation Report
August 15, 2015

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September 1, 2015
Subcontract Number: AXL - 4 - 23368-01

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MET MAST LOG

Site Information			
Project Name	Bangladesh Wind Mapping	**Site Name / Number**	Mymensingh
Division	Dhaka	**District**	Mymensingh
Nearest Town	Batipara	**Time Offset/Time Zone**	UTC + 6
Prevailing Wind Direction for Install	South	**Magnetic Declination**	0.26° W, by 0.04° E PY
AS BUILT Latitude (NAD83)	N 24.71546°	**AS BUILT Elevation (m)**	9
AS BUILT Longitude (NAD83)	E 90.46680°	**Programmed Time Offset**	Local – UTC + 6
Commissioning Date	15 Aug 2015	**Commissioning Time (Local)**	17:00
Access	Access from road to North of tower. Small walking path from road to tower past guard house. Guards have gate key.		
Site Description	Flat, agricultural land on the North river bank. Small to medium sized trees scattered in all directions.		
Comments			

Fixed Object Vista Table

Description of Object	Azimuth (Deg)	Distance (m)	Height of Object (m)	Relative Elevation
Road	0	150	2	0
Guard House	60	120	4.5	0
Concrete Bridge	100	275	3	0
Mixed Trees	120-220	100-250	5-10	0

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Logger Information			
Manufacturer	Campbell Scientific	**Type**	CR3000
Serial Number	9791	**Calibration Date**	16 Sept 14
Program File	Harness_80m_Mymensingh_v2	**Mounting Orientation – Enlc.**	NW – 310°
Mounting Height (m)	3.8	**Low Level AC**	CS LLAC4 – SN 3775
Charging Regulator	CS CH200 – SN 4010	**Battery**	RIMSO Solar – 12V, 80 Ah
Card Module	CS CFM100 – SN11695	**Memory Card**	2G CFM
Enclosure	Fiberglass – 16x18	**Lock Combination**	4-2-7-6
Comments	85 W Solar PV mounted on steel frame with power system for aviation light. Mounting orientation 180°. Battery mounted in steel enclosure with batteries for aviation light power system.		

Modem Information			
Manufacturer	Sierra Wireless	**Type**	AirLink LS300
Serial Number	CA81594014610	**Phone Number**	01733560995
IMEI	354166050192070	**IP Address**	Dynamic
Network	Grameen Phone GSM	**APN Name (GPRS/GSM)**	gpinternet
Antenna Type	Omni Cellular	**Next Scheduled Call**	19:00 UTC + 6
Antenna Strength	-51 dB	**Modem Template**	LS300G_115200
E-Mail Subject Line	NREL_Bangladesh_Mymensingh	**Recipient's E-Mail Address**	nrel.mymensingh.bd@gmail.com
Sender's E-Mail Address	Winddata.bd@gmail.com		
Comments			

Tower Information			
Manufacturer	Construction BD	**Type**	Guyed Lattice
Height (m)	82	**Face Width / Diameter**	0.90 m
Tower Steel – New / Used	New	**Guy Wires – New / Used**	New – 9mm OD
Meas. Tower Height (m) AGL	83.92	**Height w/ Grounding Rod (m) AGL**	84.92
Comments	See tower drawings for more details. Tower height verification photos measured from 0.74 meters AGL.		

Tower Marking Information			
Lighting – Manufacturer	Construction BD	**Marker Balls - Sets**	N/A
Lighting - Model	CBD - 14300	**Marker Balls - Distance along GW**	N/A
Lighting - Mounting Height	83.7m & 53.6m	**Guy Guards**	10' Yellow on all guy lines
Lighting – Power Supply	400 W PV, 300 Ah Battery Bank	**Paint**	Full Tower – 4 Red/3 White Alt.
		Fencing	Bamboo & Barb Wire
Comments	Fencing around tower base with locked gate. Fencing around each anchor.		

Environmental Marking Information			
Bat Monitoring	N/A	**Bird Diverters**	Yellow PLP
Bat Mounting Orientation	N/A	**BD Guys**	1, 4, 8
Bat Mounting Height (m)	N/A	**Spacing**	28'
Comments			

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Anchor Information						
	Dist. From Tower (m)	**Orient. (True)**	**Type**	**Pull Test – Value**	**Paint – Yes/No**	**Notes**
Anchor 1	30	358°	Rein. Concrete	No	Yes	
Anchor 2	57.5	358°	Rein. Concrete	No	Yes	
Anchor 3	30.2	118°	Rein. Concrete	No	Yes	
Anchor 4	59	118°	Rein. Concrete	No	Yes	
Anchor 5	30	238°	Rein. Concrete	No	Yes	
Anchor 6	59	238°	Rein. Concrete	No	Yes	
Comments						

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MET MAST LOG

SENSOR INFORMATION

Sensor Information – Part I						
	Sensor 1	**Sensor 2**	**Sensor 3**	**Sensor 4**	**Sensor 5**	**Sensor 6**
Logger Channel	WS_East_80m	WS_West_80m	WS_East_60m	WS_West_60m	WS_East_40m	WS_West_40m
Instrument Type	Anemometer	Anemometer	Anemometer	Anemometer	Anemometer	Anemometer
Manufacturer	NRG Systems	NRG Systems	NRG Systems	NRG Systems	NRG Systems	NRG Systems
Model	Class 1	Class 1	Class 1	#40C	Class 1	Class 1
Serial Number	3806	3807	3801	235644	3808	3809
Slope/Multiplier	.770	.771	.769	.765	.771	.768
Offset	.23	.21	.24	.33	.22	.23
Averaging Period	10 min.	10 min.	10 min.	10 min.	10 min.	10 min.
Units	m/s	m/s	m/s	m/s	m/s	m/s
Test Certificate	Y	Y	Y	Y	Y	Y
Req Sensor Height (m)	80	80	60	60	40	40
Sensor Height (m)	80.23	80.23	60.61	60.61	40.09	40.09
Stub Mast Length (m)	.80	.80	.80	.80	.80	.80
Stub Mast Diameter (mm)	12.5	12.5	12.5	12.5	12.5	12.5
Boom Length (m)	4.57	4.57	4.57	4.57	4.57	4.57
Boom Diameter (mm)	40	40	40	40	40	40
Req Boom Orientation (True)	90°	270°	90°	270°	90°	270°
Boom Orientation (True)	87°	267°	87°	267°	87°	267°
Req DB Orientation (In/Out)	N/A	N/A	N/A	N/A	N/A	N/A
Deadband Orientation (True)	N/A	N/A	N/A	N/A	N/A	N/A
Functional Checks	4.85	4.83	4.085	4.155	4.075	4.07
Comments	Please see boom drawings for boom specs. Please see tower drawing for detailed mounting height and orientation information. Class 1 anemometer serial numbers start with 59670000-, #40C anemometer serial number starts with 179500-. Pictures showing mounting heights measured from 0.74 meters.					

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MET MAST LOG

Sensor Information – Part II						
	Sensor 7	**Sensor 8**	**Sensor 9**	**Sensor 10**	**Sensor 11**	**Sensor 12**
Logger Channel	WindDir_79m	WindDir_59m	WindDir_39m	RTD_Temp_C_80m	RTD_Temp_C_4m	HMP155P_TempC_80m RH_80m
Instrument Type	Wind Vane	Wind Vane	Wind Vane	Temperature	Temperature	Temperature / RH
Manufacturer	NRG Systems	NRG Systems	NRG Systems	RM Young	RM Young	Vaisala
Model	#200P	#200P	#200P	1k RTD	1k RTD	HMP-155L
Serial Number	N/A	N/A	N/A	25357	24464	K2870022
Slope/Multiplier	N/A	N/A	N/A	2.402801, 1.141266	2.397535, 1.172908	0.14
Offset	90	90	90	-251.760549	-251.541623	-80
Averaging Period	10 min.	10 min.	10 min.	10 min.	10 min.	10 min.
Units	Degrees	Degrees	Degrees	°C	°C	°C
Test Certificate	N	N	N	Y	Y	Y
Req Sensor Height (m)	78	58	38	80	4	80
Sensor Height (m)	78.37	58.28	38.24	78.28	3.72	79.04
Stub Mast Length (m)	.80	.80	.80	N/A	N/A	N/A
Stub Mast Diameter (mm)	12.5	12.5	12.5	N/A	N/A	N/A
Boom Length (m)	4.57	4.57	4.57	N/A	N/A	N/A
Boom Diameter (mm)	40	40	40	N/A	N/A	N/A
Req Boom Orientation (True)	270°	270°	270°	0°	0°	0°
Boom Orientation (True)	267°	267°	267°	0°	0°	0°
Req DB Orientation (In/Out)	In	In	In	N/A	N/A	N/A
Deadband Orientation (True)	87°	87°	87°	N/A	N/A	N/A
Functional Checks	155°	140°	135°	28.547	29.276	28.4313/84.9737
Comments	Please see boom drawings for boom specs. Please see tower drawing for detailed mounting height and orientation information. Pictures showing mounting heights measured from 0.74 meters.					

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MET MAST LOG

Sensor Information – Part III						
	Sensor 13	**Sensor 14**	**Sensor 15**	**Sensor 16**	**Sensor 17**	**Sensor 18**
Logger Channel	HMP155P_TempC_4m RH_4m	BP_80m	BP_4m	SlrW	LWmV	
Instrument Type	Temperature / RH	Barometric Pressure	Barometric Pressure	Pyranometer	Leaf Wetness	
Manufacturer	Vaisala	Setra	Setra	Huskeflux	Decagon	
Model	HMP-155L	278	278	LP02	Leaf Wetness	
Serial Number	K2870025	5904825	5937935	45052	N/A	
Slope/Multiplier	0.14	0.2	0.2	56.548	2500	
Offset	-80	600	600	N/A	0	
Averaging Period	10 min.	10 min.	10 min.	1 min.	10 min.	
Units	°C	mB	mB	W/m^2		
Test Certificate	Y	Y	Y	Y	N	
Req Sensor Height (m)	4	80	4	4	4	
Sensor Height (m)	4.49	78.66	4.69	5.10	4.26	
Stub Mast Length (m)	N/A	N/A	N/A	N/A	N/A	
Stub Mast Diameter (mm)	N/A	N/A	N/A	N/A	N/A	
Boom Length (m)	N/A	N/A	N/A	N/A	N/A	
Boom Diameter (mm)	N/A	N/A	N/A	N/A	N/A	
Req Boom Orientation (True)	0°	0°	0°	180°	-	
Boom Orientation (True)	0°	0°	310°	180°	180°	
Req DB Orientation (In/Out)	N/A	N/A	N/A	N/A	N/A	
Deadband Orientation (True)	N/A	N/A	N/A	N/A	N/A	
Functional Checks	29.1534/84.7555	994.670	1001.86	186.392	279.835 mV	
Comments	Please see boom drawings for boom specs. Please see tower drawing for detailed mounting height and orientation information. Pictures showing mounting heights measured from 0.74 meters.					

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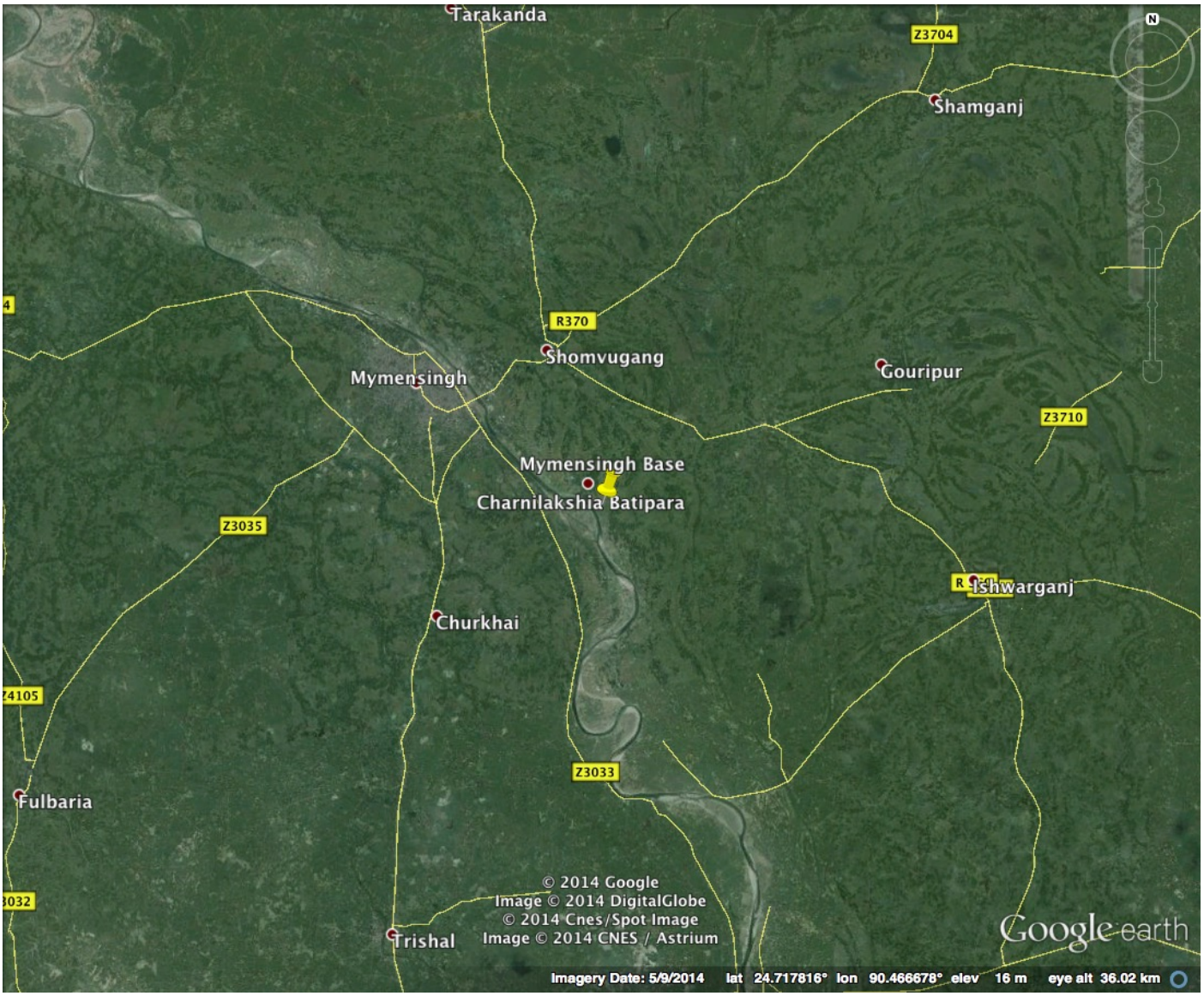
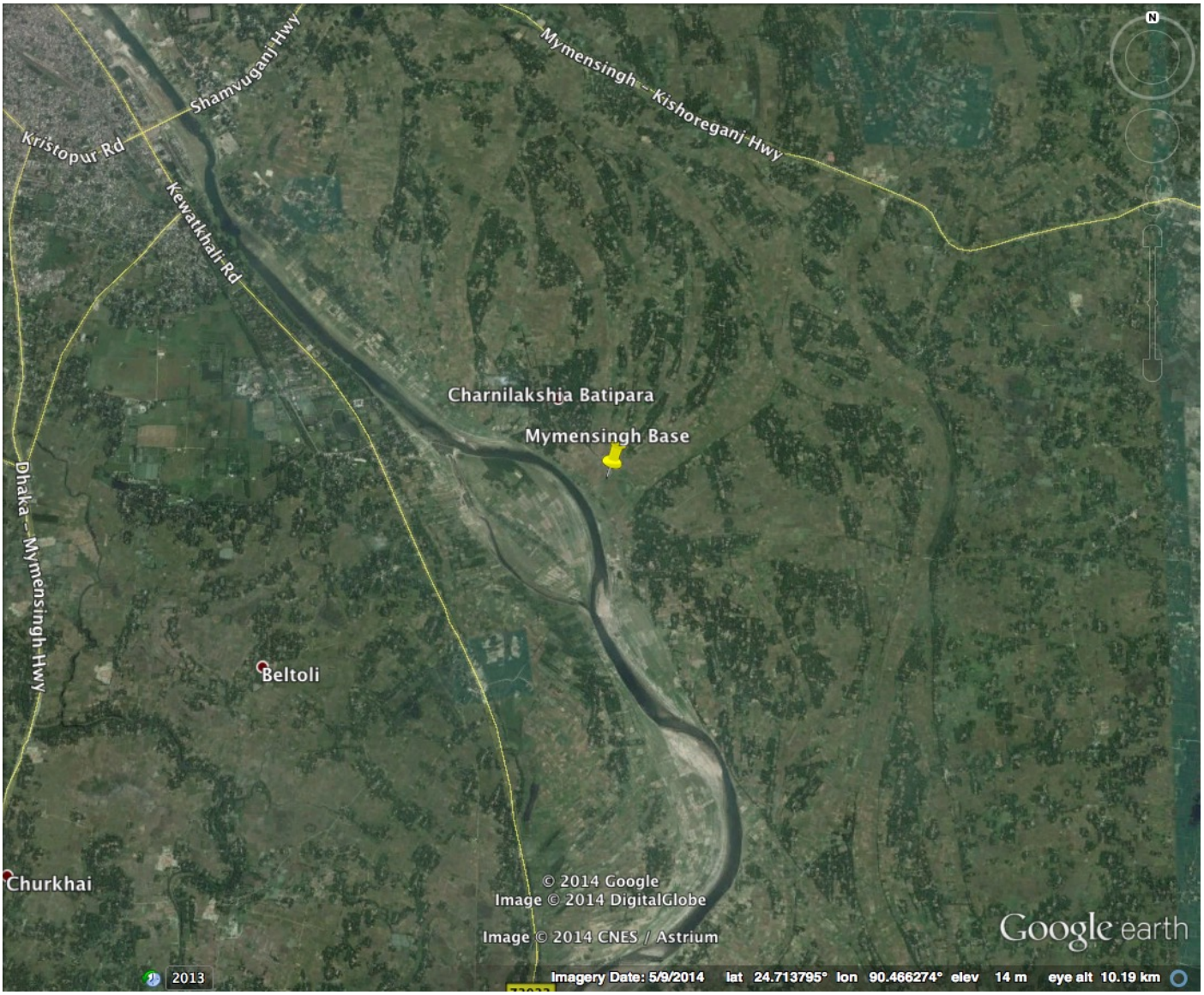
Site Information

I. View from 35 km

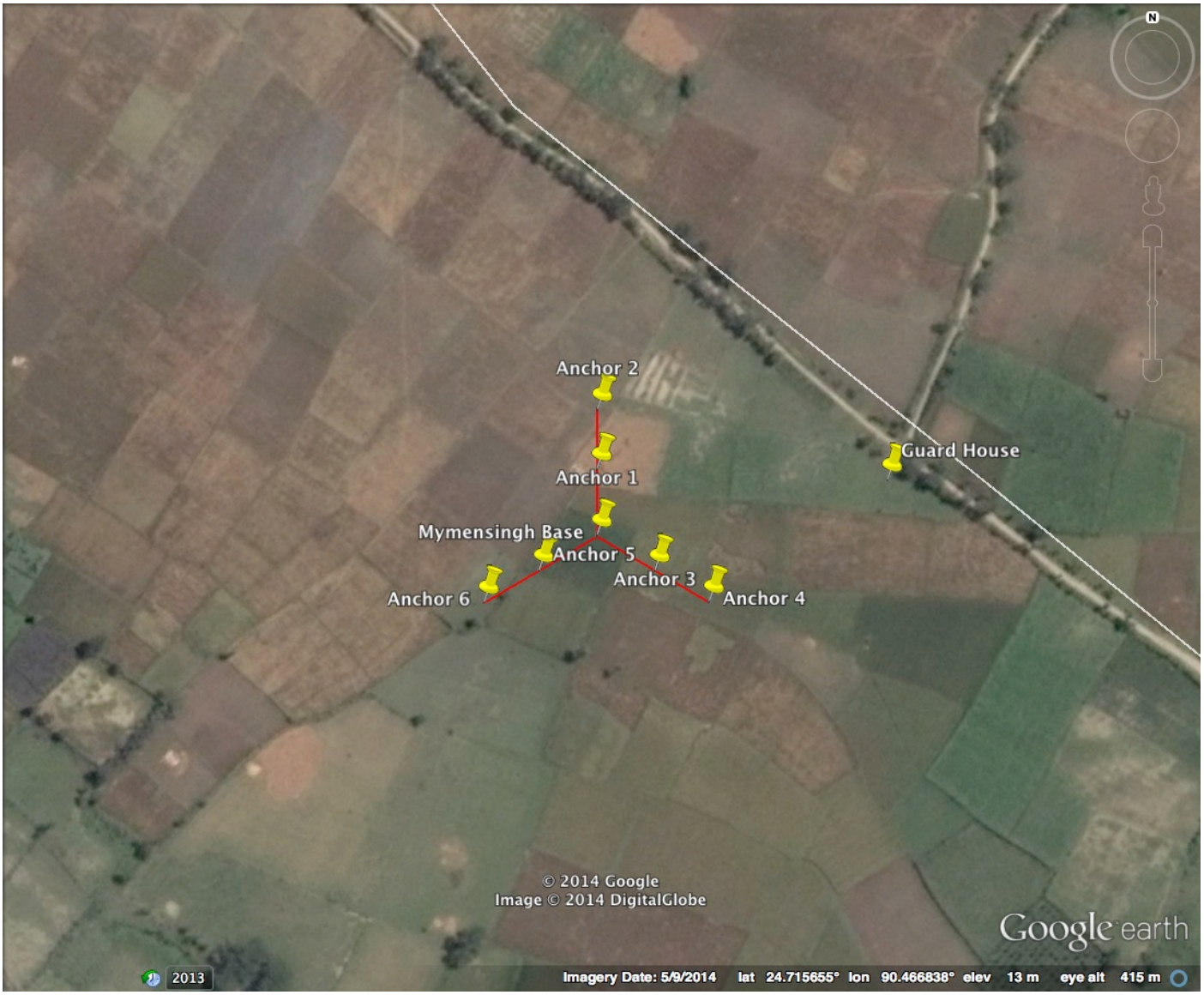


II. View from 10 km



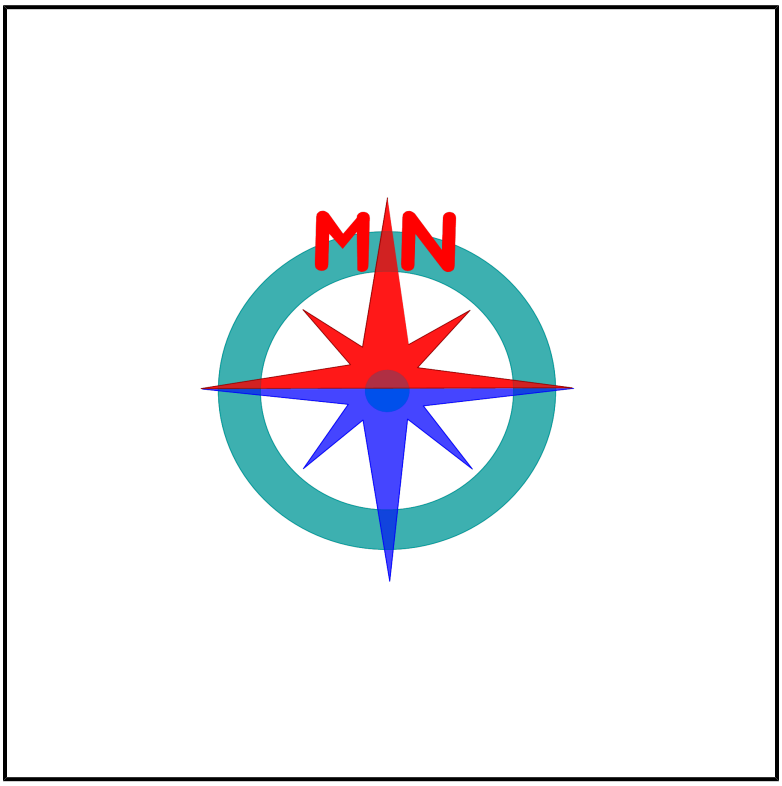
III. View from 2 km

IV. View from 400 m



Declination

Date	2015-08-15
Latitude	24.71546° N
Longitude	90.46680° E
Elevation	0.0 km GPS
Model Used	WMM2015
Declination	0.26° W changing by 0.04° E per year
Uncertainty	0.28°



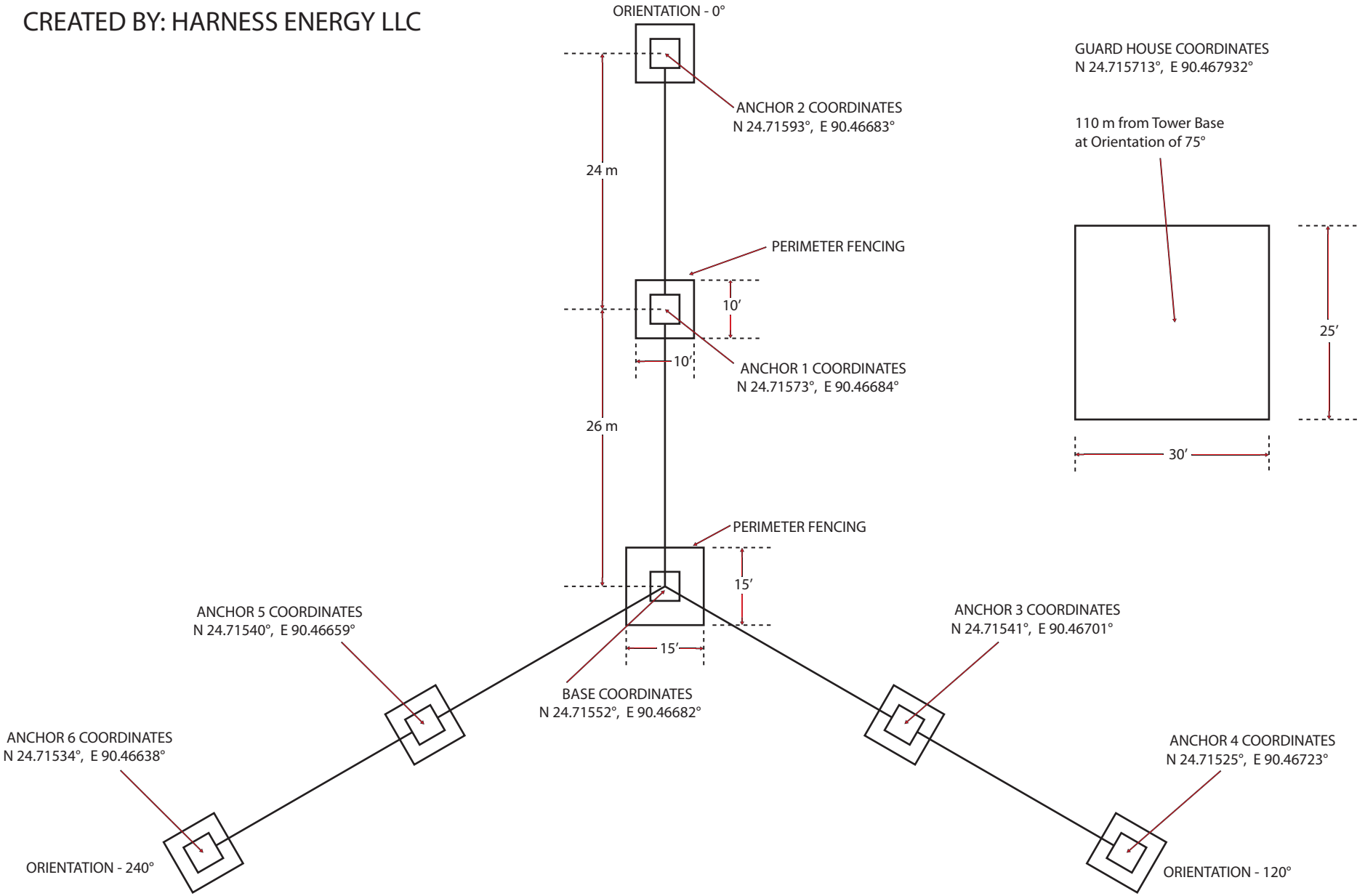
Compass shows the approximate bearing of the magnetic north (MN)

Magnetic declination is the angle between true north and the horizontal trace of the local magnetic field. In general, the present day field models such as the IGRF and World Magnetic Model (WMM) are accurate to within 30 minutes of arc for the declination. However, local anomalies exceeding 10 degrees, although rare, do exist.

Document created: 2015-08-31 12:31 UTC

Help: How to interpret results Questions: geomag.models@noaa.gov

BANGLADESH WIND MAPPING
SITE: MYMENSINGH
VERSION: 4.0
DATE: 25 OCT 2014
CREATED BY: HARNESS ENERGY LLC



0 Degrees

30 Degrees

60 Degrees

90 Degrees

120 Degrees

150 Degrees

180 Degrees

210 Degrees

240 Degrees

270 Degrees

300 Degrees

330 Degrees

Looking in from North

Looking in from North East

Looking in from East

Looking in from South East

Looking in from South

Looking in from South West

Looking in from North West

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Tower Information

CLIENT.

NATIONAL RENEWABLE ENERGY LABORATORY (NREL).
(HARNESS ENERGY BANGLADESH LTD.)

SUB – SOIL INVESTIGATION REPORT

FOR THE CONSTRUCTION OF PROPOSED 82 METER TOWER AT MYMENSINGH.

NOVEMBER-2014

SUB-SOIL INVESTIGATION REPORT PREPARED BY:-

CONFIDENCE GEO SOIL ENGINEERS

BIA BHABAN, 53, MOHAKHALI C/A, DHAKA-1212.
MOBILE – 01720-672903, 01716-814334.

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Attachment

A. Site Plan

B. Boring Logs

C. Unconfined Test

D. Consolidation Test

E. Direct Shear Test

F. Grain Size Analysis

G. Summery Sheet

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1.0 INTRODUCTION :

CONFIDENCE GEO SOIL ENGINEERS a well renowned geotechnical firm in Dhaka has got the opportunity for sub-soil investigation, which has been done by at the site of **Mymensingh.** for proper planning and designing the Structure, Sub-soil Investigation is very important-which also confirm the structure safe and stable.

CONFIDENCE GEO SOIL ENGINEERS has executed Standard Penetration Test (SPT) for investigation of sub- soil at a depth of 51 ft.for each Consists of 04 (Four) Borings at the site of **Mymensingh.**

2.0 PURPOSE OF SOIL EXPLORATION:

The process of identifying the layers of deposits that underline a proposed structure and their physical characteristics is generally referred to as subsurface exploration. The purpose of subsurface exploration is to obtain information that will aid the Foundation Engineer in-

a). Selecting the type and depth of foundation suitable for a given structure.

b). Evaluation the load-bearing capacity of a foundation.

c). Estimate the probable settlement of a structure.

d). Determining potential foundation problems (for example, expansive soil, collapsible soil, sanitary landfill and so on).

e). Predicting lateral earth pressure for structures such as retaining walls, sheet pile bulkheads and braces cuts.

3.0 FIELD WORKS:

All the field works and field test were conducted as per standard procedure as laid down in **ASTM specification** are as follows:

4.0 Exploratory Boring drilling:

Drilling was executed by wash boring method. A hole was started by driving vertically a 4" diameter steel casing into the ground to some depth and then the formation ground casing was broken up by repeated drops of a chopping bit attached to the lower and of drilling pipe. The upper end of the same was forced at high pressure through pressure pipe. Forced slurry or water emerges at high velocity through the pores of the chopping bit, and returns to the surface through the annular space between drilling pipe and the side of the casing or hole, carrying with it the broken-up soils. In this way drilling is advanced up to a level of 6" above the depth, where SPT has to be executed.

5.0 Standard Penetration Test:

Standard penetration Tests have been executed in all the bore holes at 5ft. interval of depth up to the final depth of boring. In this test, a split spoon sampler of 2" out diameter and 1-3/8" inner weighing 140 lbs. failing freely for a height of 30 inch length of the sampler is recorded. The number of blows for the last 12 inch penetration of the total 18 inch is known as the standard penetration value (N-Values) as **specified by ASTM** and is plotted SPT value of the particular depth.

6.0 Extraction of soil samples:

Distributed soil samples were collected at 5'-0" intervals and at every change of soil strata by split spoon sampler. These soil samples were studied visually and the soil classification were done to prepare strata chart of soils up to the explored depth. Before collection of samples, the hole is washed and cleaned the drill pipe with the help of an adapter and is lowered into the hole. The sampler is then pressed down into the ground in one rapid continuous movement until the tube, except 4 inches from the top is filled with soil sample. Undisturbed soil samples are taken at a depth where layer of soil is changed such as 8ft or 12ft. undisturbed soil samples are collected by means of thin walled sharp ended 3 inch dia. Shelby tube from the cohesive soil formation. The collected tubes were then sealed with detailed job designation, date and shifted to the laboratory for testing.

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7.0 LABORATORY TESTS:

All Laboratory Tests conducted on soil samples collected either in the disturbed or in the undisturbed state. All tests were done as per ASTM procedures, are as follow:

8.0 Natural Moisture Content:

The water content of a soil sample is the ratio of the weight of the water in the sample to its dry weight. It is usually expressed as a percentage. The soil sample is weighed both in natural state and in oven dry state and the moisture content is calculated by dividing the loss of weight of the sample by its dry weight.

9.0 Complete Grain Size Analysis:

The object of grain size analysis is to determine the size of the soil grains, and the percentage by weight of soil particles of different particles size, comprising a soil sample. The process consists of either sieve analysis or hydrometer analysis or both. The hydrometer analysis is adopted for sample passing sieve No. 200.

For hydrometer analysis, a 40 gms of the oven dry sample, is thoroughly mixed with required quantity of water in a calibrated glass cylinder. In order to avoid flocculation, a little dispersing agent is added. The density of the suspension is measured at specified time intervals, by means of a hydrometer or special design. At any particular time the size of the largest particle remounting in suspension at the level of the hydrometer can be computed by means of Stocks Law, where as he weight of the particles finer than size, can be computed from the density of the suspension at the same level.

The mixture is washed through U.S Standard sieve No. 200 and the fraction retained is dried. The fraction retained on each sieve is weighed for calculation of the percentage of different fraction. The results are represented by cumulative curves plotted on semi-logarithmic graph paper.

10.0 Atterberg limits:

Physical properties of clay are greatly influenced by eater content. A given soil behave as fluid or a soil or, as a plastic materials, depending on how much water it contents that correspond to the boundaries between the states of consistency are called as the Atterberg limit.

Liquid Limit is the minimum water content at which a clay soil just starts behaving like a fluid. It is determined with the help of a standard limit device which consists of brass cup and an arrangement to impart blows to cup at an uniform rate. The water content at which 25 blows are required is termed as the limit.

The plastic limit is the minimum water content at which a soil is just plastic and is determined by rolling out a soil sample at a slowly decreasing water content until, the desired water content is reached, at which a thread of 1/8 inch diameter. Just begging to crumble. The thread is rolled on a glass plate with hand.

11.0 Specific Gravity Test:

The specific gravity of a solid defined as the ratio of the unit weight of the solid in air to the unit weight of water. To determine the specific gravity of soil sample, 25 grams of oven dried soil sample is thoroughly pulverized and is placed in a calibrated pycnometer. Water is purred incise the pycnometer until it's top is lightly below the calibrated mark. The mixture is then boiled thoroughly in order to eliminate all the air bubbles. More water is then added to the mixture till it over night, the temperature is then recorded and the bottle is weighed.

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The specific Gravity Gs is given by:

$$Gs = \frac{Gt \times Ws}{Ws - W1 + W2}$$

Where,

Gt	=	Specific Gravity of water at TOC.
Ws	=	The weight of over dry soil (25 gm).
W1	=	Weight of flask + soil + water.
W2	=	Weight of flask + water.

12.0 Direct Shear Test:

Direct shear test can be performed for both cohesion less & cohesive soil to determine shear strength, angle of internal friction, cohesion c, volume change etc. The test is done in a direct shear machine which consists of a normal loading device, shearing, device, 5 cm by two pieces sample, square box, etc. The rate on shearing displacement of approximately 10 mm per minute is often for a sample used for a sample thickness of about 1.2 cm.

The results of a direct shear test on a cohesion less & cohesive soil can be presented in a summary table & by stress-strain curve. A stress-strain curve normally consists of shear Stress, various shear displacement for both the undisturbed and the remolded tests under a specified normal load. The normal load usually varies from 1/3 kg/cm². Another curve normal stress verses shearing stress will give angle of internal friction and cohesion for cohesive soils.

13.0 Unconfined Compression Test:

Unconfined compression test is a simple method for determination of shearing strength of shearing strength of cohesive soil which is important to determine the bearing capacity of soil. As the name implies, the lateral confining pressure in an unconfined compression test is kept zero, unsupported specimen and at failure is measured. The specimen is prepared from the undisturbed soil sample by carefully trimming it to a cylindrical shape of 7 cm height and 3.5 cm dia. The specimen is then placed on the level pedestal of the unconfined compression apparatus in a vertical position. The load is applied axially on the top of the specimen an is distributed uniformly over surface of the specimen with the help of double providing ring assembly fitted with a strain gauge, fitted with the apparatus. The load is applied at such a rate that the vertical deformation of the sample is nearly 2% (two percent) per minute in order to avoid and drainage during compression. The load is kept increasing until the specimen fails along shearing plane. The aximum load at failure known as the unconfined compressive strength of the sample the shearing strength of the sample is half of the unconfined compressive strength.

14.0 Consolidation Test:

The gradual process compression of soil under the action of static load and with decrease of void ratio due to expulsion of water from the soil pores is termed consolidation phenomenon compressibility characteristics of a soil as the period and magnitude of settlement of a foundation depends on these characteristics. The test is performed on a specimen of circular shape of 6.35 cm dia and 2.54 cm thickness, the specimen is prepared from the undisturbed sample by carefully trimming it to the required dimension with the help of a cutting edge and wire saw the specimen is then placed in the consolidation ring and its top and bottom are trimmed of level with that of the ring. The specimen along with the ring on the top and the other at the bottom of the help of a level arrangement with the apparatus. Decreases in volume of specimen are read from a strain gauge attached to the consolidation unit at specified time intervals the consolidation unit is always kept full with water in order to avoid evaporation of the specimen.

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The load increment is allowed after each twenty four hours, the observed readings are then plotted on semi-logarithmic graph paper to give the pressure-void ratio curve from which compression index, Cc can be calculated. Cc is important factor governing the settlement process of underlying soils.

15.0 Description of Soil Composition:

The following terms are used in this report for description of soil composition:

Trace	:	1 to 10%
Little	:	11 to 20%
Some	:	20 to 35%
Sandy	:	35 to 50%
Clayey	:	35 to 50%
Salty	:	35 to 50%

16.0 CORRELATION TABLE OF SOILS BASED ON SPT-VALUES:

Two tables for Non-Cohesive and Cohesive Soils Based on N-Values as below:

17.0 Values of Unit Weight And Angle of International Friction of Non-Cohesive Soil Based on N-Values (After K. Terzaghi and R.B Peck):

Table No. 1

N-Values	Condition	Relative density	Angle of internal friction	Moist unit wt. In pcf.
0-4	Very loose	0.0-0.2	25° - 30°	70-100
4-10	Loose	0.2-0.4	30° - 35°	90-115
10-30	Medium	0.4-0.6	35° - 40°	110-130
30-50	Dense	0.6-0.85	40° - 45°	110-140
Over 50	Very dense	1.00	45°	130-150

The tabulated values apply for dry/most cohesion less sand. For salty sands the bearing capacity values must be reduced by study of grain size classification and applying judgment. Correction for water table close to bottom of foundation the bearing values should be reduced to half. The bearing values are, however, not affected by water table at a depth greater than 1.5B below foundation level, B being least dimension of the bottom of foundation. Bearing values for intermediate position of water table may be reduced by liner interpolation.

18.0 Values of Approximate Unconfined Compressive Strength Based on N-Values for Cohesive Soil (After K. Terzaghi and R.B Peck):

Table No. 2

N-Values	Condition	Unconfined compressive Strength in Tsf.
Below 2	Very soft	Below 0.25
2 – 4	Soft	0.25 – 0.50
4 – 8	Medium	0.50 – 1.00
8 – 15	Stiff	1.00 – 2.00
15 – 30	Very stiff	2.00 – 4.00
Over 30	Hard	Over 4.00

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19.0 LABORATORY SOIL TESTS:

The following soil tests have been done in the laboratory:

i)	Grain size analysis	: 06Nos
ii)	Specific gravity	: 06Nos
iii)	Atterberg Limit	: **00**Nos
iv)	Natural Moisture Content	: 00Nos
v)	Unit Weight (Dry & wet)	: **00**Nos
vi)	Unconfined compression test	: 00Nos
vii)	Consolidation Test	: **00**Nos
viii)	Direct shear Test	: **02**Nos

20.0 PROPERTIES OF SOIL (From laboratory test):

a) Physical properties-

i) The consistency of cohesive soil is very soft to medium but dense to very dense for Granular soil.

ii) Natural Moisture Content:- Specific Gravity:- Unit Weight:lb/cft

b) Engineering Properties -

i) The value of internal friction:-32°-34°

21.0 EVALUATION OF BEARING CAPACITY:

Bearing capacities of the shallow condition from the SPT:

The bearing capacities of the shallow foundations particularly for the top layer of cohesive soil may be estimated from the SPT values, as suggested by Terzaghi, according to the following table.

Table No. 3.

Bearing Capacities of the Shallow Foundation (Values in Tsf, F.S = 3.0):

SPT range	Allowable Bearing capacity (Tsf).	
	Continuous footing (B = 4ft)	Isolated Column footing (B=8ft).
0 – 2	0.00 – 0.225	0.00 – 0.30
2 – 4	0.255 – 0.45	0.30 – 0.60
4 – 8	0.45 – 0.90	0.60 – 1.20
8 – 15	0.90 – 1.80	1.20 – 2.40
15 – 30	1.80 – 3.60	2.40 – 4.80
> 30	> 3.60	> 4.80

Note:

a. Width = 4 ft for strip footing and width = 8 ft for isolated footing respectively.

b. The above values are the net allowable bearing capacities.

c. The cohesive soil has been considered in a saturated condition.

22.0 Bearing capacity of the shallow foundation from the soil parameters:

The bearing capacities of the shallow foundation may more appropriately be determined from the parameters of soil such as the values of cohesion and he angle of internal friction as obtained from the performance of laboratory tests. These have been done considering the general equations of the bearing capacity of the foundation as suggested by Terzaghi. The evaluated values are provided in the following Table No. 4 and Table No. 5.

DHAKA

23.0 FORMULA USED FOR A COMPUTERATION:

For Cohesion Soil:

The ultimate bearing capacity.

$$Qult = CNc = \frac{Qu.}{2} Nc \quad \text{J.E. (Bowles)}$$

$$qall = \frac{qu.\ Nc}{2 \times 3} + \gamma Df \frac{qu.}{6} Nc \gamma Df \quad \text{factor of safety} = 3.00$$

Where, qu = Unconfined Compressive strength in TSF.
Nc = Bearing Capacity Factor.
= 6.8 square footing.
= 5.7 continuous footing.

For Non-Cohesion Soil:

Qult = C Nc Sc + γ Df Nq + 0.5 γ B Nγ Sγ (J.E Bowles)

Where, C = Cohesion, γ = Unit weight of soil.
Df = Depth of footing, B = Width of footing.
Nc, Nq & Nγ Bearing Capacity Factors = f (φ) = f (N)
Sc & S γ = Shape Factors = f (B,Df)
Qallowable = qult / F.S. (F.S. = 3)

(Ref. Book: Foundation Analysis and Design by J.E Bowles, Page No. 213-277).

24.0 ULTIMATE SKIN FRICTION (fs) AND END BEARING (fq).

For Cohesion soil:

Where, fs = F Cd (M. J. Tomlinson)
Cd = qu / 2;
qu = Unconfined Compressive Strength of soil and
F = Bearing Capacity Factor (Ranges between 0.60 & 45)

For Non-Cohesion Soil:
For high displacement piles, fs = 2.0 N kN / m²
For low displacement fs = 1.0 N kN / m²
Where N average of corrected N-value along the length of the pile.
For bored piles in sand, fq = 14 N (Db / B) kN / m²
Where Db = actual penetration into the granular soil.
For bored piles in sand, the unit frictional resistance (fs) is given by
fs = 0.67 N kN / m² (K.R. Arora)

Consolidation Settlement:

S = (Cc / 1 + eo)) * H * log (po + Δp) / po

(Ref. Book: Soil Mechanics and Foundation Engineering by K.R ARORA, page No. 383-450, 638-647 & 1003 – 1006).

25.0 LOAD CALCULATION FOR ANY DIAMETER / ANY LENGTH OF PILE:

P = π D L fs + π/4 D² fb

a. P = Allowable working Load.
b. fs = Average allowable value of the skin friction = - tsf.
c. fb = Allowable value of the pile end bearing capacity = - tsf.
d. π = Pi, a constant = 3.146.
e. D = Pile diameter.
f. L = Required length of pile = - ft.

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TABLE NO:-4 BEARING CAPACITIES OF THE SHALLOW FOUNDATION FROM THE FIELD AND LABORATORY TEST (F.S.=3.00)

Bore Hole	Depth in ft	Field SPT	Corrected N	Cohesion Kg/cm^2	Bearing Capacity (Tsf)	
					For Circular or square Footing	For strip Footing
BH-1	5'-0"	2	2	0.13	0.37	0.31
	10'-0"	2	2	0.13	0.45	0.38
	15'-0"	2	2	0.13	0.53	0.45
	20'-0"	3	3	0.19	0.75	0.63
BH-2	5'-0"	1	1	0.06	0.22	0.18
	10'-0"	2	2	0.13	0.45	0.38
	15'-0"	3	3	0.19	0.67	0.57
	20'-0"	2	2	0.13	0.61	0.51
BH-3	5'-0"	1	1	0.06	0.22	0.18
	10'-0"	3	3	0.19	0.59	0.50
	15'-0"	2	2	0.13	0.53	0.45
	20'-0"	4	4	0.25	0.89	0.75
BH-4	5'-0"	1	1	0.06	0.22	0.18
	10'-0"	2	2	0.13	0.45	0.38
	15'-0"	2	2	0.13	0.53	0.45
	20'-0"	3	3	0.19	0.75	0.63

NOTE:

i. Corrected SPT Formula, Ncor = 15 + (Nf – 15) / 2.

ii. The Bearing Capacity Factors Have Been Taken from Terzagthis Bearing Capacity Factor Table.

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Bearing Capacities of pile from the SPT & Soil Parameters.
Table No:-5 The Allowable skin friction & the point bearing capacities of driven pile foundation (Values in TSF) F.S=2.5.

Depth (ft.)	BH-1				BH-2				BH-3			
	N	C	f_{sa}	q_{pa}	N	C	f_{sa}	q_{pa}	N	C	f_{sa}	q_{pa}
5	2	2	0.012	-	1	1	0.006	-	1	1	0.006	-
10	2	2	0.012	-	2	2	0.012	-	3	3	0.018	-
15	2	2	0.012	-	3	3	0.018	-	2	2	0.012	-
20	3	3	0.018	-	2	2	0.012	-	4	4	0.024	-
25	9	9	0.054	10.80	8	8	0.048	-	8	8	0.048	-
30	11	11	0.066	13.20	14	14	0.084	16.80	10	10	0.060	12.00
35	15	15	0.090	18.00	17	16	0.096	19.20	14	14	0.084	16.80
40	18	16	0.096	19.20	19	17	0.102	20.40	21	18	0.108	21.60
45	22	18	0.108	21.60	21	18	0.108	21.60	24	19	0.114	22.80
50	27	21	0.126	25.20	25	20	0.120	24.00	28	21	0.126	25.20

Depth (ft.)	BH-4			
	N	C	f_{sa}	q_{pa}
5	1	1	0.006	-
10	2	2	0.012	-
15	2	2	0.012	-
20	3	3	0.018	-
25	10	10	0.060	12.00
30	11	11	0.066	13.20
35	14	14	0.084	16.80
40	17	16	0.096	19.20
45	23	19	0.114	22.80
50	27	21	0.126	25.20

Note:

i. N = Field SPT values ii. C=Cohesion
iii. q_{pa} =Allowable point bearing capacity for pile foundation with F.S. = 2.5
iv. f_{sa} = Allowable skin friction with F.S. = 2.5
v. The above bearing capacities should be two third in case of RCC cast-in-situ pile
vii 1 Kg/cm$_2$= 1 tsf and 1 ton = 2000 Lbs.

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26.0 CONCLUSION & RECOMMENDATION:

CONCLUTION:

The overall investigation results of the site defines that **Pile Foundation** is suitable for the best economic and structurally safe of the project.

RECOMMENDATION:

On the basis aforesaid condition, the following recommendations are Suggested for **82 meter tower on Mymensingh.**

The Bearing Capacity of single pile is given in the Table - 5 at the different depth of 20″ & 24″ diameter However may accept the embedment length up to **50′-0″** from EGL of each of the boring are as follows.

Length below from EGL	20 inch dia	24 inch dia
45' - 0"	39. 0 ton	55. 0 ton
50' - 0"	43. 0 ton	62. 0 ton

Note.

a) 1Tsf = 1Kg/cm^2, 1Ton = 2000 Lbs, E.G.L. = Existing Ground Level.

b) The theories on the ultimate bearing capacity presented in this report are based on idealized conditions of soil profiles.

c) Pile load test should be performed if pile load test is not performed then the value of pile should be Considered half.

d) Foundation base should be kept dry during Construction period.

However, the design Engineer may select any other alternative type, depth as well as the bearing capacity of the foundation in the light of information provided in this report.

07.11.14

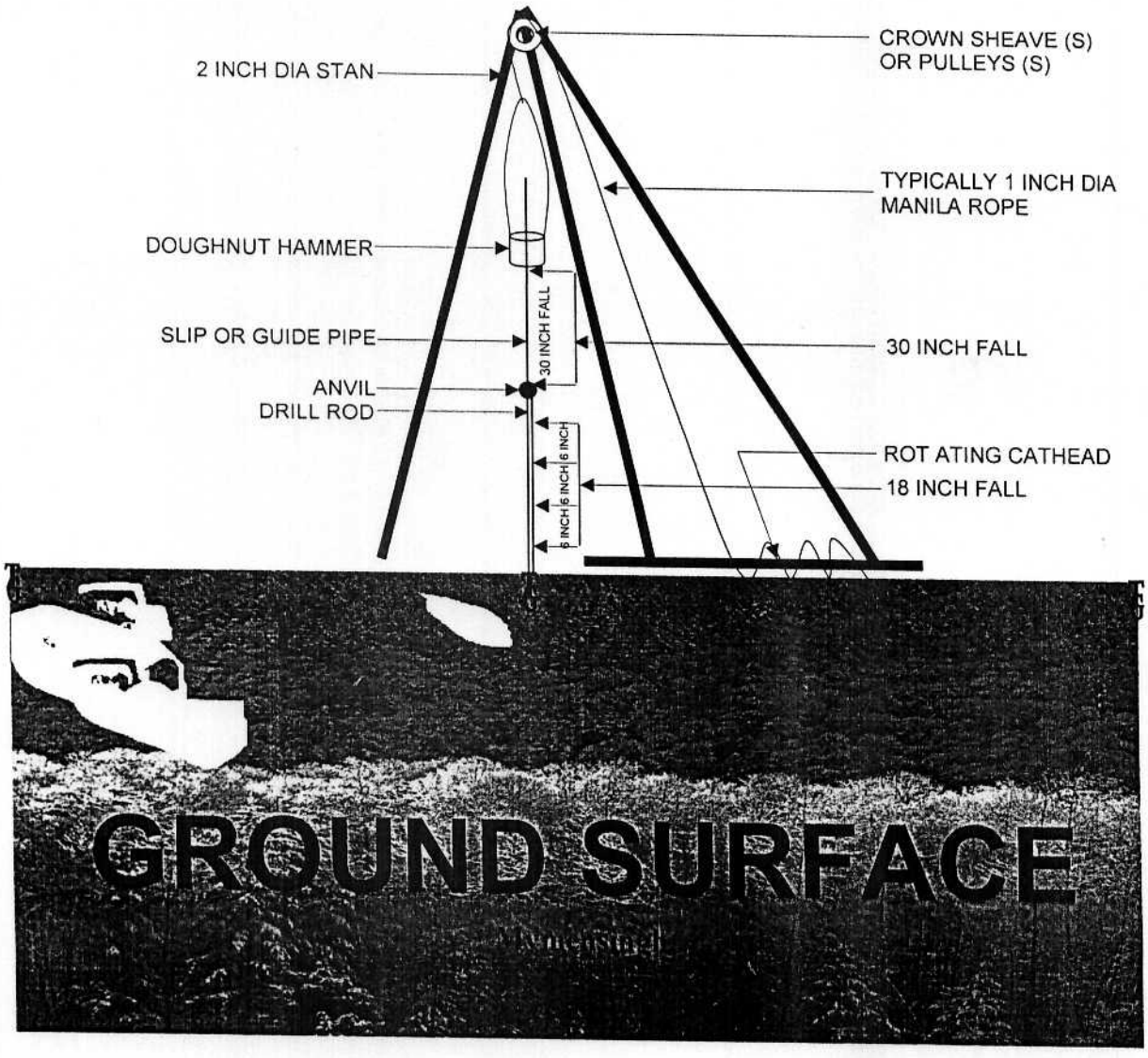
Engr. Rafiqul Islam Bhuiyan
B.Sc. Engr. (Civil) BUET
M-11528 (IEB)

CONFIDENCE GEO SOIL ENGINEERS DHAKA

TYPE OF DRILLING : MANUAL DRIVE (HAND WASH)

STANDARD PENETRATION TEST:

STANDARD PENETRATION TESTS HAVE BEEN EXECUTED IN ALL THE BORE HOLES AT 5FT. INTERVAL OF DEPTH UP TO THE FINAL DEPTH OF BORING, IN THIS TEST, A SPLIT SPOON SAMPLER OF 2" OUT DIAMETER AND 1-3/8" INNER WEIGHING 140LBS/63.5KG. FAILING FREELY FOR A HEIGHT OF 30" LENGTH OF THE SAMPLER IS RECORDED. THE NUMBER OF BLOWS FOR THE LAST 12" PENETRATION OF THE TOTAL 18" IS KNOWN AS THE STANDARD PENETRATION VALUE (N - VALUES) AS **SPECIFIED BY ASTM** AND IS PLOTTED **SPT** VALUE OF THE PARTICULAR DEPTH.



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DHAKA

LOCATION: MYMENSINGH.

BORING NO-1

DATE	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIA OF BORING	STANDARD PENETRATION TEST Blows/ft.	REMARKS (G.W.T.SOIL) VANE SHEAR TEST Lbs./sq in
	EGL.						
			G.W.T = (-) 8'-0" **R.L. = (-) 11'-0"**				
		23'-0"	Grey SILTYEY clay and some sand.			2, 2, 2, 3	
	23'-0"	15'-0"	Grey med. dense fine SAND some to little silt .			9, 11, 15, 18	
	38'-0"	13'-0"	Grey med. Dense to dense fine SAND some silt .			22, 27	
	51'-0"						

5' 10' 15' 20' 25' 30' 35' 40' 45' 50' 55' 60' 65' 70' 75' 80'

DISTURBED SAMPLES .....

UNDISTURBED SAMPLES .....

TESTED BY: DWG BY: CHECKED BY:

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DHAKA

LOCATION: MYMENSINGH.

BORING NO-2

DATE	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIA OF BORING	STANDARD PENETRATION TEST Blows/ft.	REMARKS (G.W.T.SOIL) VANE SHEAR TEST Lbs./sq in
	EGL.					G.W.T = (-) 8'-0" R.L. = (-) 11'-0"	
		23'-0"	Grey SILTYEY clay and some sand.			1, 2, 3, 2	
	23'-0"	15'-0"	Grey med. dense fine SAND some to little silt .			8, 14, 17, 19	
	38'-0"	13'-0"	Grey med. Dense to dense fine SAND some silt .			21, 25	
	51'-0"						

5' 10' 15' 20' 25' 30' 35' 40' 45' 50' 55' 60' 65' 70' 75' 80'

DISTURBED SAMPLES ..... UNDISTURBED SAMPLES .....

TESTED BY: DWG BY: CHECKED BY:

CONFIDENCE GEO SOIL ENGINEERS DHAKA

CONFIDENCE GEO SOIL ENGINEERS
DHAKA

LOCATION: MYMENSINGH.

BORING NO-3

DATE	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIA OF BORING	STANDARD PENETRATION TEST Blows/ft.	REMARKS (G.W.T.SOIL) VANE SHEAR TEST Lbs./sq in
	EGL.					G.W.T = (-) 8'-0" R.L. = (-) 11'-0"	
	23'-0"	23'-0"	Grey SILTYEY clay and some sand.			1, 3, 2, 4	
	38'-0"	15'-0"	Grey med. dense fine SAND some to little silt .			8, 10, 14	
	51'-0"	13'-0"	Grey med. Dense to dense fine SAND some silt .			21, 24, 28	

5' 10' 15' 20' 25' 30' 35' 40' 45' 50' 55' 60' 65' 70' 75' 80'

DISTURBED SAMPLES .....

UNDISTURBED SAMPLES .....

TESTED BY: DWG BY: CHECKED BY:

CONFIDENCE GEO SOIL ENGINEERS DHAKA

CONFIDENCE GEO SOIL ENGINEERS
DHAKA

LOCATION: MYMENSINGH.

BORING NO-4

DATE	DEPTH IN FEET	THICKNESS	STRATA ENCOUNTERED	LOG	DIA OF BORING	STANDARD PENETRATION TEST Blows/ft.	REMARKS (G.W.T.SOIL) VANE SHEAR TEST Lbs./sq in
	EGL.					G.W.T = (-) 7'-0" R.L. = (-) 11'-0"	
	23'-0"	23'-0"	Grey SILTYEY clay and some sand.			1, 2, 2, 3, 10	
	38'-0"	15'-0"	Grey med. dense fine SAND some to little silt .			11, 14	
	51'-0"	13'-0"	Grey med. Dense to dense fine SAND some silt .			17, 23, 27	

5' 10' 15' 20' 25' 30' 35' 40' 45' 50' 55' 60' 65' 70' 75' 80'

DISTURBED SAMPLES .....

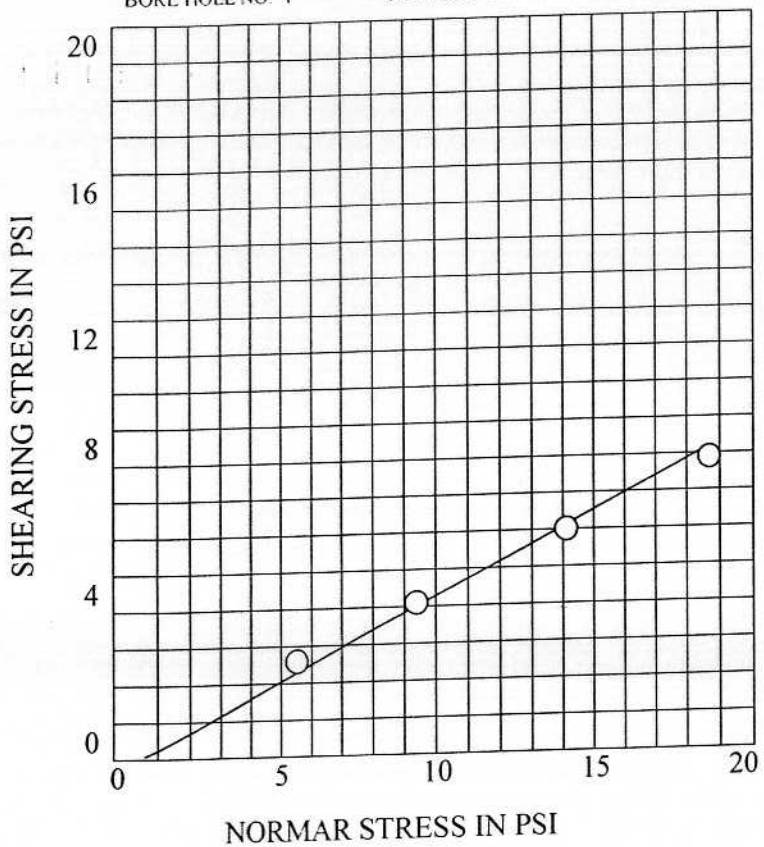
UNDISTURBED SAMPLES .....

CONFIDENCE GEO SOIL ENGINEERS DHAKA

TESTED BY: DWG BY: CHECKED BY:

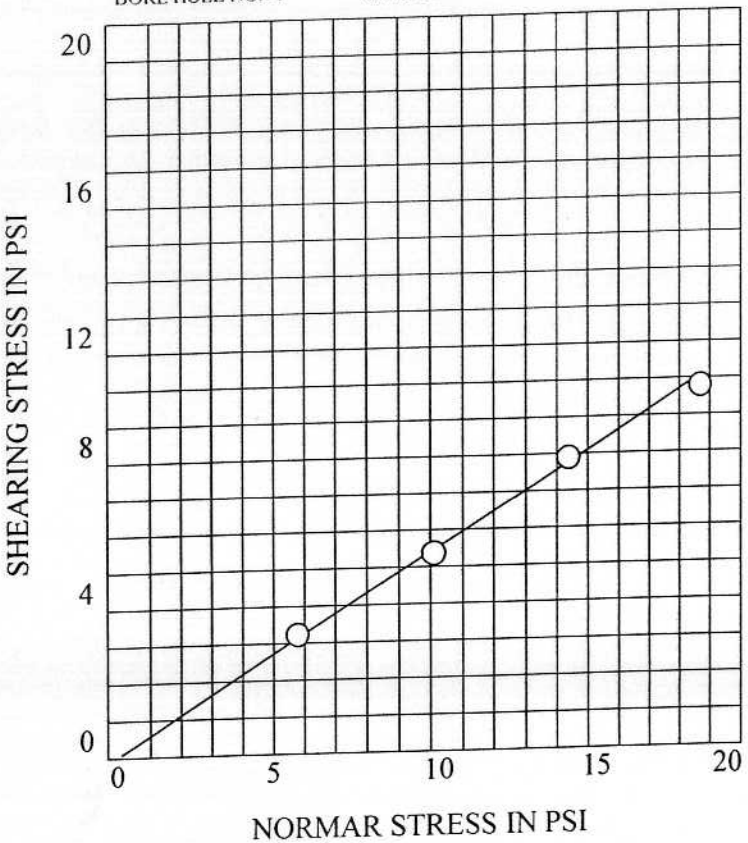
CONFIDENCE GEO SOIL ENGINEERS	Direct Shear Test	Location: Mymensingh.

BORE HOLE NO. 1 SAMPLE NO: 9 DEPTH: 45 ft



DEGREE (Ø)	32
COHESION, C	--

BORE HOLE NO. 4 SAMPLE NO. 10 DEPTH: 50 ft



DEGREE (Ø)	34
COHESION, C	--

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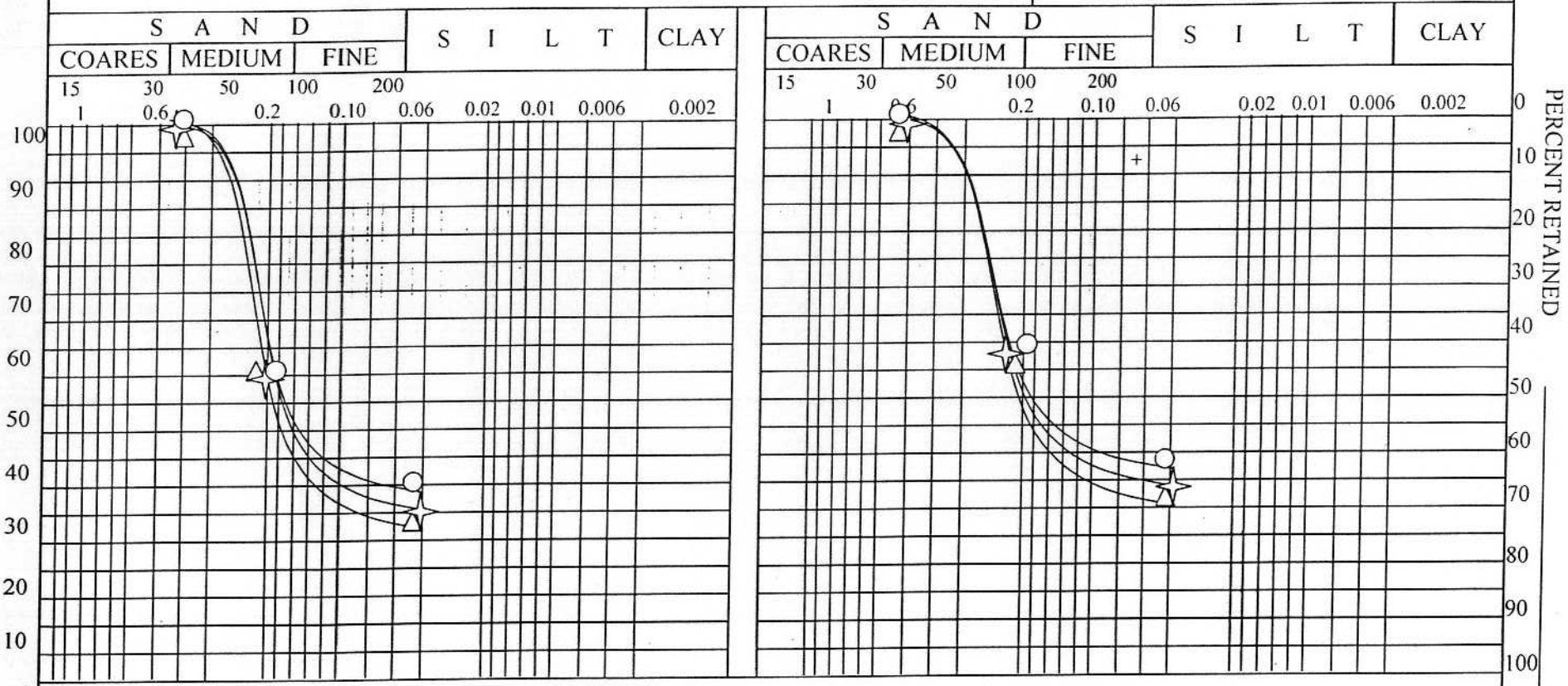
GRAIN SIZE DISTRIBUTION

Location: Mymensingh.



SYMBOL	BORE	SAMPLE	DEPTH IN FT.	N.M.C	ATTERBERG LIMIT			SPECIFIC CRAVITY	SOIL CLASSIFICATION	SAND %	SILT OR CLAY%
					L.L.	P.L.	P.I.				
○○○	1	D-2	10′-0″					2.64		22	78
×××	1	D-5	25`-0”					2.66		45	55
▽▽▽	1	D-9	45′-0″					2.68		82	18
○○○	2	D-3	15′-0″					2.64		23	77
×××	3	D-6	30`-0”					2.67		60	40
▽▽▽	4	D-10	50′-0″					2.69		85	15

CONFIDENCE GEO SOIL ENGINEERS DHAKA

CONFIDENCE GEO SOIL ENGINEERS	SUMMARY OF LABORATORY TEST RESULTS	Location: Mymensingh.

Bore hole No.		1		2	3	4									
Sample No.		D-2	D-5	D-9	D-3	D-6	D-10								
Depth in feel		10′-0″	25′-0″	45′-0″	15′-0″	30′-0″	50′-0″								
Natural moisture content (%)															
Specific gravity		2.62	2.66	2.68	2.64	2.67	2.68								
Atterberg limits	Liquid limit, LW														
	Plastic limit, PW														
Density	Wel (lbs/cft.)														
	Dry (lbs/cft.)														
Grain size analysis	Gravel (%)														
	Sand (%)	22	45	82	23	60	85								
	Silt / Clay	78	55	18	77	40	15								
Consolidation testes	Natural void ratic, Co														
	Compression Index, Cc														
Unconfined compression tests	Strain of failure%)														
	Stress undist (T.S.F)														
	Stressemould (T.S.F)														
	Sensitivity														
Direct shear tests	ϕ (degree)			32°			34°								
	C (P.s.i)														
Triaxial shear tests	ϕ (degree)														
	C (P.s.i)														

TESTED BY: DWG BY: CHECKED BY:

CONFIDENCE GEO SOIL ENGINEERS DHAKA

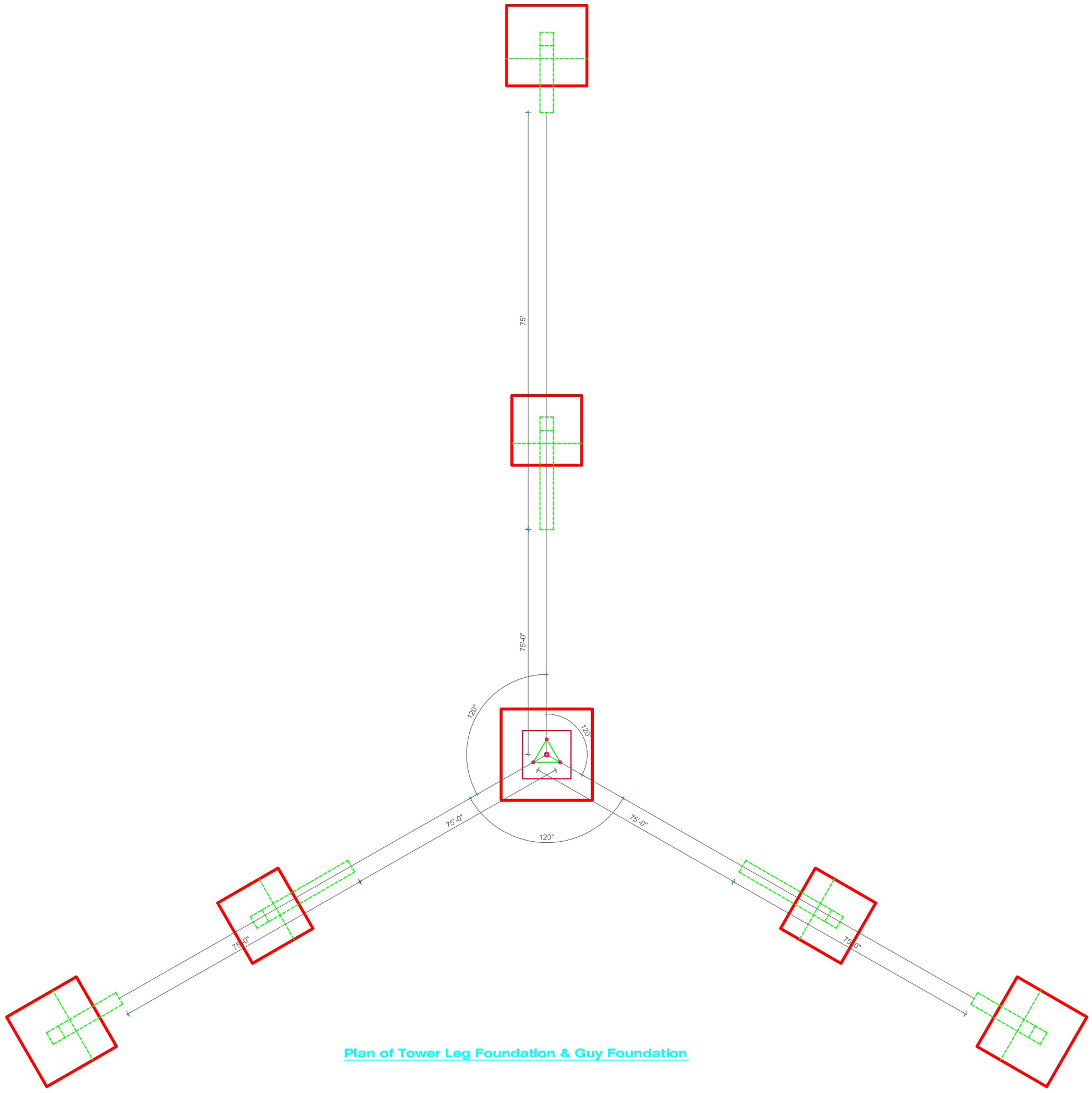
PROPOSED 82 M GUY TOWER FOUNDATION DESIGN
AT MYMENSING, BANGLADESH.

CLIENT

HARNESS ENERGY BANGLADESH LTD.

DATE :

STRUCTURAL DRAWING



Plan of Tower Leg Foundation & Guy Foundation

PROJECT :

PROPOSED 52m Tower Foundation Design AT Mymensing, Bangladesh.

CLIENT :

HARNESS ENERGY BANGLADESH LTD.

CONSULTANT :

JSK BUILDING DESIGN HOUSE
ARCHITECTS & ENGINEERS
DHAKA: 85/1-B, Purana Paltan Lane, Dhaka-1000.
NARSINGDI: A.K. Bhaban, C&B Road, Narsingdi-1600.
PH: 02-9462603 MOB: 01612-766055, 01712-766055.

DRAWING TITLE :

PLAN OF TOWER FOUNDATION

SCALE : NOT TO SCALE.

ARCHITECT : SIGNATURE :

STRUCTURAL ENGINEER :

ENGR. GOUTAM KUMAR SHARMA
MIEB-30751
B.Sc. ENGINEERING (CIVIL)
M.Sc. ENGINEERING (STRUCTURAL)

ASST. ENGINEER :

CATEGORY :	STRUCTURAL
CHECKED BY :	
APPROVAL CLIENT	
ISSUED FOR	COMMENTS / CONSTRUCTION

SL. NO.	DATE	AMMENDMENT

NOTES :

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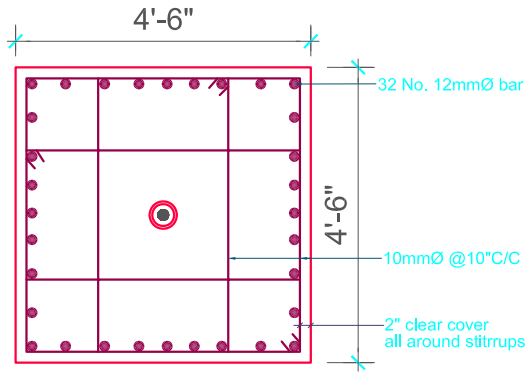
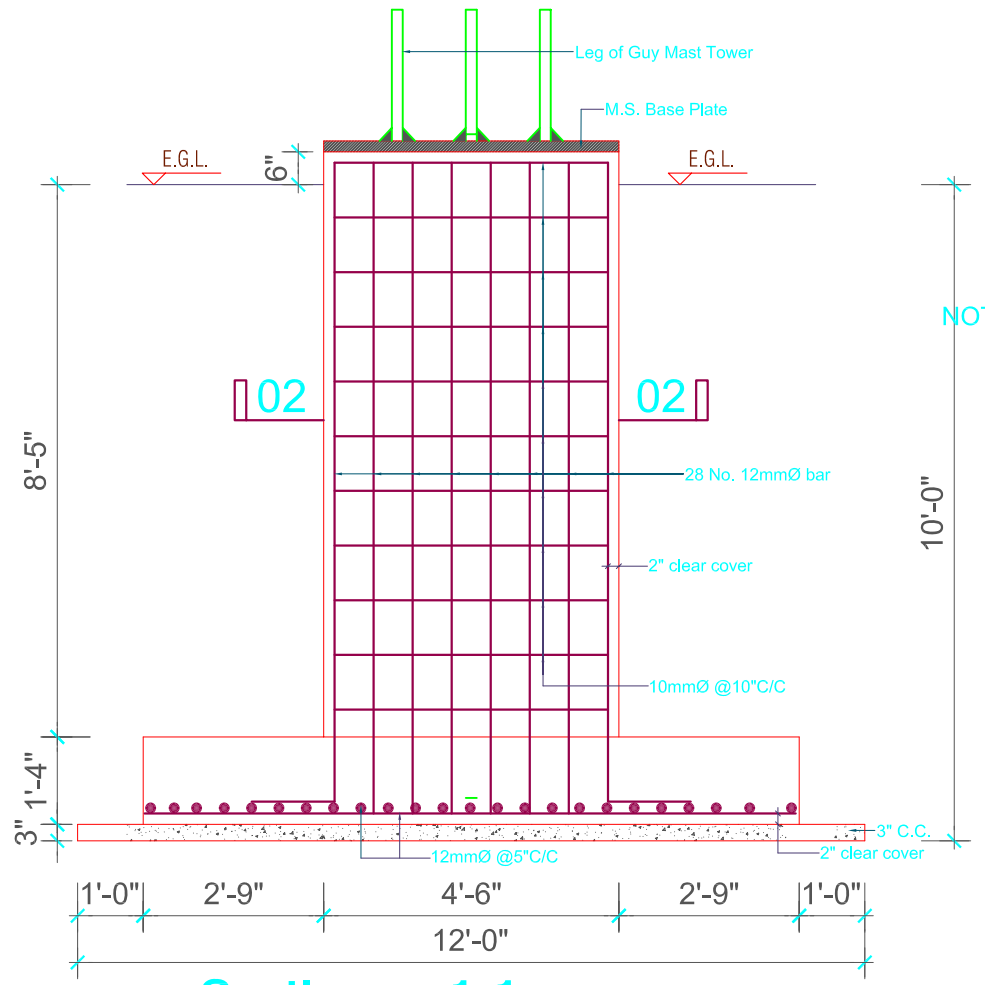
[Article-7, Condition for engagement of Architects, Section-3, IAB Rules & Regulations]

DATE : SHEET NO :

S-01

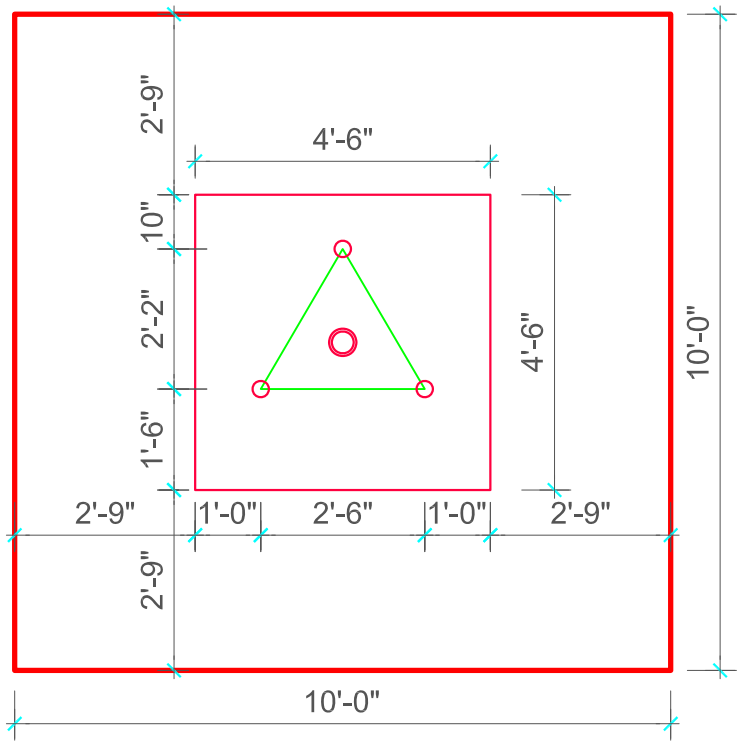


Cross Section of Pedestal on 2-2

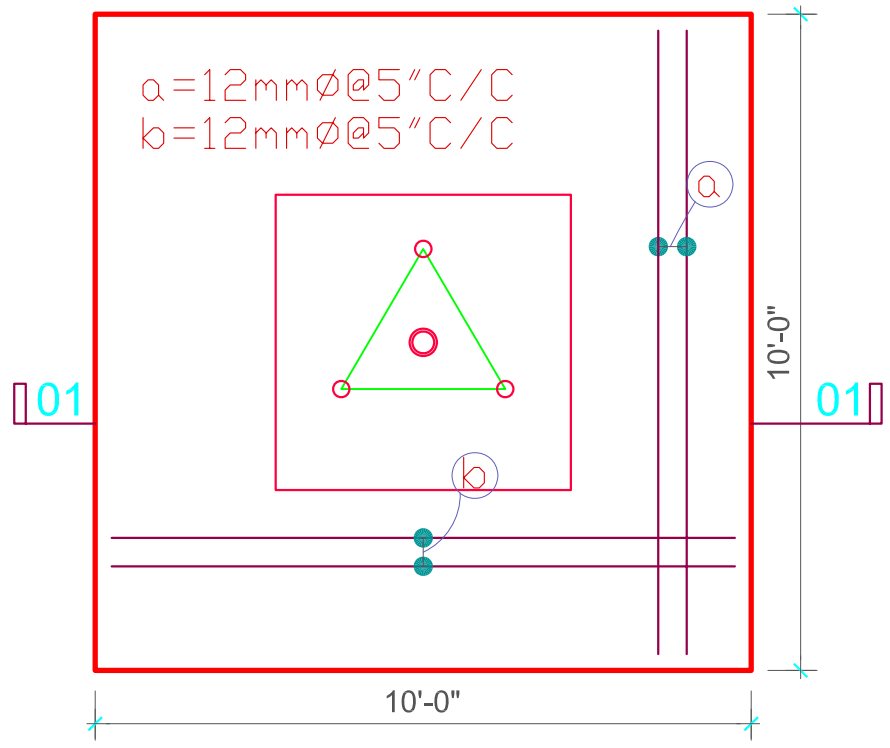


Section on 1-1

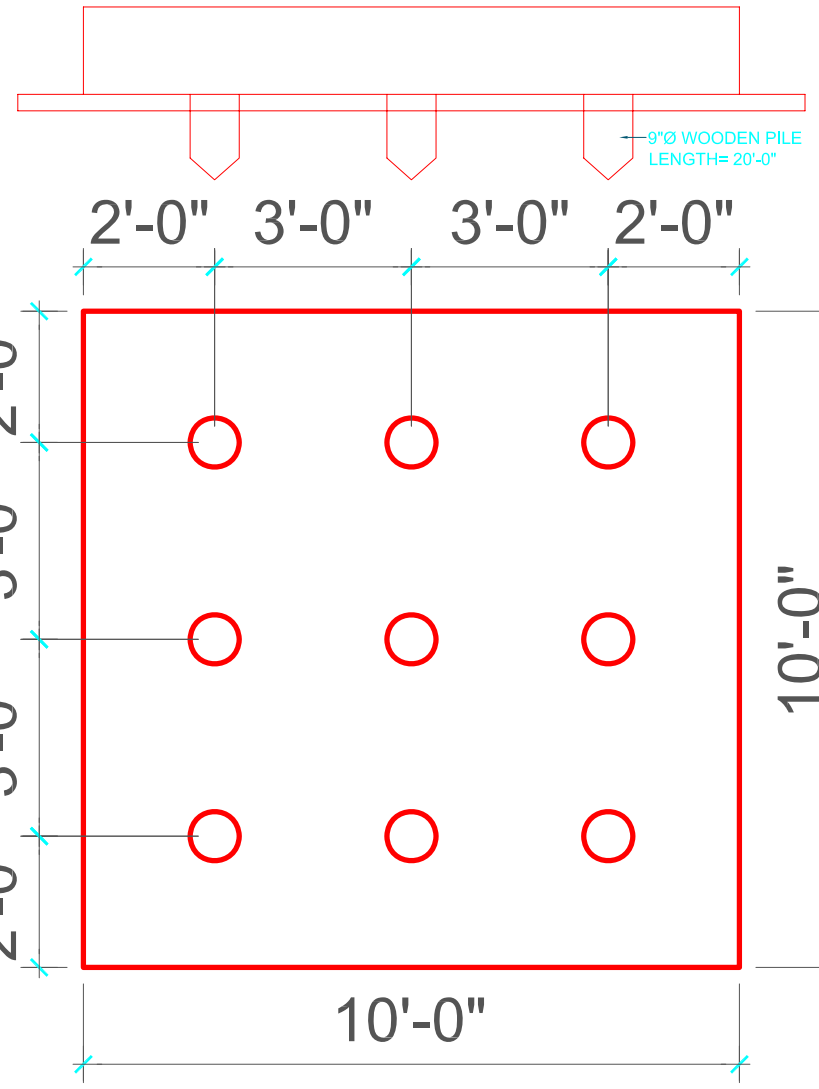
1. BEARING CAPACITY 1.0 TSF. AS SOIL REPORT(10'-0")
2. CONCRETE STRENGHT , F'c= 3,000 psi.
3. STEEL RE-BAR , Fy= 40,000 psi.
4. Anchor Length abc shall be 24" minimum
5. Angle of column bar should not be more than 90 degree



Plan of Leg Foundation



Plan of Leg Foundation



WOODEN PILE LAYOUT PLAN

Fig: Details of Base Foundation

PROJECT :

PROPOSED 82m Tower Foundation Design AT Mymensing, Bangladesh.

CLIENT :

HARNESS ENERGY BANGLADESH LTD.

CONSULTANT :

JSK BUILDING DESIGN HOUSE
ARCHITECTS & ENGINEERS
DHAKA: 85/1-B, Purana Paltan Lane, Dhaka-1000.
NARSINGDI: A.K. Bhaban, C&B Road, Narsingdi-1600.
PH: 02-9462603 MOB: 01612-766055, 01712-766055.

DRAWING TITLE :

TOWER LEG BASE FOUNDATION PLAN

SCALE : NOT TO SCALE.

ARCHITECT : SIGNATURE :

STRUCTURAL ENGINEER :

ENGR. GOUTAM KUMAR SHARMA
MIEB-30751
B.Sc. ENGINEERING (CIVIL)
M.Sc. ENGINEERING (STRUCTURAL)

ASST. ENGINEER :

CATEGORY : STRUCTURAL

CHECKED BY :

APPROVAL CLIENT

ISSUED FOR : COMMENTS / CONSTRUCTION

SL. NO.	DATE	AMMENDMENT

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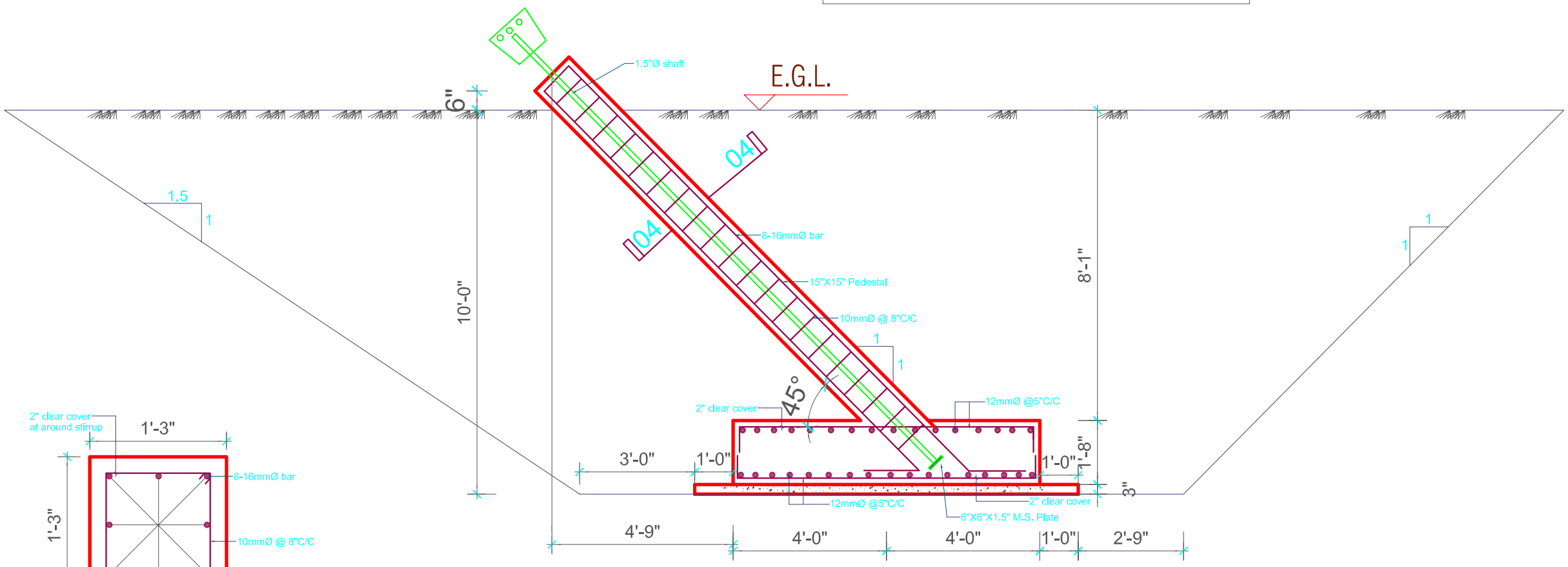
[Article-7, Condition for engagement of Architects, Section-3, IAB Rules & Regulations]

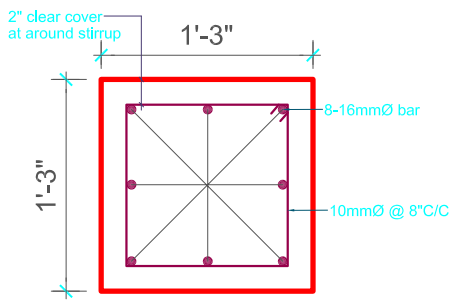
DATE : SHEET NO : S-02

NOTE:

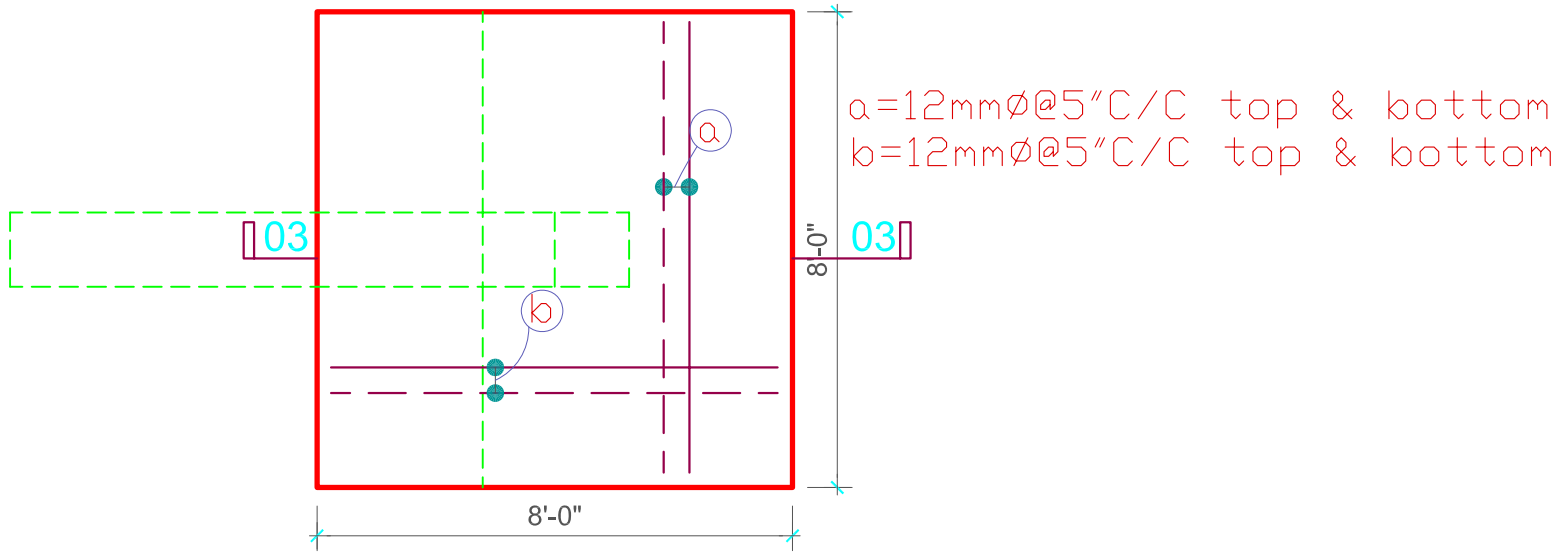
1. BEARING CAPACITY 1.0 TSF. AS SOIL REPORT(10'-0")
2. CONCRETE STRENGHT , F'c= 3,000 psi.
3. STEEL RE-BAR , Fy= 40,000 psi.
4. Anchor Length abc shall be 24" minimum
5. Angle of column bar should not be more than 90 degree



Section on 3-3



Cross Section of on 4-4



Plan of Inner Guy Foundation

Fig: Details of Inner Guy

PROJECT :

PROPOSED 82m Tower Foundation Design AT Mymensing, Bangladesh.

CLIENT :

HARNESS ENERGY BANGLADESH LTD.

CONSULTANT :

JSK BUILDING DESIGN HOUSE
ARCHITECTS & ENGINEERS
DHAKA: 85/1-B, Purana Paltan Lane, Dhaka-1000.
NARSINGDI: A.K. Bhaban, C&B Road, Narsingdi-1600.
PH: 02-9462603 MOB: 01612-766055, 01712-766055,

DRAWING TITLE :

INNER GUY FOUNDATION PLAN

SCALE : NOT TO SCALE.

ARCHITECT : SIGNATURE :

STRUCTURAL ENGINEER :

ENGR. GOUTAM KUMAR SHARMA
MIEB-30751
B.Sc. ENGINEERING (CIVIL)
M.Sc. ENGINEERING (STRUCTURAL)

ASST. ENGINEER :

CATEGORY :	STRUCTURAL
CHECKED BY :	
APPROVAL CLIENT	
ISSUED FOR	COMMENTS ☐
	CONSTRUCTION ☐

SL. NO.	DATE	AMMENDMENT

NOTES :

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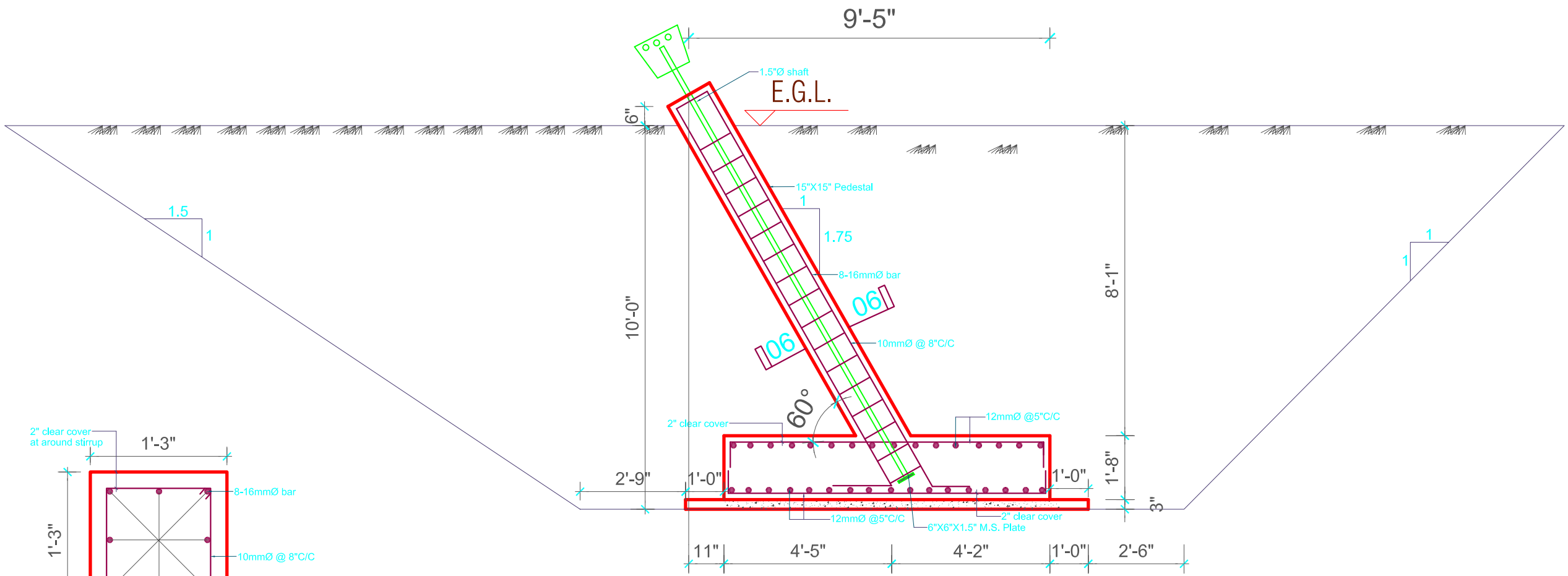
[Article-7, Condition for engagement of Architects, Section-3, IAB Rules & Regulations]

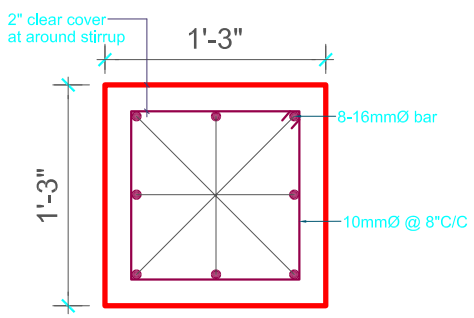
DATE : SHEET NO : S-03

NOTE:

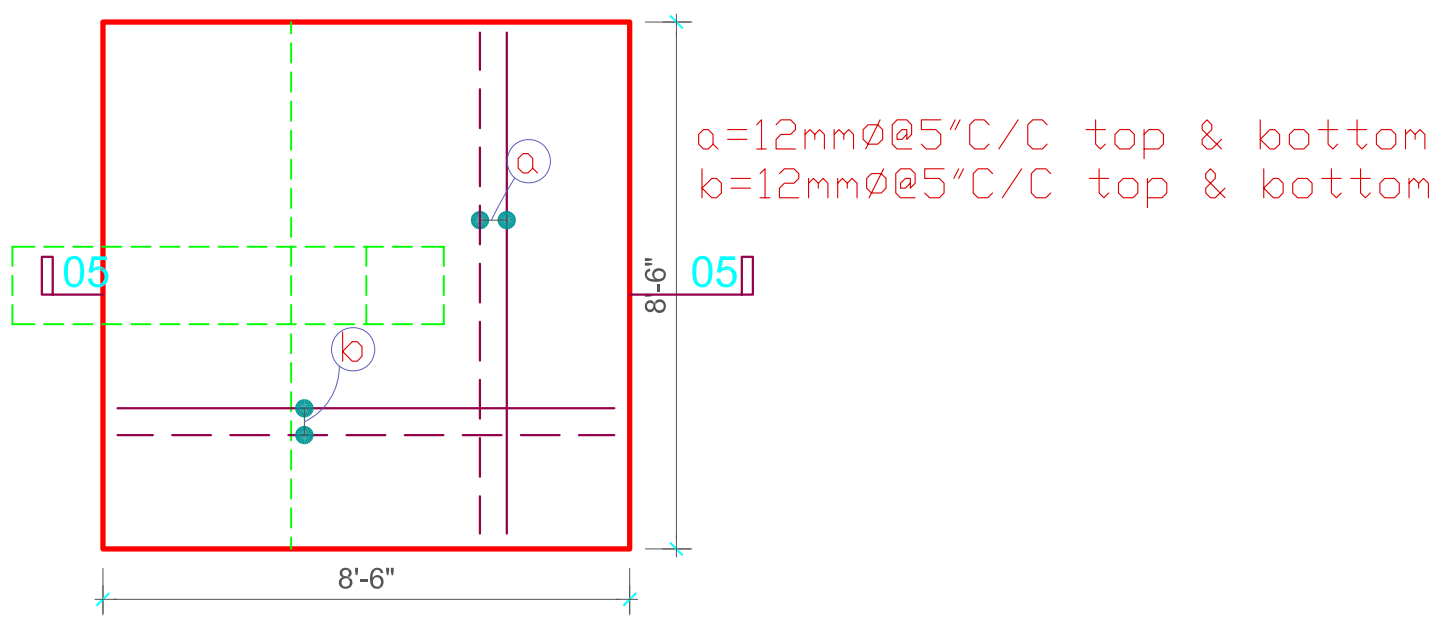
1. BEARING CAPACITY 1.0 TSF. AS SOIL REPORT(10'-0")
2. CONCRETE STRENGHT , F'c= 3,000 psi.
3. STEEL RE-BAR , Fy= 40,000 psi.
4. Anchor Length abc shall be 24" minimum
5. Angle of column bar should not be more than 90 degree



Section on 5-5



Cross Section of on 6-6



a=12mmØ@5"C/C top & bottom
b=12mmØ@5"C/C top & bottom

Plan of Outer Guy Foundation

Fig: Details of outer Guy

PROJECT :

PROPOSED 82m Tower Foundation Design AT Nymensing, Bangladesh.

CLIENT :

HARNESS ENERGY BANGLADESH LTD.

CONSULTANT :

JSK BUILDING DESIGN HOUSE
ARCHITECTS & ENGINEERS
DHAKA: 85/1-B, Purana Paltan Lane, Dhaka-1000.
NARSINGDI: A.K. Bhaban, C&B Road, Narsingdi-1600.
PH: 02-9462603 MOB: 01612-766055, 01712-766055.

DRAWING TITLE :

OUTER GUY FOUNDATION PLAN

SCALE : NOT TO SCALE.

ARCHITECT : SIGNATURE :

STRUCTURAL ENGINEER :

ENGR. GOUTAM KUMAR SHARMA
MIEB-30751
B.Sc. ENGINEERING (CIVIL)
M.Sc. ENGINEERING (STRUCTURAL)

ASST. ENGINEER :

CATEGORY :	STRUCTURAL
CHECKED BY :	
APPROVAL CLIENT	
ISSUED FOR	COMMENTS ☐
	CONSTRUCTION ☐

SL. NO	DATE	AMMENDMENT

NOTES :

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[Article-7, Condition for engagement of Architects, Section-3, IAB Rules & Regulations]

DATE : SHEET NO :

S-04

Anchors – 0 Degrees

Inner Anchor – 0 Degrees

Outer Anchor – 0 Degrees

Anchors – 120 Degrees

Inner Anchor – 120 Degrees

Outer Anchor – 120 Degrees

Anchors – 240 Degrees

Inner Anchor – 240 Degrees

Outer Anchor – 240 Degrees

Tower Base – North Side

Tower Base – East Side

Tower Base – South Side

Tower Base – West Side

PROJECT :

LATTICE GUYED MAST TOWER (82m)
WIND SPEED: 160 kph

CLIENT :

CONSTRUCTION (BD)

DESIGNER:

MOHAMMAD MAHFUZUR RAHMAN
Senior Structural Engineer
The Civil and Structures
DMINB CE 0344, MIEB 27032

Mohammad Mahfuzur Rahman
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Expert
MIEB-27032, DMINB-CE-0344

DESIGN CRITERIA AND MATERIAL SPECIFICATION

1. STRUCTURE: 3 LEGGED GUYED TOWER
2. WIND SPEED : 160 km/h
3. TOWER HEIGHT : 82m
4. ANTENNA : #40C Anemometer (2 Set at 40m, 60m & 80m)
   #200P Wind Direction Vane (3 Set at 40m, 60m & 80m)
5. AVIATION LIGHT : TO BE PROVIDED
6. WORKING PLATFORM : 3 NOS.

7. TOWER MEMBER : BRAND NEW GI PIPE
8. GUY WIRE : STAINLESS STEEL STRAND
9. CLIMBING LADER :WITH RESTING PLATFORM FOR EASY CLIMBING
10. CABLE / WAVE GUIDE TRAY : VERTICAL AND HORIZONTAL
    FROM TOWER TO EQUIPMENT RACK
11. PAINTING : ICAO STANDARD ANTICORROSIVE PAINTING
12. ALL MS MATERIALS TO BE HOT-DIP GALVANIZED
13. MATERIAL STRENGTH :

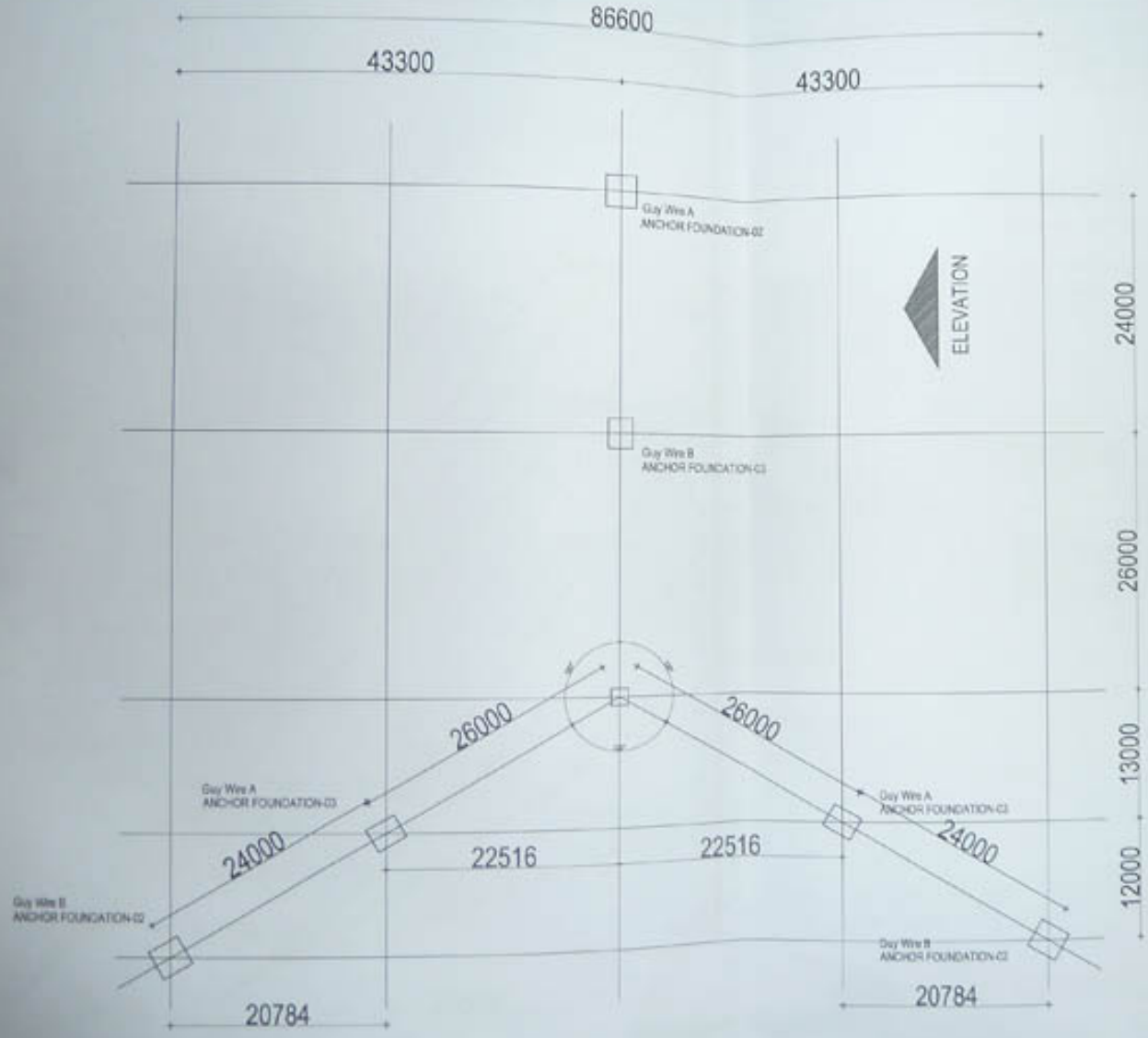
ALL STRUCTURAL STEEL TO BE GRADE OF,
YIELD STRENGTH fy = 275 N/mm

BOLTS AND NUTS TO BE GRADE 8.8,
YIELD STRENGTH fy = 627 N/mm
ULTIMATE TENSILE STRENGTH fu = 784 N/mm^2
SHEAR STRENGTH fv = 375 N/mm^2

23/02/14

Mohammad Mahfuzur Rahman
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Build
MIEB-27032, CWENG-CE-2244

DESIGN CRITERIA & STANDRAD::	
Basic wind speed	: 160 Km/hr
Nut & Bolts yield strength	: 415 MPa
Pipe yield strength	: 275MPa
Loading and Design code	: TIA EIA 222-F
CLIENT : Construction (BD)	
DESIGNER : MOHAMMAD MAHFUZUR RAHMAN SENIOR STRUCTURAL ENGINEER, MSc (CIVIL AND STRUCTURAL) CWENG CE 2244, MIEB 27032	
DRAWING TITEL : ELEVATION DETAILS	
All Measurement are mm	SIGNATURE : SUBMISSION DATE:



SITE LAYOUT PLAN (82m TOWER)

DESIGN CRITERIA & STANDRAD :

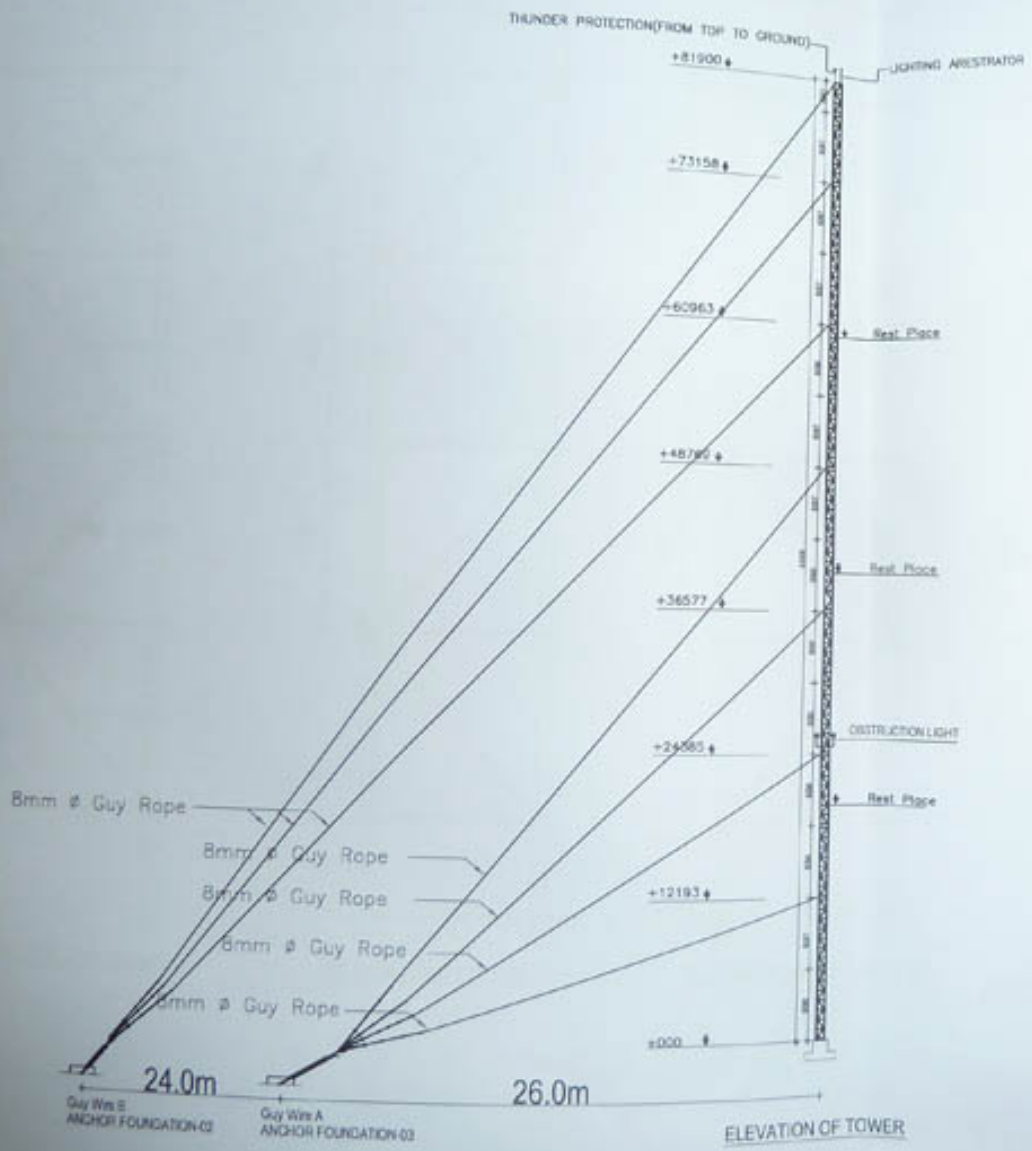
CLIENT : Construction (BD)

DESIGNER :

MOHAMMAD MAHFUZUR RAHMAN

SIGNATURE

SCALE : NOT TO SCALE



ELEVATION OF TOWER

MEMBER TYPE AND SIZE :

DESCRIPTION	ELEVATION	OUTER DIA (mm)	THICKNESS (mm)
Leg	00 mm to 30485mm	76	3.66
Leg	30485 mm to 82000 mm	60	3.66
Cross Bracing	00 mm to 70000 mm	38	2.65
Ladder Bracing	00 mm to 70000 mm	25	2.65

DATA FOR GUY CABLE :

GUY DIA (mm)	NUMBER OF STRANDS AND DIA	WEIGHT PER FT. (pound)	AREA (sq. inch)	BREAKING STRENGTH (pound) Extra High-Strength
8 mm	7x0.120	0.275	0.0790	18000

FOUNDATION FORCE

Leg / Guy	Compression, kN	Tension, kN	Sliding, kN	Uplift, kN
Main Leg	350	-	3	-
Guy Wire A ANCHOR FOUNDATION-03	-	70	50	65
Guy Wire B ANCHOR FOUNDATION-02	-	100	80	75

Mohammad Mahfuzur Rahman
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Bureau
BCE/S-37332, SMIEB-CE-0344

DESIGN CRITERIA & STANDRAD:

Basic wind speed	: 160 Km/hr
fcu & Bolts yield strength	: 415 MPa
Pipe yield strength	: 275MPa
Loading and Design code	: TIA EIA 222-F

CLIENT : Construction (90)

DESIGNER :

MOHAMMAD MAHFUZUR RAHMAN

DRAWING TITLE : ELEVATION DETAILS

All Measurement are in mm	SIGNATURE :	SUBMISSION DATE
		SCALE : NOT TO SCALE
		DRAWING NO. 01

REPORT ON STRUCTURAL DESIGN OF 82M GUYED MAST (WIND SPEED: 160 KPH)

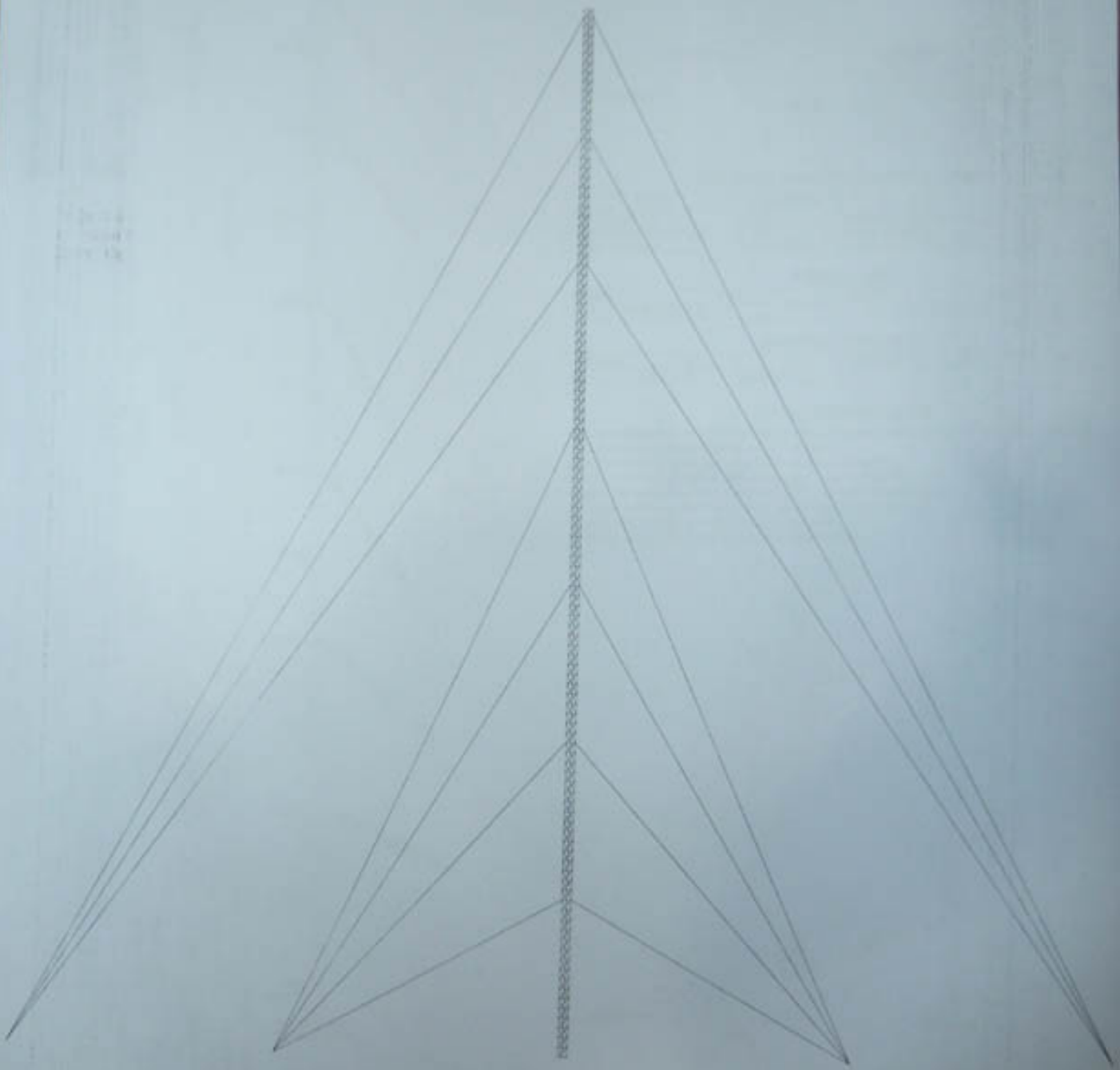
23/02/14

Mohammad Mahfuzur Rahman
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Build
MIEB-27032, DMINB-CE-0344

REVISION HISTORY		
0	Revision-0 (Original Issue ID: TCS.CBD-01)	22.02.2014
Rev.	**Revision information**	**Date**

Design & Approved by
Mohammad Mahfuzur Rahman (DMINB CE 0344, MIEB 27032)

Project: 82m Gyed mast
Job: 82m Guyed Mast (160kph Wind Speed)
Client: Construction (BD)



23/02/14

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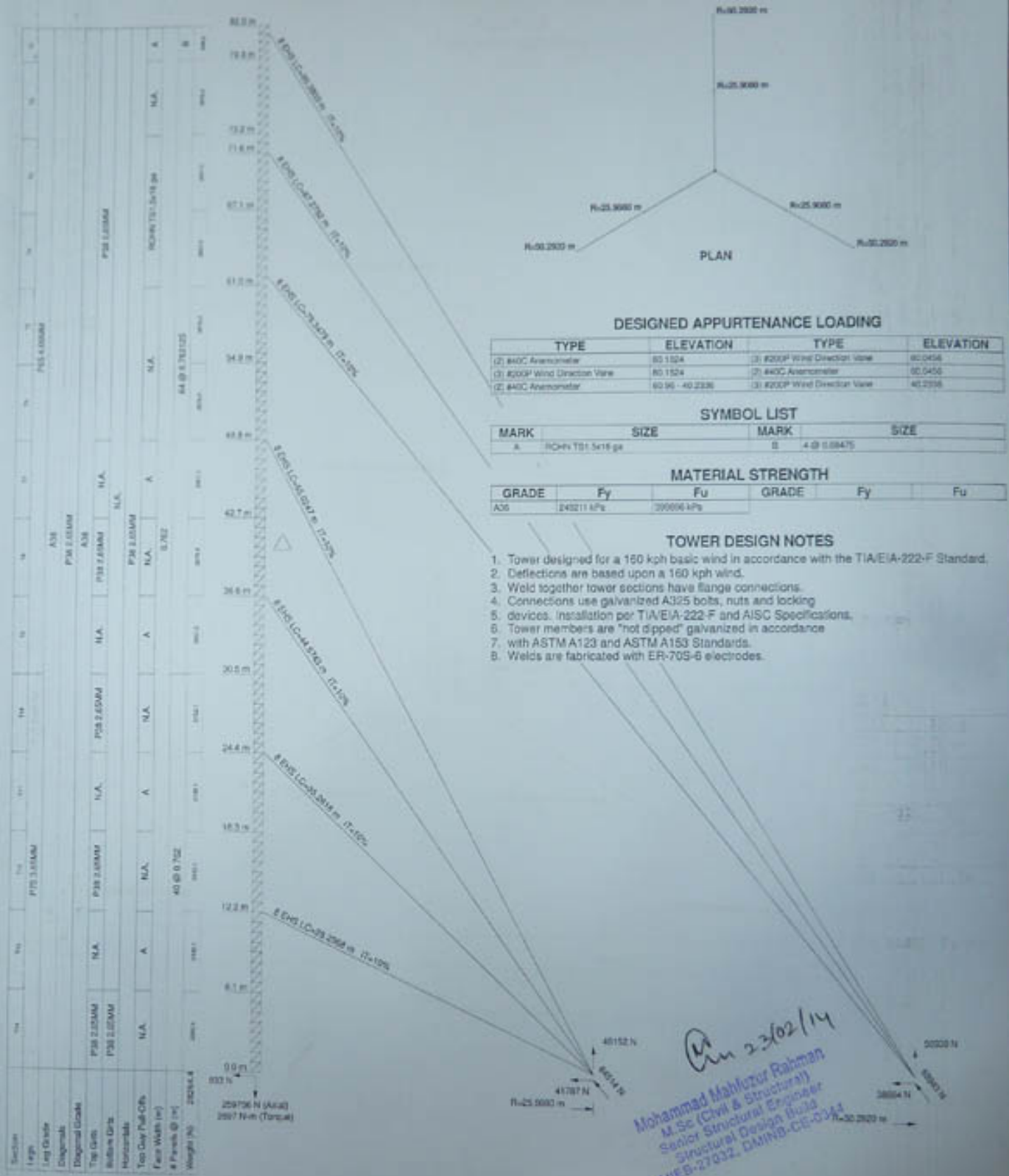
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Build
MIEB-27032, DMINB-CS-0344



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
(2) #40C Anemometer	80.1524	(3) #200P Wind Direction Vane	60.0456
(3) #200P Wind Direction Vane	80.1524	(2) #40C Anemometer	60.0456
(2) #40C Anemometer	60.96 - 40.2336	(3) #200P Wind Direction Vane	40.2336

SYMBOL LIST

MARK	SIZE	MARK	SIZE
A	ROHN TS1.5x16 ga	B	4 @ 0.09475

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A36	248211 kPa	399896 kPa			

TOWER DESIGN NOTES

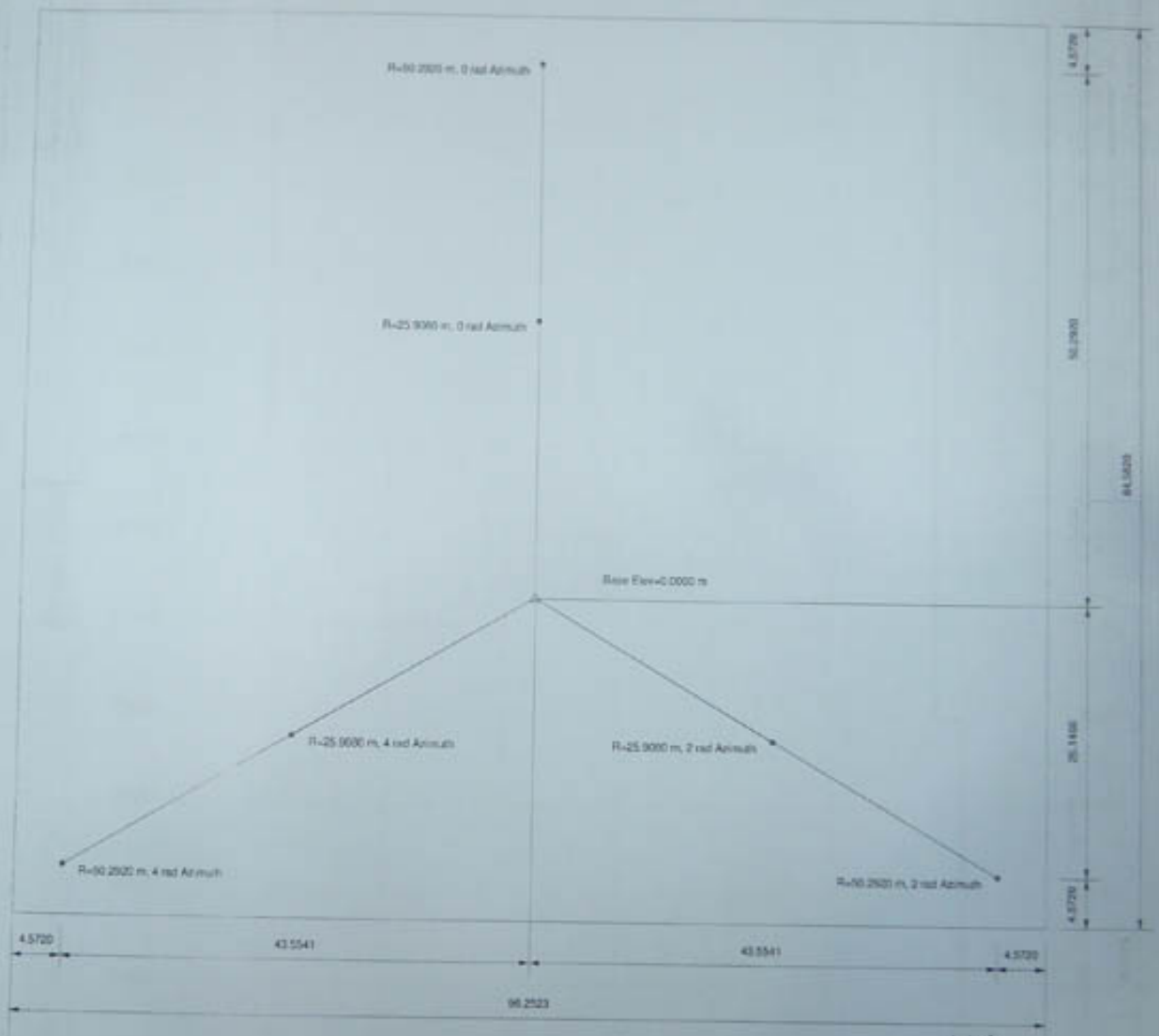
1. Tower designed for a 160 kph basic wind in accordance with the TIA/EIA-222-F Standard.
2. Deflections are based upon a 160 kph wind.
3. Weld together tower sections have flange connections.
4. Connections use galvanized A325 bolts, nuts and locking
5. devices. Installation per TIA/EIA-222-F and AISC Specifications.
6. Tower members are "hot dipped" galvanized in accordance
7. with ASTM A123 and ASTM A153 Standards.
8. Welds are fabricated with ER-70S-6 electrodes.

23/02/14

Mohammad Mahfuzur Rahman
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Build
MIEB-27032, DMNB-CE-0344

The Civil and Structures Dhaka	82m Guyed Mast (160kph Wind Speed)	
Consulting Engineers Phone: +8801556331582 FAX:	Project: 82m Gyed mast	
	Client: Construction (BD)	Drawn by: Mohammad Mahfuzur Rahman
	Code: TIA/EIA-222-F	Date: 02/23/14
	Path:	Scale: N
		Dwg No:

Plot Plan
Total Area - 2.01 Acres



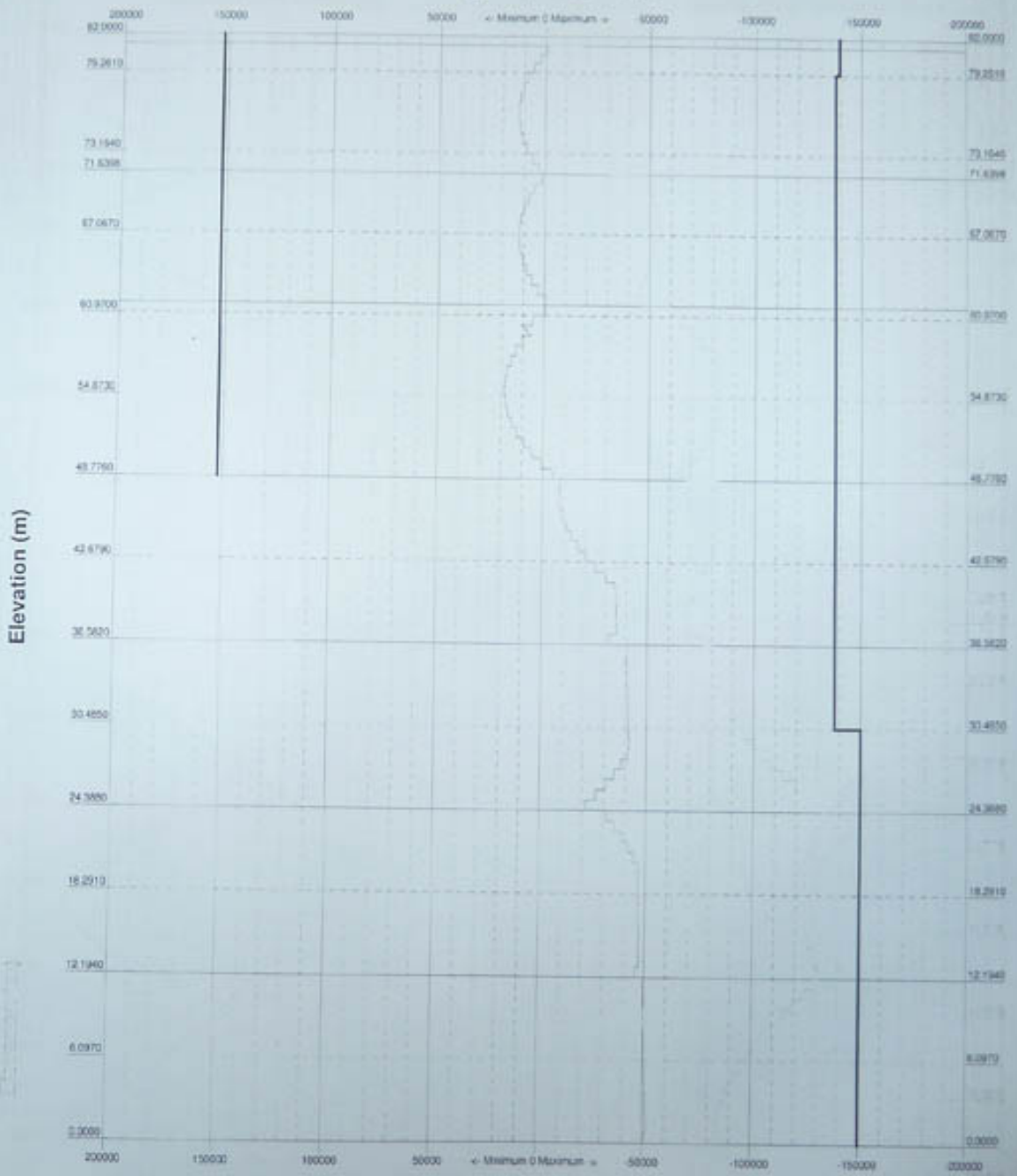
23/02/14

Mohammad Mahfuzur Rahman
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Build
MIEB-27032, DMHND-CE-0344

The Civil and Structures Dhaka	Job: 82m Guyed Mast (160kph Wind Speed)	
	Project: 82m Gyed mast	
	Client: Construction (BD)	Drawn By: Mohammad Mahfuzur Rahman
Consulting Engineers Phone: +8801556331582 FAX:	Code: TIA/EIA-222-F	Date: 02/23/14
	Path:	Scale: NTS
		Dwg No. S-2

TIA/EIA-222-F - 160 kph

Leg Capacity ——— Leg Compression (N)



23/02/14

Mohammad Mahfuzur Rahman
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Build
MIEB-27032, DMIIB-CE-0344

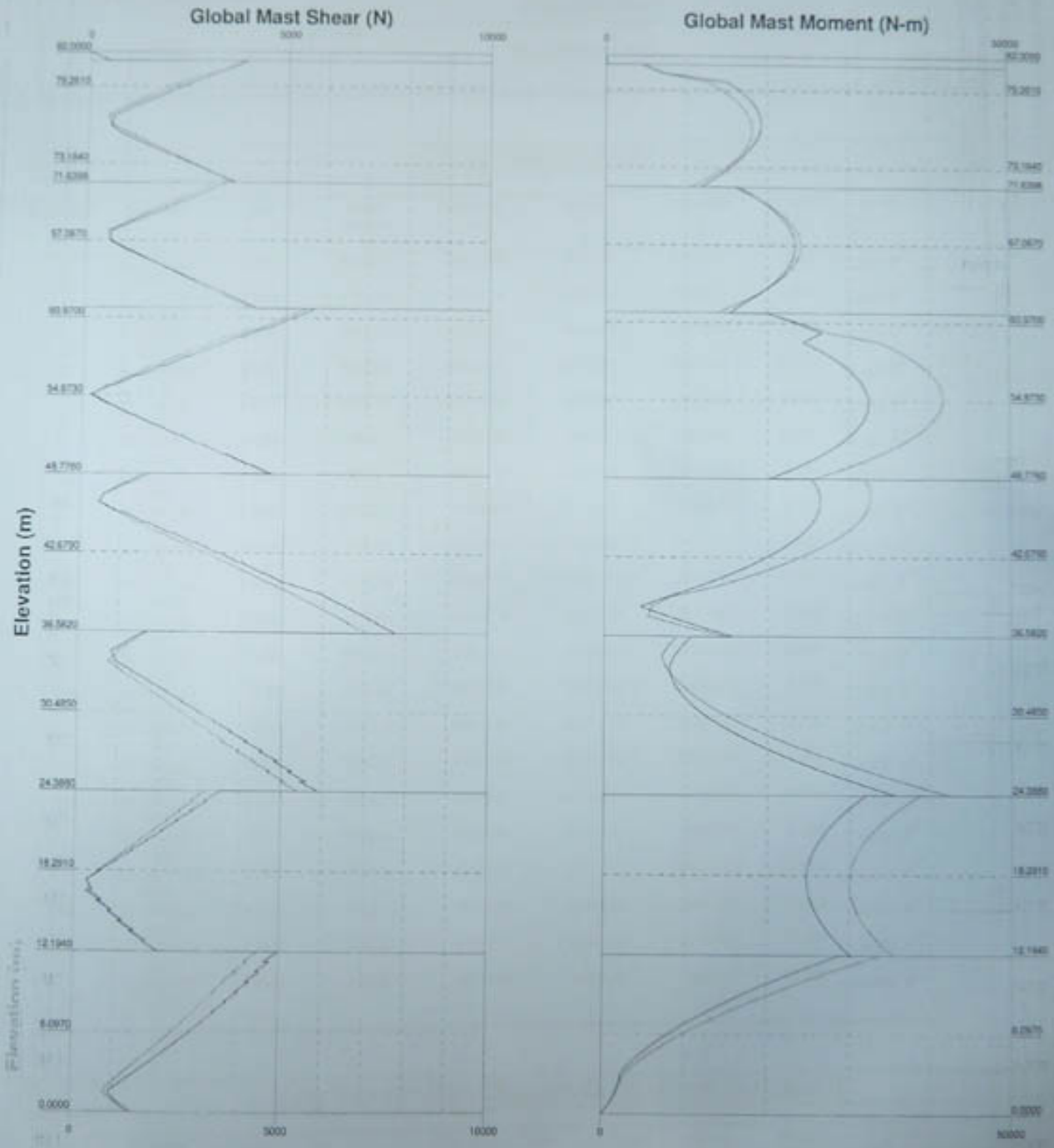
The Civil and Structures Dhaka	*82m Guyed Mast (160kph Wind Speed)*
Consulting Engineers Phone: +8801556331582 FAX:	Project: *82m Gyed mast*
	Client: Construction (BD) Drawn by: Mohammad Mahfuzur Rahman
	Code: TIA/EIA-222-F Date: 02/23/14
	Path:

TIA/EIA-222-F - 160 kph

Vx Vz

Maximum Values

Mx Mz



Mohammad Mahfuzur Rahman 23/02/14
M.Sc (Civil & Structural)
Senior Structural Engineer
Structural Design Build
MIEB-27032, DMINB-CE-0344

The Civil and Structures Dhaka Consulting Engineers Phone: +8801556331582 FAX:	Title: *82m Guyed Mast (160kph Wind Speed)* Project: *82m Gyed mast* Client: Construction (BD) Drawn by: Mohammad Mahfuzur Rahman Appd: Code: TIA/EIA-222-F Date: 02/23/14 Scale: NTS Path: Dwg No: E-4

RISATower *The Civil and Structures* *Phone* *FAX*	Job 82m Guyed Mast (160kph Wind Speed)	Page 1 of 8
	Project 82m Gyed mast	Date 08:33:37 02/23/14
	Client Construction (BD)	Designed by Mohammad Mahfuzur Rahman

Guy Design Data

Section No.	Elevation m	Size	Initial Tension N	Breaking Load N	Actual T N	Allowable T_a N	Required S.F.	Actual S.F.
T1	81.3153 (A) (714)	8 EHS	4982.01	49819.99	19793.29	24910.03	2.000	2.517 ✓
	81.3153 (B) (713)	8 EHS	4982.01	49819.99	19592.54	24910.03	2.000	2.543 ✓
	81.3153 (C) (712)	8 EHS	4982.01	49819.99	19461.01	24910.03	2.000	2.560 ✓
T3	71.6398 (A) (711)	8 EHS	4982.01	49819.99	21382.24	24910.03	2.000	2.330 ✓
	71.6398 (B) (710)	8 EHS	4982.01	49819.99	21359.96	24910.03	2.000	2.332 ✓
	71.6398 (C) (709)	8 EHS	4982.01	49819.99	21663.10	24910.03	2.000	2.300 ✓
T4	61.7321 (A) (708)	8 EHS	4982.01	49819.99	22956.33	24910.03	2.000	2.170 ✓
	61.7321 (B) (707)	8 EHS	4982.01	49819.99	23260.28	24910.03	2.000	2.142 ✓
	61.7321 (C) (706)	8 EHS	4982.01	49819.99	23513.38	24910.03	2.000	2.119 ✓
T7	48.7760 (A) (705)	8 EHS	4982.01	49819.99	20529.16	24910.03	2.000	2.427 ✓
	48.7760 (B) (704)	8 EHS	4982.01	49819.99	20957.83	24910.03	2.000	2.377 ✓
	48.7760 (C) (703)	8 EHS	4982.01	49819.99	20721.86	24910.03	2.000	2.404 ✓
T9	36.5820 (A) (702)	8 EHS	4982.01	49819.99	20023.66	24910.03	2.000	2.488 ✓
	36.5820 (B) (701)	8 EHS	4982.01	49819.99	20211.11	24910.03	2.000	2.465 ✓
	36.5820 (C) (700)	8 EHS	4982.01	49819.99	19853.79	24910.03	2.000	2.509 ✓
T11	24.3880 (A) (699)	8 EHS	4982.01	49819.99	15560.23	24910.03	2.000	3.202 ✓
	24.3880 (B) (698)	8 EHS	4982.01	49819.99	15470.51	24910.03	2.000	3.220 ✓
	24.3880 (C) (697)	8 EHS	4982.01	49819.99	15310.46	24910.03	2.000	3.254 ✓
T13	12.1940 (A) (696)	8 EHS	4982.01	49819.99	10344.83	24910.03	2.000	4.816 ✓
	12.1940 (B) (695)	8 EHS	4982.01	49819.99	10240.16	24910.03	2.000	4.865 ✓
	12.1940 (C) (694)	8 EHS	4982.01	49819.99	10264.31	24910.03	2.000	4.854 ✓

Leg Interaction Design Data (Compression)

Section No.	Elevation m	Size	Ratio $\frac{P}{P_a}$	Ratio $\frac{f_{bx}}{F_{bx}}$	Ratio $\frac{f_{by}}{F_{by}}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
T1	82 - 79.261	P65 4.00MM	0.375	0.016	0.000	0.391 ✓	1.333	H1-3 ✓
T2	79.261 - 73.164	P65 4.00MM	0.416	0.021	0.000	0.437 ✓	1.333	H1-3 ✓
T3	73.164 -	P65 4.00MM	0.518	0.024	0.000	0.542	1.333	H1-3 ✓

Section No.	Elevation m	Size	Ratio $\frac{P}{P_a}$	Ratio $\frac{f_{bw}}{F_{bw}}$	Ratio $\frac{f_{bv}}{F_{bv}}$	Comb. Stress Ratio	Allow Stress Ratio	Criteria
	67.067					✓		
T4	67.067 - 60.97	P65 4.00MM	0.588	0.034	0.000	0.622 ✓	1.333	H1-3 ✓
T5	60.97 - 54.873	P65 4.00MM	0.804	0.032	0.000	0.836 ✓	1.333	H1-3 ✓
T6	54.873 - 48.776	P65 4.00MM	0.803	0.032	0.000	0.835 ✓	1.333	H1-3 ✓
T7	48.776 - 42.679	P65 4.00MM	0.810	0.031	0.000	0.841 ✓	1.333	H1-3 ✓
T8	42.679 - 36.582	P65 4.00MM	0.748	0.020	0.000	0.768 ✓	1.333	H1-3 ✓
T9	36.582 - 30.485	P65 4.00MM	0.889	0.020	0.000	0.909 ✓	1.333	H1-3 ✓
T10	30.485 - 24.388	P75 3.65MM	1.175	0.053	0.000	1.228 ✓	1.333	H1-3 ✓
T11	24.388 - 18.291	P75 3.65MM	1.193	0.053	0.000	1.246 ✓	1.333	H1-3 ✓
T12	18.291 - 12.194	P75 3.65MM	1.165	0.044	0.000	1.209 ✓	1.333	H1-3 ✓
T13	12.194 - 6.097	P75 3.65MM	1.150	0.044	0.000	1.194 ✓	1.333	H1-3 ✓
T14	6.097 - 0	P75 3.65MM	0.844	0.012	0.000	0.855 ✓	1.333	H1-3 ✓

Diagonal Design Data (Compression)

Section No.	Elevation m	Size	L m	L_u m	Kl/r	F_a kPa	A mm²	Actual P N	Allow P_a N	Ratio $\frac{P}{P_a}$
T1	82 - 79.261	P38 2.65MM	1.0245	0.9371	74.8 K=1.00	109815	294	-4206.05	32318.15	0.130 ✓
T2	79.261 - 73.164	P38 2.65MM	1.0777	0.9858	78.7 K=1.00	106899	294	-3123.74	31460.00	0.099 ✓
T3	73.164 - 67.067	P38 2.65MM	1.0777	0.9858	78.7 K=1.00	106899	294	-4881.48	31460.00	0.155 ✓
T4	67.067 - 60.97	P38 2.65MM	1.0777	0.9858	78.7 K=1.00	106899	294	-8244.02	31460.00	0.262 ✓
T5	60.97 - 54.873	P38 2.65MM	1.0777	0.9858	78.7 K=1.00	106899	294	-8037.89	31460.00	0.255 ✓
T6	54.873 - 48.776	P38 2.65MM	1.0777	0.9858	78.7 K=1.00	106899	294	-7121.82	31460.00	0.226 ✓
T7	48.776 - 42.679	P38 2.65MM	1.0777	0.9858	78.7 K=1.00	106899	294	-6986.42	31460.00	0.222 ✓
T8	42.679 - 36.582	P38 2.65MM	1.0777	0.9858	78.7 K=1.00	106899	294	-10359.06	31460.00	0.329 ✓
T9	36.582 - 30.485	P38 2.65MM	1.0777	0.9858	78.7 K=1.00	106899	294	-7445.16	31460.00	0.237 ✓
T10	30.485 - 24.388	P38 2.65MM	1.0777	0.9716	77.5 K=1.00	107753	294	-9699.97	31711.54	0.306 ✓
T11	24.388 - 18.291	P38 2.65MM	1.0777	0.9716	77.5	107753	294	-7889.63	31711.54	0.249

Section No.	Elevation m	Size	L m	L_u m	KL/r	F_a kPa	A mm²	Actual P N	Allow. P_a N	Ratio P/P_a
T12	18.291 - 12.194	P38 2.65MM	1.0777	0.9716	K=1.00 77.5 K=1.00	107753	294	-6951.32	31711.54	✓ 0.219 ✓
T13	12.194 - 6.097	P38 2.65MM	1.0777	0.9716	77.5 K=1.00	107753	294	-9464.75	31711.54	0.298 ✓
T14	6.097 - 0	P38 2.65MM	1.0777	0.9716	77.5 K=1.00	107753	294	-7813.25	31711.54	0.246 ✓

Horizontal Design Data (Compression)

Section No.	Elevation m	Size	L m	L_u m	KL/r	F_a kPa	A mm²	Actual P N	Allow. P_a N	Ratio P/P_a
T1	82 - 79.261	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-1492.02	36206.47	0.041 ✓
T2	79.261 - 73.164	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-680.96	36206.47	0.019 ✓
T3	73.164 - 67.067	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-1253.69	36206.47	0.035 ✓
T4	67.067 - 60.97	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-768.91	36206.47	0.021 ✓
T5	60.97 - 54.873	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-682.32	36206.47	0.019 ✓
T6	54.873 - 48.776	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-266.93	36206.47	0.007 ✓
T8	42.679 - 36.582	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-1519.32	36206.47	0.042 ✓

Top Girt Design Data (Compression)

Section No.	Elevation m	Size	L m	L_u m	KL/r	F_a kPa	A mm²	Actual P N	Allow. P_a N	Ratio P/P_a
T1	82 - 79.261	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-42.75	36206.47	0.001 ✓
T2	79.261 - 73.164	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-857.39	36206.47	0.024 ✓
T3	73.164 - 67.067	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-1033.89	36206.47	0.029 ✓
T5	60.97 - 54.873	P38 2.65MM	0.7620	0.6970	55.6 K=1.00	123027	294	-948.32	36206.47	0.026 ✓

Tension Checks

Leg Interaction Design Data (Tension)

Section No.	Elevation m	Size	Ratio $\frac{P}{P_a}$	Ratio $\frac{f_{bx}}{F_{bx}}$	Ratio $\frac{f_{by}}{F_{by}}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
T1	82 - 79.261	P65 4.00MM	0.047	0.017	0.000	0.064 ✓	1.333	H2-1 ✓
T2	79.261 - 73.164	P65 4.00MM	0.108	0.021	0.000	0.129 ✓	1.333	H2-1 ✓
T3	73.164 - 67.067	P65 4.00MM	0.105	0.027	0.000	0.132 ✓	1.333	H2-1 ✓
T4	67.067 - 60.97	P65 4.00MM	0.106	0.027	0.000	0.133 ✓	1.333	H2-1 ✓
T5	60.97 - 54.873	P65 4.00MM	0.162	0.042	0.000	0.203 ✓	1.333	H2-1 ✓
T6	54.873 - 48.776	P65 4.00MM	0.158	0.041	0.000	0.199 ✓	1.333	H2-1 ✓

Diagonal Design Data (Tension)

Section No.	Elevation m	Size	L m	L_u m	Kl/r	F_a kPa	A mm²	Actual P N	Allow. P_a N	Ratio $\frac{P}{P_a}$
T1	82 - 79.261	P38 2.65MM	1.0245	0.9371	74.8	148927	294	2319.75	43828.63	0.053 ✓
T2	79.261 - 73.164	P38 2.65MM	1.0777	0.9858	78.7	148927	294	1302.27	43828.63	0.030 ✓
T3	73.164 - 67.067	P38 2.65MM	1.0777	0.9858	78.7	148927	294	2234.85	43828.63	0.051 ✓
T4	67.067 - 60.97	P38 2.65MM	1.0777	0.9858	78.7	148927	294	1604.98	43828.63	0.037 ✓
T5	60.97 - 54.873	P38 2.65MM	1.0777	0.9858	78.7	148927	294	1258.57	43828.63	0.029 ✓
T6	54.873 - 48.776	P38 2.65MM	1.0777	0.9858	78.7	148927	294	738.25	43828.63	0.017 ✓
T8	42.679 - 36.582	P38 2.65MM	1.0777	0.9858	78.7	148927	294	2426.03	43828.63	0.055 ✓
T10	30.485 - 24.388	P38 2.65MM	1.0777	0.9716	77.5	148927	294	166.77	43828.63	0.004 ✓

Horizontal Design Data (Tension)

Section No.	Elevation m	Size	L m	L_u m	Kl/r	F_a kPa	A mm²	Actual P N	Allow. P_a N	Ratio $\frac{P}{P_a}$
T1	82 - 79.261	P38 2.65MM	0.7620	0.6970	55.6	148927	294	3079.76	43828.63	0.070 ✓
T2	79.261 - 73.164	P38 2.65MM	0.7620	0.6970	55.6	148927	294	2115.59	43828.63	0.048

Section No.	Elevation m	Size	L m	L_u m	KL/r	F_a kPa	A mm²	Actual P N	Allow P_a N	Ratio P/P_a
T3	73.164 - 67.067	P38 2.65MM	0.7620	0.6970	55.6	148927	294	3396.82	43828.63	0.078
T4	67.067 - 60.97	P38 2.65MM	0.7620	0.6970	55.6	148927	294	3835.24	43828.63	0.088
T5	60.97 - 54.873	P38 2.65MM	0.7620	0.6970	55.6	148927	294	5323.19	43828.63	0.121
T6	54.873 - 48.776	P38 2.65MM	0.7620	0.6970	55.6	148927	294	4990.28	43828.63	0.114
T7	48.776 - 42.679	P38 2.65MM	0.7620	0.6970	55.6	148927	294	4697.14	43828.63	0.107
T8	42.679 - 36.582	P38 2.65MM	0.7620	0.6970	55.6	148927	294	7356.11	43828.63	0.168
T9	36.582 - 30.485	P38 2.65MM	0.7620	0.6970	55.6	148927	294	5090.23	43828.63	0.116
T10	30.485 - 24.388	P38 2.65MM	0.7620	0.6870	54.8	148927	294	6839.14	43828.63	0.156
T11	24.388 - 18.291	P38 2.65MM	0.7620	0.6870	54.8	148927	294	5576.07	43828.63	0.127
T12	18.291 - 12.194	P38 2.65MM	0.7620	0.6870	54.8	148927	294	4872.00	43828.63	0.111
T13	12.194 - 6.097	P38 2.65MM	0.7620	0.6870	54.8	148927	294	6723.26	43828.63	0.153
T14	6.097 - 0	P38 2.65MM	0.7620	0.6870	54.8	148927	294	5398.85	43828.63	0.123

Top Girt Design Data (Tension)

Section No.	Elevation m	Size	L m	L_u m	KL/r	F_a kPa	A mm²	Actual P N	Allow P_a N	Ratio P/P_a
T1	82 - 79.261	P38 2.65MM	0.7620	0.6970	55.6	148927	294	87.59	43828.63	0.002
T2	79.261 - 73.164	P38 2.65MM	0.7620	0.6970	55.6	148927	294	2220.59	43828.63	0.051
T3	73.164 - 67.067	P38 2.65MM	0.7620	0.6970	55.6	148927	294	2426.54	43828.63	0.055
T4	67.067 - 60.97	P38 2.65MM	0.7620	0.6970	55.6	148927	294	2137.02	43828.63	0.049
T5	60.97 - 54.873	P38 2.65MM	0.7620	0.6970	55.6	148927	294	5804.97	43828.63	0.132
T6	54.873 - 48.776	P38 2.65MM	0.7620	0.6970	55.6	148927	294	2746.91	43828.63	0.063
T8	42.679 - 36.582	P38 2.65MM	0.7620	0.6970	55.6	148927	294	5039.21	43828.63	0.115
T10	30.485 - 24.388	P38 2.65MM	0.7620	0.6970	55.6	148927	294	5307.88	43828.63	0.121
T12	18.291 - 12.194	P38 2.65MM	0.7620	0.6970	55.6	148927	294	4037.94	43828.63	0.092
T14	6.097 - 0	P38 2.65MM	0.7620	0.6970	55.6	148927	294	5574.33	43828.63	0.127

Section No	Elevation m	Size	L m	L_u m	K/r	F_a kPa	A mm^2	Actual P N	Allow. P_a N	Ratio P / P_a
										✓

Bottom Girt Design Data (Tension)

Section No.	Elevation m	Size	L m	L_u m	K/r	F_a kPa	A mm^2	Actual P N	Allow. P_a N	Ratio P / P_a
T14	6.097 - 0	P38 2.65MM	0.7620	0.6870	54.8	148927	294	206.09	43828.63	0.005 ✓

Top Guy Pull-Off Design Data (Tension)

Section No.	Elevation m	Size	L m	L_u m	K/r	F_a kPa	A mm^2	Actual P N	Allow. P_a N	Ratio P / P_a
T1	82 - 79.261	ROHN TS1.5x16 ga	0.7620	0.6970	53.8	148927	170	6169.77	25245.48	0.244 ✓
T3	73.164 - 67.067	ROHN TS1.5x16 ga	0.7620	0.6970	53.8	148927	170	7545.43	25245.48	0.299 ✓
T4	67.067 - 60.97	ROHN TS1.5x16 ga	0.7620	0.6970	53.8	148927	170	9489.74	25245.48	0.376 ✓
T7	48.776 - 42.679	ROHN TS1.5x16 ga	0.7620	0.6970	53.8	148927	170	7757.83	25245.48	0.307 ✓
T9	36.582 - 30.485	ROHN TS1.5x16 ga	0.7620	0.6970	53.8	148927	170	9076.59	25245.48	0.360 ✓
T11	24.388 - 18.291	ROHN TS1.5x16 ga	0.7620	0.6870	53.0	148927	170	9136.47	25245.48	0.362 ✓
T13	12.194 - 6.097	ROHN TS1.5x16 ga	0.7620	0.6870	53.0	148927	170	8171.47	25245.48	0.324 ✓

Section Capacity Table

Section No.	Elevation m	Component Type	Size	Critical Element	P N	$SF*P_{allow}$ N	% Capacity	Pass / Fail
T1	82 - 79.261	Leg	P65 4.00MM	1	-39322.23	139643.35	29.4	Pass
		Diagonal	P38 2.65MM	24	-4206.05	43080.09	9.8	Pass
		Horizontal	P38 2.65MM	21	3079.76	58423.56	5.3	Pass
		Top Girt	P38 2.65MM	5	87.59	58423.56	0.1	Pass
		Guy A@81.3153	8	714	19793.29	24910.03	79.5	Pass
		Guy B@81.3153	8	713	19592.54	24910.03	78.7	Pass
		Guy C@81.3153	8	712	19461.01	24910.03	78.1	Pass
		Top Guy Pull-Off@81.3153	ROHN TS1.5x16 ga	26	6169.77	33652.22	18.3	Pass
T2	79.261 - 73.164	Leg	P65 4.00MM	31	-42968.25	137781.49	32.8	Pass
		Diagonal	P38 2.65MM	39	-3123.74	41936.17	7.4	Pass

Section No.	Elevation m	Component Type	Size	Critical Element	P N	SF*P_{allow} N	% Capacity	Pass Fail
		Horizontal	P38 2.65MM	42	2115.59	58423.56	3.6	Pass
		Top Girt	P38 2.65MM	8	2220.59	58423.56	3.8	Pass
T3	73.164 - 67.067	Leg	P65 4.00MM	82	-53516.98	137781.49	40.7	Pass
		Diagonal	P38 2.65MM	119	-4881.48	41936.17	11.6	Pass
		Horizontal	P38 2.65MM	116	3396.82	58423.56	5.8	Pass
		Top Girt	P38 2.65MM	36	2426.54	58423.56	4.2	Pass
		Guy A@71.6398	8	711	21382.24	24910.03	85.8	Pass
		Guy B@71.6398	8	710	21359.96	24910.03	85.7	Pass
		Guy C@71.6398	8	709	21663.10	24910.03	87.0	Pass
		Top Guy Pull-Off@71.6398	ROHN TS1.5x16 ga	123	7545.43	33652.22	22.4	Pass
T4	67.067 - 60.97	Leg	P65 4.00MM	133	-60777.82	137781.49	46.7	Pass
		Diagonal	P38 2.65MM	140	-8244.02	41936.17	19.7	Pass
		Horizontal	P38 2.65MM	150	3835.24	58423.56	6.6	Pass
		Top Girt	P38 2.65MM	87	2137.02	58423.56	3.7	Pass
		Guy A@61.7321	8	708	22956.33	24910.03	92.2	Pass
		Guy B@61.7321	8	707	23260.28	24910.03	93.4	Pass
		Guy C@61.7321	8	706	23513.38	24910.03	94.4	Pass
		Top Guy Pull-Off@61.7321	ROHN TS1.5x16 ga	144	9489.74	33652.22	28.2	Pass
T5	60.97 - 54.873	Leg	P65 4.00MM	185	-83119.89	137781.49	62.7	Pass
		Diagonal	P38 2.65MM	233	-8037.89	41936.17	19.2	Pass
		Horizontal	P38 2.65MM	230	5323.19	58423.56	9.1	Pass
		Top Girt	P38 2.65MM	137	5804.97	58423.56	9.9	Pass
T6	54.873 - 48.776	Leg	P65 4.00MM	236	-82977.11	137781.49	62.6	Pass
		Diagonal	P38 2.65MM	241	-7121.82	41936.17	17.0	Pass
		Horizontal	P38 2.65MM	244	4990.28	58423.56	8.5	Pass
		Top Girt	P38 2.65MM	187	2746.91	58423.56	4.7	Pass
T7	48.776 - 42.679	Leg	P65 4.00MM	287	-83716.40	137781.49	63.1	Pass
		Diagonal	P38 2.65MM	293	-6986.42	41936.17	16.7	Pass
		Horizontal	P38 2.65MM	296	4697.14	58423.56	8.0	Pass
		Guy A@48.776	8	705	20529.16	24910.03	82.4	Pass
		Guy B@48.776	8	704	20957.83	24910.03	84.1	Pass
		Guy C@48.776	8	703	20721.86	24910.03	83.2	Pass
		Top Guy Pull-Off@48.776	ROHN TS1.5x16 ga	238	7757.83	33652.22	23.1	Pass
T8	42.679 - 36.582	Leg	P65 4.00MM	339	-77327.42	137781.49	57.6	Pass
		Diagonal	P38 2.65MM	344	-10359.06	41936.17	24.7	Pass
		Horizontal	P38 2.65MM	347	7356.11	58423.56	12.6	Pass
		Top Girt	P38 2.65MM	290	5039.21	58423.56	8.6	Pass
T9	36.582 - 30.485	Leg	P65 4.00MM	390	-91933.60	137781.49	68.2	Pass
		Diagonal	P38 2.65MM	395	-7445.16	41936.17	17.8	Pass
		Horizontal	P38 2.65MM	398	5090.23	58423.56	8.7	Pass
		Guy A@36.582	8	702	20023.66	24910.03	80.4	Pass
		Guy B@36.582	8	701	20211.11	24910.03	81.1	Pass
		Guy C@36.582	8	700	19853.79	24910.03	79.7	Pass
		Top Guy Pull-Off@36.582	ROHN TS1.5x16 ga	340	9076.59	33652.22	27.0	Pass
T10	30.485 - 24.388	Leg	P75 3.65MM	441	-132130.38	149856.87	92.1	Pass
		Diagonal	P38 2.65MM	452	-9699.97	42271.48	22.9	Pass
		Horizontal	P38 2.65MM	449	6839.14	58423.56	11.7	Pass
		Top Girt	P38 2.65MM	392	5307.88	58423.56	9.1	Pass
T11	24.388 - 18.291	Leg	P75 3.65MM	492	-134148.10	149856.87	93.5	Pass
		Diagonal	P38 2.65MM	532	-7889.63	42271.48	18.7	Pass
		Horizontal	P38 2.65MM	535	5576.07	58423.56	9.5	Pass
		Guy A@24.388	8	699	15560.23	24910.03	62.5	Pass
		Guy B@24.388	8	698	15470.51	24910.03	62.1	Pass
		Guy C@24.388	8	697	15310.46	24910.03	61.5	Pass
		Top Guy Pull-Off@24.388	ROHN TS1.5x16 ga	443	9136.47	33652.22	27.1	Pass
T12	18.291 - 12.194	Leg	P75 3.65MM	543	-131004.54	149856.87	90.7	Pass

Section No.	Elevation m	Component Type	Size	Critical Element	P N	SF*P_{allow} N	% Capacity	Pass Fail
		Diagonal	P38 2.65MM	554	-6951.32	42271.48	16.4	Pass
		Horizontal	P38 2.65MM	551	4872.00	58423.56	8.3	Pass
		Top Girt	P38 2.65MM	493	4037.94	58423.56	6.9	Pass
T13	12.194 - 6.097	Leg	P75 3.65MM	594	-129297.76	149856.87	89.6	Pass
		Diagonal	P38 2.65MM	634	-9464.75	42271.48	22.4	Pass
		Horizontal	P38 2.65MM	637	6723.26	58423.56	11.5	Pass
		Guy A@12.194	8	696	10344.83	24910.03	41.5	Pass
		Guy B@12.194	8	695	10240.16	24910.03	41.1	Pass
		Guy C@12.194	8	694	10264.31	24910.03	41.2	Pass
		Top Guy Pull-Off@12.194	ROHN TS1.5x16 ga	546	8171.47	33652.22	24.3	Pass
T14	6.097 - 0	Leg	P75 3.65MM	645	-94846.30	149856.87	64.2	Pass
		Diagonal	P38 2.65MM	691	-7813.25	42271.48	18.5	Pass
		Horizontal	P38 2.65MM	688	5398.85	58423.56	9.2	Pass
		Top Girt	P38 2.65MM	595	5574.33	58423.56	9.5	Pass
		Bottom Girt	P38 2.65MM	647	206.09	58423.56	0.4	Pass
							Summary	
						Leg (T11)	93.5	Pass
						Diagonal (T8)	24.7	Pass
						Horizontal (T8)	12.6	Pass
						Top Girt (T5)	9.9	Pass
						Bottom Girt (T14)	0.4	Pass
						Guy A (T4)	92.2	Pass
						Guy B (T4)	93.4	Pass
						Guy C (T4)	94.4	Pass
						Top Guy Pull-Off (T4)	28.2	Pass
						RATING =	**94.4**	**Pass**

23/02/14

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Senior Structural Engineer
Structural Design Build
MIEB-27032, DMINB-CE-0344

Full Tower

Up Tower – North Side

Up Tower – East Side

Up Tower – South Side

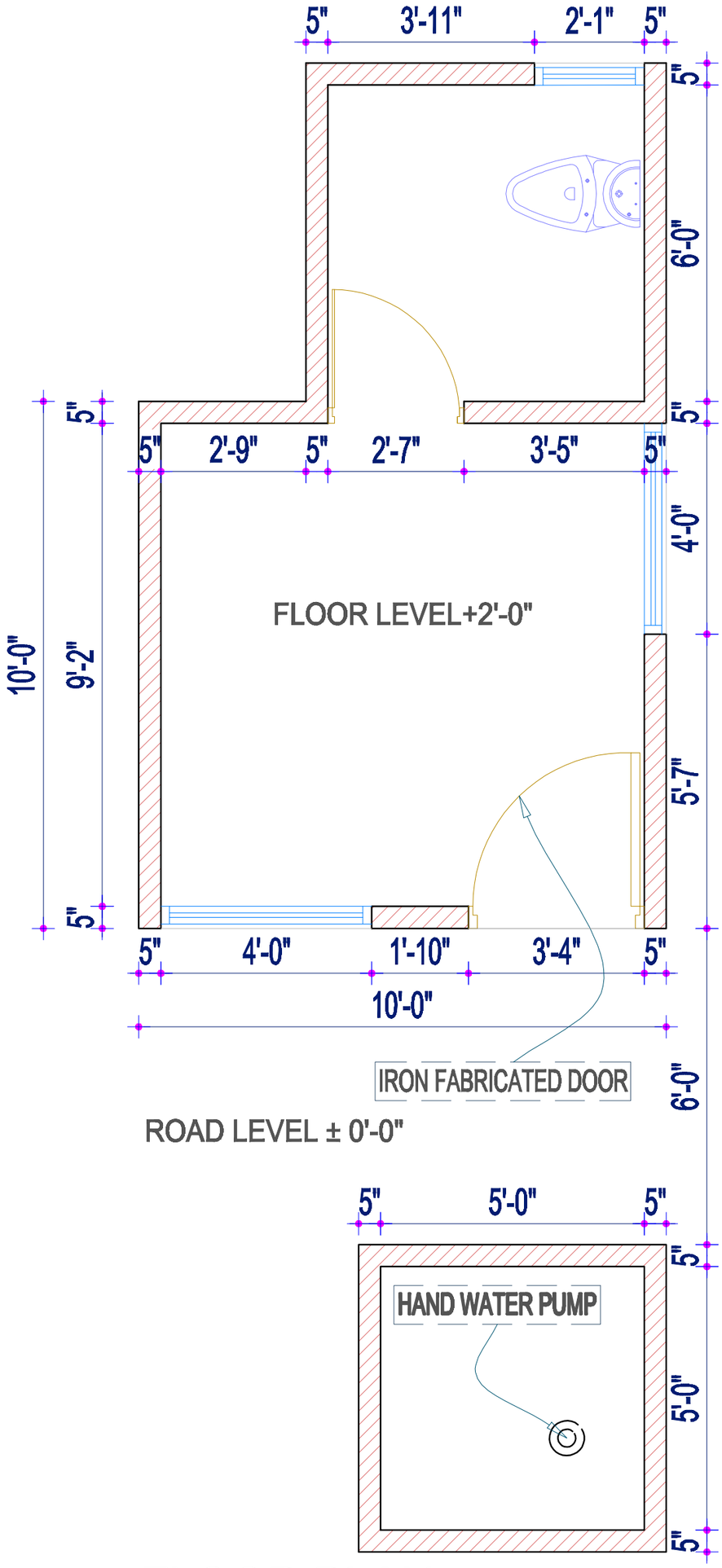
Up Tower – West Side

Tower Height

Top Light

Mid Light

Guy Guards & Bird Flight Diverter Example



FLOOR PLAN

PROJECT TITLE
"BSB TOWER(GUARD ROOM)"

PROJECT TYPE
COMMERCIAL/INDUSTRIAL/OFFICE/HOTEL

PROJECT ADDRESS
BANGLADESH

CLIENT NAME
HARMONY ENERGY BANGLADESH LTD
SHOP NO.-01(1ST FLOOR), SUVANNAH BAZAR,DHAKA CA, DHAKA,BANGLADESH.

ARCHITECTURAL DESIGN
MONOLITH S. Design WORKSHOP
4TH FLR.FLOOR, DARUS SALAM ARCADE, PURANA PALTAN, DHAKA.

ARCHITECT
SHAHID MAHMUD EMARN
SIGNATURE

STRUCTURAL CONSULTANT
MECHANICAL CONSULTANT
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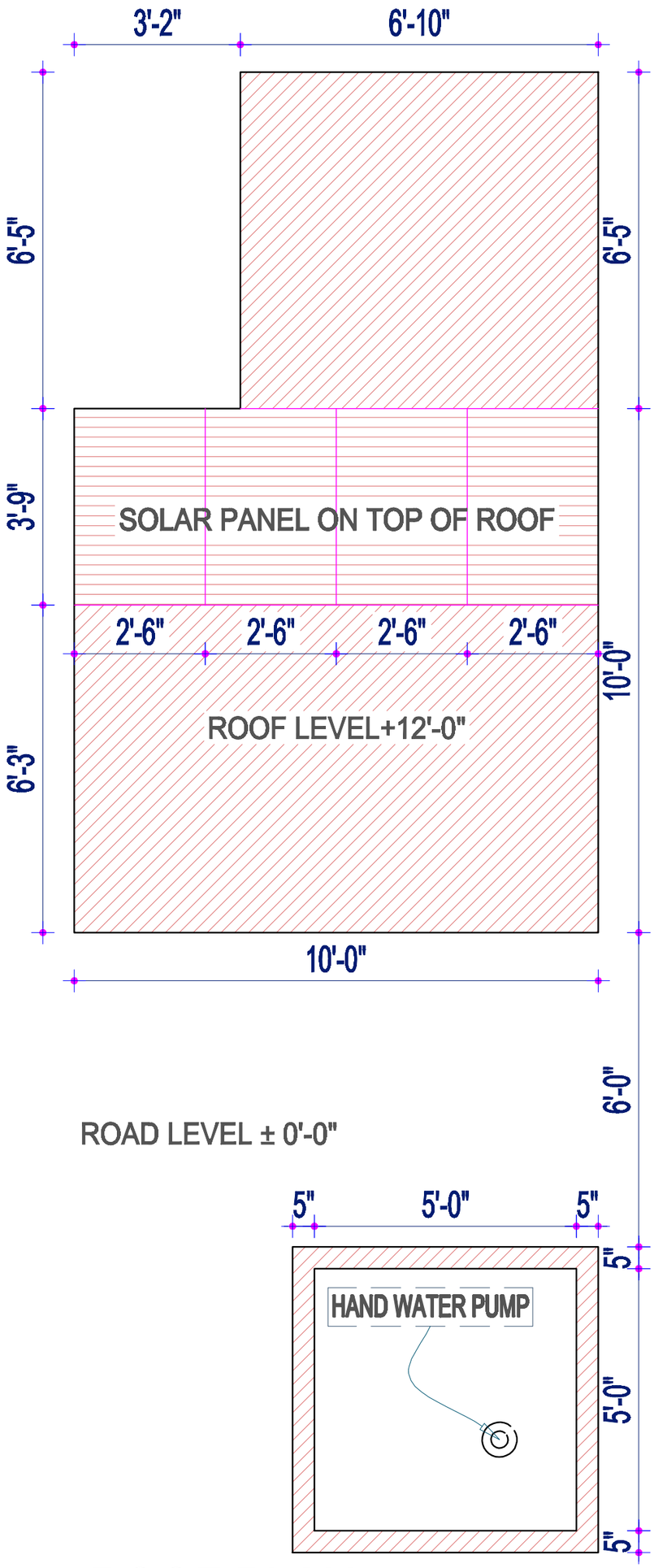
SUBMISSION
DESCRIPTION | DATE
FOR TENDER | 19.07.2014

REVISION
NO. | DATE
NO. | 26.07.2014

DRAWING TITLE
FLOOR PLAN

SCALE: AS NOTED
PAPER SIZE: A3
DRAWING NO: A-08a



ROOF PLAN

"EBL TOWER GUARD ROOM"

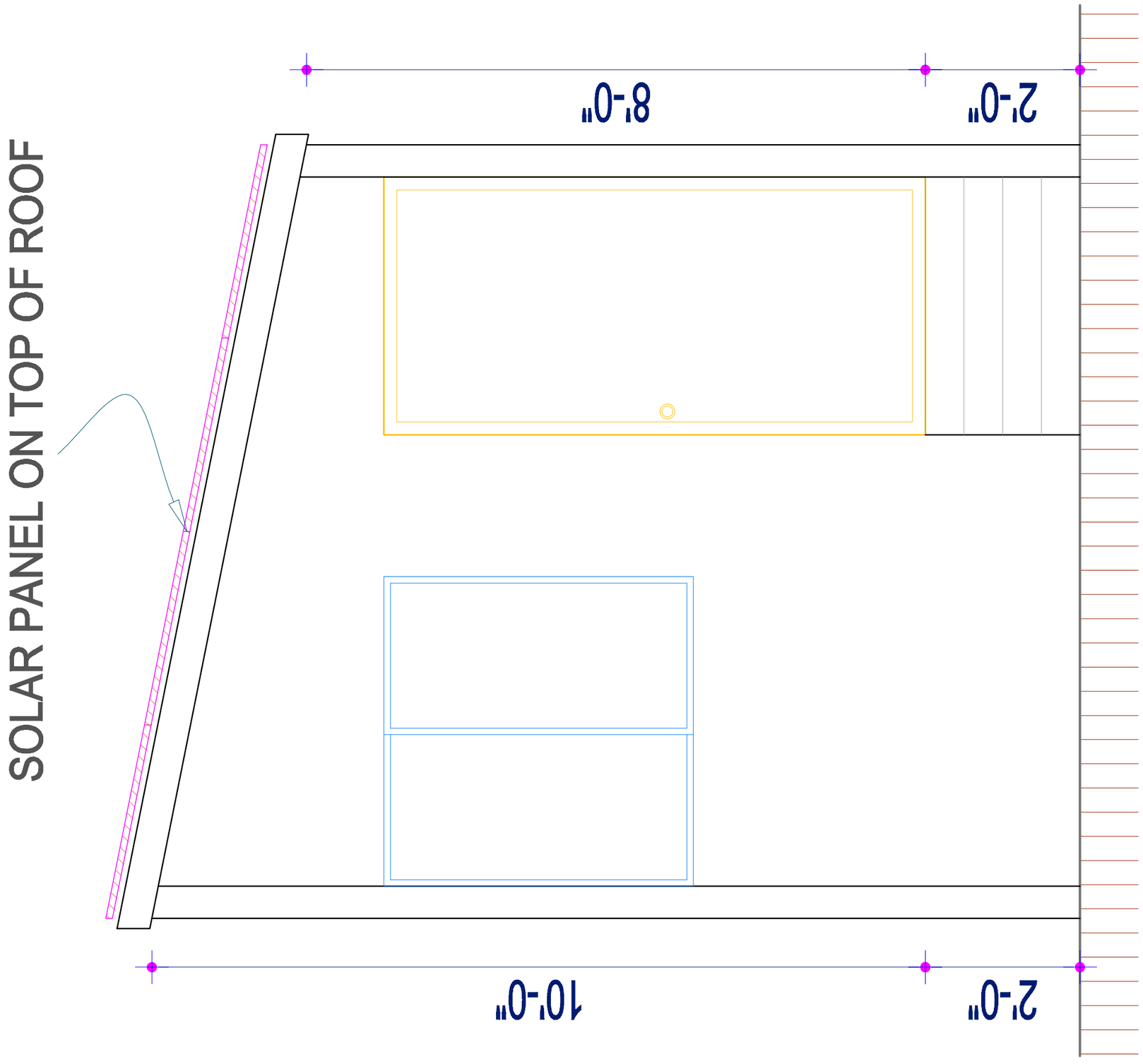
HARNESS ENERGY — BANGLADESH LTD

S.S. Design WORKSHOP

ROOF PLAN

A3

A-08b



PROJECT TITLE
"BSM TOWER GUARD ROOM "

PROJECT TYPE
GUARD METEOROLOGICAL LATTICE TOWER

PROJECT LOCATION
BANGLADESH.

CLIENT NAME
HARNESS ENERGY BANGLADESH LTD
SHAH ALI TOWER (10th FLOOR),
33,KAWRAN BAZAR,DHAKA CIA,
BANGLADESH.

ARCHITECTURAL DESIGN
MONOLITH S. Design WORKSHOP
197,6th FLOOR, DARUS SALAM ARCADE,
PURANA PALTAN,
DHAKA.

ARCHITECT — SIGNATURE
SHAKIL MAHMUD SHAMS

ENGINEERING WORKS

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[illegible]

SUBMISSION

ISSUED TO	FOR	DATE
CONSTRUCTION		28.07.2014
CONSULTANT		
BID TENDER		

REVISIONS

SL.	DESCRIPTION	DATE
01.		28.07.2014
02.		

DRAWING TITLE
FRONT ELEVATION

SCALE	AS SHOWN
SHEET SIZE	A3
SHEET NO	A-08c
PUBLICATION	

HARNESS ENERGY

MET MAST LOG

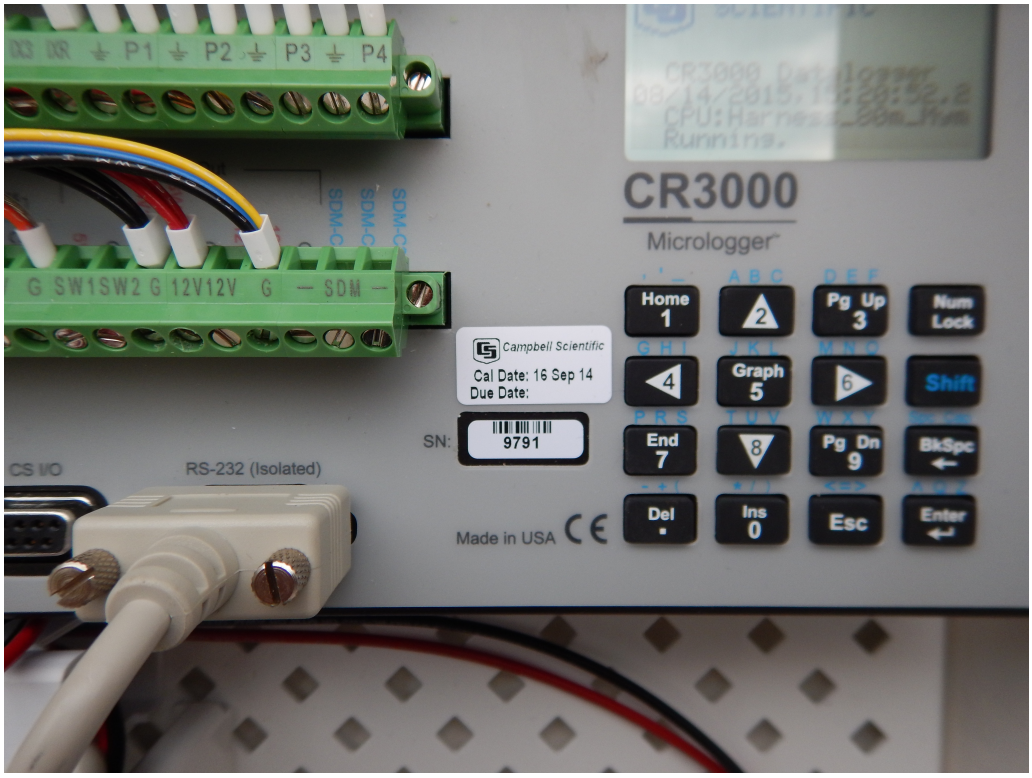
6820 N Broadway, Unit B, Denver, CO 80221 USA
www.harnessre.com

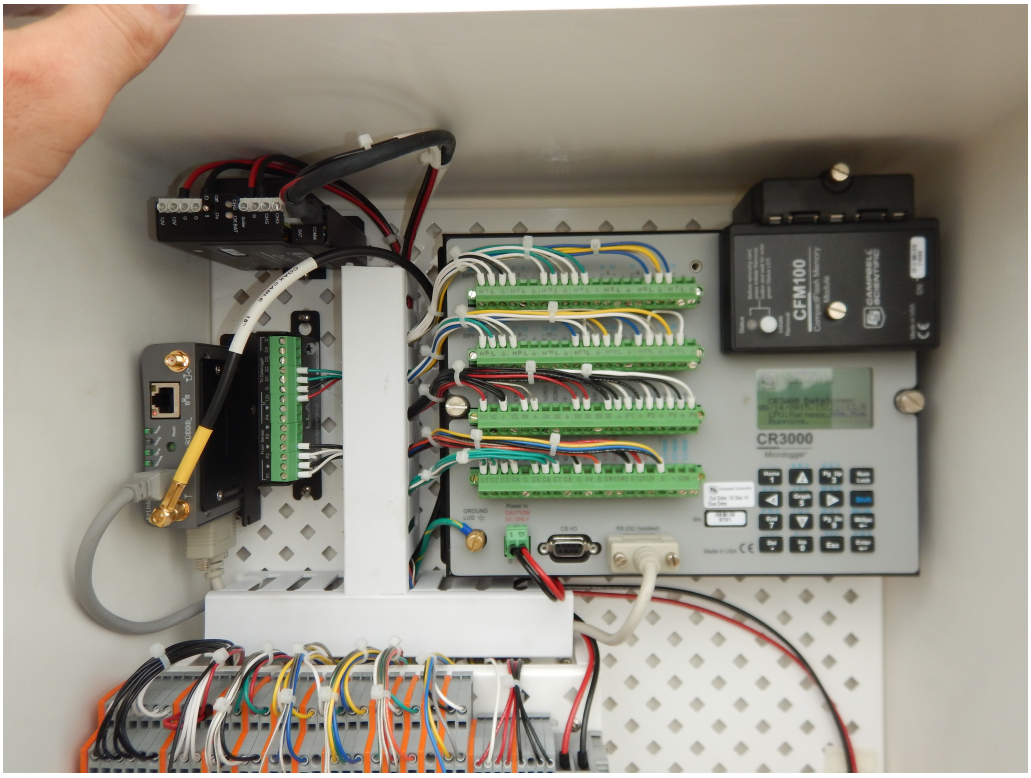
HARNESS ENERGY

Logger Information

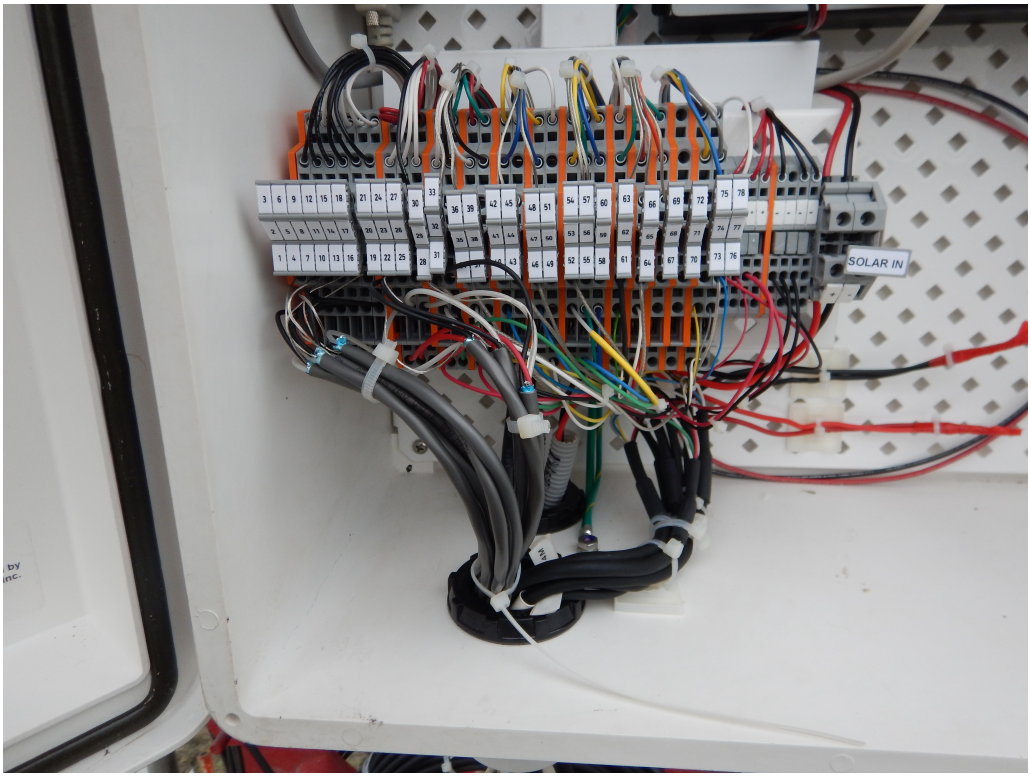
HARNESS ENERGY

MET MAST LOG




CFM100
CR3000

Status
Before removing card, press Initiate Removal button and wait for solid green Status LED.
Initiate Removal
CFM100
CompactFlash Memory Module
CAMPBELL SCIENTIFIC
Made in USA
SN:
11695


SOLAR IN

```
'CR3000
'Created for Harness Energy
'Site: Mymensingh, 80m Tower
'Author: Justin Baumgartner, CSI, 1/20/2014, 6/2/2014
'Edited: Taj Capozzola, Harness Energy, 5/23/2014, 6/2/2014, email instructions added 6/10/14, OneMin table file added & Values added to TenMin file on 2Jul14
'Edited: Taj Capozzola, Harness Energy, 8/14/2015 - constant table updated to include constants for wind vanes, RTD temps, HMP155 temp/rh, Setra BP, LP02
pyranometer; constants updated to reflect installed sensors; email information updated; new constant values added to main scan instructions

ConstTable
  'NRG First Class Wind Speed Sensor measurements 'WS_East_80m' Serial Number: 596700003806
  Const East_NRG1stC_80m_mult = 0.770
  Const East_NRG1stC_80m_offset = 0.23

  'NRG First Class Wind Speed Sensor measurements 'WS_West_80m' Serial Number: 597600003807
  Const West_NRG1stC_80m_mult = 0.771
  Const West_NRG1stC_80m_offset = 0.21

  'NRG First Class Wind Speed Sensor measurements 'WS_East_60m' Serial Number: 596700003801
  Const East_NRG1stC_60m_mult = 0.769
  Const East_NRG1stC_60m_offset = 0.24

  'NRG #40C Wind Speed Sensor measurements 'WS_West_60m' Serial Number: 179500235644
  Const West_NRG40C_60m_mult = 0.765
  Const West_NRG40C_60m_offset = 0.33

  'NRG First Class Wind Speed Sensor measurements 'WS_East_40m' Serial Number: 596700003808
  Const East_NRG1stC_40m_mult = 0.771
  Const East_NRG1stC_40m_offset = 0.22

  'NRG First Class Wind Speed Sensor measurements 'WS_West_40m'Serial Number: 596700003809
  Const West_NRG1stC_40m_mult = 0.768
  Const West_NRG1stC_40m_offset = 0.23

  'NRG #200P Wind Direction Sensor measurements 'WindDir_79m'
  Const WindDir_79m_Orient = 90

  'NRG #200P Wind Direction Sensor measurements 'WindDir_59m'
   Const WindDir_59m_Orient = 90

  'NRG #200P Wind Direction Sensor measurements 'WindDir_39m'
   Const WindDir_39m_Orient = 90

  '43347-IX RTD Temperature Probe (calibrated) measurement 'RTD_temp_C_80m' Serial #25357
   Const RTD_temp_C_80m_T = -251.760549
   Const RTD_temp_C_80m_R = 2.402801e-1
   Const RTD_temp_C_80m_R2 = 1.141266e-5

  '43347-IX RTD Temperature Probe (calibrated) measurement 'RTD_temp_C_4m'
   Const RTD_temp_C_4m_T = -251.541623
   Const RTD_temp_C_4m_R = 2.397535e-1
   Const RTD_temp_C_4m_R2 = 1.172908e-5

  'HMP155 (constant power) Temperature & Relative Humidity Sensor measurements 'HMP155_temp_80m' and 'RH_80m' Serial #K2870022
  'HMP155 (constant power) Temperature & Relative Humidity Sensor measurements 'HMP155_temp_4m' and 'RH_4m' Serial #K2870025

  'Setra 278 Barometric Pressure Sensor measurement 'BP_80m' Serial #5904825
  'Setra 278 Barometric Pressure Sensor measurement 'BP_4m' Serial #5937935

  'LP02 Pyranometer measurements Serial Number:45052 - Constant = 1000/17.08
  Const LP02_Sens = 58.548

 Const LOCAL_TIME_OFFSET = 6 'Local time offset relative to UTC time

  'Email Send Constants
  Const ServerAdd = "smtp.gmail.com:587"
  Const UserName = "winddata.bd@gmail.com"
```

```
Const Password = "WindDataBD"
Const ToAddr = "nrel.mymensingh.bd@gmail.com"
Const FromAddr = "winddata.bd@gmail.com"
Const Subject = "NREL_Bangladesh_Mymensingh"
Const Attach = "USR:TenMin.dat,USR:OneMin.dat"
Const Message = ""

EndConstTable

'Declare Variables and Units
Public BattV
Public PTemp_C
Public WS_east_80m
Public WS_west_80m
Public WS_east_60m
Public WS_west_60m
Public WS_east_40m
Public WS_west_40m
Public WindDir_79m
Public WindDir_59m
Public WindDir_39m
Public RTD_temp_C_80m
Public RTD_temp_C_4m
Public HMP155_temp_80m
Public RH_80m
Public HMP155_temp_4m
Public RH_4m
Public BP_80m
Public BP_4m
Public SlrW
Public LWmV
Public LWMDry
Public LWMCon
Public LWMWet

'Array to hold all the data coming from the PS200/CH200
Public CH200_M0(9)
'Alias names for array elements.
'Battery voltage: VDC
Alias CH200_M0(1)=VBatt
'Current going into, or out of, the battery: Amps
Alias CH200_M0(2)=IBatt
'Current going to the load: Amps
Alias CH200_M0(3)=ILoad
'Voltage coming into the charger: VDC
Alias CH200_M0(4)=V_in_chg
'Current coming into the charger: Amps
Alias CH200_M0(5)=I_in_chg
'Charger temperature: Celsius
Alias CH200_M0(6)=Chg_TmpC
'Charging state: Cycle, Float, Current Limited, or None
Alias CH200_M0(7)=Chg_State
'Charging source: None, AC, or Solar
Alias CH200_M0(8)=Chg_Source
'Check battery error: 0=normal, 1=check battery
Alias CH200_M0(9)=Ck_Batt
'Arrays to hold the associated words for the charge state, charge source,
'and check battery values.
Dim ChargeStateArr(6) As String
Dim ChargeSourceArr(3) As String
Dim CheckBatteryArr(2) As String

'Variables to hold the words for charge state, charge source, and check
'battery.
Public ChargeState As String
Public ChargeSource As String
```

```
Public CheckBattery As String


Public outstat
Public lastfilename As String * 25
Public outstat1
Public lastfilename1 As String * 25
Public emailresult
Public ServerResp As String * 75



Dim nmea_sentence(2) As String * 90
Public gps_data(15)
Alias gps_data(1) = latitude_a 'Degrees latitude (+ = North; - = South)
Alias gps_data(2) = latitude_b 'Minutes latitude
Alias gps_data(3) = longitude_a 'Degress longitude (+ = East; - = West)
Alias gps_data(4) = longitude_b 'Minutes longitude
Alias gps_data(5) = speed 'Speed
Alias gps_data(6) = course 'Course over ground
Alias gps_data(7) = magnetic_variation 'Magnetic variation from true north (+ =
'East; - = West)
Alias gps_data(8) = fix_quality 'GPS fix quality: 0 = invalid, 1 = GPS, 2 =
'differential GPS, 6 = estimated
Alias gps_data(9) = nmbr_satellites 'Number of satellites used for fix
Alias gps_data(10) = altitude 'Antenna altitude
Alias gps_data(11) = pps 'usec into sec of system clock when PPS
'rising edge occurs, typically 990,000 once
'synced
Alias gps_data(12) = dt_since_gprmc 'Time since last GPRMC string, normally less
'than 1 second
Alias gps_data(13) = gps_ready 'Counts from 0 to 10, 10 = ready
Alias gps_data(14) = max_clock_change 'Maximum value the clock was changed in msec
Alias gps_data(15) = nmbr_clock_change 'Number of times the clock was changed
'Define Units to be used in data file header
Units latitude_a = degrees
Units latitude_b = minutes
Units longitude_a = degrees
Units longitude_b = minutes
Units speed = m/s
Units course = degrees
Units magnetic_variation = unitless
Units fix_quality = unitless
Units nmbr_satellites = unitless
Units pps = ms
Units dt_since_gprmc = s
Units gps_ready = unitless
Units max_clock_change = ms
Units nmbr_clock_change = samples

Units BattV=Volts
Units PTemp_C=Deg C
Units WS_east_80m=meters/second
Units WS_west_80m=meters/second
Units WS_east_60m=meters/second
Units WS_west_60m=meters/second
Units WS_east_40m=meters/second
Units WS_west_40m=meters/second
Units WindDir_79m=degrees
Units WindDir_59m=degrees
Units WindDir_39m=degrees
Units RTD_temp_C_80m=Deg C
Units RTD_temp_C_4m=Deg C
Units HMP155_temp_80m=Deg C
Units RH_80m=%
Units HMP155_temp_4m=Deg C
```

```
Units RH_4m=%
Units BP_80m=mbar
Units BP_4m=mbar
Units SlrW=W/m^2
Units LWmV=mV
Units LWMDry=Minutes
Units LWMCon=Minutes
Units LWMWet=Minutes


'Define Data Tables
'Stored Ten Minute Data
DataTable(TenMin,True,-1)
  DataInterval(0,10,Min,10)
  CardOut (0 ,-1)
TableFile ("USR:TenMin",8,0,0,24,Hr,outstat,lastfilename)
  Average(1,WS_east_80m,FP2,False)
  Maximum(1,WS_east_80m,FP2,False,False)
  Minimum(1,WS_east_80m,FP2,False,False)
  StdDev(1,WS_east_80m,FP2,False)
  Average(1,WS_west_80m,FP2,False)
  Maximum(1,WS_west_80m,FP2,False,False)
  Minimum(1,WS_west_80m,FP2,False,False)
  StdDev(1,WS_west_80m,FP2,False)
  Average(1,WS_east_60m,FP2,False)
  Maximum(1,WS_east_60m,FP2,False,False)
  Minimum(1,WS_east_60m,FP2,False,False)
  StdDev(1,WS_east_60m,FP2,False)
  Average(1,WS_west_60m,FP2,False)
  Maximum(1,WS_west_60m,FP2,False,False)
  Minimum(1,WS_west_60m,FP2,False,False)
  StdDev(1,WS_west_60m,FP2,False)
  Average(1,WS_east_40m,FP2,False)
  Maximum(1,WS_east_40m,FP2,False,False)
  Minimum(1,WS_east_40m,FP2,False,False)
  StdDev(1,WS_east_40m,FP2,False)
  Average(1,WS_west_40m,FP2,False)
  Maximum(1,WS_west_40m,FP2,False,False)
  Minimum(1,WS_west_40m,FP2,False,False)
  StdDev(1,WS_west_40m,FP2,False)
  WindVector (1,WS_east_80m,WindDir_79m,FP2,False,0,0,4)
  FieldNames("WindDir_79m_D1_WVT,WindDir_79m_SD1_WVT")
  WindVector (1,WS_east_60m,WindDir_59m,FP2,False,0,0,4)
  FieldNames("WindDir_59m_D1_WVT,WindDir_59m_SD1_WVT")
  WindVector (1,WS_east_40m,WindDir_39m,FP2,False,0,0,4)
  FieldNames("WindDir_39m_D1_WVT,WindDir_39m_SD1_WVT")
  Average(1,RTD_temp_C_80m,FP2,False)
  Maximum(1,RTD_temp_C_80m,FP2,False,False)
  Minimum(1,RTD_temp_C_80m,FP2,False,False)
  StdDev(1,RTD_temp_C_80m,FP2,False)
  Average(1,RTD_temp_C_4m,FP2,False)
  Maximum(1,RTD_temp_C_4m,FP2,False,False)
  Minimum(1,RTD_temp_C_4m,FP2,False,False)
  StdDev(1,RTD_temp_C_4m,FP2,False)
  Average(1,HMP155_temp_80m,FP2,False)
  Maximum(1,HMP155_temp_80m,FP2,False,False)
  Minimum(1,HMP155_temp_80m,FP2,False,False)
  StdDev(1,HMP155_temp_80m,FP2,False)
  Average(1,RH_80m,FP2,False)
  Maximum(1,RH_80m,FP2,False,False)
  Minimum(1,RH_80m,FP2,False,False)
  StdDev(1,RH_80m,FP2,False)
  Average(1,HMP155_temp_4m,FP2,False)
  Maximum(1,HMP155_temp_4m,FP2,False,False)
  Minimum(1,HMP155_temp_4m,FP2,False,False)
  StdDev(1,HMP155_temp_4m,FP2,False)
  Average(1,RH_4m,FP2,False)
```

```
  Maximum(1,RH_4m,FP2,False,False)
  Minimum(1,RH_4m,FP2,False,False)
  StdDev(1,RH_4m,FP2,False)
  Average(1,BP_80m,FP2,False)
  Maximum(1,BP_80m,FP2,False,False)
  Minimum(1,BP_80m,FP2,False,False)
  StdDev(1,BP_80m,FP2,False)
  Average(1,BP_4m,FP2,False)
  Maximum(1,BP_4m,FP2,False,False)
  Minimum(1,BP_4m,FP2,False,False)
  StdDev(1,BP_4m,FP2,False)
  Average(1,LWmV,FP2,False)
  Sample(1,LWmV,FP2)
  Minimum (1,VBatt,FP2,False,False)
  Minimum (1,IBatt,FP2,False,False)
  Minimum (1,ILoad,FP2,False,False)
  Minimum (1,V_in_chg,FP2,False,False)
  Minimum (1,I_in_chg,FP2,False,False)
  Average (1,Chg_TmpC,FP2,False)
  Sample (1,Chg_State,FP2)
  Sample (1,Ck_Batt,FP2)
  Minimum (1,BattV,FP2,False,False)
  Average (1,PTemp_C,FP2,False)
  Sample (1,latitude_a,FP2)
  Sample (1,latitude_b,FP2)
  Sample (1,longitude_a,FP2)
  Sample (1,longitude_b,FP2)
  Sample (1,magnetic_variation,FP2)
  Sample (1,fix_quality,FP2)
  Sample (1,nmbr_satellites,FP2)
  Sample (1,altitude,FP2)
  Sample (1,max_clock_change,FP2)
  Sample (1,nmbr_clock_change,FP2)
EndTable

'Stored One Minute Data
DataTable(OneMin,True,-1)
  DataInterval(0,1,Min,10)
  CardOut(0 ,-1)
TableFile ("USR:OneMin",8,0,0,24,Hr,outstat1,lastfilename1)
  Average(1,SlrW,FP2,False)
  Maximum(1,SlrW,FP2,False,False)
  Minimum(1,SlrW,FP2,False,False)
  StdDev(1,SlrW,FP2,False)
EndTable

'Stored Hourly Data.
DataTable (Hour,1,-1)
  DataInterval (0,1,Hr,10)
  Minimum (6,CH200_M0(),FP2,0,False)
  Maximum (6,CH200_M0(),FP2,False,False)
EndTable



'Main Program
BeginProg
SetStatus ("USRdrivesize",500000)
  'Load arrays with words to associate with the charge state, charge source
  'and check battery values from the PS/CH200.
  ChargeStateArr(1) = "Regulator Fault"
  ChargeStateArr(2) = "No Charge"
  ChargeStateArr(3) = "Current Limited"
  ChargeStateArr(4) = "Cycle Charging"
  ChargeStateArr(5) = "Float Charging"
  ChargeStateArr(6) = "Battery Test"
  ChargeSourceArr(1) = "None"
```

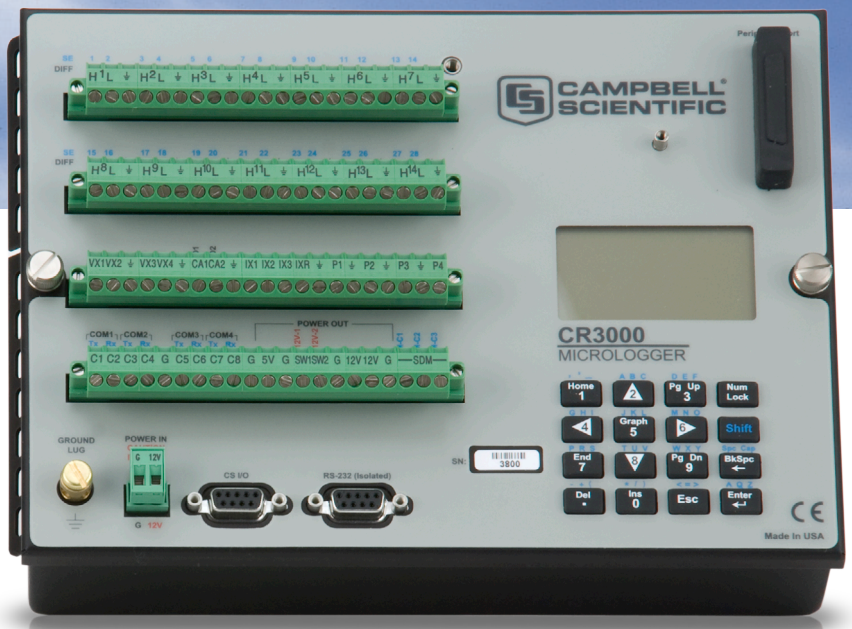
```
  ChargeSourceArr(2) = "Solar"
  ChargeSourceArr(3) = "Continuous"
  CheckBatteryArr(1) = "Normal"
  CheckBatteryArr(2) = "Check Battery"

  'Main Scan
  Scan(1,Sec,1,0)
    'Default Datalogger Battery Voltage measurement 'BattV'
    Battery(BattV)
    'Default Wiring Panel Temperature measurement 'PTemp_C'
    PanelTemp(PTemp_C,_60Hz)

'GPS Measurement
    GPS (latitude_a,Com2,LOCAL_TIME_OFFSET*3600,100,nmea_sentence(1))


    'NRG First Class Wind Speed Sensor measurements 'WS_East_80m'
    PulseCount(WS_east_80m,1,1,1,1,East_NRG1stC_80m_mult,East_NRG1stC_80m_offset)
    If WS_east_80m<=East_NRG1stC_80m_offset Then WS_east_80m=0

    'NRG First Class Wind Speed Sensor measurements 'WS_West_80m'
    PulseCount(WS_west_80m,1,2,1,1,West_NRG1stC_80m_mult,West_NRG1stC_80m_offset)
    If WS_west_80m<=West_NRG1stC_80m_offset Then WS_west_80m=0

    'NRG First Class Wind Speed Sensor measurements 'WS_East_60m'
    PulseCount(WS_east_60m,1,3,1,1,East_NRG1stC_60m_mult,East_NRG1stC_60m_offset)
    If WS_east_60m<=East_NRG1stC_60m_offset Then WS_east_60m=0

    'NRG #40C Wind Speed Sensor measurements 'WS_West_60m'
    PulseCount(WS_west_60m,1,4,1,1,West_NRG40C_60m_mult,West_NRG40C_60m_offset)
    If WS_west_60m<=West_NRG40c_60m_offset Then WS_west_60m=0

    'NRG First Class Wind Speed Sensor measurements 'WS_East_40m'
    PulseCount(WS_east_40m,1,11,0,1,East_NRG1stC_40m_mult,East_NRG1stC_40m_offset)
    If WS_east_40m<=East_NRG1stC_40m_offset Then WS_east_40m=0

    'NRG First Class Wind Speed Sensor measurements 'WS_West_40m'
    PulseCount(WS_west_40m,1,12,0,1,West_NRG1stC_40m_mult,West_NRG1stC_40m_offset)
    If WS_west_40m<=West_NRG1stC_40m_offset Then WS_west_40m=0

    'NRG #200P Wind Direction Sensor measurements 'WindDir_79m'
    BrHalf(WindDir_79m,1,mV5000,1,1,1,5000,True,0,_60Hz,360,0)
    WindDir_79m=(WindDir_79m+WindDir_79m_Orient-360+360)MOD 360 'Adjust for actual orientation and deadband: Formula: Wind dir=(wind dir+actual
orientation-manufacturers notch angle+360)MOD 360

    'NRG #200P Wind Direction Sensor measurements 'WindDir_59m'
    BrHalf(WindDir_59m,1,mV5000,2,1,1,5000,True,0,_60Hz,360,0)
    WindDir_59m=(WindDir_59m+WindDir_59m_Orient-360+360)MOD 360

    'NRG #200P Wind Direction Sensor measurements 'WindDir_39m'
    BrHalf(WindDir_39m,1,mV5000,3,1,1,5000,True,0,_60Hz,360,0)
    WindDir_39m=(WindDir_39m+WindDir_39m_Orient-360+360)MOD 360

    'Delta Temp Temperature measurements
    '43347-IX RTD Temperature Probe (calibrated) measurement 'RTD_temp_C_80m'
    Resistance(RTD_temp_C_80m,1,mV1000,3,1,1,170,True,True,0,_60Hz,1,0)
    RTD_temp_C_80m=RTD_temp_C_80m_T+(RTD_temp_C_80m*RTD_temp_C_80m_R)+((RTD_temp_C_80m^2)*RTD_temp_C_80m_R2)

    '43347-IX RTD Temperature Probe (calibrated) measurement 'RTD_temp_C_4m'
    Resistance(RTD_temp_C_4m,1,mV200,4,2,1,170,True,True,0,_60Hz,1,0)
    RTD_temp_C_4m=RTD_temp_C_4m_T+(RTD_temp_C_4m*RTD_temp_C_4m_R)+((RTD_temp_C_4m^2)*RTD_temp_C_4m_R2)

    'HMP155 (constant power) Temperature & Relative Humidity Sensor measurements 'HMP155_temp_80m' and 'RH_80m'
    VoltDiff (HMP155_temp_80m,1,mV1000,14,True ,0,_60Hz,.14,-80)
    VoltDiff (RH_80m,1,mV1000,13,True ,0,_60Hz,.1,0)
    If RH_80m>100 AND RH_80m<108 Then RH_80m=100
```

```
  'HMP155 (constant power) Temperature & Relative Humidity Sensor measurements 'HMP155_temp_4m' and 'RH_4m'
  VoltDiff (HMP155_temp_4m,1,mV1000,12,True ,0,_60Hz,.14,-80)
  VoltDiff (RH_4m,1,mV1000,11,True ,0,_60Hz,.1,0)
  If RH_4m>100 AND RH_4m<108 Then RH_4m=100

  'Setra 278 Barometric Pressure Sensor measurement 'BP_80m'
  PortSet(6,1)
  VoltSe(BP_80m,1,mV5000,12,1,0,_60Hz,0.2,600)

  'Setra 278 Barometric Pressure Sensor measurement 'BP_4m'
  PortSet(6,1)
  VoltSe(BP_4m,1,mV5000,13,1,0,_60Hz,0.2,600)

  'LP02 Pyranometer measurements
  VoltDiff(SlrW,1,mV50,8,True,0,_60Hz,LP02_Sens,0)
  If SlrW<0 Then SlrW=0

  'LWS Dielectric Leaf Wetness Sensor measurement 'LWmV'
  BrHalf(LWmV,1,mv5000,17,Vx4,1,2500,False,10000,_60Hz,2500,0)
  'Determine Minutes Dry 'LWMDry', Minutes Wet or Contaminated 'LWMCon', and Minutes Wet 'LWMWet' for this Scan
  LWMDry=0
  LWMCon=0
  LWMWet=0
  If LWmV<274 Then
    LWMDry=0.08333333
  Else
    If LWmV>=284 Then
      LWMWet=0.08333333
    Else
      LWMCon=0.08333333
    EndIf
  EndIf


  'Call Data Tables and Store Data
  CallTable(TenMin)
  CallTable(OneMin)
  CallTable(hour)
 NextScan

 SlowSequence 'To measure soil moisture and temp every 60 secs
 Scan (60,Sec,3,0)

  SDI12Recorder (CH200_M0(),5,0,"MC!",1.0,0)
  'Array values start with one. Values for charge state start with -1.
  'Have to shift the value by two to line it up with the correct words
  'in the array.
  ChargeState = ChargeStateArr(Chg_State + 2)
  'Values for charge source start with zero. Have to shift the value
  'by one to line it up with the correct words in the array.
  ChargeSource = ChargeSourceArr(Chg_Source + 1)
  'Values for check battery start with zero. Have to shift the value
  'by one to line it up with the correct words in the array.
  CheckBattery = CheckBatteryArr(Ck_Batt + 1)



If IfTime (19,24,Hr) Then
  emailresult=EMailSend(ServerAdd,ToAddr,FromAddr,Subject,Message,Attach,UserName,Password,ServerResp,10,0,Sec,8)
EndIf
  NextScan

EndProg
```

CAMPBELL SCIENTIFIC®
WHEN MEASUREMENTS MATTER

CR3000
Micrologger

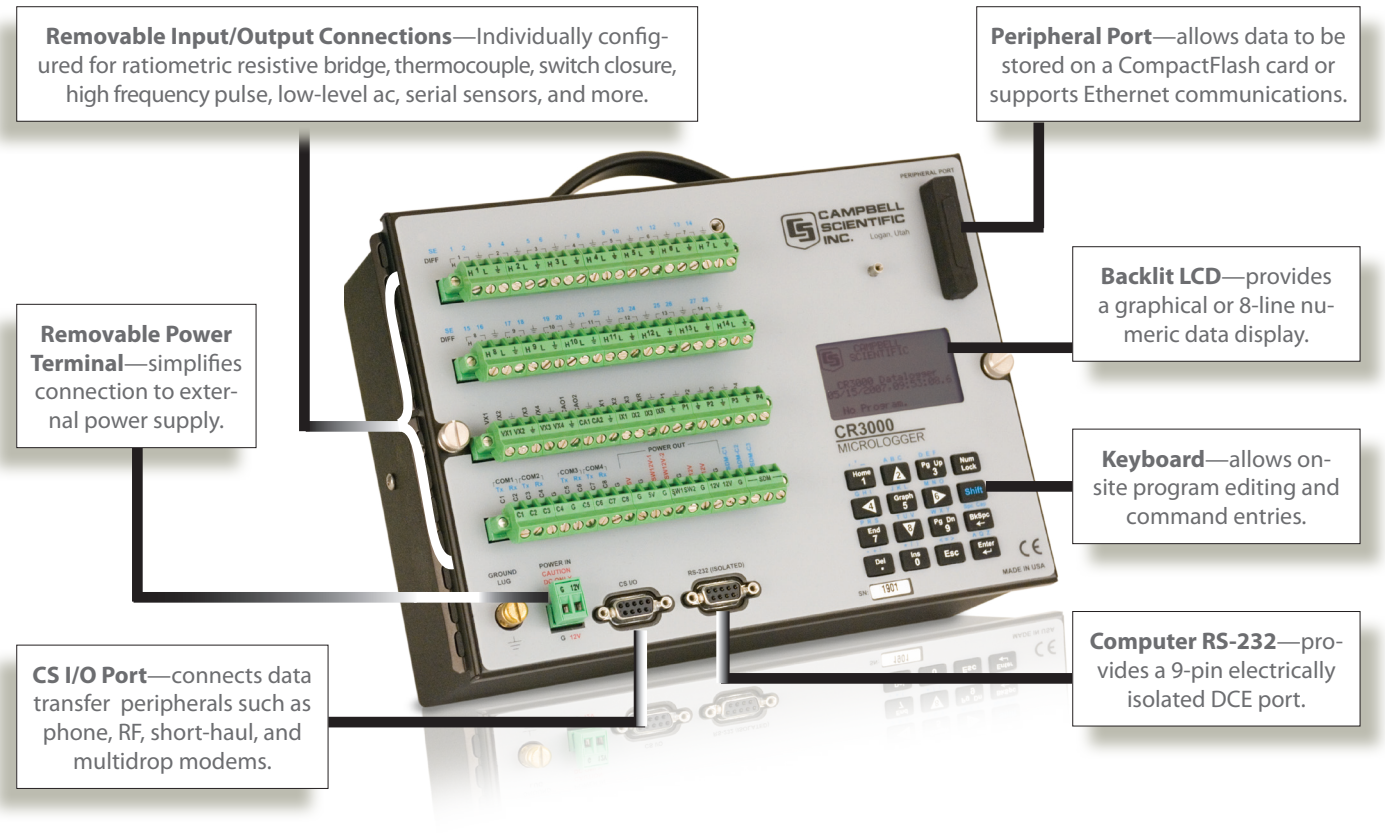
Rugged, Reliable, and Ready for any Application



More info: **435.227.9000**
campbellsci.com/cr3000

CR3000 Micrologger®

The CR3000 Micrologger® is a compact, rugged, powerful datalogger. Housed in a portable, self-contained package, the Micrologger consists of measurement and control electronics, communication ports, keyboard, display, power supply, and carrying handle. The CR3000's low power requirements allow extended field use from a dc voltage source.



Benefits and Features

- Program execution rate of up to 100 Hz
- 16-bit analog to digital conversions
- 16-bit microcontroller with 32-bit internal CPU architecture
- Temperature compensated real-time clock
- Background system calibration for accurate measurements over time and temperature changes
- Gas Discharge Tube (GDT) protected inputs
- Data values stored in tables with a time stamp and record number
- 4 MB data storage memory
- Battery-backed SRAM and clock that ensure data, programs, and accurate time are maintained while the CR3000 is disconnected from its main power source
- Serial communications with serial sensors and devices supported via I/O port pairs
- PakBus®, Modbus, DNP3, TCP/IP, FTP, and SMTP protocols supported

Operating System/Logic Control

The on-board operating system includes measurement, processing, and output instructions for programming the datalogger. The programming language, CRBasic, uses a BASIC-like syntax. Measurement instructions specific to bridge configurations, voltage outputs, thermocouples, and pulse/frequency signals are included. Processing instructions support algebraic, statistical, and transcendental functions for on-site processing. Output instructions process data over time and control external devices.

Data Storage Capacity

The CR3000 provides 2 MB of flash memory for the operating system (OS) and 4 MB of battery-backed SRAM for CPU usage, program storage, and data storage. Data is stored in a table format. The storage capacity of the CR3000 can be increased by using a CompactFlash® card.

Operating Temperature Ranges

Standard operating range is -25° to +50°C; an extended range of -40° to +85°C is available. Battery bases have different temperature ranges (see Battery Base Options).

Input Output Terminals

Analog Inputs

Twenty-eight single-ended (14 differential) channels measure voltage levels with 16-bit resolution on five software selectable voltage ranges.

Pulse Counters

Four 24-bit pulse channels measure switch closures, high frequency pulses, or low-level ac.

Switched Excitation Outputs

Four switched voltage and three switched current outputs provide precision excitation for ratiometric sensor/bridge measurements.

Digital I/O Ports

Eight ports have multiple functions including digital control output, interrupt, pulse counting, switch closure, frequency/period measurements, edge timing, or SDI-12 communication. Three additional ports are dedicated for measuring SDM devices.

The I/O ports can be paired as transmit and receive. Each pair has 0 to 5 V UART hardware that allows serial communications with serial sensors and devices. An RS232-to-logic level converter may be required in some cases.

Continuous Analog Outputs

Two continuous analog outputs provide voltage levels to displays or proportional controllers.

Peripheral Port

One 40-pin port interfaces with the NL115 Ethernet Interface and CompactFlash Module, the NL120 Ethernet Interface, or the CFM100 CompactFlash Module.

RS-232 Port

The RS-232 port is for connecting a PC, serial sensor, or RS-232 modem. The PC attaches to the CR3000 via an RS-232 cable—no interface required. This port isolates the PC's electrical system from the datalogger, thereby protecting against ground loops, normal static discharge, and noise.

CS I/O Port

Many communication peripherals connect with the CR3000 via this port. A PC may connect with this port via an SC32B, SC-USB, or SC115 interface.

Power Connections

The continuous 5 V and 12 V terminals are for connecting sensors and non-Campbell Scientific peripherals. Two switched 12 V terminals are program controlled.

Transient Protection

Gas Discharge Tube (GDT) protects the inputs from electrical transients. The CR3000 is CE compliant under the European Union's EMC Directive, meeting ESD, EMC, Fast Transient standards.

Communication Protocols

The CR3000 supports the PakBus, Modbus, DNP3, TCP/IP, FTP, and SMTP communication protocols. With the PakBus protocol,networks have the distributed routing intelligence to continually evaluate links. Continually evaluating links optimizes delivery times and, in the case of delivery failure, allows automatic switch over to a configured backup route.

The Modbus RTU protocol supports both floating point and long formats. The datalogger can act as a slave and/or master.

The DNP3 protocol supports only long data formats. The dataloggers are level 2 slave compliant, with some of the operations found in a level 3 implementation.

The TCP/IP, FTP, and SMTP protocols provide TCP/IP functionality when the CR3000 is used in conjunction with an NL240, NL201, NL115, or NL120.

Battery Base Options

Alkaline Base

The alkaline base includes 10 D-cell batteries that provide a 10 A h rating at 20°C. Operating temperature range is -25° to +50°C.

Rechargeable Base

This base includes an internal 7 A h sealed rechargeable battery that can be charged via a vehicle, solar panel, or ac wall charger. Operating temperature range is -40° to +60°C.

When using vehicle power, our DCDC18R is used to increase the vehicle's supply voltage to charging levels required by the CR3000.

Low-Profile Base (no battery)

The low-profile base requires a user-supplied dc source. It is preferred when the system's power consumption needs a larger capacity battery or when it's advantageous for the Micrologger to be thinner and lighter.

Communication Options

To determine the best option for an application, consider the accessibility of the site, availability of services (e.g., cellular phone or satellite coverage), quantity of data to collect, and desired time between data-collection sessions. Some communication options can be combined—increasing the flexibility, convenience, and reliability of the communications.

External Data Storage Devices

A CFM100 or NL115 module can store the CR3000's data on an industrial-grade CompactFlash (CF) card. The CR3000 can also store data on an SC115 2 GB Flash Memory Drive.

The CFM100 (shown) and NL115 attach directly to the CR3000's peripheral port.

iOS Devices and Android Devices

An iOS device or Android device can be used to view and collect data, set the clock, and download programs. To use an iOS or Android device, go to the Apple Store or Google Play and purchase our LoggerLink Mobile Apps.

Direct Links

A PC or laptop can be connected directly to the datalogger's RS-232 port (no interface required). This port provides electrical isolation. Alternatively, the PC or laptop can be connected to the CR3000's CS I/O port via an SC32B, SC-USB, or SC115 interface.

Keyboard Display

The CR3000's integrated keyboard display is used to program the datalogger, manually initiate data trans-fer, and display data. It displays 8 lines x 21 characters (64 x 128 pixels) and has a 16-character keyboard. Custom menus are supported allowing customers to set up choices within the datalogger program that can be initiated by a simple toggle or pick list.

Telephone Networks

The CR3000 can communicate with a PC using landlines, cellular CDMA, or cellular GPRS transceivers. A voice synthesized modem enables anyone to call the CR3000 via phone and receive a verbal report of real-time site conditions.

Mountable Display

The CD295 can be mounted in an enclosure lid, which allows customers to view the CR3000's data on-site without opening the enclosure. It displays one real-time value, a description, and units.

Internet and IP Networks

The NL240, NL115, NL120, or NL201 interfaces enable the CR3000 Micrologger to communicate with a PC via TCP/IP.

Multidrop Interface

The MD485 intelligent RS-485 interface permits a PC to address and communicate with one or more dataloggers over a single cable. Distances up to 4000 feet are supported.

Short Haul Modems

The SRM-5A RAD Short Haul Modem supports communications between the CR3000 and a PC via a four-wire unconditioned line (two twisted pairs).

Radios

Radio frequency (RF) communications are supported via narrow-band UHF, narrow-band VHF, spread spectrum, or meteor burst radios. Line-of-sight is required for all of our RF options.

Satellite Transmitters

Our NESDIS-certified GOES satellite transmitter provides one-way communications from a Data Collection Platform (DCP) to a receiving station. Campbell Scientific also offers an Argos transmitter that is ideal for high-latitude applications.

This station for the National Estuarine Research Reserve (NERR) in Virginia transmits data via our GOES satellite transmitter.

Enclosures

An ENC12/14 or larger enclosure can house the CR3000. A CR3000 housed in a weather-resistant enclosure can collect data under extremely harsh conditions.

Channel Expansion

Multiplexers

Multiplexers increase the number of sensors that can be measured by a datalogger by sequentially connecting each sensor to the datalogger. Several multiplexers can be controlled by a single datalogger. The CR3000 is compatible with the AM16/32B and AM25T multiplexers.

Synchronous Devices for Measurement (SDMs)

SDMs are addressable peripherals that expand the datalogger's measurement and control capabilities. For example, SDMs are available to add control ports, analog outputs, pulse count channels, interval timers, or even a CANbus interface to the system. Multiple SDMs, in any combination, can be connected to one datalogger.

Besides SDMs and multiplexers, Campbell Scientific offers the LLAC4, which increases the number of available low-level ac inputs. It can be used to measure up to four anemometers, and is especially useful for wind profiling applications.

Software

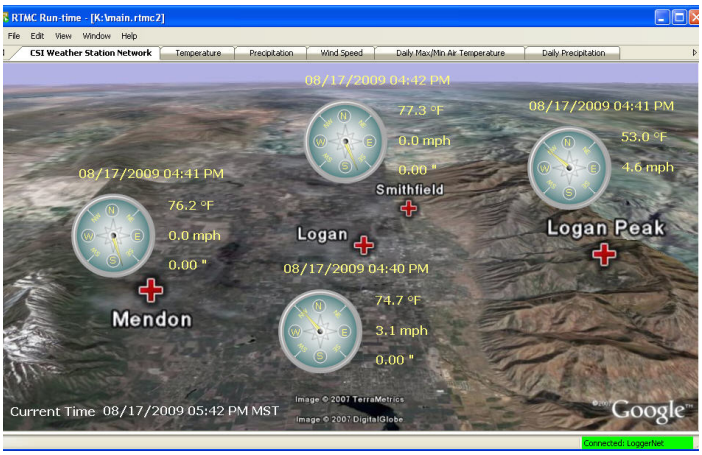
Starter Software

Our easy-to-use starter software is intended for first time users or applications that don't require sophisticated communications or datalogger program editing. SCWin Short Cut generates straight-forward datalogger programs in four easy steps. PC200W allows customers to transfer a program to, or retrieve data from a CR3000 via a direct communications link.

At www.campbellsci.com/downloads, the starter software can be downloaded at no charge. Our Resource DVD also provides this software as well as PDF versions of our brochures and manuals.

Datalogger Support Software

Our datalogger support software packages provide more capabilities than our starter software. These software packages contains program editing, communications, and display tools that can support an entire datalogger network.

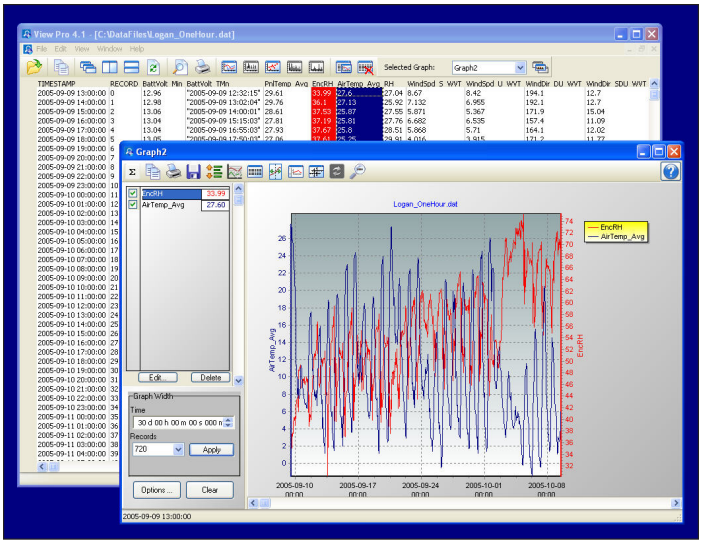


RTMC, a program for displaying the datalogger's data, is bundled with LoggerNet and RTDAQ. Customers may also purchase the RTMCRT and RTMC Web Server clients, which use forms created in the developer mode of RTMC.

PC400, our mid-level software, supports a variety of telemetry options, manual data collection, and data display. For programming, it includes both Short Cut and the CRBasic program editor. PC400 does not support combined communication options (e.g., phone-to-RF), PakBus® routing, and scheduled data collection.

RTDAQ is an ideal solution for industrial and real-time users desiring to use reliable data collection software over a single telecommunications medium, and who do not rely on scheduled data collection. RTDAQ's strength lies in its ability to handle the display of high speed data.

LoggerNet is Campbell Scientific's full-featured datalogger support software. It is referred to as "full-featured" because it provides a way to accomplish almost all the tasks you'll need to complete when using a datalogger. LoggerNet supports combined communication options (e.g., phone-to-RF) and scheduled data collection.



Both LoggerNet and RTDAQ use View Pro to display historical data in a tabular or graphical format.

Applications

Measurement precision, flexibility, and long-term reliability of the CR3000 make it ideal for scientific, commercial, and industrial applications.

Open Path Eddy Covariance Systems

For eddy covariance applications, the CR3000 can measure the EC150 Open-Path CO_2 Analyzer, CSAT3A Sonic Anemometer, and KH20 Krypton Hygrometer then compute fluxes on-line.

The open path eddy covariance systems measure sonic sensible heat flux, momentum flux, and the flux of other scalars between the atmosphere and earth's surface.

The system consists of a CR3000 datalogger, fast response three-dimensional sonic anemometer, and fast response scalar sensors. An independent measurement of temperature and humidity from a slow response sensor is also used to calculate background meteorological variables. Horizontal wind speed and direction are computed by the datalogger from the three-dimensional measurements of wind made by the sonic anemometer.

Meteorology

The CR3000 is used in long-term climatological monitoring, meteorological research, and routine weather measurement applications.

Sensors the CR3000 can measure include:

- cup, propeller, and sonic anemometers
- tipping bucket rain gages
- wind vanes
- pyranometers
- ultrasonic ranging sensor
- thermistors, RTDs, and thermocouples
- barometers
- RH probes
- Cooled mirror hygrometers

Wind Profiling

Our data acquisition systems can monitor conditions at wind assessment sites, at producing wind farms, and along transmission lines. The reliability of these systems ensures data collection, even under adverse conditions. Wide operating temperature ranges and weatherproof enclosures allow our systems to operate reliably in harsh environments.

The CR3000 makes and records measurements, controls electrical devices, and can function as PLCs or RTUs. Because the datalogger has its own power supply (batteries, solar panels), it can continue to measure and store data and perform control during power outages.

Typical sensors for wind assessment applications include, but are not limited to:

- cup, propeller, and sonic anemometers (up to 10 anemometers can be measured by using two LLAC4 peripherals)
- wind vanes
- thermistors, RTDs, and thermocouples
- barometers
- pyranometers

For turbine performance applications, the CR3000 monitors electrical current, voltage, wattage, stress, and torque.

Photo courtesy RADTech Ltd. UK

A Campbell Scientific datalogging system monitors this offshore wind farm located between Rhyl and Prestatyn in North Wales at about 7 to 8 km out to sea.

Agriculture and Agricultural Research

The versatility of the CR3000 allows measurement of agricultural processes and equipment in applications such as:

- plant water research
- canopy energy balance
- plant pathology
- machinery performance
- frost prediction
- crop management decisions
- food processing/storage
- integrated pest management
- irrigation scheduling

Air Quality

The CR3000 can monitor and control gas analyzers, particle samplers, and visibility sensors. The datalogger can also automatically control calibration sequences and compute conditional averages that exclude invalid data (e.g., data recorded during power failures or calibration intervals).

The CR3000 can be used in networks of dataloggers that continuously monitor air quality.

Road Weather/RWIS

Our fully NTCIP-compliant Environmental Sensor Stations (ESS) are robust, reliable weather stations used for road weather/RWIS applications. A typical ESS includes a tower, CR3000, two road sensors, remote communication hardware, and sensors that measure wind speed and direction, air temperature, humidity, barometric pressure, solar radiation, and precipitation.

Soil Water

The CR3000 is compatible with soil water blocks, matric water potential sensors, Time-Domain Reflectometery (TDR) systems, self-contained water content reflectometers, and tensiometers. These soil water instruments are used extensively to monitor water content and matric potential in applications requiring knowledge of soil water inventory or movement.

Vehicle Testing

This versatile, rugged datalogger is ideally suited for testing cold and hot temperature, high altitude, off-highway, and cross-country performance. The CR3000 is compatible with our SDM-CAN interface and GPS16X-HVS receiver.

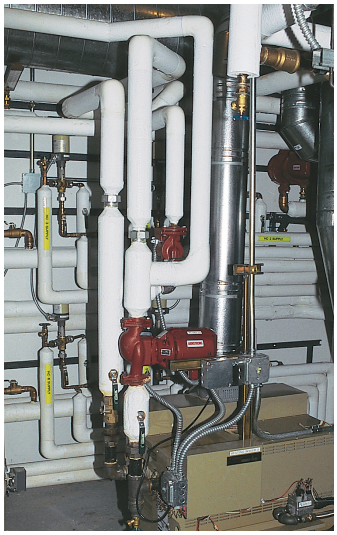
Vehicle monitoring includes not only passenger cars, but airplanes, locomotives, helicopters, tractors, buses, heavy trucks, drilling rigs, race cars, and motorcycles.

The CR3000 can measure:

- Suspension—strut pressure, spring force, travel, mounting point stress, deflection, ride.
- Fuel system—line and tank pressure, flow, temperature, injection timing
- Comfort control—ambient and supply air temperature, solar radiation, fan speed, ac on and off, refrigerant pressures, time-to-comfort, blower current
- Brakes—line pressure, pedal pressure and travel, ABS, line and pad temperature.
- Engine—pressure, temperature, crank position, RPM, time-to-start, oil pump cavitation.
- General vehicle—chassis monitoring, road noise, vehicle position and speed, steering, air bag, hot/cold soaks, wind tunnels, traction, CANbus, wiper speed and current, vehicle electrical loads.

Other Applications

- Structural or fatigue analysis
- Wireless sensor/datalogger networks
- Water quality
- Water level/flow
- Mesonet systems
- Avalanche forecasting, snow science, polar, high altitude
- HVAC Systems
- Aerospace/aviation



The CR3000 can monitor and control pumps, fans, and starter motors in an HVAC system.

CR3000 Specifications

Electrical specifications are valid over a -25° to +50°C, non-condensing environment, unless otherwise specified. Recalibration recommended every three years. Critical specifications and system configuration should be confirmed with Campbell Scientific before purchase.

PROGRAM EXECUTION RATE

10 ms to one day @ 10 ms increments

ANALOG INPUTS *(SE1–SE28 or DIF1–DIF14)*

14 differential (DIFF) or 28 single-ended (SE) individually configured input channels. Channel expansion provided by optional analog multiplexers.

RANGES, RESOLUTION: Basic resolution (Basic Res) is the resolution of a single A/D conversion. A DIFF measurement with input reversal has better (finer) resolution by twice than Basic Res.

Range (mV)[1]	*DF Res (µV)* [2]	*Basic Res (µV)*
±5000	83.33	167
±1000	16.67	33.4
±200	3.33	6.67
±50	0.83	1.67
±20	0.33	0.67

[1]Range overhead of ~9% on all ranges guarantees full-scale voltage will not cause over range.

[2]Resolution of DF measurements with input reversal.

ANALOG INPUT ACCURACY[3]:

±(0.04% of reading + offset), 0° to 40°C
±(0.07% of reading + offset), -25° to 50°C
±(0.09% of reading + offset), -40° to 85°C (-XT only)

[3]Accuracy does not include sensor and measurement noise. Offsets are defined as:

Offset for DIFF w/input reversal = 1.5·Basic Res + 1.0 µV
Offset for DIFF w/o input reversal = 3·Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 5.0 µV

ANALOG MEASUREMENT SPEED:

Integration Type/ Code	*Integration Time*	*Settling Time*	*Total Time*[4] *SE w/ No Rev*	*Total Time*[4] *DF w/ Input Rev*
250	250 µs	200 µs	~0.7 ms	~1.4 ms
60 Hz[5]	16.67 ms	3 ms	~20 ms	~40 ms
50 Hz[5]	20.00 ms	3 ms	~23 ms	~46 ms

[4]Includes 250 µs for conversion to engineering units.

[5]AC line noise filter.

INPUT NOISE VOLTAGE: For DIFF measurements with input reversal on ±20 mV input range; digital resolution dominates for higher ranges.

250 µs Integration: 0.4 µV RMS
50/60 Hz Integration: 0.19 µV RMS

INPUT LIMITS: ±5 Vdc

DC COMMON MODE REJECTION: >100 dB

NORMAL MODE REJECTION: 70 dB @ 60 Hz when using 60 Hz rejection

INPUT VOLTAGE RANGE W/O MEASUREMENT CORRUPTION: ±8.6 Vdc max.

SUSTAINED INPUT VOLTAGE W/O DAMAGE: ±16 Vdc max.

INPUT CURRENT: ±1 nA typical, ±6 nA max. @ 50°C; ±120 nA @ 85°C

INPUT RESISTANCE: 20 GΩ typical

ACCURACY OF BUILT-IN REFERENCE JUNCTION THERMISTOR (for thermocouple measurements):

±0.3°C, -25° to 50°C;
±0.8°C, -40° to 85°C (-XT only)

ANALOG OUTPUTS *(Vx1-Vx4, Ix1-Ix3, CAO1, CAO2)*

4 switched voltage and 3 switched current outputs sequentially active during measurement. Two continuous outputs.

Channel	*Range*	*Res.*	*Current Source/Sink*	*Compliance Voltage*
VX 1-4	±5 V	17 mV	±50 mA	N/A
IX 1-3	±2.5 mA	0.08 µA	N/A	±5 V
CAO	±5 V	17 mV	±15 mA	N/A

ANALOG OUTPUT ACCURACY (VX and CAO):

±(0.04% of setting + 0.5 mV), 0° to 40°C
±(0.07% of setting + 0.5 mV), -25° to 50°C
±(0.09% of setting + 0.5 mV), -40° to 85°C (-XT only)

ANALOG OUTPUT ACCURACY (IX):

±(0.1% of setting + 0.5 µA), 0° to 40°C
±(0.13% of setting + 0.5 µA), -25° to 50°C
±(0.15% of setting + 0.5 µA), -40° to 85°C (-XT only)

VX FREQUENCY SWEEP FUNCTION: Switched outputs provide a programmable swept frequency, 0 to 5000 mV square wave for exciting vibrating wire transducers.

PERIOD AVERAGE

Any of the 28 SE analog inputs can be used for period averaging. Accuracy is ±(0.01% of reading+resolution), where resolution is 68 ns divided by the specified number of cycles to be measured.

INPUT AMPLITUDE AND FREQUENCY:

Voltage Gain	*Input Range (±mV)*	*Signal (peak to peak) Min. (mV)* [6]	*Signal (peak to peak) Max (V)*[7]	*Min Pulse Width (µV)*	*Max*[8] *Freq (kHz)*
1	1000	500	10	2.5	200
5	25	10	2	10	50
20	7.5	5	2	62	8
50	2.5	2	2	100	5

[6]Signal centered around Threshold (see PeriodAvg() instruction).

[7]Signal centered around ground

[8]The maximum frequency = 1/(Twice Minimum Pulse Width) for 50% of duty cycle signals.

RATIOMETRIC MEASUREMENTS

MEASUREMENT TYPES: Provides ratiometric resistance measurements using voltage or current excitation. 4 switched voltage excitation outputs are available for measurement of 4- and 6-wire full bridges, and 2-, 3-, and 4-wire half bridges. 3 switched current excitation outputs are available for direct resistance measurements. Optional excitation polarity reversal minimizes dc errors.

RATIOMETRIC MEASUREMENT ACCURACY[9, 10, 11]:

±(0.02% of voltage reading + offset[12])/VX, 0° to 40°C
±(0.025% of voltage reading + offset[12])/VX, -25° to 50°C
±(0.03% of voltage reading + offset[12])/VX, -40° to 85°C

[9] Accuracy specification assumes excitation reversal for excitation voltages < 500 mV and excitation currents < 500 µA. Assumption does not include bridge resistor errors and sensor and measurement noise.

[10]For Resistance() instruction, the sensor resistance is determined from VS / IX, where excitation current IX is measured across a 1000 Ω, ±0.005% at 25°C, 2 ppm·°C^{-1} TCR internal resistor.

[11]Estimated accuracy, ΔX (where X is value returned from measurement with Multiplier =1, Offset = 0):
BrHalf() instruction: $\Delta X = \Delta V_1/V_x$
BrFull() instruction $\Delta X = 1000 \cdot \Delta V_1/V_x$, expressed as mV·V^{-1}.
ΔV^{-1} is calculated from the ratiometric measurement accuracy. See Resistance Measurements Section in the manual for more information.

[12]Offset definitions:
Offset for DIFF w/input reversal = 1.5·Basic Res + 1.0 µV
Offset for DIFF w/o input reversal = 3·Basic Res + 2.0 µV
Offset for SE = 3·Basic Res + 5.0 µV
Excitation reversal reduces offsets by a factor of two.

PULSE COUNTERS *(P1-P4)*

4 inputs individually selectable for switch closure, high frequency pulse, or low-level AC. Independent 24-bit counters for each input.

MAXIMUM COUNTS PER SCAN: 16.8 x 10^6

SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Max. Bounce Time: 1 ms open w/o being counted

HIGH FREQUENCY PULSE MODE:
Maximum Input Frequency: 250 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 0.9 V to above 2.2 V after input filter with 1.2 µs time constant.

LOW LEVEL AC MODE: Internal AC coupling removes dc offsets up to ±0.5 Vdc.

Input Hysteresis: 12 mV RMS @ 1 Hz
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

Sine Wave (mV RMS)	*Range(Hz)*
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

DIGITAL CONTROL PORTS *(C1-C8, SDM)*

8 ports software selectable as binary inputs or control outputs. Provide on/off, pulse width modulation, edge timing, subroutine interrupts / wake up, switch-closure pulse counting, high-frequency pulse counting, asynchronous communications (UARTs), and SDI-12 communications.

LOW FREQUENCY MODE MAX: <1 kHz

HIGH FREQUENCY MAX: 400 kHz

SWITCH CLOSURE FREQUENCY MAX: 150 Hz

OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low <0.1

OUTPUT RESISTANCE: 330 Ω

INPUT STATE: high 3.8 to 16 V; low -8.0 to 1.2 V

INPUT HYSTERESIS: 1.4 V

INPUT RESISTANCE: 100 kΩ with < 6.2 Vdc; 220 Ω with inputs ≥6.2 Vdc

SERIAL DEVICE / RS-232 SUPPORT: 0 to 5 Vdc UART

ADDITIONAL DIGITAL PORTS: SDM-C1, SDM-C2, SDM-C3 are dedicated for measuring SDM devices.

SWITCHED 12 V *(SW12V)*

2 independent 12 Vdc unregulated sources switched on and off under program control. Thermal fuse hold current = 900 mA at 20°C, 650 mA @ 50°C, 360 mA @ 85°C.

CE COMPLIANCE

STANDARD(S) TO WHICH CONFORMITY IS DECLARED: IEC61326:2002

COMMUNICATION

RS-232 PORTS:
DCE 9-pin (electrically isolated): for computer connection or connection of modems not manufactured by Campbell Scientific.
COM1 to COM4: 4 independent Tx/Rx pairs on control ports (non-isolated); 0 to 5 Vdc UART
Baud Rate: Selectable from 300 to 115.2k bps.
Default Format: 8 data bits; 1 stop bit; no parity
Optional Format: 7 data bits; 2 stop bits; odd, even parity

CS I/O PORT: Interface with telecommunication peripherals manufactured by Campbell Scientific.

SDI-12: Digital Control ports C1, C3, C5, and C7 are individually configurable and meet SDI Standard v 1.3 for datalogger mode. Up to 10 SDI-12 sensors are supported per port.

PERIPHERAL PORT: 40-pin interface for attaching CompactFlash or Ethernet peripherals

PROTOCOLS SUPPORTED: PakBus, AES-128 Encrypted PakBus, Modbus, DNP3, FTP, HTTP, XML, HTML, POP3, SMTP, Telnet, NTCIP, NTP, Web API, SDI-12, SDM.

SYSTEM

PROCESSOR: Renesas H8S 2674 (16-bit CPU with 32-bit internal core)

MEMORY: 2 MB of flash for operating system; 4 MB of battery-backed SRAM for CPU usage, program storage and final data storage

REAL-TIME CLOCK ACCURACY: ±3 min. per year. Correction via GPS optional

REAL-TIME CLOCK RESOLUTION: 10 ms

SYSTEM POWER REQUIREMENTS

VOLTAGE: 10 to 16 Vdc

INTERNAL BATTERIES: 1200 mAhr lithium battery for clock and SRAM backup. Typically provides 3 years of backup. Optional 10 A h alkaline or 7 A h rechargeable battery plus base available as primary power supply.

EXTERNAL BATTERIES: Optional 12 Vdc nominal alkaline and rechargeable available. Power connection is reverse polarity protected.

TYPICAL CURRENT DRAIN:
Sleep Mode: 2 mA
1 Hz Sample Rate (one fast SE meas.): 3 mA
100 Hz Sample Rate (one fast SE meas.): 10 mA
100 Hz Sample Rate (one fast SE meas. w/RS-232 communications): 38 mA
Active integrated keyboard display adds 1 mA (42 mA with backlight on).

PHYSICAL SPECIFICATIONS

DIMENSIONS: 24.1 x 17.8 x 9.6 cm (9.5 x 7.0 x 3.8 in); additional clearance required for cables and leads.

WEIGHT:

Base Type	*Mass (kg)*	*Weight (lb)*
Low profile	1.6	3.6
Alkaline	3.8	8.3
Rechargeable	4.8	10.7

WARRANTY

3 years against defects in materials and workmanship.

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February 10, 2014

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WHEN MEASUREMENTS MATTER

CFM100

CompactFlash® Module

Portable Memory

Adds CompactFlash capability to CR1000 and CR3000 dataloggers

Overview

Campbell Scientific's CFM100 module stores the datalogger's data on a removable CompactFlash® (CF) card. The CFM100/CF card combination can be used to expand the datalogger's memory, and transport data/programs from the field site(s) to the office. The module connects to the 40-pin peripheral port on a CR1000 or CR3000 datalogger.

Benefits and Features

- Used to expand data storage of our CR1000 and CR3000 dataloggers
- Connects to the datalogger's peripheral port
- Small, light-weight CF cards fit in your pocket for easy transport between the datalogger and PC

CF Cards

One Type I or Type II CF card fits into the CFM100's card slot. Campbell Scientific offers and recommends the CFMC256M, CFMC2G, and CFMC16G CF cards (see Ordering Information). To use the CFMC16G, the datalogger operating system must be OS 25 or later.

Only industrial-grade CF cards should be used with our products. Although consumer-grade cards cost less than industrial-grade cards, the consumer-grade cards are more susceptible to failure resulting in both the loss of the card and its stored data. Industrial-grade cards also function over wider temperature ranges and have longer life spans than consumer-grade cards.

Data Retrieval

Data stored on the card can be retrieved either through a communications link with the datalogger or by removing the card and carrying it to a computer. The computer can read the CF card either with the computer's PCMCIA slot and the CF1 adapter or the computer's USB port and the 17752 Reader/Writer.

Campbell Scientific offers 256 MB, 2 GB (shown), and 16 GB industrial-grade CF cards.

Ordering Information

CompactFlash® Module	
CFM100	CompactFlash Module for Campbell Scientific CR1000 or CR3000 dataloggers.
Temperature Range Options (choose one)	
-ST	Tested -25° to +50°C
-XT	Tested -55 ° to +85°C
Reader/Writer or Adapter	
17752	USB Memory Card Reader
CF1	SanDisk® CompactFlash Adapter for PCMCIA Slots

CompactFlash Cards	
CFMC256M	256 MB Industrial-grade CompactFlash Memory Card. The card is formatted as FAT32.
CFMC2G	2 GB Industrial-grade CompactFlash Memory Card. The card is formatted as FAT32.
CFMC16G	16 GB Industrial-grade CompactFlash Memory Card. The card is formatted as FAT32. The datalogger operating system must be OS 25 or later to read this card.

Specifications

- CE Compliant Devices: CFM100, 17752 USB Reader/Writer

CFM100

- Typical Access Speed: 200 to 400 kbits s^{-1}
- Memory Configuration: User selectable; ring (default) or fill-and-stop
- Power Requirements: 12 V supplied through the datalogger's peripheral port
- CF Card Requirements: Industrial grade
- Datalogger Operating System (OS): The CR1000 OS must be OS 4 or later. Both the CR1000 and CR3000 need OS 25 or later to read cards with more than 2 GB of storage.
- Dimensions: 10.0 x 8.3 x 6.5 cm (4.0 x 3.3 x 2.6 in)
- Weight: 133 g (4.7 oz)

Temperature Range

- Standard: -25° to +50°C
- Extended: -55° to +85°C

Typical Current Drain

- RS-232 Port Active: 30 mA (writing to card); 20 mA (reading card)
- RS-232 Port Not Active: 20 mA (writing to card); 15 mA (reading card)
- Low Power Standby: 700 to 800 µA

Software Requirements

- LoggerNet: Version 3.1.3 or later
- PC400: Version 1.2.1 or later

CFMC256M, CFMC2G, and CFMC16G

- Manufacturer: FMJ
- Card Description: Industry standard Type I
- Storage Capacity: 256 MB, 2 GB, or 16 GB
- Operating Temperature: -40° to +85°C
- Storage Temperature: -55° to +125°C (CFMC256M, CFMC2G); -50° to +100°C (CFMC16G)
- Compliancy: RoHS
- Card Format: FAT32
- Dimensions: 4.28 x 3.64 x 0.33 cm (1.69 x 1.43 x 0.13 in.)
- Weight: 10 g (0.35 oz)

17752 USB Reader/Writer

- Dimensions: 8.9 x 6.9 x 1.9 cm (3.5 x 2.7 x 0.75 in)
- Operating Temperature: 0° to 60°C
- Storage Temperature: -20° to 85°C

Minimum Computer Requirements

- Windows 8, 7, Vista (SP1, SP2), XP (SP3), 2000 (SP4); MAC OS X v. 10.6.x+; or Linux v. 2.6.x+
- USB Port: USB 2.0 or 3.0

CF1 Adapter

- Manufacturer: SanDisk
- Dimensions: 8.6 x 5.4 x 0.5 cm (3.4 x 2.1 x 0.2 in.)

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August 8, 2013

CFMC2G

2 GB CompactFlash Memory Card

Request a Quote
Ask a Question

Overview Specifications Compatibility Ordering Support Image Gallery

The CFMC2G is a 2 GB, industrial-grade CompactFlash card that has been selected specifically to provide optimum performance and extreme reliability. It is used with the CFM100, NL115, or CF1 to expand a datalogger's memory and to transport data, camera images, programs, and operating systems without having to use a PC.

Resources and Links

Related Documents

- CF Card Information (3SM-F) *App. Note*
- A Better Way to Write High-Frequency Data to 16 GB and Smaller CF Cards (3SM-G) *App. Note*

Related Products

- CFMC256M 256 MB CompactFlash Card
- CFMC16G 16 GB CompactFlash Memory Card

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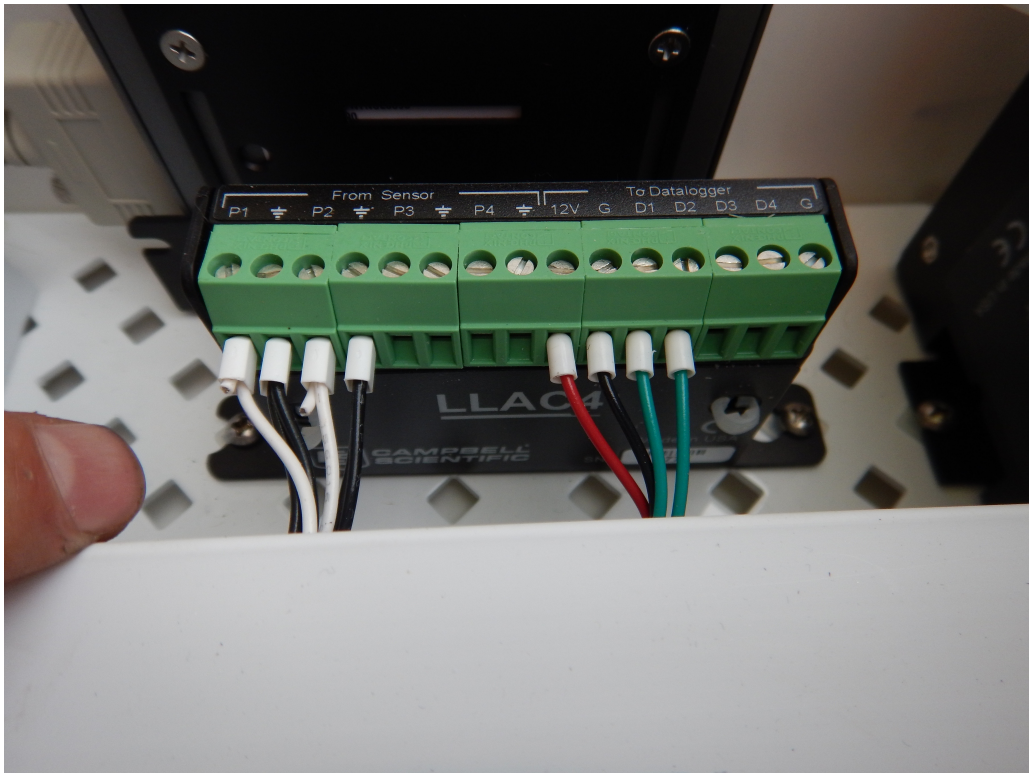
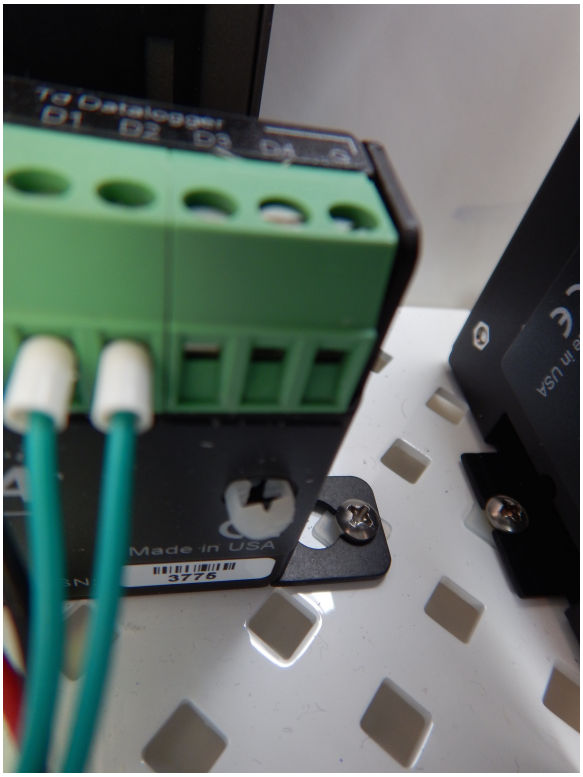
Feedback?


From Sensor
P1
P2
P3
P4
12V
G
To Datalogger
D1
D2
D3
D4
G
LLAC4
CAMPBELL SCIENTIFIC


To Datalogger
D1
D2
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D4
G
Made in USA
3776

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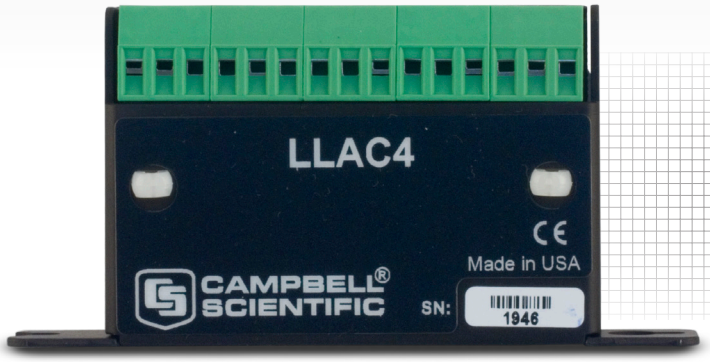
LLAC4

Four-Channel, AC-Conversion Module



Expands Capacity

Increases number of signals datalogger can monitor

Overview

The LLAC4 is a small peripheral that increases the number of low-level ac signals a datalogger can monitor. The LLAC4 is often used to measure up to four anemometers, and is especially useful for wind profiling applications.

Benefits and Features

- Ideal for applications that require high numbers of pulse channels, but fewer control ports, such as in wind prospecting
- Compatible with our CR200(X)-series*, CR800, CR850, CR1000, CR3000, and CR5000 dataloggers

Technical Description

The LLAC4 enables four datalogger control ports to emulate pulse-counting channels by converting the low-level ac signals to logic levels read by the control ports. To use the LLAC4, the datalogger control ports must accept high frequency pulses.

The LLAC4 typically measures anemometers but can measure other sensors that output pulse counting signals. Compatible anemometers include the 05103 Wind Monitor, 05103-45 Alpine Wind Monitor, 05106 Marine Wind Monitor, 05305 Wind Monitor-AQ, 03002 Wind Sentry Set, and 03101 Wind Sentry Anemometer (the 014A Anemometer and 034B Windset are not compatible).

Specifications

- Power: 0.1 mA @ 12 Vdc
- Minimum AC Input Voltage versus Output Square Wave Frequency

Input Sine Wave (mV RMS)	Output Range (Hz)
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

- AC Coupling Removal of DC Offset: up to ±0.5 V
- Input Hysteresis: 16 mV @ 1 Hz
- Maximum AC Input Voltage: ±20 V
- Cable Length: 0.6 m (2 ft)
- Weight: 92 g (3.2 oz)
- Width
  Without Mounting Base Flanges: 8.0 cm (3.1 in)
  With Mounting Base Flanges: 11.2 cm (4.5 in)
- Height: 5.4 cm (2.1 in)
- Depth: 2.5 cm (1.0 in)

**To be compatible with the CR200(X)-series dataloggers, the low-level ac signals must not exceed 1 kHz.*

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RIMSO
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MODEL 6 RBT 120A 80Ah
INDUSTRIAL TUBULAR BATTERY

XIHE SOLAR CO.,LTD
www.xihesolar.cn
Model: XH85P(36)
RIMSO FOUNDATION
Rated Maximum Power (Pmax) 85Wp
Tolerance 0-3%
Voltage at Pmax (Vmp) 17.5V
Current at Pmax (Imp) 4.86A
Open-Circuit Voltage (Voc) 21.7V
Short-circuit Current (Isc) 5.37A
Nominal Operating Cell Temp (NOCT) 47℃±2℃
Maximum System Voltage 1000 VDC
Maximum Series Fuse Rating 10A
Operating Temperature -40℃ to +85℃
All technical data at standard test condition
AM=1.5 E=1000W/m² TC=25℃
Solar modules generate electricity as so on as they are exposed to light One module on its own is below the safety extra low voltlevel,but multiple modules connected inseries (summing the voltage)represent a danger

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WHEN MEASUREMENTS MATTER

PS200 and CH200

Smart Power Supply and Charge Controller

Optimized Power Performance

Manages voltage and amperage to protect battery

Overview

The PS200 and CH200 are charge controllers that manage amperage and voltage for safe, optimized battery charging from a solar-panel or ac power source. They also measure various input, output, and status parameters to allow close monitoring of the battery during charging and use. The PS200 includes a 12 Vdc valve-regulated lead-acid (VRLA) battery, while the CH200 is for use with a user-supplied battery (typically the BP12 or BP24).

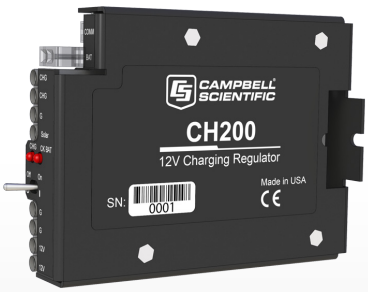
Benefits and Features

- Protects against high-amperage and high-voltage damage to power supply
- Ability to monitor both load and battery current
- Real-time measurements of charge input voltage, battery voltage, on-board temperature, battery current, and load current
- Battery reversal protection
- Two-step constant voltage charging and temperature compensation optimize battery charging and increase the battery's life
- Allows simultaneous connection of two charging sources (e.g., solar panel, ac wall charger)

Technical Description

The PS200 and CH200 are micro-controller-based smart chargers with two-step constant voltage charging and temperature compensation that optimize battery charging and increase the battery's life. Two input terminals enable simultaneous connection of two charging sources. They also incorporate a maximum power point tracking algorithm for solar inputs that maximize available solar charging resources. RS-232 and SDI-12 terminals allow the PS200 and CH200 to convey charging parameters to a datalogger.

The PS200 and CH200 have several safety features intended to protect the charging source, battery, charger, and load devices. Both the SOLAR – G and CHARGE – CHARGE input terminals incorporate hardware current limits and polarity-reversal protection. A fail-safe, self-resettable thermal fuse protects the CHARGE – CHARGE inputs in the event of a catastrophic AC/AC or AC/DC charging source failure. Another self-resettable thermal fuse protects the 12 V output terminals of the charger in the event of an output load fault. The PS200 and CH200 also have battery-reversal protection, and include ESD and surge protection on all of its inputs and outputs.



Ordering Information

Power Supplies

CH200	12 V Charging Regulator
PS200	12 V Power Supply with Charging Regulator and 7 A h Sealed Rechargeable Battery

12 Vdc Battery Packs for CH200

BP12	12 A h Sealed Rechargeable Battery with Mounts
BP24	24 A h Sealed Rechargeable Battery with Mounts

Cables (interface and external battery)

20769	SDI-12 Interface Cable with a 2 ft length. Connects the power supply's SDI-12 terminal to the datalogger's terminals, allowing the datalogger to receive the power supply's charging, load, battery voltage and current information.
25356	RS-232 Pigtail Interface Cable with a 2 ft length. Connects the power supply's RS-232 terminal to the datalogger's terminals, allowing the datalogger to receive the power supply's charging, load, battery voltage and current information.
20770	9-pin RS-232 Interface Cable with 6 ft length. Connects a PS200 or CH200 to a computer for changing its settings or downloading a new operating system.
6186	Battery Cable for connecting a an external 12 Vdc flooded battery such as a deep-cycle marine or RV battery.

Adapters

Only one adapter can be used at a time.

A100	Null Modem Adapter for powering peripherals and external devices at non-datalogger sites such as repeater stations.
A105	12 V Terminal Expansion Adapter that increases the number of 12 V and ground terminals available on the PS200 or CH200.

Wall Chargers

29796	Wall Charger 24 Vdc 1.67 A Output, 100 to 240 Vac, 1A Input, 5 ft Cable. Must choose a power plug option (see below).
22110	Wall Charger 24 Vdc 1.67 A Output, 100 to 240 Vac, 1A Input for prewired enclosure. Must choose a power plug option (see below).

Power Plug Options (choose one)

-US	US/Canada Plug
-IP	7 International Plugs

Unregulated Solar Panels

Regulated solar panels such as the SP10R are not recommended.

SP10	10 W Solar Panel with 20 ft cable
SP10-PW	10 W Solar Panel with 20 ft cable for prewired enclosure
SP20	20 W Solar Panel with 15 ft cable
SP20-PW	20 W Solar Panel with 15 ft cable for prewired enclosure

Specifications

- Operational Temperature[a]: –40° to +60°C
- Dimensions:

	Height	Length	Width
PS200	10.6 cm (4.2 in)	19 cm (7.5 in)	7.6 cm (3 in)
CH200	10 cm (3.9 in)	7.5 cm (3 in)	3.7 cm (1.5 in)

CHARGE – CHARGE Terminals (AC or DC Source)

- AC: 18 to 24 V RMS with 1.2 A RMS maximum
- DC: 16 to 40 Vdc with 1.1 A DC maximum

SOLAR Terminals (Solar Panel or Other DC Source)[b]

- Input Voltage Range: 15 to 40 Vdc
- Maximum Charging Current: 3.6 Adc typical;
  2.8 Adc to 4.3 Adc depending on individual charger)

Battery Charging[c]

- CYCLE Charging: Vbatt(T) = 14.70 V – (24 mV) x (T – 25°C)
- FLOAT Charging: Vbatt(T) = 13.65 V – (18 mV) x (T – 25°C)
- Accuracy: ±1% accuracy on charging voltage over -40° to +60°C

Quiescent Current

- No Charge Source Present: 300 µA maximum
- No Battery Connected: 2 mA maximum

Power Out (+12 terminals)

- Voltage: Unregulated 12 V from battery
- 4 A Self-Resettable Thermal Fuse Hold Current Limits
  < 20°C: > 4 A
  20°C: 4.0 A
  50°C: 3.1 A
  60°C: 2.7 A

Measurements

- Average Battery Voltage (-40° to +60°C): ±(1% of reading + 15 mV)
- Average Battery/Load Current Regulator Input Voltage (-40° to +60°C)[d]: ±(2% of reading +2 mA)
- Solar (-40° to +60°C)[e]: ±(1% of reading – 0.25 V) / –(1% of reading + 1 V)
- Continuous (-40° to +60°C)[f]:
  ±(1% of reading – 0.5 V) / – (1% of reading + 2 V)
- Charger Temperature: ± 2°C

[a]VRLA battery manufacturers state that "heat kills batteries" and recommend operating batteries ≤50°C.

[b]Battery voltages below 8.7 V may result in <3.0 A current limit because of fold-back current limit.

[c]Two-step temperature compensated constant-voltage charging for valve-regulated lead-acid batteries. Cycle and float charging voltage parameters are programmable with the default values listed.

[d]Impulse type changes in current may have an average current error of ±(10% of reading + 2 mA).

[e]1.0 V negative offset is worst-case due to reversal protection diode on input. Typical diode drop is 0.35 V.

[f]2.0 V negative offset is worst-case due to two series diodes in AC full-bridge. Typical diode drops are 0.35 V each for 0.7 V total.

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December 13, 2013

GARMIN

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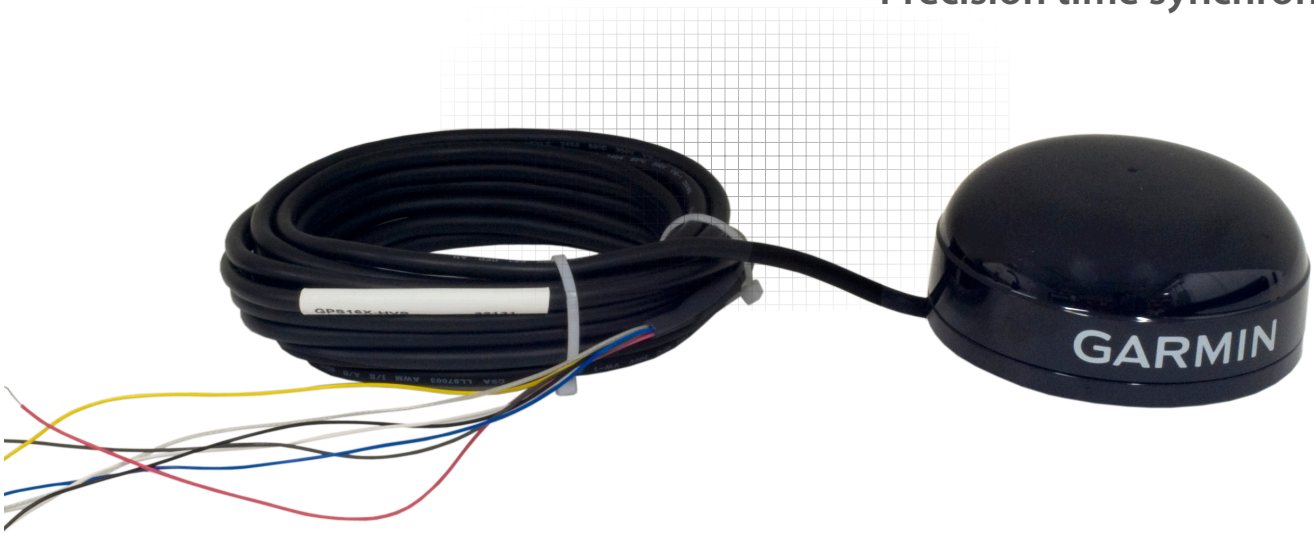
WHEN MEASUREMENTS MATTER

GPS16X-HVS

GPS Receiver

Position and Time

Precision time synchronization



Overview

The GPS16X-HVS is a global positioning system (GPS) receiver that provides position, velocity, and timing information. Campbell Scientific configures the GPS16X-HVS and modifies its cable. The GPS16X-HVS is typically used with our CR800, CR850, CR1000, and CR3000 dataloggers.

Benefits and Features

- Supports real-time WAAS or RTCM corrections for accuracy of 3 to 5 m
- Connects directly to the control ports of a CR800, CR850, CR1000, or CR3000 datalogger—adapter not required
- Processes data from up to 12 satellites depending on the number of satellites viewable above the horizon
- Allows the datalogger clock to be set to the highly accurate GPS time
- Configured by Campbell Scientific to output RMC and GGA data strings at 38400 bps
- Extremely accurate timing pulse (PPS) can be used to synchronize time between the datalogger and other instruments

Technical Description

The GPS16X-HVS consists of a receiver and an integrated antenna. It receives signals from orbiting Global Positioning System (GPS) satellites, and then uses the signals to calculate position and velocity. The GPS16X-HVS also provides a highly accurate one-pulse-per-second (PPS) output for precise timing measurements.

Default settings are typically used. The default settings and options are changed using GPS16 software, which is available, at no charge, from the Garmin website (www.garmin.com). Additional hardware is required to connect the GPS16X-HVS to the PC running the GPS16 software (see Ordering Information for more information).

Ordering Information

Geographic Position Receivers

GPS16X-HVS	GPS Receiver with antenna and 15-ft cable that terminates in pigtails. The pigtails connect directly to the control ports of a CR800, CR850, CR1000, or CR3000.
GPS16X-HVS-PW	GPS Receiver with antenna and 15-ft cable that terminates in a connector. The connector attaches to a prewired enclosure.

Both the 17212 Magnetic Mount (above) and the CM235 Magnetic Mount Stand (right) are used to attach the GPS sensor to a mast or a CM202, CM203, CM204, or CM206 crossarm.

Accessories

17212	Magnetic Mount that allows the sensor to be attached to a magnetically susceptible metallic surface, typically the CM235 Magnetic Stand (see below).
CM235	Magnetic Mounting Stand for attaching the receiver to a crossarm such as the CM202, CM204, or CM206, or a tripod or tower mast. The 17212 is required (see above).
28840	DB9 Female to Terminal Block with Hood and Hardware Kit allows the sensor to be connected to a PC's USB port. The sensor needs to be connected to a PC to change its default settings and options.
A200	Sensor to PC Interface allows the sensor to be connected to a PC's RS-232 9-pin terminal. The sensor needs to be connected to a PC to change its default settings and options.

Specifications

- Receiver: WAAS enabled; 12 parallel channel GPS receiver continuously tracks and uses up to 12 satellites (up to 11 with PPS active) to compute and update the position
- Update Rate: Factory set to 1 s between updates; programmable from 1 to 900 s
- PPS Output: 1 Hz pulse; 1 µs accuracy; width factory set to 100 ms
- Baud Rate: Factory set to 38400 bps
- Operating Temperature Range: -30° to 80°C
- Storage Temperature Range: -40° to 80°C
- Operating Voltage Range: 8 to 40 Vdc
- Current Drain @ 12 Vdc: 65 mA active
- Velocity Accuracy: 0.1 knot RMS steady state
- Diameter: 9.1 cm (3.58 in)
- Height: 4.2 cm (1.65 in)
- Weight: 332 g (12 oz)

Acquisition Times

- Reacquisition: < 2 s
- Hot: ~1 s (all data known)
- Warm: ~38 s (initial position, time and almanac known, ephemeris unknown)
- Cold: ~45 s

Position Accuracy (95% typical)

- GPS Standard Positioning Service (SPS): < 15 m
- DGPS (USCG/ RTCM) Correction: 3 to 5 m
- DGPS (WAAS) Correction: < 3 m

The GPS16X-HVS connects directly to COM port pairs of a CR800, CR850, CR1000 (shown), or CR3000 datalogger.

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Campbell Scientific, Inc.
July 2, 2013

HARNESS ENERGY

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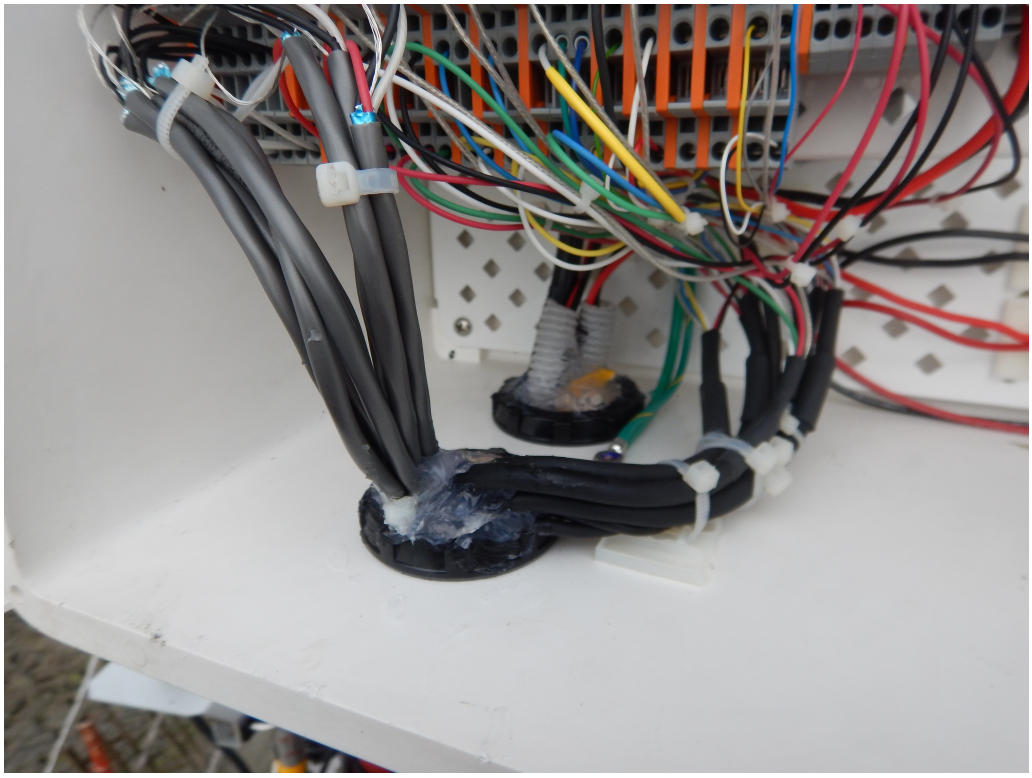

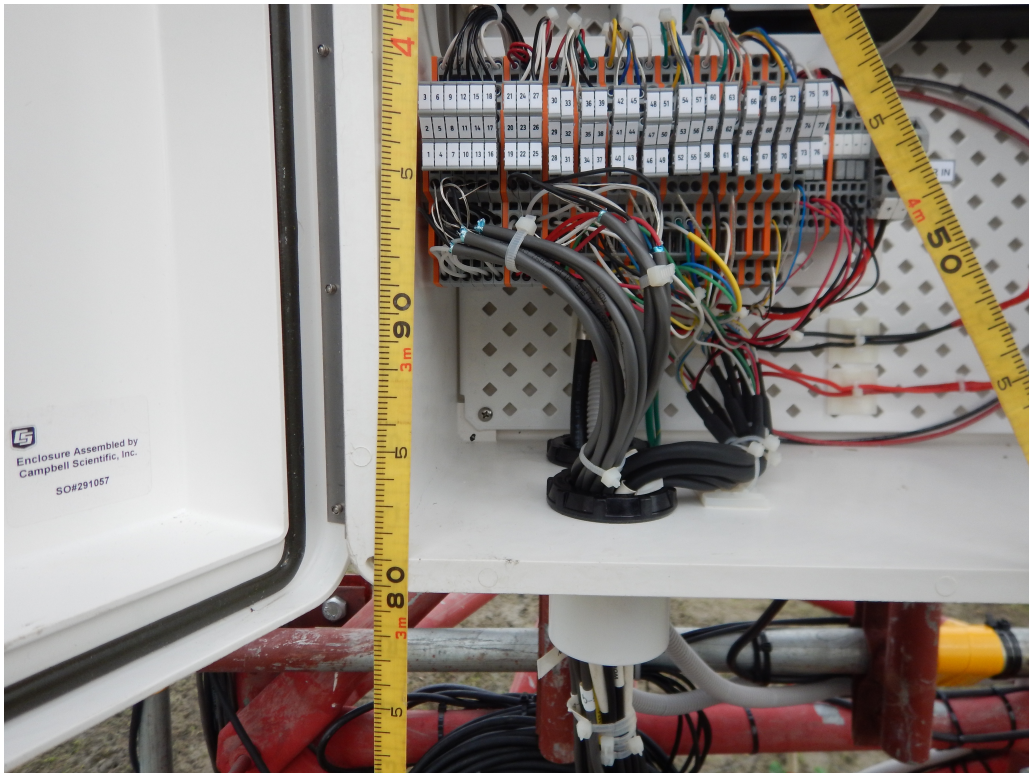
Enclosure Assembled by
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SO#291057

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WHEN MEASUREMENTS MATTER

FIBERGLASS ENCLOSURES

ENC10/12, ENC10/12R, ENC12/14, ENC14/18, and ENC16/18

Rugged, Versatile

Campbell components mount easily and securely

Overview

Campbell Scientific offers fiberglass-reinforced polyester enclosures for housing our dataloggers and peripherals. Dataloggers and peripherals housed in an enclosure with desiccant are protected from water and most pollutants.

Benefits and Features

- Weather resistant to protect instruments
- Backplate designed so that Campbell Scientific components mount easily and securely
- White, UV-stabilized enclosure reflects solar radiation—reducing temperature gradients inside the enclosure without requiring a separate radiation shield

Enclosure Supply Kit

The enclosure supply kit is included with these enclosures. The assembled equipment aids in mounting your equipment inside the enclosure as well as monitoring relative humidity and sealing the enclosure. The kit consists of desiccant packs, humidity indicator card, cable ties, putty, screws, grommets, PVC plug, and a Phillips-head screwdriver.

Cable-Entry Option Details

Conduit(s)

Multiple cables can be routed through one conduit. A plug included in the 7363 enclosure supply kit can reduce the conduit's internal diameter to 1.3 cm (0.5 in). The enclosure supply kit also contains the putty used to seal each conduit.

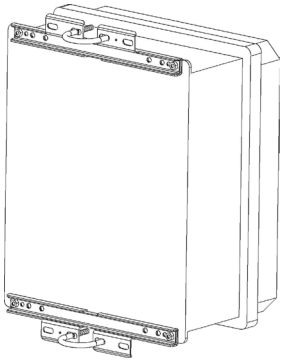
Entry Seals

Cable entry seals have a more water-tight seal than the conduits. Each entry seal is compressed around one cable. A small vent is included to equalize pressure with the atmosphere. The entry seals come in three sizes that accept the following cable diameters:

- Large—6 to 13 mm (0.24 to 0.51 in)
- Medium—5.8 to 10 mm (0.23 to 0.39 in)
- Small—3 to 7 mm (0.12 to 0.28 in)

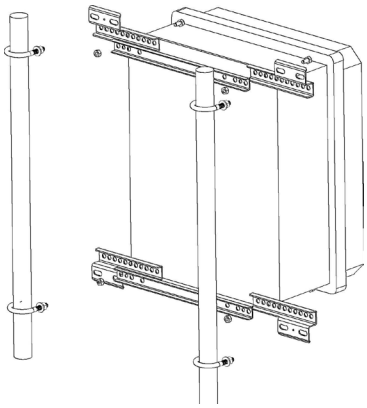
The number of cable entry seals provided depends on the enclosure model:

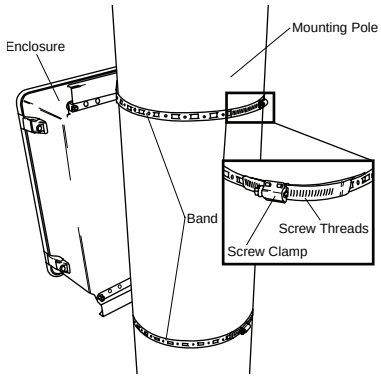
- ENC10/12—(1) medium, (2) small
- ENC10/12R—(1) medium, (2) small
- ENC12/14—(2) medium, (2) small
- ENC14/16—(2) large, (2) medium, (2) smalll
- ENC16/18—(2) large, (2) medium, (2) small



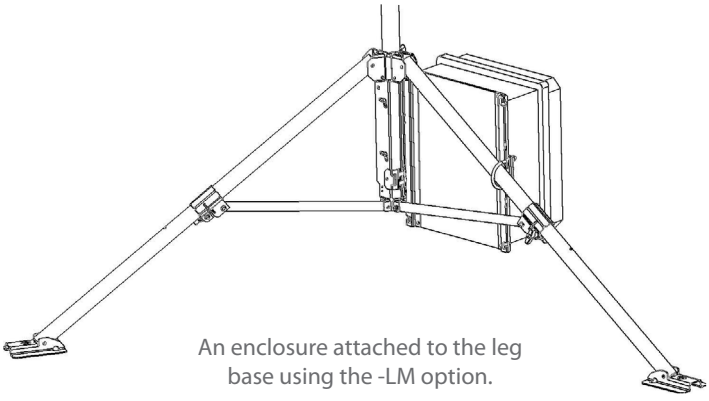
At left is an enclosure with the *-MM* mount option. The bracket is ready to be attached to a mast or user-supplied vertical pipe with a 1.25-in. to 2.1-in. outer diameter.

At right is an exploded view of the -TM option. It shows the bracket components and how the enclosure attaches to a tower.





At left shows the -PM option, where the enclosure is mounted to a large diameter pole via band clamps.



An enclosure attached to the leg base using the -LM option.

Ordering Information

Fiberglass Enclosures

ENC10/12	Weather-Resistant 10 x 12 inch Enclosure. Includes an internal plate punched with a grid of one-inch-on-center holes for mounting devices.
ENC10/12R	Weather-Resistant 10 x 12 inch Enclosure with raised lid. Includes an internal plate punched with a grid of one-inch-on-center holes for mounting devices.
ENC12/14	Weather-Resistant 12 x 14 inch Enclosure. Includes an internal plate punched with a grid of one-inch-on-center holes for mounting devices.
ENC14/16	Weather-Resistant 14 x 16 inch Enclosure. Includes an internal plate punched with a grid of one-inch-on-center holes for mounting devices.
ENC16/18	Weather-Resistant 16 x 18 inch Enclosure. Must choose a backplate option (see below).

Enclosure Hole Options

-SC	One Conduit for cable entry.
-DC	Two horizontally-arranged 3.8 cm (1.5 in) diameter conduits for cable entry.
-VC	Two vertically-arranged 3.8 cm (1.5 in) diameter conduits for cable entry (available for the ENC16/18 only).
-ES	Individual-Cable Entry Seals. The number of cable entry seals provided depends on the enclosure model (see page 1 for details)

Enclosure Mounts Options

Besides the options listed below, special brackets are also available for attaching enclosures to CTS Towers, Rohn Towers, Aluma Towers, or other non-Campbell Scientific instrument mounts. Contact Campbell Scientific for more information.

- MM	Tripod Mast Mounting for attachment to the mast of one of our tripods or to a user-supplied pipe with a 3.18 cm to 5.33 cm (1.25 to 2.1 in) outer diameter.
-LM	Tripod Leg Mounting. This option allows an ENC10/12, ENC10/12R, ENC12/14, or ENC14/16 to be attached to the leg base of a CM106B, CM110, CM115, or CM120 tripod. For the ENC16/18 enclosure, this option allows the enclosure to be attached to the leg base of a CM106B tripod.
-TM	Tower Mounting for attachment to a UT10, UT20, or UT30 tower (see note at bottom of page).
-PM	Pole Mounting for attachment to a large-diameter pole with a 10.16 to 24.4 cm (4 to 10 in) outer diameter.

Backplate Options for ENC16/18 only

-SB	Standard Backplate with a grid of one-inch-on-center holes for mounting devices.
-EB	Backplate and sideplate. Both plates include a grid of one-inch-on-center holes for mounting devices.

***Note**: Enclosures with the -TM option are shipped configured for the UT10 tower. UT20 and UT30 customers will need to:*

(1) Remove the bolts attaching the bracket to the enclosure.
(2) Slide out the flange sections so that the distance between the center of each flange is 43.2 cm (17 in).
(3) Reattach the bracket to the enclosure using the original bolts.

Ordering Information Continued

Antenna Cable/Bulkhead Installations

These accessories are offered for enclosures that will house a cellular phone, satellite transmitter, or radio. They allow an antenna to be connected to the outside of the enclosure.

19332 Compatible with the type N-to-type N antenna cable used with the RF320-series radios, RF310-series radios, and GOES satellite transmitters.

19335 Compatible with the type N-to-RPSMA antenna cable used with the RF401-series spread spectrum radios, CR200(X)-series dataloggers, or AVW200-series Interfaces.

19334 Compatible with the type N-to-SMA antenna cable used with the RF450 radio or RavenXT-series cellular modems.

19333 Compatible with the type N-to-TNC antenna cable used with the retired Raven100-series or retired Redwing100-series digital cellular modems.

19336 Compatible with the type SMA-to-SMA antenna cable used with the GPS device included with our GOES satellite transmitters.

Other Campbell-Installed Accessories

28701 Enclosure Desiccant and Document Holder Installed in Enclosure Lid. It contains a zipped bag for two-packs of desiccant and an open pocket for documents.

27814 CD100 Mountable Display with Keypad Installed in Enclosure Lid. The CD100 provides the same operation and functionality as the CR1000KD, allowing both data entry and display without opening the enclosure. It is typically used with our CR800 and CR1000 dataloggers.

18132 CD295 DataView II Display Installed in Enclosure Lid. The CD295 displays real-time data only, and is used with PakBus® dataloggers (i.e., CR200(X), CR800, CR850, CR1000, CR3000).

18166 Door Open Indicator Installed in Enclosure. This small accessory monitors when the door of the enclosure is open. The switch is monitored with a datalogger control port.

Miscellaneous Accessories

10525 User-installed two-pack desiccant holder that mounts to the inside of the enclosure lid.

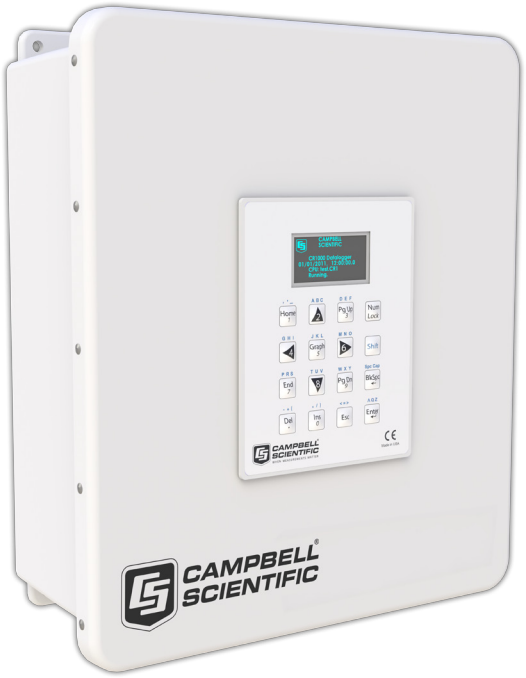
CS210 Enclosure Humidity Sensor contains an Elan HM2000-series precision bulk polymer relative humidity sensor.

6714 Replacement Desiccant 4 Unit Bag (Qty 20).

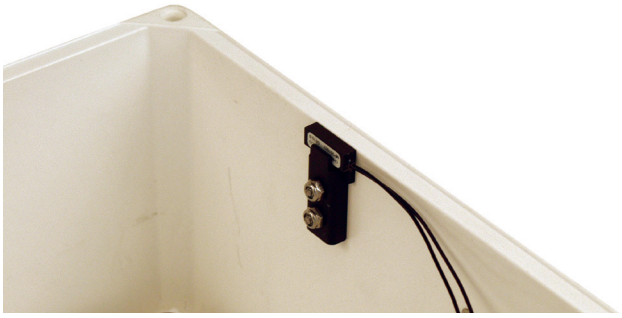
28960 Enclosure Stack Mounting Kit.

18165 User-installed door open indicator. This small accessory monitors when the door of the enclosure is open. The switch is monitored with a datalogger control port.

The CS210 senses relative humidity levels inside the environmental enclosure for the purpose of scheduling desiccant exchange. The desiccant should be exchanged when the sensor indicates an RH level of 35% or more inside the enclosure.



The CD100 has a vacuum fluorescent display for responsive use through a very wide operating temperature range. It has a water and dust ingress protection rating of IP66 when installed.



The door switch indicator consists of an actuator and a magnetic switch—one is located on the case side, the other on the door side of the enclosure. It monitors when the door of the enclosure is open.

The 28960 kit includes two leg brackets and a top bracket. It is used to raise a datalogger up off of the backplate so that wiring is easier or so that components can be stacked.

Specifications

	ENC10/12	ENC10/12R	ENC12/14	ENC14/16	ENC16/18
Can House	CR200(X)-series datalogger, power supply, and a small peripheral.	CR200(X)-series datalogger, power supply, and a small peripheral. A CR800, CR850, or CR1000 can also be housed if using the 28960 stack bracket kit.	CR200(X)-series, CR800, CR850, CR1000, or CR3000 datalogger, power supply, and one or more peripherals (depending on the peripheral's footprint)	CR200(X)-series, CR800, CR850, CR1000, or CR3000 datalogger, power supply, and one or more peripherals (depending on the peripheral's footprint).	CR200(X)-series, CR800, CR850, CR1000, or CR3000 datalogger, power supply, and one or more peripherals (depending on the peripheral's footprint).
Color	White (reflects solar radiation, reducing temperature gradients inside the enclosure without using a separate radiation shield)				
Construction	Fiberglass-reinforced polyester enclosure with door gasket, external grounding lug, stainless-steel hinge, and lockable hasps				
Classification	NEMA 4X (before being modified for cable entry)				
Dimensions	25.4 x 30.5 x 11.4 cm (10 x 12 x 4.5 in)	25.4 x 30.5 x 14 cm (10 x 12 x 5.5 in)	30.5 x 35.6 x 14 cm (12 x 14 x 5.5 in)	35.6 x 40.6 x 14 cm (14 x 16 x 5.5 in)	40.6 x 45.7 x 22.9 cm (16 x 18 x 9 in)
Weight	4.1 kg (9 lb)	4.1 kg (9 lb)	5 kg (11.2 lb)	6 kg (13 lb)	7.7 kg (17 lb)

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Campbell Scientific, Inc.
February 28, 2014

HARNESS ENERGY

Modem Information

SIERRA WIRELESS
AirLink LS300
AT&T
RoHS
IMEI: 354166050192070
S/N: CA81594014610
3056308
Contains: FCC ID: N7NSL8090
IC: 2417C-SL8090
Conforms to ISA-12.12.01
Certified to CAN/CSA STD C22.2 No. 213
7 - 28VDC
1000 mA
Made in China

MYMENSINGH
Grameenphone Prepaid
01733560995
grameenphone
PIN (1&2) 1234
PUK (1&2) 59756980
PIN and PUK Codes on this SIM Card are for your personal reference only. Considering future usage of these codes, please preserve the card at a secured place.
এই সিম কার্ডের PIN ও PUK কোডগুলো একান্তই আপনার ব্যক্তিগত। ভবিষ্যৎ প্রয়োজন বিবেচনা করে অনুগ্রহপূর্বক কার্ডটি সযত্নে সংরক্ষণ করুন।

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

LS300G

3G GSM Cellular Gateway

Cellular Connectivity

For GSM/GPRS/EDGE/HSPA+ networks

Overview

The LS300G is a cellular gateway for use on GSM/GPRS/EDGE/HSPA+ networks[a] such as AT&T, Rogers, Bell, and Telus. The LS300G comes standard with Ethernet, USB, and serial interfaces, making it easy for you to configure, deploy, and connect it to Campbell Scientific dataloggers, cameras, radios, and more. The LS300G can be used with any of our dataloggers. The LS300G requires a cellular data account for operation. Please contact your cellular network provider for data service.

Benefits and Features

Be confident in your choice

The LS300G is compatible with all Campbell Scientific dataloggers, which allows datalogger and/or software initiated M2M communications through a variety of protocols. The LS300G has a rugged design that adheres to military-specifications for extreme and hazardous conditions (MIL-STD 810). This makes it ideal for industrial deployments, and allows you to be confident that it'll work for your application.

Convenient and easy

Take advantage of the wide coverage of cellular networks to provide an internet connection to your remote data acquisition system. Collect data or control and manage devices through independent IP serial server and Ethernet host connections. You can even configure and troubleshoot your remote LS300G without leaving the office.

What You Will Need

- SIM card activated with data plan from your cellular provider
- Web browser access to the LS300G for configuration using the browser based AceManager utility
- Serial or Ethernet cable for connecting the LS300G to your device
- SW12 or control port with relay for controlling power
- A plan for how you wish to have your data reported or collected

[a]Compatible with virtually all 2G GSM networks; compatible with some 3G GSM networks outside the U.S. and Canada; see your local provider for more information.

Ordering Information

Digital Cellular Modem

LS300G	Airlink 3G GSM Digital Modem

Communication Cables and Interfaces

18663	Null Modem Cable 9-Pin Male to Male connects the LS300G directly to the datalogger's RS-232 port.
SC105	CS I/O to 9-Pin RS-232 DCE Synchronous Interface. Includes SC12 cable for connecting the LS300G to the datalogger's CS I/O port.
28899	CAT6 Cable, Unshielded with RJ45 Connectors for connecting the LS300G to an NL120 or NL201.
27555	USB 2.0 Cable Type A Male to Micro B Male for connecting the LS300G to the USB port on the NL201.

Temperature Ranges for SC105

-ST	-25° to +50°C
-XT	-55° to +85°C

Antennas (choose one)

21831	800 MHz, 0 dBd 1/2 Wave Whip Dipole Cellular Antenna with SMA connector that attaches directly to the LS300G. It can transmit short distances.
18285	1 dBd, Omnidirectional Antenna that covers both the 800 MHz and 1.9 GHz bands. It includes a mounting bracket. Connection to the modem requires an antenna cable (see right column).
20679	800 MHz/0 dBd and 1.9 GHz/3 dBd Omnidirectional Antenna. It includes a mounting bracket. Connection to the modem requires an antenna cable (see right column).
31128	Wideband 9 dBd, Yagi Antenna with mounting hardware. Connection to the modem requires an antenna cable (see right column).

Cables/Surge Suppressors for 18285, 20679, or 31128 Antenna

21847	Type N Male-to-SMA Antenna Cable with 12 ft length. If surge suppression is required, use the COAXNTN-L cable and 19533 Surge Suppressor Kit instead of this cable.
COAXSMA-L	Type N Male-to-SMA Antenna Cable with user-specified length; enter length, in feet, after the -L. Length should not exceed 6 m (20 ft). If surge suppression is required, use the COAXNTN-L cable and 19533 Surge Suppressor Kit instead of this cable.
COAXNTN-L	Type N Male-to-Type N Male Antenna Cable with user-specified length; enter length, in feet, after the -L. Cable lengths longer than 6 m (20 ft) will weaken the signal strength. This cable is used with the 19533 surge suppressor (see below) and is recommended for environments susceptible to lightning or electrostatic buildup.
19533	Antenna Surge Protector Kit that includes one COAXSMA-L1.5 cable. A COAXNTN-L cable is required (see above). This surge suppressor is used with the COAXNTN cable (see above) and is recommended for environments susceptible to lightning or electrostatic buildup.

Adjustable Angle Mounting Kits

CM230	Adjustable Angle Mounting Kit allows the 31128 Yagi or 20679 antenna to be aimed at the service provider's antenna. It attaches to a mast or pipe with a 1.3 to 2.1 in. OD.
CM230XL	Adjustable Angle Mounting Kit with Extended Length. Provides the same functionality as the CM230, but the CM230XL places the antenna further from the pole or crossarm.

Specifications

- Carrier Approval: AT&T, Rogers, Bell, and Telus
- Network: 3G HSPA+ with fallback to GSM/GPRS/EDGE

Host Interfaces

- 10/100 Base-T RJ45 Ethernet
- RS-232 serial port, DB9 Female
- USB version 2.0 with micro-B connector
- 2 SMA antenna connectors (primary, GPS/diversity)
- Active antenna support

Power

- Input Voltage: 7 to 28 Vdc
- Typical Current Drain (@12 Vdc):
  Dormant (idle for 10 to 20 s): 185 mA
  Transmit/Receive: 255 mA

Frequency[b]

- GSM/GPRS/EDGE: 1900/850/900/1800 MHz
- WCDMA: 1900/2100/850 MHz

Size

- Dimensions: 76 mm x 90 mm x 25 mm (3.0 in x 3.5 in x 1.0 in)
- Weight: 190 g (6.7 oz)

Environmental

- Operating Temperature Range: -30° to +70°C (-22° to +158°F)
- Storage Temperature: -40° to +85°C (-40° to +185°F)
- Humidity: 90% RH @ 60°C
- Military Specification: MIL-STD-810 conformance to thermal, mechanical shock, and humidity

Industry Certifications

- PTCRB, R&TTE, FCC, Industry Canada, CE, RoHS Compliant, Class 1 Div 2

[b] *This product uses the LS300G Sierra Wireless SL8090 radio module. Contact Campbell Scientific if you require WCDMA operation at 900/1200 MHz (SL8092 radio module).*

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Campbell Scientific, Inc.
October 15, 2014

18285

Dual-Band 1 dBd Omnidirectional Antenna

The 18285 is a dual-band, omnidirectional antenna for our CDMA and GPRS digital-cellular modems. It covers both the 800-MHz band and the 1.9-GHz band. For both bands, the 18285 provides a 1-dBd gain.

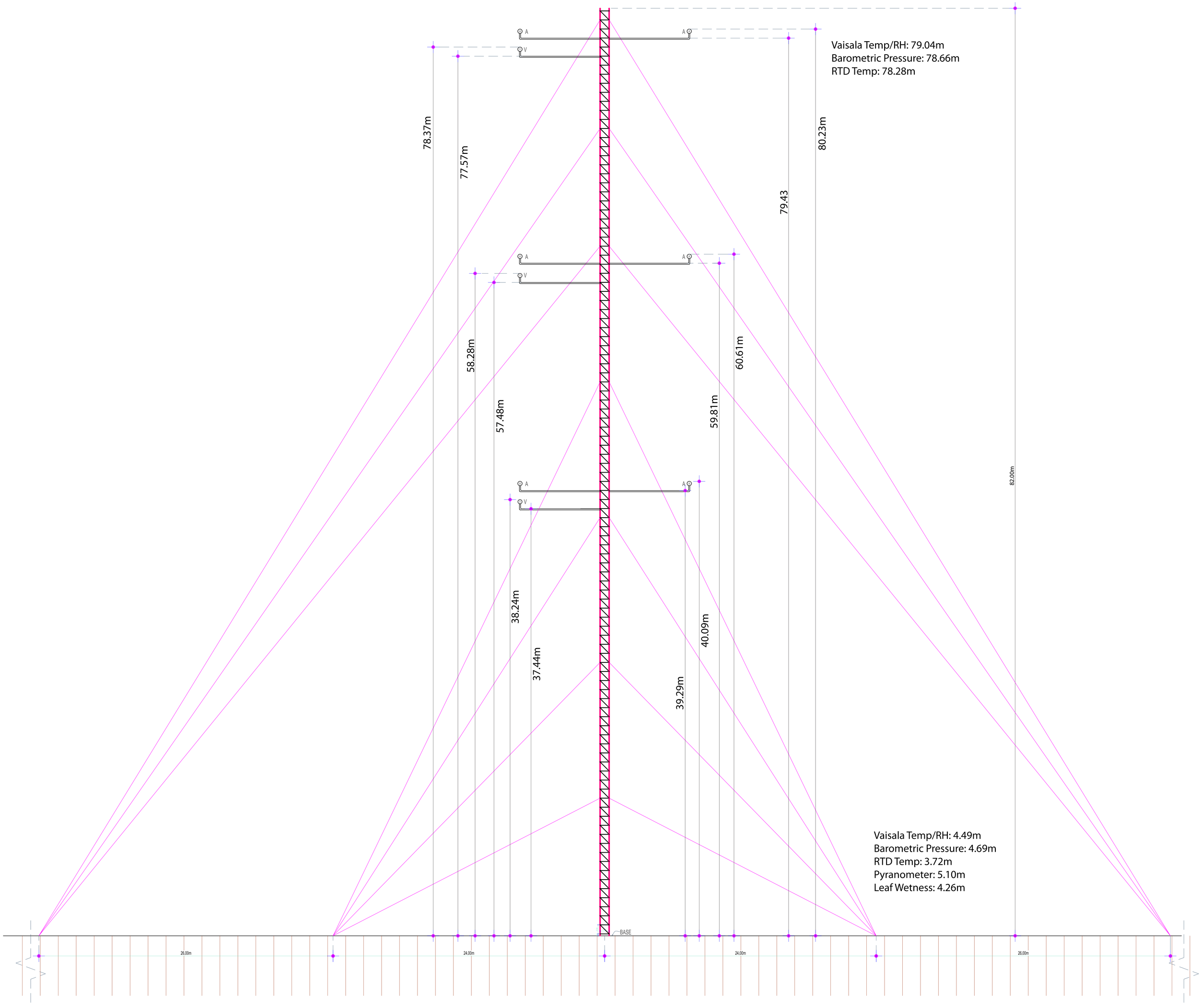
HARNESS ENERGY

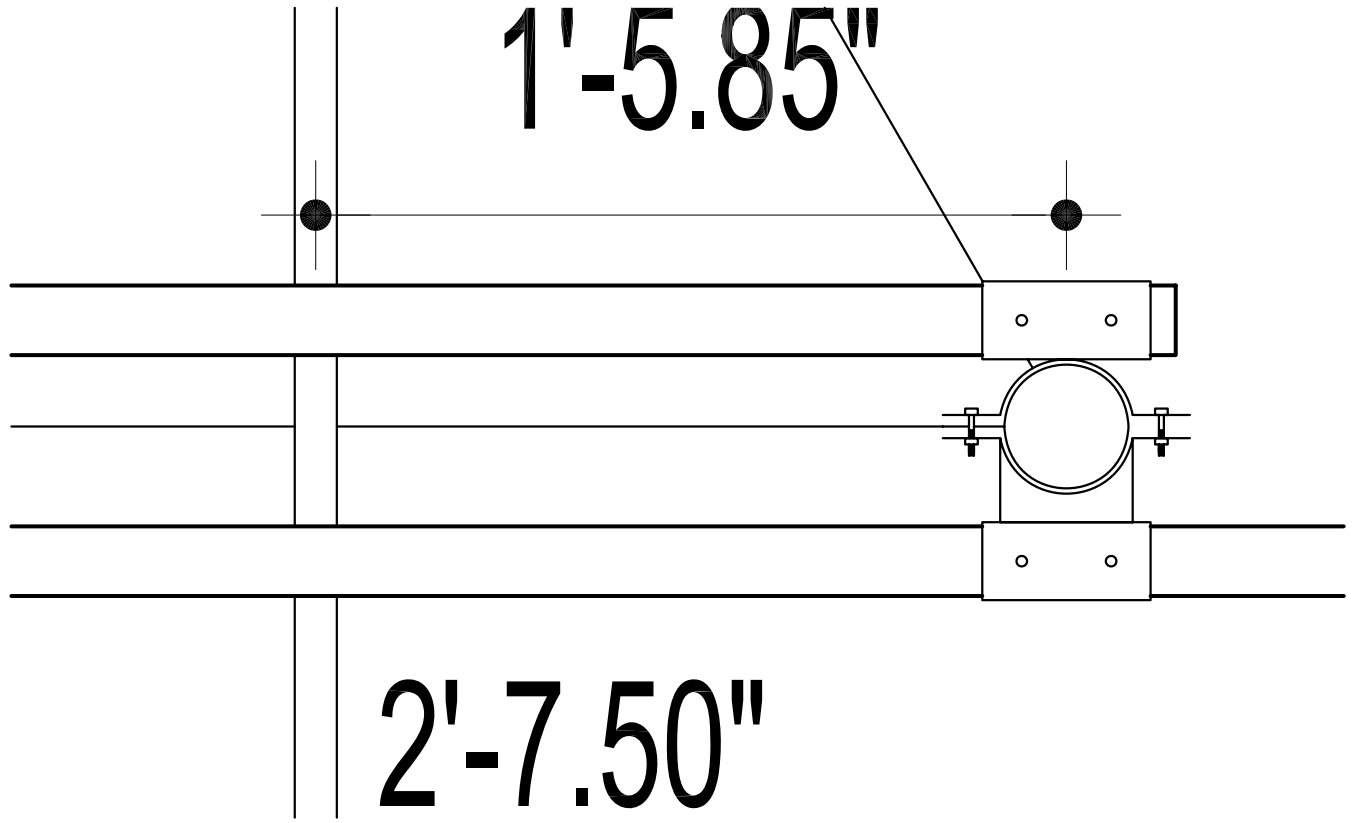
Sensor Information

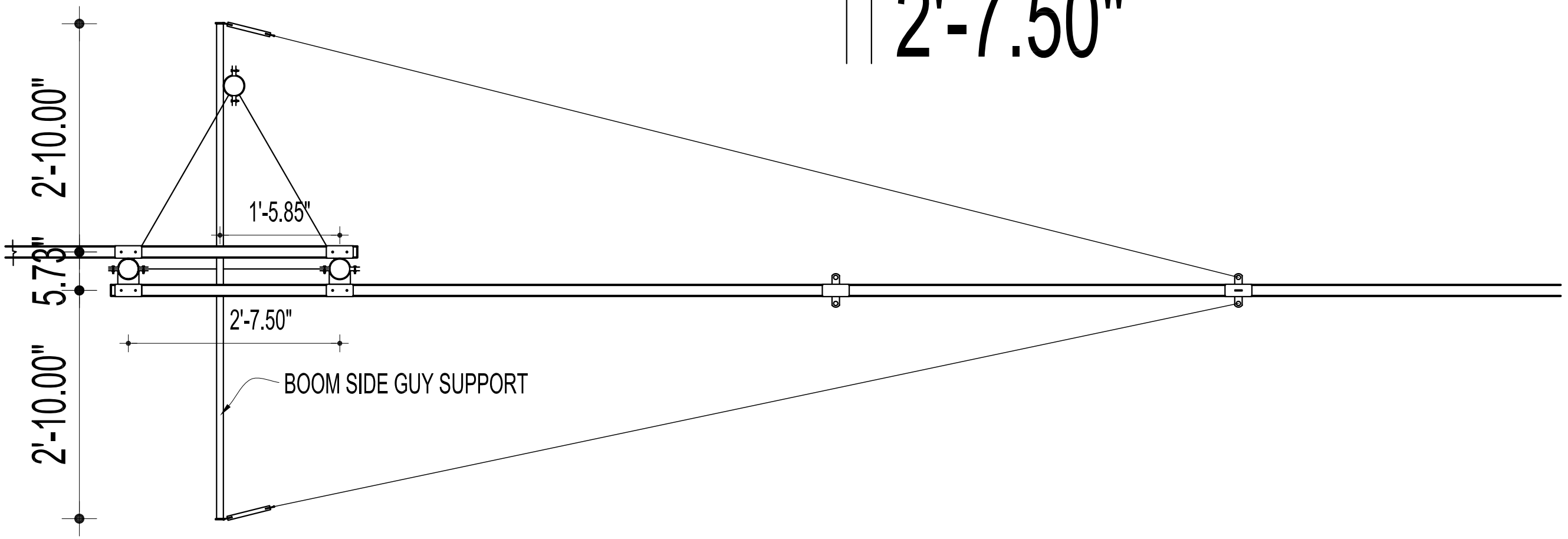
MYMENSINGH

INSTRUMENT MOUNTING

15 AUG 2015







TOP VIEW

PROJECT NAME
"BOOM DESIGN "

PROJECT TYPE
GUYED METEOROLOGICAL LATTICE TOWER

PROJECT LOCATION
BANGLADESH.

CLIENT'S NAME
HARNESS ENERGY BANGLADESH LTD

ARCHITECTURAL DESIGN

MONOLITH S. Design WORKSHOP
15/7,6th FLOOR, DARUS SALAM ARCADE,
PURANA PALTAN,
DHAKA.

ARCHITECT SIGNATURE
SHAKIL MAHMUD SHAMS

ENGINEER/CONSULTANTS

STRUCTURAL CONSULTANT

MECHANICAL CONSULTANT

PLUMBING CONSULTANT

ELECTRICAL CONSULTANT

BOOM AND ACCESSORIES
WEIGHT ±9.5KG

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[Article-7, Condition for engagement of Architects, Section-3, IAB Rules & Regulations]

SUBMISSION

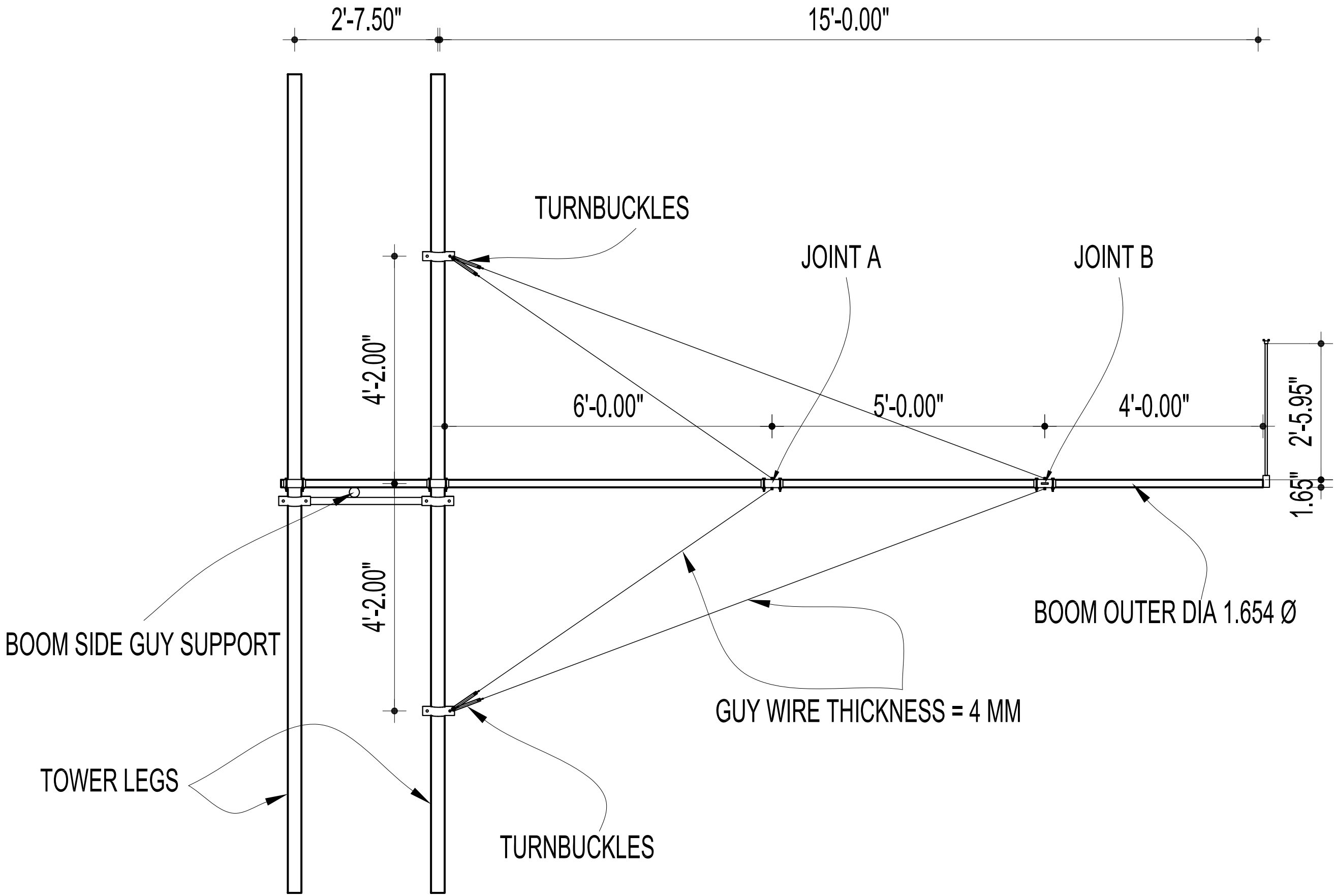
ISSUED TO	FOR	DATE
OWNER'S NAME		07.05.2014
CONSULTANT		
BID/ TENDER		

REVISIONS

SL.	DESCRIPTION	DATE
01.		
02.		

DRAWING TITLE
TOP VIEW

SCALE	AS SHOWN
SHEET SIZE	A3
SHEET NO	A-02
FILE LOCATION:	



SIDE VIEW

PROJECT NAME
"BOOM DESIGN "

PROJECT TYPE
GUYED METEOROLOGICAL LATTICE TOWER

PROJECT LOCATION
BANGLADESH.

CLIENT'S NAME
HARNESS ENERGY BANGLADESH LTD

ARCHITECTURAL DESIGN

MONOLITH
S. Design WORKSHOP
15/7,6th FLOOR, DARUS SALAM ARCADE,
PURANA PALTAN,
DHAKA.

ARCHITECT SIGNATURE
SHAKIL MAHMUD SHAMS

ENGINEER/CONSULTANTS

STRUCTURAL CONSULTANT

MECHANICAL CONSULTANT

PLUMBING CONSULTANT

ELECTRICAL CONSULTANT

BOOM AND ACCESSORIES
WEIGHT ±9.5KG

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[Article-7, Condition for engagement of Architects, Section-3, IAB Rules & Regulations]

SUBMISSION

ISSUED TO	FOR	DATE
OWNER'S NAME		07.05.2014
CONSULTANT		
BID/ TENDER		

REVISIONS

SL.	DESCRIPTION	DATE
01.		
02.		

DRAWING TITLE
SIDE VIEW

SCALE	AS SHOWN
SHEET SIZE	A3
SHEET NO	A-01

FILE LOCATION:

West Booms

East Booms

80m Level

80m West

80m East

60m Level

60m West

60m East

40m Level

40m West

40m East

Pyranometer

4m Temp / RH / GPS / Antenna

80m Temp / RH / BP

NRG Systems Class 1 Anemometer, MEASNET Calibrated

The Class 1 anemometer is the ideal, low-cost solution for wind resource assessment projects that require an anemometer with Class 1A compliance.

SPECIFICATIONS

	Description
Sensor type	3-cup anemometer
Applications	• wind resource assessment • meteorological studies • environmental monitoring
Sensor range	1 m/s to 96 m/s (2.2 mph to 215 mph) (highest tested)
Instrument compatibility	all NRG Systems data loggers
	Output signal
Signal type	low level AC sine wave, frequency linearly proportional to wind speed
Anemometer Transfer Function	• Refer to individual calibration report for anemometer transfer function. • All NRG Class 1 anemometers are calibrated per IEC 61400-12-1, Annex F.
Output voltage at threshold	80 mV (peak-to-peak) minimum
Output voltage at 60Hz	• 12 V (peak-to-peak) typical • output amplitude NOT proportional to wind speed
Calibration	each anemometer individually calibrated, calibration reports provided via electronic download
Output signal range	0 Hz to 125 Hz (highest recorded)
Uncertainty	IEC 61400-12-1 Classification • Class 1.01A • Class 8.44B IEC 61400-12-1 operational standard uncertainty: • ± 0.06 m/s at 10 m/s for class A

	• ± 0.49 m/s at 10 m/s for class B • Refer to individual calibration sheet for information on calibration uncertainty.
Response characteristics	
Threshold	0.79 m/s (1.77 mph) per ASTM D 5096-02
Distance constant (63% recovery)	• 2.36 m (7.74 ft) at 5 m/s per ASTM D 5096-02 • 2.28 m (7.48 ft) at 10 m/s per ASTM D 5096-02
Moment of inertia	• 1.01 x 10^{-4} kg-m^2 • 74.5 x 10^{-6} S-ft^2
Swept diameter of rotor	190 mm (7.5 inches)
Installation	
Mounting	onto a 13 mm (0.5 inch) diameter mast with cotter pin and set screw
Tools required	0.25 inch nut driver, petroleum jelly, electrical tape
Environmental	
Operating temperature range	-55 °C to 60 °C (-67 °F to 140 °F)
Operating humidity range	0 to 100% RH
Physical	
Connections	4-40 brass hex nut/post terminals
Weight	0.14 kg (0.3 lbs)
Dimensions	• 3 cups of conical cross-section, 51 mm (2 inches) dia. • 81 mm (3.2 inches) overall assembly height
Materials	
Cups	one piece injection-molded black polycarbonate
Body	housing is black ABS plastic
Shaft	hardened 400 series stainless steel
Bearing	ball bearings
Magnet	Indox 1, 25 mm (1 inch) diameter, 13 mm (0.5 inch) long, 4 poles
Coil	single coil, bobbin wound, 4100 turns of #40 wire, shielded for ESD protection
Boot	protective PVC sensor terminal boot included
Terminals	brass

Renewable NRG Systems #40C Anemometer, Calibrated, With Boot

The industry standard anemometer used worldwide. Constructed of rugged Lexan cups molded in one piece for repeatable performance. Includes calibration certificate.

SPECIFICATIONS

	Description
Sensor type	3-cup anemometer
Applications	• wind resource assessment • meteorological studies • environmental monitoring
Sensor range	1 m/s to 96 m/s (2.2 mph to 215 mph) (highest recorded)
Instrument compatibility	all NRG loggers
	Output signal
Signal type	Low level AC sine wave, frequency linearly proportional to wind speed
Anemometer Transfer Function	• Consensus Transfer Function: Scale Factor (Slope): 0.765 m/s/Hz (1.711 mph/Hz) Offset: 0.35 m/s (0.78 mph) • Refer to the white paper "The Maximum Type 40 Anemometer Calibration Project" for more information on the consensus transfer function • All NRG #40C Anemometers are calibrated per IEC 61400-12-1, Annex F
Output voltage at threshold	80 mV (peak-to-peak) minimum
Output voltage at 60Hz	• 12 V (peak-to-peak) typical • output amplitude NOT proportional to wind speed
Calibration	Each anemometer individually calibrated, calibration reports provided via electronic download
Output signal range	0 Hz to 125 Hz (highest recorded)

Output signal range	0 Hz to 125 Hz (highest recorded)
Uncertainty	Accuwind (Riso-R-1556) Classification: • Class 2.4A • Class 7.7B IEC 61400-12-1 operational standard uncertainty: • ± 0.14 m/s at 10 m/s for Class A • ± 0.45 m/s at 10 m/s for Class B • Refer to calibration sheet for information on calibration uncertainty • Refer to application note "#40C Anemometer Uncertainty" for definitions and more information
Response characteristics	
Distance constant (63% recovery)	• 2.55 m (8.37 feet) at 5m/s per ASTM D 5096-02 • 2.56 m (8.40 feet) at 10m/s per ASTM D 5096-02
Moment of inertia	• 1.01 x 10^{-4} kg-m^2 • 74.5 x 10^{-6} S-ft^2
Swept diameter of rotor	190 mm (7.5 inches)
Installation	
Mounting	Onto a 13 mm (0.5 inch) diameter mast with cotter pin and set screw
Tools required	0.25 inch nut driver, petroleum jelly, electrical tape
Environmental	
Operating temperature range	-55 °C to 60 °C (-67 °F to 140 °F)
Operating humidity range	0 to 100% RH
Physical	
Connections	4-40 brass hex nut/post terminals
Weight	0.14 kg (0.3 pounds)
Dimensions	• 3 cups of conical cross-section, 51 mm (2 inches) dia. • 81 mm (3.2 inches) overall assembly height
Materials	
Cups	One piece injection-molded black polycarbonate
Body	housing is black ABS plastic
Shaft	beryllium copper, fully hardened
Bearing	modified Teflon, self-lubricating
Magnet	Indox 1, 25 mm (1 inch) diameter, 13 mm (0.5 inch) long, 4 poles
Coil	single coil, bobbin wound, 4100 turns of #40 wire, shielded for ESD protection
Boot	protective PVC sensor terminal boot included
Terminals	brass

5967-00003806
80m - WS - EAST

80m - WS - EAST

80m - WS - EAST

HARNESS ENERGY

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WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 14.02.05250 **Date of issue:** September 15, 2014

Type: NRG Class 1 **Serial number:** 596700003806

Manufacturer: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: August 19, 2014 **Anemometer calibrated:** September 13, 2014

Calibrated by: apo **Procedure:** MEASNET, referring to IEC 61400-12-1

Certificate prepared by: cea **Approved by:** Calibration engineer, jsk

Calibration equation obtained: v [m/s] = 0.76963 · f [Hz] + 0.23476

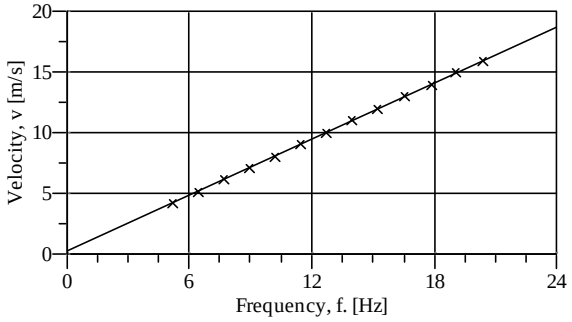
Standard uncertainty, slope: 0.00204 **Standard uncertainty, offset:** 0.09075

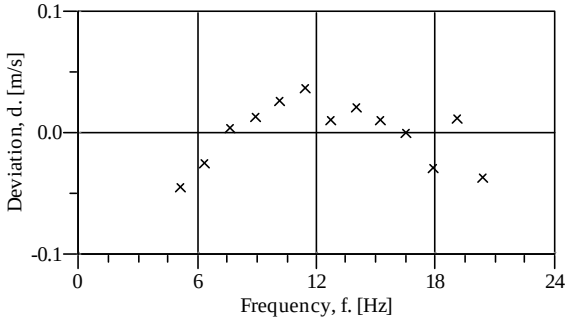
Covariance: -0.0000313 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999977$

Absolute maximum deviation: -0.045 m/s at 4.164 m/s

Barometric pressure: 1024.4 hPa **Relative humidity:** 31.0%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.99	34.4	24.4	4.164	5.1628	-0.045	0.021
4	15.21	34.3	24.3	5.136	6.4010	-0.025	0.025
6	21.64	34.2	24.3	6.126	7.6491	0.004	0.029
8	29.09	34.2	24.3	7.101	8.9031	0.014	0.033
10	37.66	34.1	24.3	8.078	10.1569	0.026	0.038
12	47.51	34.0	24.3	9.072	11.4338	0.037	0.042
13-last	58.18	34.0	24.3	10.039	12.7254	0.010	0.046
11	70.02	34.1	24.3	11.015	13.9799	0.021	0.051
9	82.82	34.1	24.3	11.981	15.2472	0.011	0.055
7	96.97	34.2	24.3	12.966	16.5411	0.001	0.060
5	112.07	34.3	24.3	13.940	17.8454	-0.029	0.064
3	128.61	34.4	24.3	14.935	19.0860	0.012	0.069
1-first	145.24	34.5	24.4	15.875	20.3709	-0.037	0.073





Accreditation to ISO 17025

CAL Reg.nr. 452

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
PS1	Pitot tube
HB2835279	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Exova Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

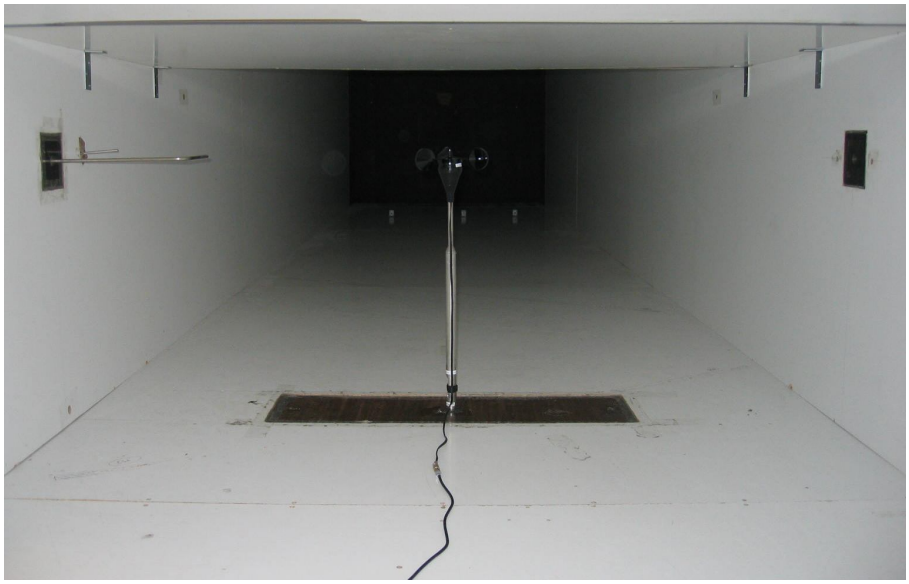


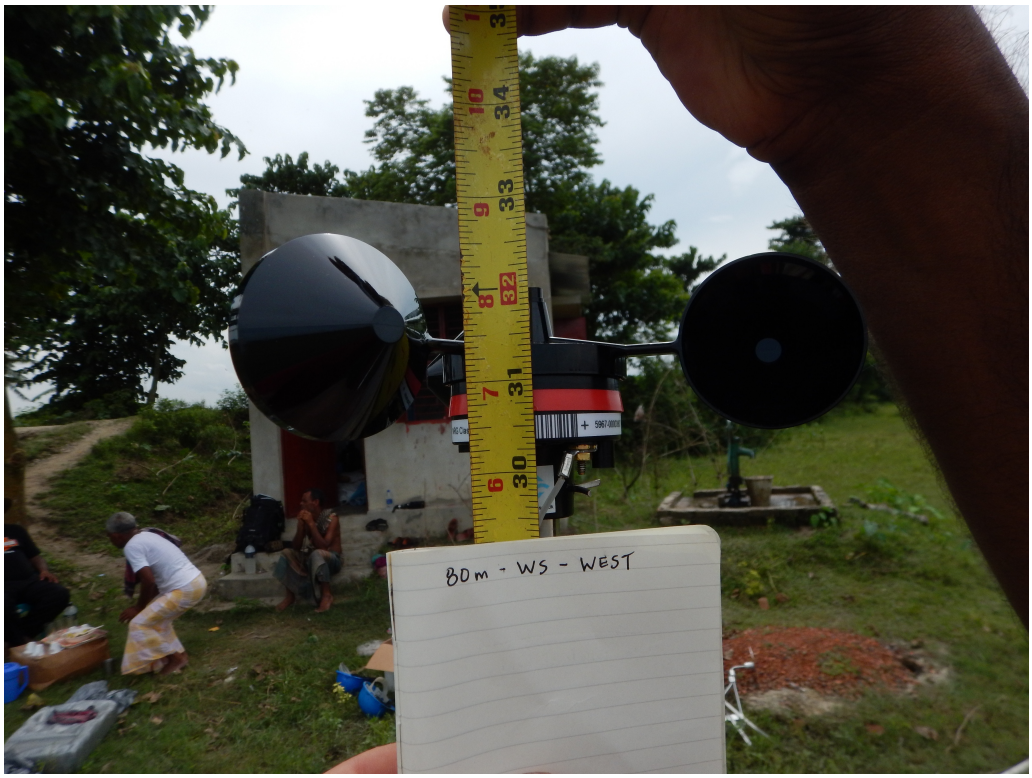
Photo of the wind tunnel setup (hxb = 0.85x1.75 m). The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 “MEASNET - Test report on the calibration campaign” for further details.

Certificate number: 14.02.05250

5967-00003807
80m - WS - WEST


80m - WS - WEST

80m - WS - WEST

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WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 14.02.05249 **Date of issue:** September 15, 2014

Type: NRG Class 1 **Serial number:** 596700003807

Manufacturer: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: August 19, 2014 **Anemometer calibrated:** September 13, 2014

Calibrated by: apo **Procedure:** MEASNET, referring to IEC 61400-12-1

Certificate prepared by: cea **Approved by:** Calibration engineer, jsk

Calibration equation obtained: v [m/s] = 0.77059 · f [Hz] + 0.20990

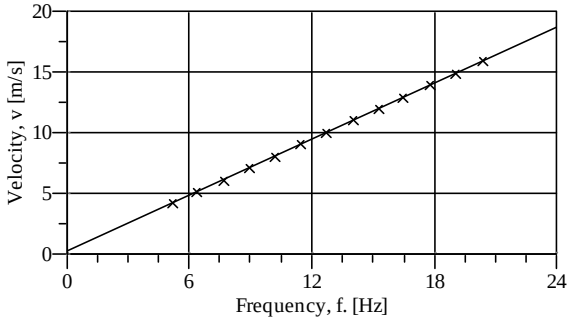
Standard uncertainty, slope: 0.00159 **Standard uncertainty, offset:** 0.07919

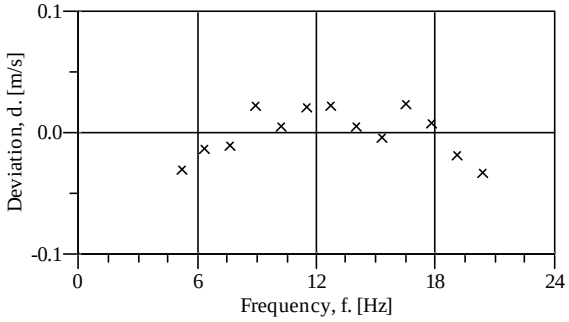
Covariance: -0.0000190 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999986$

Absolute maximum deviation: -0.033 m/s at 15.875 m/s

Barometric pressure: 1024.2 hPa **Relative humidity:** 31.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	10.15	34.3	24.3	4.197	5.2136	-0.031	0.021
4	15.11	34.2	24.3	5.119	6.3870	-0.013	0.025
6	21.52	34.1	24.2	6.107	7.6663	-0.010	0.029
8	29.05	34.1	24.2	7.095	8.9057	0.023	0.033
10	37.63	34.0	24.2	8.074	10.1990	0.005	0.038
12	47.62	33.9	24.2	9.082	11.4863	0.021	0.042
13-last	58.06	33.9	24.2	10.028	12.7112	0.023	0.046
11	69.98	33.9	24.2	11.010	14.0091	0.005	0.051
9	82.95	34.0	24.2	11.988	15.2894	-0.003	0.055
7	96.84	34.1	24.2	12.955	16.5082	0.024	0.060
5	112.10	34.2	24.3	13.940	17.8073	0.008	0.064
3	128.00	34.2	24.3	14.898	19.0851	-0.019	0.069
1-first	145.28	34.4	24.3	15.875	20.3718	-0.033	0.073





Accreditation to ISO 17025

CAL Reg.nr. 452

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
PS1	Pitot tube
HB2835279	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Exova Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

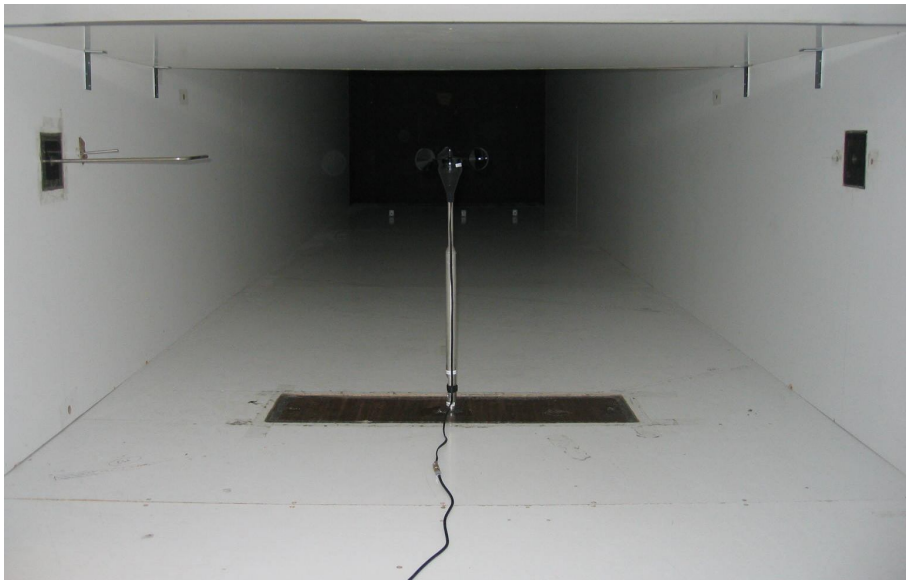


Photo of the wind tunnel setup (hxb = 0.85x1.75 m). The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 “MEASNET - Test report on the calibration campaign” for further details.

Certificate number: 14.02.05249

5967-00003801
WS - 60m - EAST

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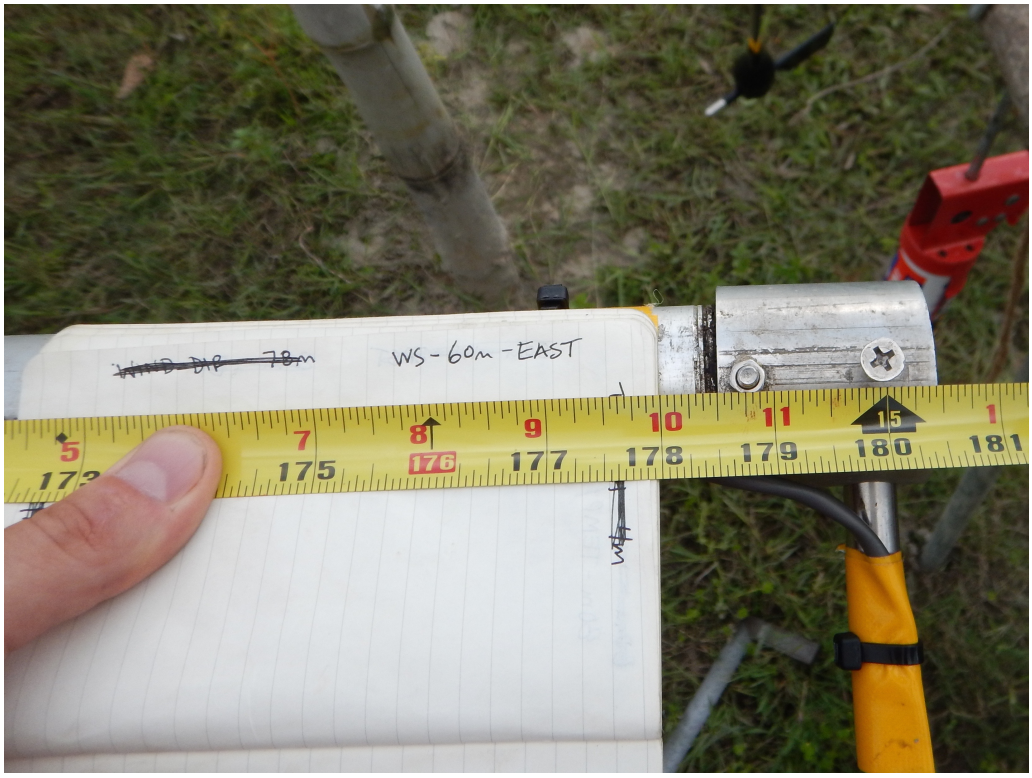
WS - 60m - EAST


~~WIND DIR 78m~~
WS - 60m - EAST
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East

HARNESS ENERGY

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WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 14.02.05255 **Date of issue:** September 15, 2014

Type: NRG Class 1 **Serial number:** 596700003801

Manufacturer: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: August 19, 2014 **Anemometer calibrated:** September 13, 2014

Calibrated by: apo **Procedure:** MEASNET, referring to IEC 61400-12-1

Certificate prepared by: cea **Approved by:** Calibration engineer, jsk

Calibration equation obtained: v [m/s] = 0.76947 · f [Hz] + 0.23779

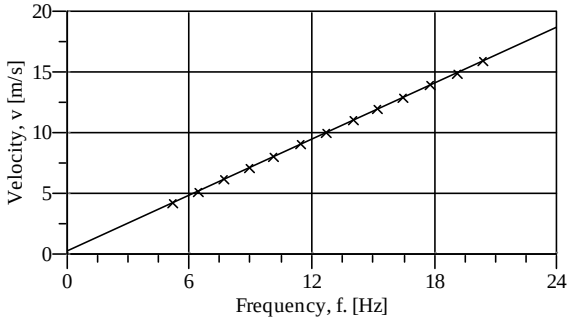
Standard uncertainty, slope: 0.00190 **Standard uncertainty, offset:** 0.08343

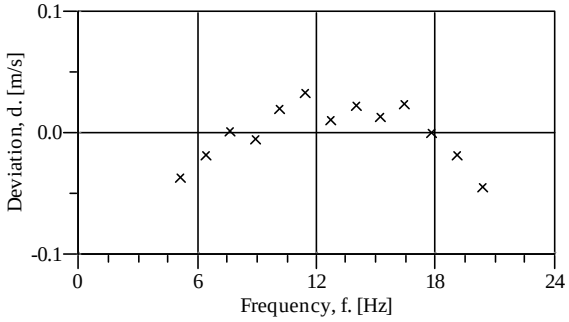
Covariance: -0.0000272 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999980$

Absolute maximum deviation: -0.044 m/s at 15.865 m/s

Barometric pressure: 1024.4 hPa **Relative humidity:** 31.0%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	10.06	34.7	24.7	4.181	5.1717	-0.037	0.021
4	15.42	34.6	24.7	5.174	6.4403	-0.019	0.025
6	21.62	34.5	24.6	6.126	7.6506	0.001	0.029
8	28.96	34.4	24.6	7.088	8.9086	-0.005	0.033
10	37.56	34.4	24.6	8.072	10.1549	0.020	0.038
12	47.26	34.3	24.6	9.053	11.4125	0.033	0.042
13-last	57.93	34.3	24.6	10.022	12.7024	0.010	0.046
11	70.22	34.3	24.6	11.035	14.0030	0.023	0.051
9	82.74	34.4	24.6	11.980	15.2425	0.013	0.055
7	96.09	34.5	24.6	12.912	16.4412	0.023	0.060
5	112.11	34.5	24.7	13.949	17.8202	-0.001	0.064
3	128.40	34.6	24.7	14.931	19.1195	-0.019	0.069
1-first	144.91	34.8	24.7	15.865	20.3671	-0.044	0.073





Accreditation to ISO 17025

CAL Reg.nr. 452

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
PS1	Pitot tube
HB2835279	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Exova Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

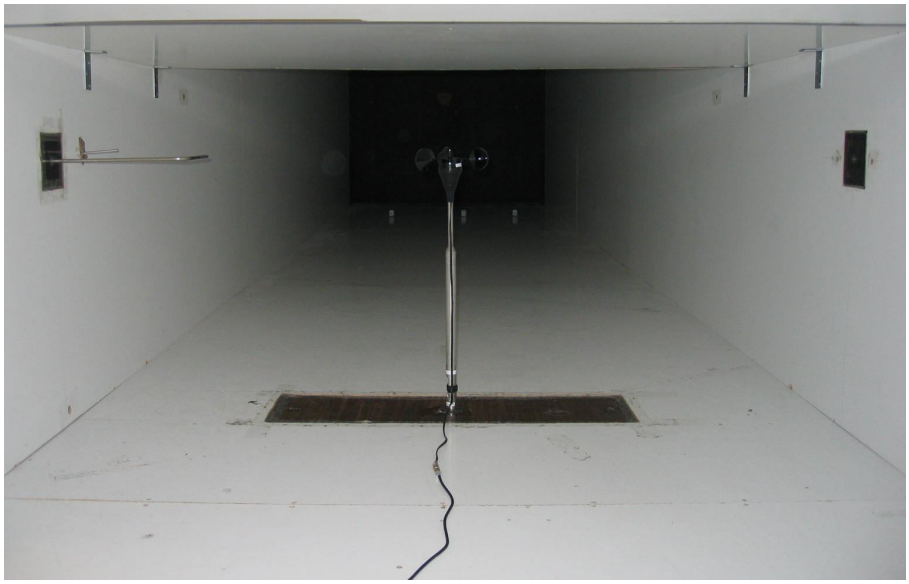


Photo of the wind tunnel setup (hxb = 0.85x1.75 m). The shown anemometer is of the same type as the calibrated one.

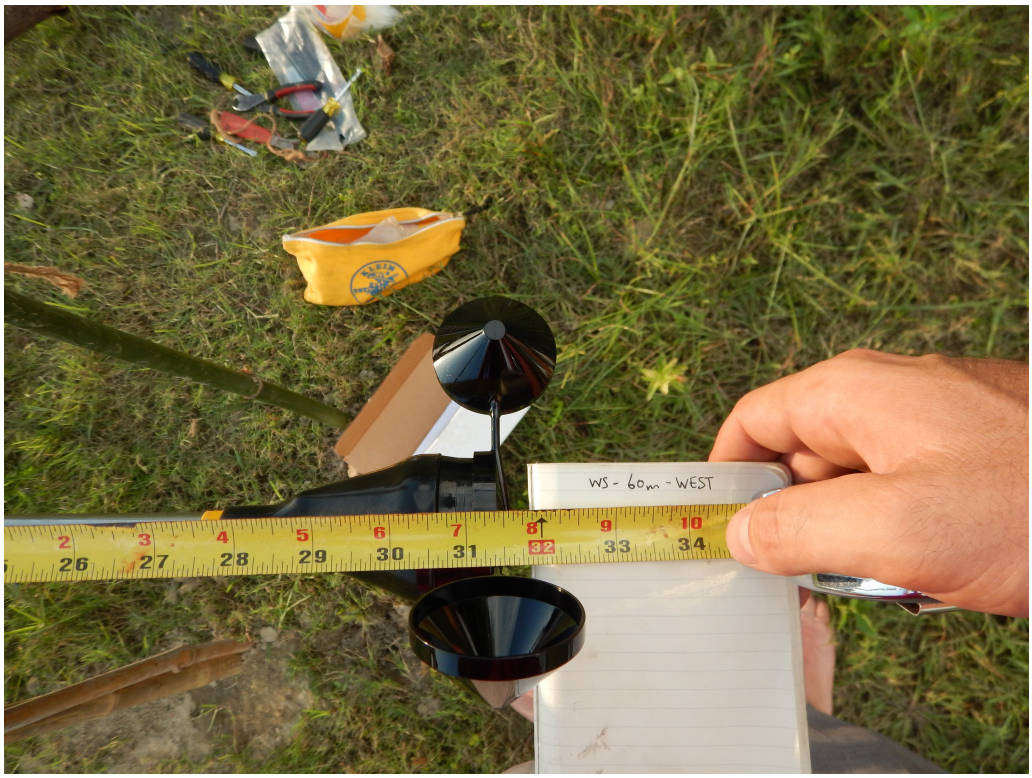
UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 “MEASNET - Test report on the calibration campaign” for further details.

Certificate number: 14.02.05255

HARNESS ENERGY

MET MAST LOG



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SOH Wind Engineering LLC

141 Leroy Road · Williston, VT 05495 · USA

Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF ANEMOMETER

Certificate number: 14.US2.04845 **Date of issue:** June 13, 2014

Type: NRG #40C **Serial number:** 179500235644

Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: May 28, 2014 **Anemometer calibrated:** June 13, 2014

Calibrated by: mej **Calibration procedure:** IEC 61400-12-1:2005(E) Annex F

Certificate prepared by: Software Revision 3 **Approved by:** Calibration engineer, rds

Calibration equation obtained: v [m/s] = 0.76475 · f [Hz] + 0.32712

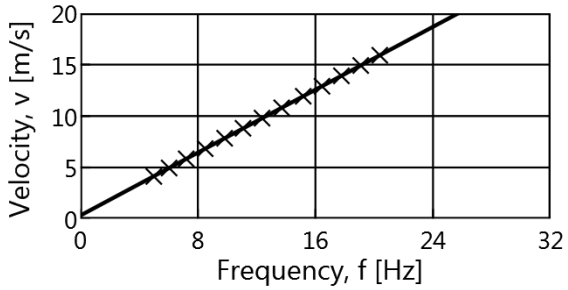
Standard uncertainty, slope: 0.00073 **Standard uncertainty, offset:** 0.02279

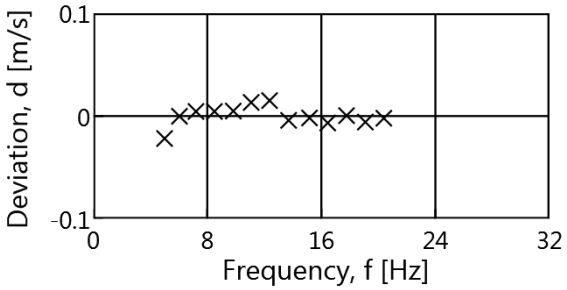
Covariance: -0.0000039 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999997

Absolute maximum deviation: 0.022 m/s at 4.134 m/s

Barometric pressure: 998.5 hPa **Relative humidity:** 54.3%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.96	23.5	25.3	4.134	5.0064	-0.022	0.047
4	14.29	23.6	25.3	4.951	6.0461	0.000	0.039
6	19.90	23.6	25.3	5.843	7.2066	0.004	0.034
8	27.21	23.6	25.3	6.833	8.5017	0.004	0.029
10	35.85	23.6	25.3	7.844	9.8233	0.005	0.026
12	45.23	23.6	25.3	8.811	11.0768	0.013	0.024
13-last	55.95	23.6	25.3	9.800	12.3671	0.015	0.023
11	67.98	23.6	25.3	10.803	13.7034	-0.004	0.022
9	82.86	23.6	25.3	11.926	15.1695	-0.002	0.022
7	96.92	23.6	25.3	12.898	16.4471	-0.007	0.022
5	112.78	23.6	25.3	13.913	17.7651	0.000	0.022
3	129.65	23.5	25.3	14.917	19.0854	-0.006	0.022
1-first	147.55	23.5	25.3	15.911	20.3808	-0.002	0.023





AC-1746

Standard: ISO/IEC 17025

EQUIPMENT USED

Serial Number	Description
Njord 2	Wind tunnel, blockage factor = 1.001
13924	Control cup anemometer
-	Mounting tube, D = 12.7 mm
TT003	Summit RT-AUI, wind tunnel
TT002	Summit RT-AUI, differential pressure box
DP007	Setra Model 239 pressure transducer
HY003	Dwyer Instruments RHP-2D20 humidity transmitter
BP003	Setra Model 278 barometer
PL4	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
66GSPS1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: TRANSCAT, Atlantic Scale, & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

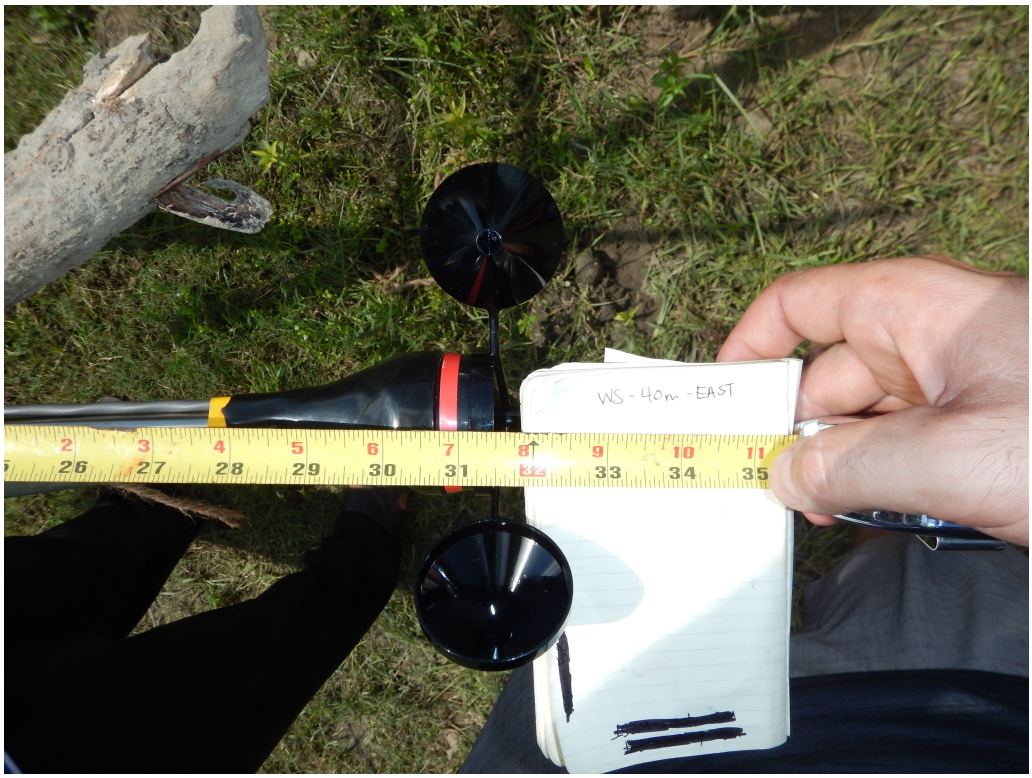
Photo of the wind tunnel setup. The cross-sectional area is 2.5 x *2.5 m.*

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.DC.016 for further details.

Certificate number: 14.US2.04845

WS - 40m - EAST


WS - 40m - EAST

Edge of Tower
WS - 40m - EAST
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40m
EAST
40m

HARNESS ENERGY

MET MAST LOG

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WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 14.02.05248 **Date of issue:** September 15, 2014

Type: NRG Class 1 **Serial number:** 596700003808

Manufacturer: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: August 19, 2014 **Anemometer calibrated:** September 13, 2014

Calibrated by: apo **Procedure:** MEASNET, referring to IEC 61400-12-1

Certificate prepared by: cea **Approved by:** Calibration engineer, jsk

Calibration equation obtained: v [m/s] = 0.77058 · f [Hz] + 0.21718

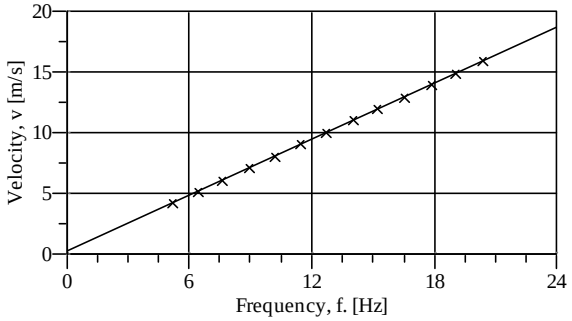
Standard uncertainty, slope: 0.00188 **Standard uncertainty, offset:** 0.09075

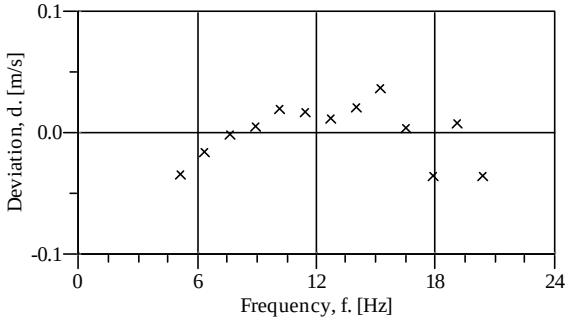
Covariance: -0.0000268 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999981$

Absolute maximum deviation: 0.037 m/s at 11.991 m/s

Barometric pressure: 1024.1 hPa **Relative humidity:** 31.2%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	10.10	34.2	24.2	4.185	5.1934	-0.035	0.021
4	15.21	34.1	24.2	5.135	6.4025	-0.016	0.025
6	21.41	34.0	24.2	6.091	7.6248	-0.002	0.029
8	29.30	33.9	24.2	7.124	8.9560	0.006	0.033
10	37.69	33.9	24.2	8.079	10.1778	0.019	0.038
12	47.16	33.8	24.2	9.036	11.4217	0.018	0.042
13-last	58.05	33.8	24.2	10.025	12.7136	0.011	0.046
11	70.32	33.8	24.2	11.035	14.0111	0.021	0.051
9	83.01	33.9	24.2	11.991	15.2308	0.037	0.055
7	96.76	34.0	24.2	12.947	16.5144	0.004	0.060
5	112.08	34.0	24.2	13.937	17.8508	-0.036	0.064
3	128.25	34.1	24.2	14.910	19.0575	0.007	0.069
1-first	145.47	34.2	24.3	15.883	20.3768	-0.036	0.073





Accreditation to ISO 17025

CAL Reg.nr. 452

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
t2	PT100 temperature sensor, control room.
9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
PS1	Pitot tube
HB2835279	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Exova Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

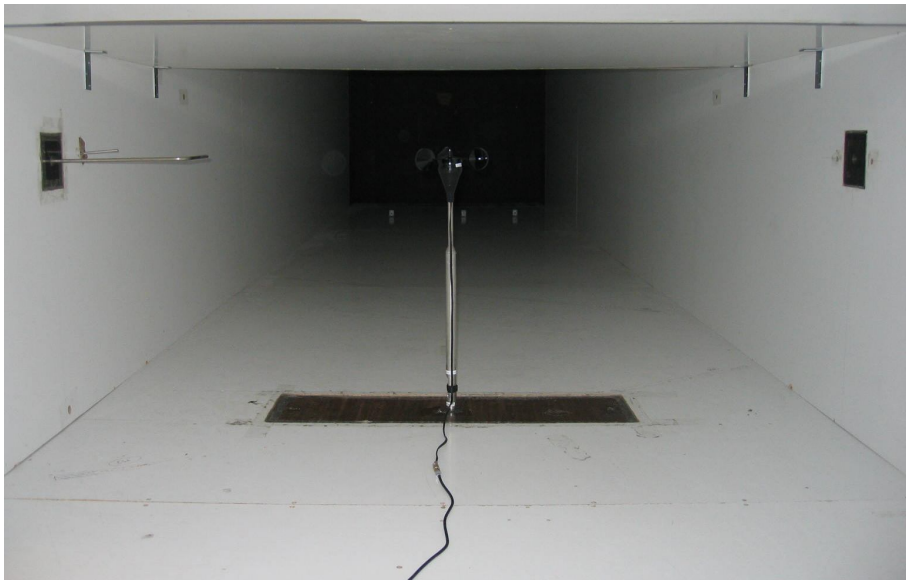


Photo of the wind tunnel setup (hxb = 0.85x1.75 m). The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 “MEASNET - Test report on the calibration campaign” for further details.

Certificate number: 14.02.05248

5967-00003809
[redacted]
WS - 40m - WEST

[redacted]
WS - 40m - WEST

WS - 40m - WEST
176
177
178
179
180
181
182
183
184
185

40m
EAST

Svend Ole Hansen ApS
SCT. JØRGENS ALLÉ 7 · DK-1615 KØBENHAVN V · DENMARK
TEL: (+45) 33 25 38 38 · FAX: (+45) 33 25 38 39 · WWW.SOHANSEN.DK

WIND ENGINEERING FLUID DYNAMICS

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 14.02.05247 **Date of issue:** September 15, 2014

Type: NRG Class 1 **Serial number:** 596700003809

Manufacturer: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems, Inc., 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: August 19, 2014 **Anemometer calibrated:** September 13, 2014

Calibrated by: jjj **Procedure:** MEASNET, referring to IEC 61400-12-1

Certificate prepared by: cea **Approved by:** Calibration engineer, jsk

Calibration equation obtained: v [m/s] = 0.76834 · f [Hz] + 0.22833

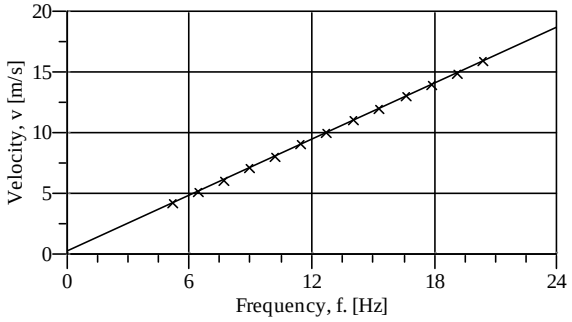
Standard uncertainty, slope: 0.00184 **Standard uncertainty, offset:** 0.08441

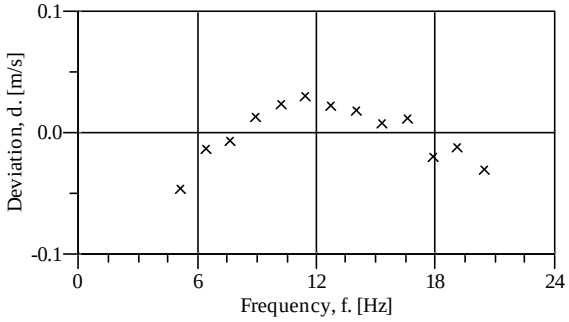
Covariance: -0.0000256 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999981$

Absolute maximum deviation: -0.046 m/s at 4.171 m/s

Barometric pressure: 1024.0 hPa **Relative humidity:** 31.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	control room [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	10.04	34.1	24.0	4.171	5.1922	-0.046	0.021
4	15.29	34.0	24.0	5.147	6.4194	-0.014	0.025
6	21.56	33.9	24.0	6.112	7.6664	-0.006	0.029
8	29.14	33.9	24.0	7.104	8.9315	0.014	0.033
10	37.73	33.8	24.0	8.084	10.1930	0.024	0.038
12	47.52	33.7	24.0	9.071	11.4701	0.030	0.042
13-last	58.20	33.7	24.0	10.037	12.7369	0.023	0.046
11	70.25	33.7	24.0	11.029	14.0332	0.019	0.051
9	82.66	33.8	24.0	11.965	15.2657	0.007	0.055
7	97.41	33.9	24.0	12.991	16.5939	0.012	0.060
5	112.02	34.0	24.0	13.932	17.8623	-0.020	0.064
3	128.22	34.0	24.0	14.908	19.1214	-0.012	0.069
1-first	145.72	34.2	24.0	15.896	20.4305	-0.030	0.073





Accreditation to ISO 17025

CAL Reg.nr. 452

EQUIPMENT USED

Serial number	Description
-	Boundary layer wind tunnel.
1256	Control cup anemometer.
-	Mounting tube, D = 25 mm
t1	PT100 temperature sensor, wind tunnel.
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9904031	PPC500 Furness pressure manometer
X4650038	HMW71U Humidity transmitter
X4350042	PTB100AVaisala analogue barometer.
PS1	Pitot tube
HB2835279	Computer Board. 16 bit A/D data acquisition board.
-	PC dedicated to data acquisition.

Traceable calibrations of the equipment are carried out by external accredited institutions: Furness (PPC500) and Exova Metech. A real-time analysis module within the data acquisition software detects pulse frequency.

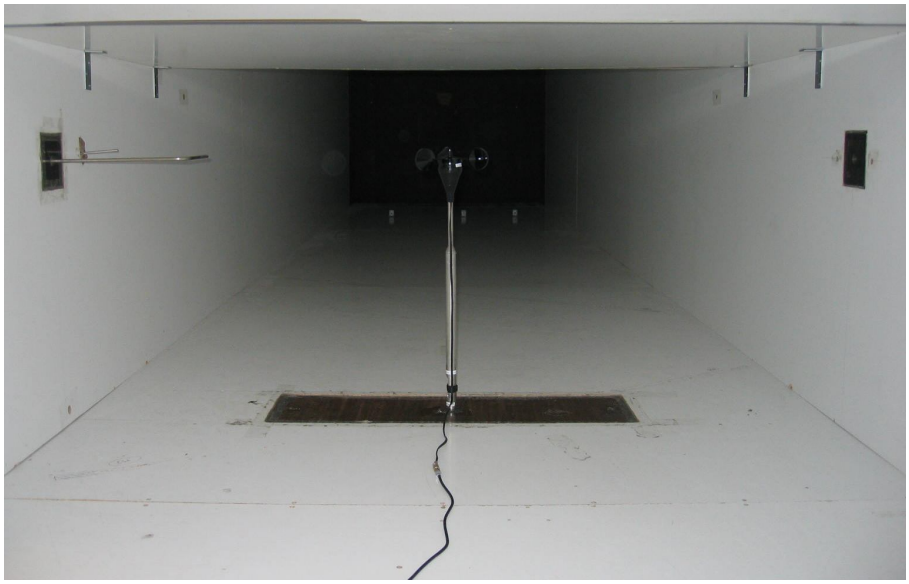


Photo of the wind tunnel setup (hxb = 0.85x1.75 m). The shown anemometer is of the same type as the calibrated one.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the MEASNET procedure that prescribes an absolute uncertainty less than 0.1 m/s at a mean wind velocity of 10 m/s, that is 1%. See Document 97.00.004 “MEASNET - Test report on the calibration campaign” for further details.

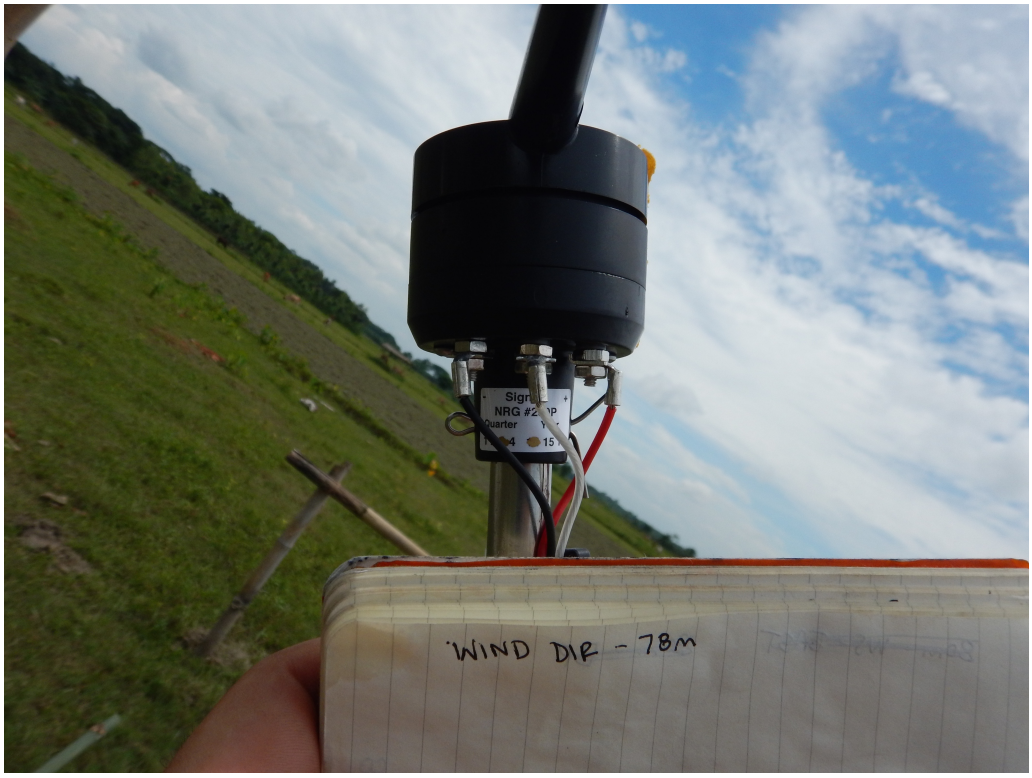
Certificate number: 14.02.05247

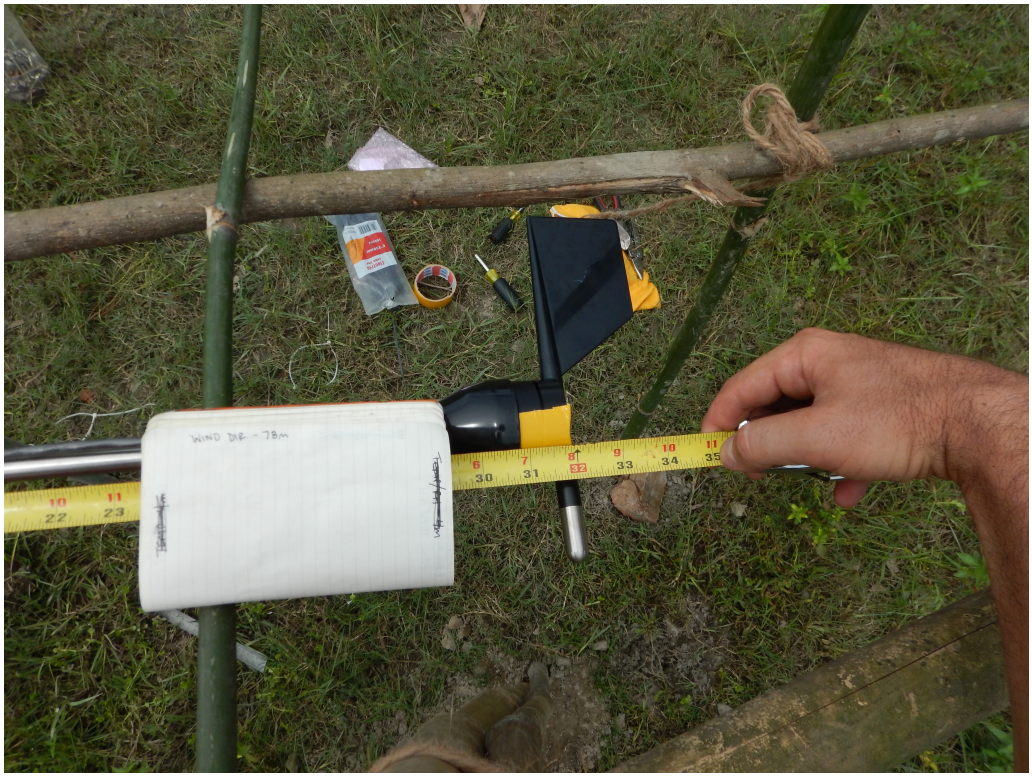
NRG #200P Wind Direction Vane, 10K, With Boot

The industry standard wind direction vane used worldwide. Thermoplastic and stainless steel components resist corrosion and contribute to a high strength-to-weight ratio.

SPECIFICATIONS

	Description
Sensor type	continuous rotation potentiometric wind direction vane
Applications	• wind resource assessment • meteorological studies • environmental monitoring
Sensor range	360° mechanical, continuous rotation
Instrument compatibility	all NRG loggers
	Output signal
Signal type	Analog DC voltage from conductive plastic potentiometer, 10K ohms
Transfer function	Output signal is a ratiometric voltage
Accuracy	potentiometer linearity within 1%
Dead band	8° Maximum, 4° Typical
Output signal range	0 V to excitation voltage (excluding deadband)
	Response characteristics
Threshold	1 m/s (2.2 miles per hour)
	Power requirements
Supply voltage	Regulated potentiometer excitation of 1 V to 15 V DC
	Installation
Mounting	onto a 13 mm (0.5 inch) diameter mast with cotter pin and set screw
Tools required	0.25 inch nut driver, petroleum jelly, electrical tape
	Environmental
Operating temperature range	-55 °C to 60 °C (-67 °F to 140 °F)
Operating humidity range	0 to 100% RH
Lifespan	50 million revolutions (2 to 6 years normal operation)
	Physical
Connections	4-40 brass hex nut/post terminals
Weight	0.14 kg (0.3 pounds)
Dimensions	• 21 cm (8.3 inches) length x 12 cm (4.3 inches) height • 27 cm (10.5 inches) swept diameter
	Materials
Wing	black UV stabilized injection molded plastic
Body	black UV stabilized static-dissipating plastic
Shaft	stainless steel
Bearing	stainless steel
Boot	protective PVC sensor terminal boot included
Terminals	brass


WIND DIR - 78m


WIND DIR - 78m

WIND DIR - 78m
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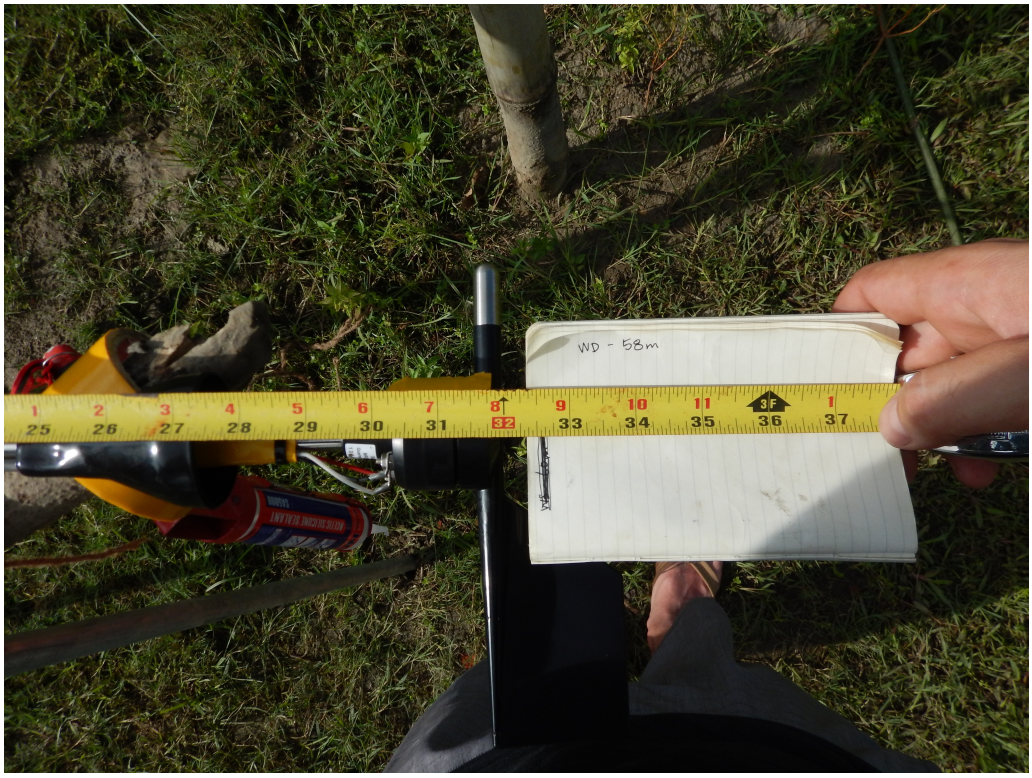
WD - 58m

WD - 58m


WD - 58m

WD - 58m
Edge of Tower

S&M VANE

WD - 38m

WD - 38m

WD - 38m

WD - 38m

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

43347 and 43502

RTD Temperature Probe and Aspirated Radiation Shield

Very High Accuracy

Good for air-quality applications

Overview

The 43347* is a highly-accurate RTD that often provides delta temperature measurements for air quality applications. Typically, it is housed in the 43502* fan-aspirated radiation shield, which greatly reduces radiation errors. The 43347 may also be housed in a 41003-5 Naturally Aspirated Shield if fan-driven aspiration is not required.

Benefits and Features

- Uses 1000 Ω RTD for highly accurate air temperature measurements
- Well-suited for air quality applications
- 43502 fan-aspirated radiation shield reduces radiation errors for more accurate measurements
- Ideal for delta temperature measurements used in calculating atmospheric stability class
- Standard RTD uncertainty is ±0.3°C. With optional three point calibration, uncertainty is only ±0.1°C.

Technical Description

Delta Temperature Measurements

To determine delta temperature, a 43347 probe mounted in a 43502 shield is attached to the mast of a UT20 or UT30 tower, while another 43347 probe mounted in a 43502 shield is attached to the tower at a 2 m height. The temperature difference of the two measurement heights is calculated and used to determine atmospheric stability as required by the EPA.

43502 Aspirated Radiation Shield

The 43502 employs concentric downward facing intake tubes and a small canopy shade to isolate the temperature probe from direct and indirect radiation. The 43347 probe mounts vertically in the center of the intake tubes. A brushless 12 Vdc blower motor pulls ambient air into the shield and across the probe to reduce radiation errors. This allows temperature to be measured with an RMS error of less than ±0.2°C. The blower operates off a 115 Vac to 12 Vdc transformer that is included with the shield.

**The 43347 and 43502 are manufactured by R. M. Young.*

Ordering Information

Temperature Probe (wiring configuration option required)

43347-L R. M. Young RTD Temperature Probe with user-specified cable length. Enter the cable length (in feet) after the -L. Order an 11 ft (43347-L11) cable length for the 2 m measurement height; a 24 ft (43347-L24) cable length for mounting to the mast of a UT20 tower, and a 34 ft (43347-L34) cable length for mounting to the mast of a UT30 tower.

Wiring Configuration Options (one required)

-VX 4-Wire Half Bridge/VX. Choose this option to connect the 43347 RTD to the datalogger's voltage switched excitation ports. With this option, the sensor can connect directly to a CR800, CR850, CR1000, CR3000, CR5000, CR9000X, CR7, CR510, or CR10X.

-IX Resistance/IX. Choose this option to connect the 43347 to the switched current outputs of a CR3000 or CR5000 datalogger.

Calibration Option

-CC Optional 3-point calibration for the 43347 that provides ±0.1°C uncertainty (-50° to +50°C).

Aspirated Shield

43502-L R. M. Young Compact Aspirated Radiation Shield with user-specified power cable length; enter the cable length (in feet) after the -L. Order an 11 ft (43502-L11) cable length for the 2 m measurement height; a 24 ft (43502-L24) cable length for mounting to the mast of a UT20 tower, and a 34 ft (43502-L34) cable length for mounting to the mast of a UT30 tower.

Accessories

41003-5 10-plate Gill Naturally Aspirated Radiation Shield for applications that do not require fan-aspiration It requires the 27251 split nut (see below).

27251 Split nut plug that is required to mount the 43347 in the 41003-5 radiation shield.

CM210 Crossarm-to-Pole Bracket for attaching the 43502 onto two tower legs via a crossarm (one of the CM210s is included with the crossarm.

Specifications

43347 RTD Temperature Probe

- Sensing Element: HY-CAL 1000 Ω Platinum RTD
- Temperature Range: ±50°C
- Accuracy: ±0.3°C at 0°C; ±0.1°C with NIST calibration
- Temperature Coefficient: 0.00375 Ω °C^{-1}
- Ambient Temperature (when housed in the 43502 shield): < 0.2°C RMS at 1000 W/m^2 intensity
- Delta T (when housed in the 43502 shield): < 0.05°C RMS with 43502 shields equally exposed
- Overall Length: 17.8 cm (7 in)
- Probe Tip Diameter: 0.318 cm (0.125 in)
- Probe Tip Length: 5.72 cm (2.25 in)
- Weight: 0.54 kg (1.2 lb)

For the 2 m measurement, the 43502 attaches to the legs of a UT20 or UT30 tower via a CM202, CM203, CM204, or CM206 crossarm. Two CM210s can be used to attach the crossarm to two tower legs.

43502 Aspirated Radiation Shield

- Aspiration Rate: 5 to 11 m s^{-1} (16 to 36 fps) depending on sensor size
- Ambient Temperature: < 0.2°C (0.4°F) RMS at 1000 W/m^2 intensity
- Delta T: < 0.05°C (0.1°F) RMS with like shields equally exposed
- Power Required: 12 to 14 Vdc at 500 mA for blower
- Mounting: V-block and U-bolt for vertical pipe with 2.5 cm to 5.0 cm (1.0 in. to 2.0 in.) diameter
- Length: 33 cm (13 in)
- Diameter: 20 cm (8 in)
- Weight: 1.1 kg (2.5 lb)

For the upper measurement, attach the 43502 to the top most mast of a UT20 or UT30 tower (20 ft and 30 ft measurement heights, respectively).

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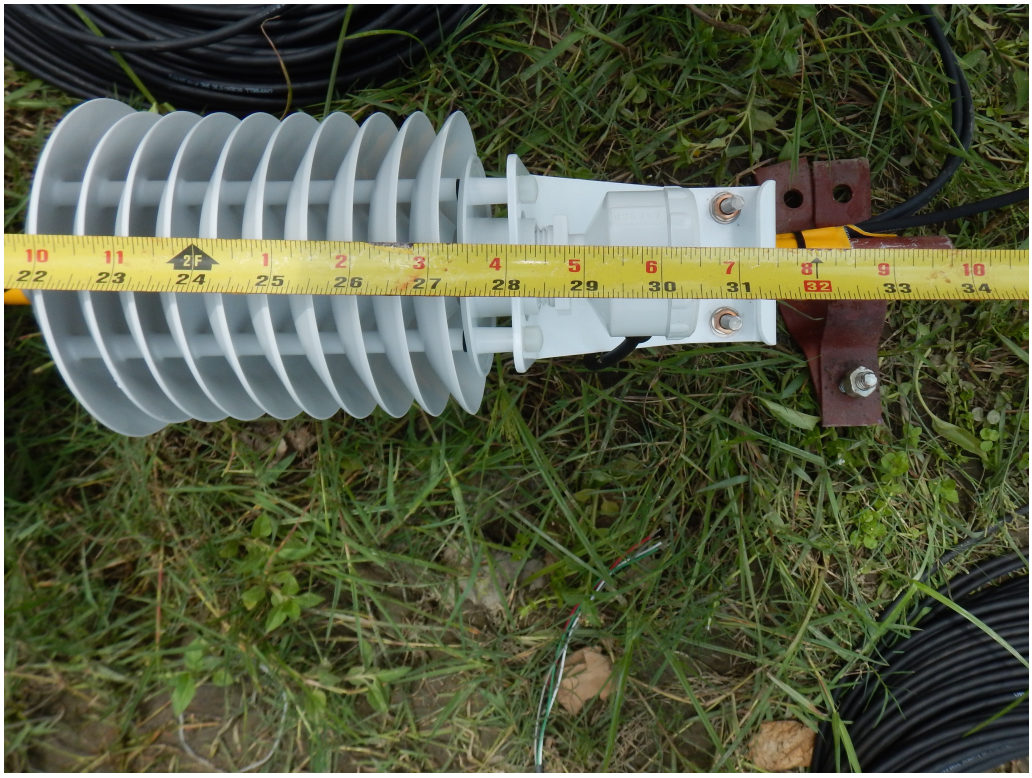
Campbell Scientific, Inc.
December 4, 2013

80m - TEMP



80
70
60

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

Mymensingh 295'

COPY

CALIBRATION REPORT

Temperature

Customer: *Campbell Scientific Inc*

Test Number: 4919-03T
Test Date: 19 September 2014
Customer PO: 115325
Sales Order: 98062

Test Sensor:
Model: 41342
Serial Number: *TS25357*
Description: Temperature Sensor

Report of calibration comparison of test temperature sensor with National Institute of Standards and Technology traceable standard thermometers at three temperatures in the R.M. Young Company controlled temperature calibration bath facilities. Calibration accuracy ± 0.1° Celsius.

Bath Temperature (degrees C)	Sensor Resistance (ohms)	Indicated (1) Temperature (degrees C)	Calculated (2) Temperature (degrees C)
49.91	1188.41	49.84	49.91
-0.01	1000.22	0.06	-0.01
-49.90	809.02	-49.70	-49.90

(1) Published Calibration: T = -251.132627 + R x 2.398537E-1 + R^2 x 1.127887E-5
(2) Calculated values using derived formula below

Over the range of -50° to +50° C the relationship between temperature and RTD resistance for this sensor has been calculated as follows

R =	*1000.257526*
+ T x	*3.801187*
+ T^2 x	*-6.267800E-04*

T =	*-251.760549*
+ R x	*2.402801E-01*
+ R^2 x	*1.141266E-05*

Where R is the RTD resistance in ohms; T is the temperature in degrees C

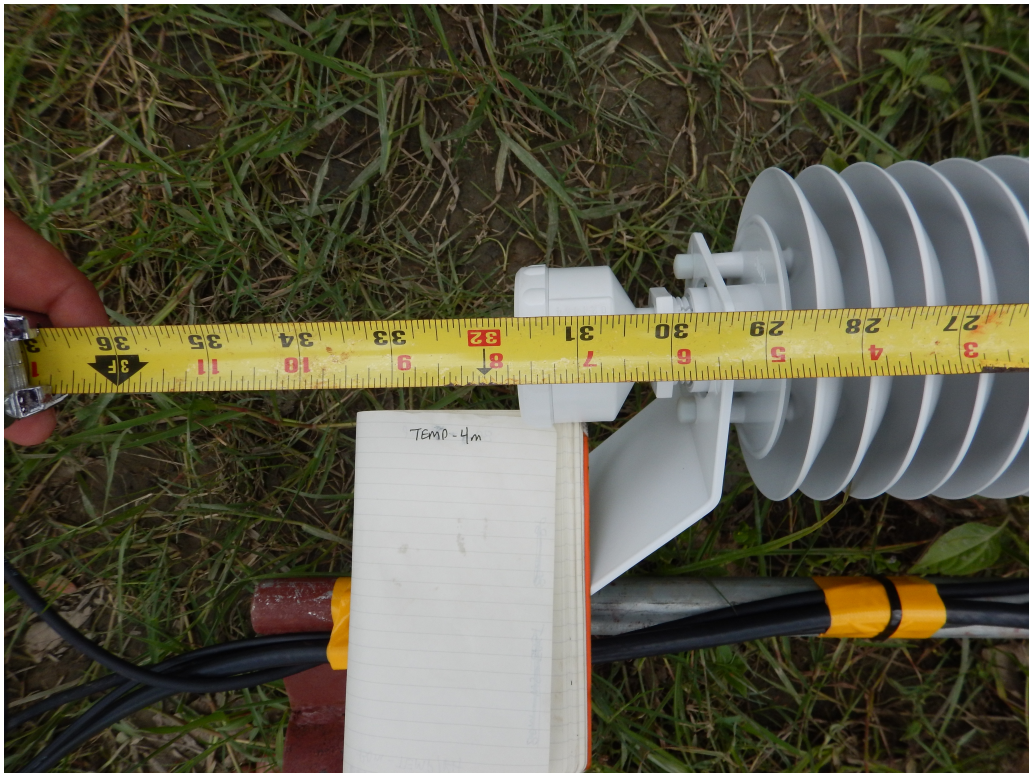
All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial #	NIST Test Reference
Brooklyn Thermometer Model 43-FC	3006-118	W204690
Brooklyn Thermometer Model 22332-D5-FC	25071	W204691
Brooklyn Thermometer Model 2X400-D7-FC	77532	W204692
Keithley Multimeter Model 191	15232	4200646497

Tested By: R Rullman

024464
TEMP - 4m

TEMP - 4m


TEMP - 4m

HARNESS ENERGY

MET MAST LOG

6820 N Broadway, Unit B, Denver, CO 80221 USA
www.harnessre.com

My mensingh 15'

R.M. Young Company
2801 Aero Park Drive
Traverse City, Michigan 49686 USA

COPY

CALIBRATION REPORT

Temperature

Customer: *Campbell Scientific Inc*

Test Number: 4212-05T
Test Date: 12 February 2014
Customer PO: 111648
Sales Order: 95656

Test Sensor:
Model: 41342
Serial Number: *TS24464*
Description: Temperature Sensor

Report of calibration comparison of test temperature sensor with National Institute of Standards and Technology traceable standard thermometers at three temperatures in the R.M. Young Company controlled temperature calibration bath facilities. Calibration accuracy ± 0.1° Celsius.

Bath Temperature (degrees C)	Sensor Resistance (ohms)	Indicated (1) Temperature (degrees C)	Calculated (2) Temperature (degrees C)
49.95	1188.41	49.84	49.95
-0.01	1000.19	0.05	-0.01
-49.90	809.02	-49.70	-49.90

(1) Published Calibration: T = -251.132627 + R x 2.398537E-1 + R^2 x 1.127887E-5
(2) Calculated values using derived formula below

Over the range of -50° to +50° C the relationship between temperature and RTD resistance for this sensor has been calculated as follows

R =	*1000.224182*
+ T x	*3.799690*
+ T^2 x	*-6.433859E-04*

T =	*-251.541623*
+ R x	*2.397535E-01*
+ R^2 x	*1.172908E-05*

Where R is the RTD resistance in ohms; T is the temperature in degrees C

All reference equipment used in this calibration procedure have been tested by comparison to traceable standards certified by the National Institute of Standards and Technology.

Reference Instrument	Serial #	NIST Test Reference
Brooklyn Thermometer Model 43-FC	3006-118	W204690
Brooklyn Thermometer Model 22332-D5-FC	25071	W204691
Brooklyn Thermometer Model 2X400-D7-FC	77532	W204692
Keithley Multimeter Model 191	15232	4200646497

Tested By: R Rudberg

CAMPBELL SCIENTIFIC®
WHEN MEASUREMENTS MATTER

HMP155A

Vaisala Temperature and Relative Humidity Probe

Accurate, Wide Temperature Range

Higher end sensor where higher accuracy is required

Overview

The HMP155A provides reliable relative humidity (RH) and temperature measurements for a wide range of applications. It uses a HUMICAP®180R capacitive thin film polymer sensor to measure RH over the 0 to 100% RH range. A PRT measures temperature over the -80° to +60°C range. This rugged, accurate temperature/RH probe is manufactured by Vaisala.

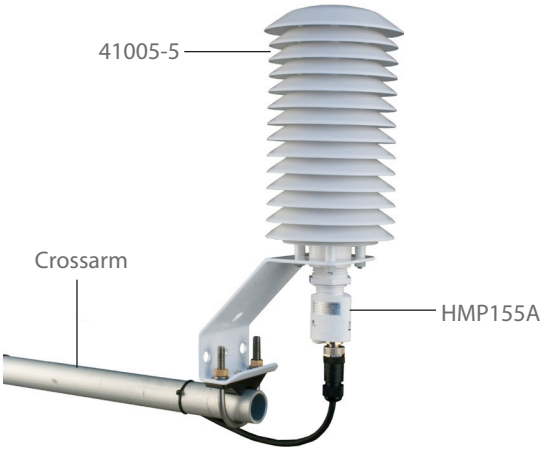
To reduce the current drain, power can be supplied to the HMP155A only during measurement when the sensor is connected to the datalogger's switched 12 V terminal. Dataloggers that do not have a switched 12 V terminal, such as the CR510 or CR7, can use the SW12V switched 12 V device to switch power to the sensor only during measurement.

Benefits and Features

- Well-suited for long-term, unattended applications
- Accurate and rugged
- Mounts to a mast, crossarm, or user-supplied pole
- Compatible with all Campbell Scientific dataloggers (including the CR200(X) series)

Sensor Mounts

The 41005-5 14-plate Radiation Shield should be used when the HMP155A is exposed to sunlight. The 41005-5 can attach directly to a mast or tower leg or to a CM202, CM204, or CM206 crossarm.



Recommended Cable Lengths

2-m Height		Atop a tripod or tower via a 2-ft crossarm such as the CM202								
Mast/Leg	CM202	CM6	CM106	CM10	CM110	CM115	CM120	UT10	UT20	UT30
2.7 m (9 ft)	3.3 m (11 ft)	3.3 m (11 ft)	4.3 m (14 ft)	4.3 m (14 ft)	4.3 m (14 ft)	5.8 m (19 ft)	7.3 m (24 ft)	4.3 m (14 ft)	7.3 m (24 ft)	11.3 m (37 ft)

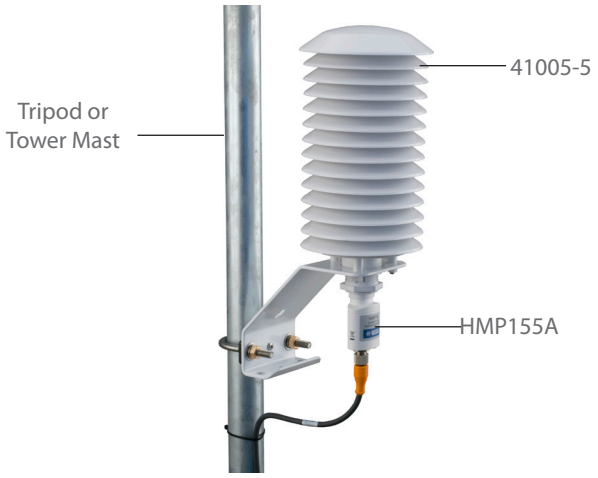
Note: Add 1 m (2 ft) to the cable length if mounting the enclosure to the leg base of a CM106, CM110, CM115, or CM120 tripod.

Ordering Information

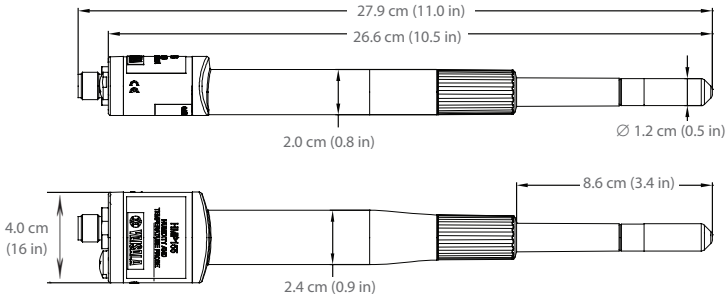
Air Temperature and Relative Humidity Probe	
HMP155A-L	Vaisala Temperature/RH Probe with user-specified cable length. Enter cable length, in feet, after the -L. Must choose a cable termination option (see below).

Cable Termination Options (choose one)	
-PT	Cable terminates in stripped and tinned leads for direct connection to a datalogger's terminals.
-PW	Cable terminates in connector for attachment to a prewired enclosure.

Accessories	
SW12V	Switched 12 V device that uses a control port and a 12 V channel to switch power to the HMP155A instead of a switched 12 V terminal.
41005-5	14-Plate Gill Radiation Shield to house the HMP155A



Specifications



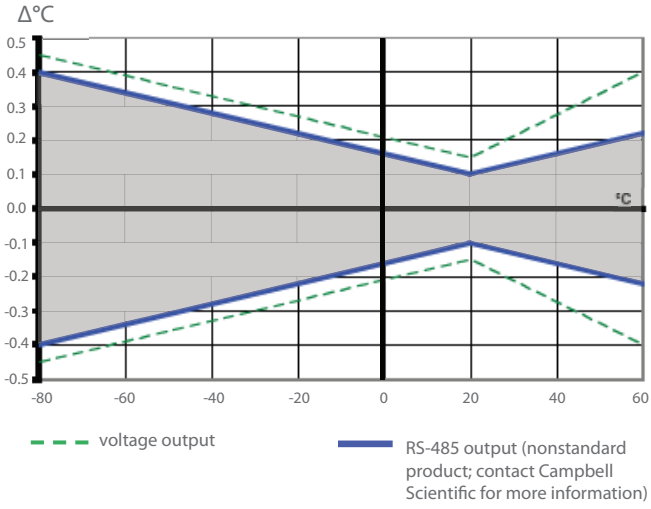
- Electromagnetic Compatibility: Complies with EMC standard EN61326-1 Electromagne
- Filter: Sintered PTFE
- Housing Material: PC
- Housing Classification: IP66
- Operating Humidity Range: 0 to 100%
- Voltage Output Range: 0 to 1 Vdc
- Average Current Consumption: ≤3 mA (analog output mode)
- Operating Voltage: 7 to 28 Vdc
- Settling Time at Power Up: 2 s

Air Temperature

- Temperature Sensor: Pt 100 RTD 1/3 class B IEC 751
- Measurement Range: -80° to +60°C
- Accuracy with Voltage Output
  -80° to +20°C: ±(0.226 - 0.0028 x temperature)°C
  +20° to +60°C: ±(0.055 + 0.0057 x temperature)°C
  Entire Temperature Range: see graph at right

Relative Humidity (RH)

- Sensor: HUMICAP®180R
- Measurement Range: 0.8 to 100% RH, non-condensing
- Response Time[a]: 20 s (63% RH); 60 s (90% RH)
- Factory Calibration Uncertainty (+20°C)[b]
  0 to 40% RH: ±0.6% RH
  40 to 97% RH: ±1.0% RH
- Accuracy (including non-linearity, hysteresis and repeatability)
  +15° to +25°C: ±1% RH (0 to 90% RH); ±1.7% RH (90 to 100% RH)
  -60° to -40°C: ± (1.4 + 0.032 × reading) % RH
  -40° to -20°C: ± (1.2 + 0.012 × reading) % RH
  -20° to +40°C: ± (1.0 + 0.008 × reading) % RH
  +40° to +60°C: ± (1.2 + 0.012 × reading) % RH



[a]The response time for the RH specification is for the HUMICAP®180R© at 20°C in still air with sintered PTFE filter.

[b]The factory calibration uncertainty is defined as ±2 standard deviation limits. Small variations possible; see also calibration certificate.

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June 12, 2013

HMP155 A2JB11A0A0A1A0A
Serial No. K2870022 2014
CH1: T -80...60 °C 0...1 V
CH2: RH 0...100 % 0...1 V
~~80m - WS - WEST~~
80m - TEMP/RH

VAISALA

Mymensingh 295'

Certificate report no. H54-14290020

CALIBRATION CERTIFICATE

Instrument	Humidity and Temperature Probe HMP155
Serial number	K2870022
Manufacturer	Vaisala Oyj, Finland
Calibration date	14th July 2014

The above instrument was calibrated by comparing the readings of the instrument to working standards of the manufacturer. The reference humidity was calculated from dewpoint temperature and temperature readings with the exception of the driest condition that was measured as relative humidity. Dewpoint temperature was measured with a 373 LHX dewpoint meter. Temperature and relative humidity were measured with two factory working standards. At the time of shipment, the instrument described above met its operating specifications.

The 373 LHX dewpoint meter has been calibrated at Centre for metrology and accreditation (MIKES) by using a MIKES working standard traceable to National Institute of Standards and Technology (NIST). The temperature readings of the factory working standards have been calibrated at an ISO/IEC 17025 accredited calibration laboratory (FINAS), Vaisala Measurement Standards Laboratory (MSL) by using MSL working standards traceable to NIST. The relative humidity readings of the factory working standards have been calibrated at the Vaisala factory by using a 373 LHX dewpoint meter.

Humidity calibration results

Reference humidity	Reference temperature	Observed humidity	Observed probe temperature	Additional probe temperature	Humidity difference	Permissible difference
%RH	°C	%RH	°C	°C	%RH	%RH
+ 0.2	+ 21.97	+ 0.2	+ 21.97	-	0.0	±1.0
+ 12.7	+ 21.98	+ 12.8	+ 21.98	-	+ 0.1	± 1.0
+ 33.4	+ 21.98	+ 33.3	+ 21.98	-	- 0.1	± 1.0
+ 54.4	+ 21.96	+ 54.4	+ 21.97	-	0.0	± 1.0
+ 74.9	+ 21.95	+ 75.0	+ 21.96	-	+ 0.1	± 1.0
+ 95.2	+ 22.00	+ 95.4	+ 21.99	-	+ 0.2	± 1.7

Temperature calibration results

Reference temperature	Observed probe temperature	Temperature difference		Additional probe temperature	Temperature difference	Permissible difference
°C	°C	°C		°C	°C	°C
+ 21.95	+ 21.96	+ 0.01		-	-	± 0.10

Equipment used in calibration

Type	Serial number	Calibration date	Certificate number
MBW 373 LHX	08-1204	2013-12-18	M-13H077
PTU303 / T	H0730006	2014-01-20	K008-X00109
HMT337 / T	D2350024	2014-01-20	K008-X00106
PTU303 / RH	H0730006	2014-05-07	H54-14191001
HMT337 / RH	D2350024	2014-05-07	H54-14191002

Uncertainties (95 % confidence level, k=2)
Humidity ± 0.6%RH @ 0...40%RH, ± 1.0%RH @ 40...97%RH
Temperature ± 0.10 °C.
Ambient conditions / Humidity 36 ± 5%RH, Temperature 23 ± 1 °C, Pressure 1010 ± 1 hPa.

Technician

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VAISALA

Mymensingh 295'

Certificate report no. H56-14280648

CALIBRATION CERTIFICATE

Instrument	Humidity and Temperature Probe HMP155
Order code	A2JB11A0A0A1A0A
Serial number	K2870022
Manufacturer	Vaisala Oyj, Finland
Calibration date	13th July 2014

The analog outputs of the above instrument were measured by using working standards of the manufacturer. The outputs were forced by digital input signals to three output values. The observed values were determined by measuring the voltage over the output terminals. All results are traceable in terms of voltage to NIST.

Analog output channel 1 calibration results

Output forced to V	Observed output V	Difference V	Permissible difference V
0.100	0.100	0.000	±0.001
0.500	0.500	0.000	±0.001
0.900	0.900	0.000	±0.001

Analog output channel 2 calibration results

Output forced to V	Observed output V	Difference V	Permissible difference V
0.100	0.100	0.000	±0.001
0.500	0.500	0.000	±0.001
0.900	0.900	0.000	±0.001

Equipment used in calibration

Type	Serial number	Calibration date	Certificate number
HP34970A	MY44064021	2014-03-11	1250-307055121

Uncertainty (95 % confidence level, k=2)
Voltage ±0.00064V

Ambient conditions / Humidity 54.00± 5%RH, Temperature23.70 ± 2 °C, Pressure 1009.50 ± 20 hPa.

Technician

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doc211861b

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HARNESS ENERGY

MET MASK LOG

6820 N Broadway, Unit B, Denver, CO 80221 USA
www.harnessre.com

VAISALA

Mymensingh 15'

Certificate report no. H56-14280654

CALIBRATION CERTIFICATE

Instrument	Humidity and Temperature Probe HMP155
Order code	A2JB11A0A0A1A0A
Serial number	K2870025
Manufacturer	Vaisala Oyj, Finland
Calibration date	13th July 2014

The analog outputs of the above instrument were measured by using working standards of the manufacturer. The outputs were forced by digital input signals to three output values. The observed values were determined by measuring the voltage over the output terminals. All results are traceable in terms of voltage to NIST.

Analog output channel 1 calibration results

Output forced to V	Observed output V	Difference V	Permissible difference V
0.100	0.100	0.000	±0.001
0.500	0.500	0.000	±0.001
0.900	0.900	0.000	±0.001

Analog output channel 2 calibration results

Output forced to V	Observed output V	Difference V	Permissible difference V
0.100	0.100	0.000	±0.001
0.500	0.500	0.000	±0.001
0.900	0.900	0.000	±0.001

Equipment used in calibration

Type	Serial number	Calibration date	Certificate number
HP34970A	MY44064021	2014-03-11	1250-307055121

Uncertainty (95 % confidence level, k=2)
Voltage ±0.00064V

Ambient conditions / Humidity 54.00± 5%RH, Temperature23.60 ± 2 ºC, Pressure 1009.40 ± 20 hPa.

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VAISALA

Mymensingh 15'

Certificate report no. H54-14290023

CALIBRATION CERTIFICATE

Instrument	Humidity and Temperature Probe HMP155
Serial number	K2870025
Manufacturer	Vaisala Oyj, Finland
Calibration date	14th July 2014

The above instrument was calibrated by comparing the readings of the instrument to working standards of the manufacturer. The reference humidity was calculated from dewpoint temperature and temperature readings with the exception of the driest condition that was measured as relative humidity. Dewpoint temperature was measured with a 373 LHX dewpoint meter. Temperature and relative humidity were measured with two factory working standards. At the time of shipment, the instrument described above met its operating specifications.

The 373 LHX dewpoint meter has been calibrated at Centre for metrology and accreditation (MIKES) by using a MIKES working standard traceable to National Institute of Standards and Technology (NIST). The temperature readings of the factory working standards have been calibrated at an ISO/IEC 17025 accredited calibration laboratory (FINAS), Vaisala Measurement Standards Laboratory (MSL) by using MSL working standards traceable to NIST. The relative humidity readings of the factory working standards have been calibrated at the Vaisala factory by using a 373 LHX dewpoint meter.

Humidity calibration results

Reference humidity	Reference temperature	Observed humidity	Observed probe temperature	Additional probe temperature	Humidity difference	Permissible difference
%RH	°C	%RH	°C	°C	%RH	%RH
+ 0.3	+ 21.99	+ 0.3	+ 22.00	-	0.0	±1.0
+ 12.7	+ 22.01	+ 12.8	+ 22.01	-	+ 0.1	± 1.0
+ 33.2	+ 22.04	+ 33.1	+ 22.04	-	- 0.1	± 1.0
+ 54.2	+ 22.01	+ 54.1	+ 22.01	-	- 0.1	± 1.0
+ 75.3	+ 21.98	+ 75.3	+ 21.98	-	0.0	± 1.0
+ 95.1	+ 21.99	+ 95.2	+ 22.00	-	+ 0.1	± 1.7

Temperature calibration results

Reference temperature	Observed probe temperature	Temperature difference		Additional probe temperature	Temperature difference	Permissible difference
°C	°C	°C		°C	°C	°C
+ 21.98	+ 21.98	0.00		-	-	± 0.10

Equipment used in calibration

Type	Serial number	Calibration date	Certificate number
MBW 373 LHX	08-1204	2013-12-18	M-13H077
PTU303 / T	H0730006	2014-01-20	K008-X00109
HMT337 / T	D2350024	2014-01-20	K008-X00106
PTU303 / RH	H0730006	2014-05-07	H54-14191001
HMT337 / RH	D2350024	2014-05-07	H54-14191002

Uncertainties (95 % confidence level, k=2)
Humidity ± 0.6%RH @ 0...40%RH, ± 1.0%RH @ 40...97%RH
Temperature ± 0.10 °C.
Ambient conditions / Humidity 36 ± 5%RH, Temperature 22 ± 1 °C, Pressure 1010 ± 1 hPa.

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CAMPBELL SCIENTIFIC®
WHEN MEASUREMENTS MATTER

CS100

Barometric Pressure Sensor

Standard Barometer

Resides inside a weather-proof enclosure

Overview

The CS100 measures barometric pressure for the range of 600 to 1100 mb. This range equates to from below sea level (as in a mine) up to 12,000 feet above sea level. Designed for use in environmental applications, the CS100 is compatible with all Campbell Scientific dataloggers.

Benefits and Features

- Optimized to mount in Campbell Scientific enclosures
- Low power consumption
- Three-year warranty
- 500 to 1100 millibar and 800 to 1100 millibar versions also available by special order—contact Campbell Scientific
- Integral switching circuit limits power consumption to the measurement cycle

Technical Description

The CS100 is a Campbell Scientific version of Setra's model 278 barometer. It uses Setra's Setraceram capacitive sensor and IC analog circuit to measure barometric pressure. The CS100 iincludes a 0.76 m (2.5 ft) cable and a terminal strip for datalogger power and signal connections.

The CS100 is encased in a stainless steel and polyester case fitted with an 1/8 in. barbed fitting for pressure connection. It has an internal switching circuit that allows the logger to power the barometer only during measurement, which reduces power usage.

Ordering Information

Barometric Pressure Sensor	
CS100	Setra 278 Barometer (600 to 1100 mb) with 30 in. cable.

Accessories	
The following accessories are used when the barometer will be housed in a different enclosure than the datalogger.	
ENC100	17 cm (6.7 in) by 14 cm (5.5 in) enclosure for housing only the CS100. Includes a backplate, compression fitting, vent, and mounting bracket.
CABLE5CBL-L	5-conductor, 24 AWG cable with drain wire and Santoprene jacket. Enter cable length, in feet, after the -L. Must choose a cable termination option (see below).

Cable Termination Options (choose one)	
-PT	Cable terminates in pigtails for direct connection to data-logger's terminals.
-PW	Cable terminates in a connector for attachment to a Campbell Scientific prewired enclosure.

The CS100 is typically mounted next to the data-logger inside an ENC12/14 or larger enclosure. The ENC100 (shown above) is available for housing the barometer in its own enclosure.

Manufacturer's Specifications

- Accuracy[1]: ±0.5 mb @ +20°C; ±1.0 mb @ 0° to 40°C; ±1.5 mb @ -20° to +50°C; ±2.0 mb @ -40° to +60°C
- Linearity: ±0.4 mb
- Hysteresis: ±0.05 mb
- Repeatability: ±0.03 mb
- Resolution: ±0.01 mb
- Long-Term Stability: ±0.1 mb per year
- Response Time: < 100 ms
- Excitation: 9.5 to 28 Vdc
- Current Consumption: < 3 mA (active); < 1 µA (sleep mode)
- Warm-up Time: < 1 s
- Resolution: 0.01 m s^{-1}
- Operating Temperature Range: -40° to 60°C
- Dimensions: 9.1 x 6.1 x 2.5 cm (3.6 x 2.4 x 1.0 in)
- Cable Diameter: 0.8 cm (0.3 in)
- Cable Length: 0.8 m (2.5 ft)
- Weight: 135 g (4.8 oz)

[1]*The root sum squared (RSS) of end point non-linearity, hysteresis, repeatability, and calibration uncertainty.*

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June 14, 2013

setra
Model: 278
Range: 600 – 1100 MB
Output: 0 – 2.5VDC
Supply: 9.8V – 28VDC
Serial: 5904825
1114
Boxborough MA
www.setra.com
EXT TRIG
AGND
AGND
SUPPLY
VOUT
80m - BP

CAMPBELL SCIENTIFIC

HARNESS ENERGY

MET MAST LOG

6820 N Broadway, Unit B, Denver, CO 80221 USA
www.harnessre.com

Calibration Certificate

Technician: SR SR
Part No: 2781600MA1B2YT1
Model: 278

Serial No: 5904825
Work Order: 24133377
Date: 03/14/2014

Range: 610 to 1100 HPA/MB
Nom. Output: 0.05 to 2.5 VDC
Supply: 24vdc

CALIBRATION DATA

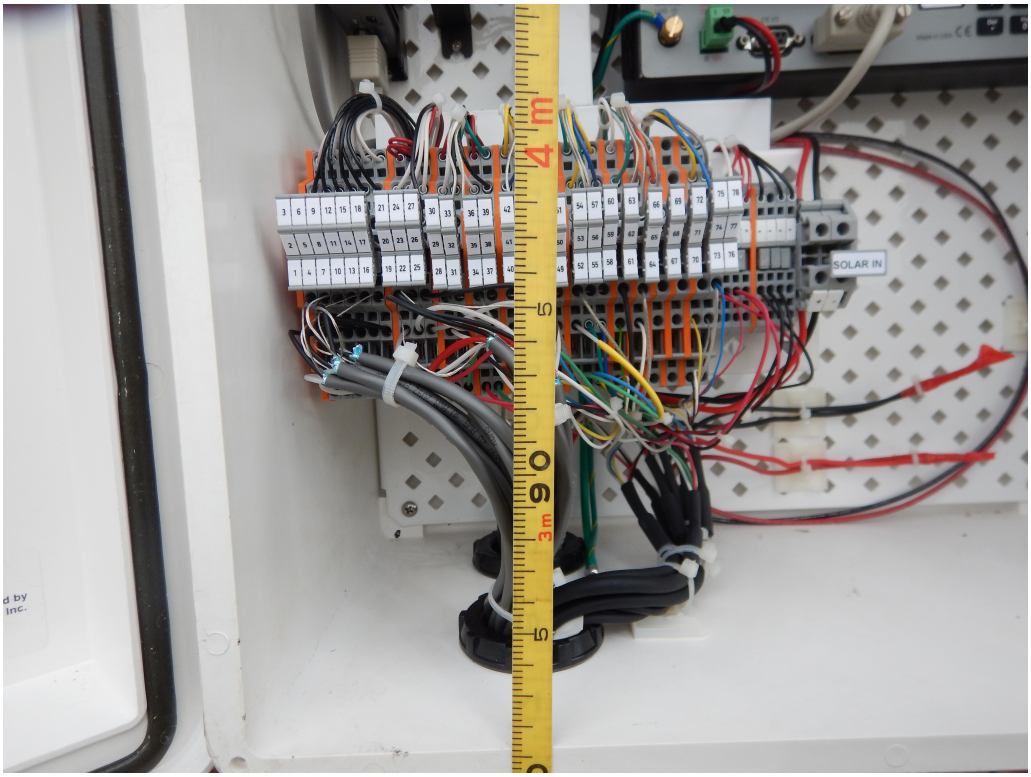
APPLIED PRESSURE (hPa)	TRANSDUCER OUTPUT (VDC)	PRESSURE CONVERSION (hPa)	ERROR (hPa)	EQUIPMENT UNCERTAINTY (hPa)
610.01	0.0492	609.85	-0.16	+/- 0.10
732.49	0.6630	732.59	0.10	+/- 0.10
855.00	1.2759	855.18	0.18	+/- 0.10
977.50	1.8884	977.69	0.19	+/- 0.10
1100.00	2.5007	1100.13	0.13	+/- 0.10

AMBIENT CONDITIONS:
Humidity: 11.3 %RH
Pressure: 1008.2 hPa
Temperature: 25.3 degree C

SPECIFICATIONS:
Accuracy Specification: +/- 0.5 hPa @ +20 degree C (+68 degree F).

NOTES:
1. This calibration was performed in compliance with ANSI/NCSL Z540-1-1994.
2. All errors are expressed in hPa.
3. Consult specification sheet for additional information.
4. This calibration is certified per N.I.S.T. traceable primary standards.
   Reference standard: I/N 00049-SN237-DHI_PPC3-2M_A1.4MS/A160KP.
   Reference standard cal. due date: 8/13/13 - 8/13/14.
5. This certificate may not be reproduced, except in full, without written approval from Setra Systems.
6. This calibration was performed using procedure P2781X.

159 Swanson Road, Boxborough, MA 01719/Telephone 1-800-257-3872, (978) 263-1400


SOLAR IN

Mymensingh

Calibration Certificate

Technician: SO SO
Part No: 2781600MA1B2YT1
Model: 278

Serial No: 5937935
Work Order: 24133377
Date: 04/09/2014

Range: 610 to 1100 HPA/MB
Nom. Output: 0.05 to 2.5 VDC
Supply: 24vdc

CALIBRATION DATA

APPLIED PRESSURE (hPa)	TRANSDUCER OUTPUT (VDC)	PRESSURE CONVERSION (hPa)	ERROR (hPa)	EQUIPMENT UNCERTAINTY (hPa)
609.99	0.0495	609.89	-0.10	+/- 0.10
732.50	0.6631	732.63	0.13	+/- 0.10
855.01	1.2761	855.23	0.22	+/- 0.10
977.50	1.8887	977.74	0.24	+/- 0.10
1100.00	2.5016	1100.33	0.33	+/- 0.10

AMBIENT CONDITIONS:
Humidity: 25.5 %RH
Pressure: 990.8 hPa
Temperature: 26.0 degree C

SPECIFICATIONS:
Accuracy Specification: +/- 0.5 hPa @ +20 degree C (+68 degree F).

NOTES:
1. This calibration was performed in compliance with ANSI/NCSL Z540-1-1994.
2. All errors are expressed in hPa.
3. Consult specification sheet for additional information.
4. This calibration is certified per N.I.S.T. traceable primary standards.
   Reference standard: I/N_00049-SN237-DHI_PPC3-2M_A1.4MS/A160KP.
   Reference standard cal. due date: 8/13/13 - 8/13/14.
5. This certificate may not be reproduced, except in full, without written approval from Setra Systems.
6. This calibration was performed using procedure P2781X.

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

LP02

Solar Radiation Sensor

High Quality

Blackened thermopile provides full solar spectrum range

Overview

The LP02* is an ISO-second-class pyranometer that monitors solar radiation for the full solar spectrum range. It produces a millivolt signal that is measured directly by a Campbell Scientific datalogger. The LP02 can provide solar radiation measurements for a variety of meteorological applications.

Benefits and Features

- Compatible with most Campbell Scientific dataloggers
- Measures reflected solar radiation when inverted
- Provides measurements in direct sunlight, under plant canopies, when the sky is cloudy, and in artificial light
- Compatible with the CWS900-series interfaces, allowing it to be used in a wireless sensor network
- Includes bubble level and leveling screws eliminating need for a separate leveling base, which simplifies installation
- Acceptable for providing the solar radiation data used in stability estimations
- Dome protects thermopile and allows water to roll off of it

Technical Description

The LP02 measures solar radiation with a high-quality blackened thermopile protected by a dome. The blackened thermopile provides a flat spectral response for the full solar spectrum range, which allows the LP02 to be used under plant canopies or lamps, when the sky is cloudy, and for reflected radiation measurements.

The LP02 includes a bubble level, three adjusting screws, and a cable gland. The bubble level and adjusting screws allow the sensor to be leveled without using a leveling base. The gland facilitates cable replacement.

Two LP02 pyranometers can be mounted back-to-back to make a low-cost albedometer. Contact Campbell Scientific for more information.

**The LP02 is manufactured by Hukseflux. Prior to December 2008, the LP02 included a 15-ft cable instead of a cable with a user-specified length. Because the LP02 is a second-class pyranometer, it is acceptable for providing the solar radiation data used in stability estimations (EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications, pages 2-10).*

Mounting

The LP02 includes a bubble level and three adjusting leveling screws, which allow the sensor to be leveled without using a leveling base. The CM225 Solar Sensor Mounting Stand is used to attach the sensor to a mast, crossarm, or pole (1.0-in. to 2.1-in. outer diameter). The CM225 consists of rectangular plate, mounting bracket, U-bolts, washers, lock washers, and nuts.

Ordering Information

Solar Radiation Sensor

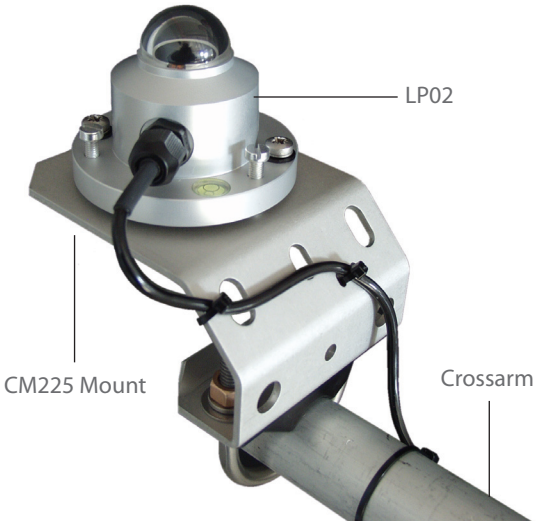
LP02-L	Hukseflux pyranometer with user-specified cable length. Enter cable length, in feet, after the -L. Must choose a cable termination option (see below).

Cable Termination Options (choose one)

-PT	Cable terminates in stripped and tinned leads for direct connection to a datalogger's terminals.
-PW	Cable terminates in a connector for attachment to a prewired enclosure.
-CWS	Cable terminates in a connector for attachment to a CWS900-series interface. Connection to a CWS900-series interface allows this sensor to be used in a wireless sensor network.

Mount

CM225	Solar Sensor Mounting Stand for attaching the sensor to a tripod or tower mast or to a CM202, CM204, or CM206 crossarm.



To attach the CM225 to a CM202, CM204, or CM206 crossarm, place the U-bolt in the holes on the bottom of the bracket (shown). If the CM225 is attached to a mast, place the U-bolt in the holes in the side of the bracket.

Specifications

- Light Spectrum Waveband: 285 to 3000 nm
- Maximum Irradiance: 2000 W/m^2
- Sensitivity (nominal): 15 µV/W/m^2
- Operating Temperature Range: -40° to +80°C
- Temperature Dependence: < 0.15% per °C
- ISO Classification: Second Class
- Width: 7.8 cm (3.1 in)
- Height: 5.9 cm (2.3 in)
- Dome Diameter: 3.0 cm (1.2 in)
- Weight with 15 ft cable: 363 g (0.8 lb)

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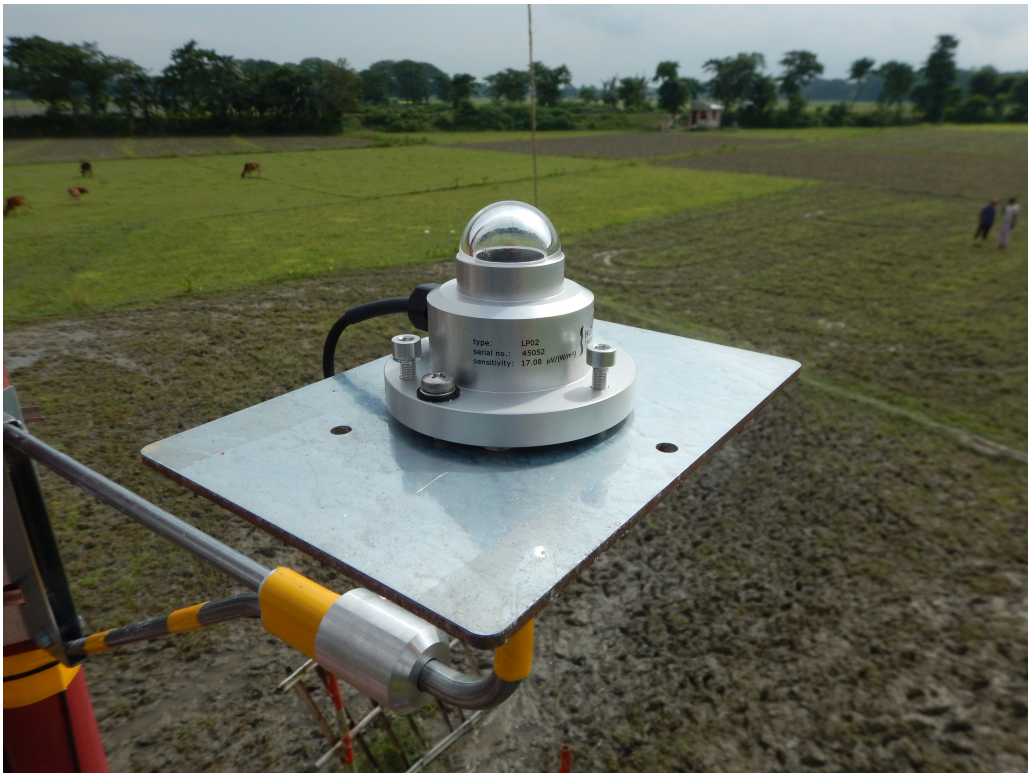
November 12, 2013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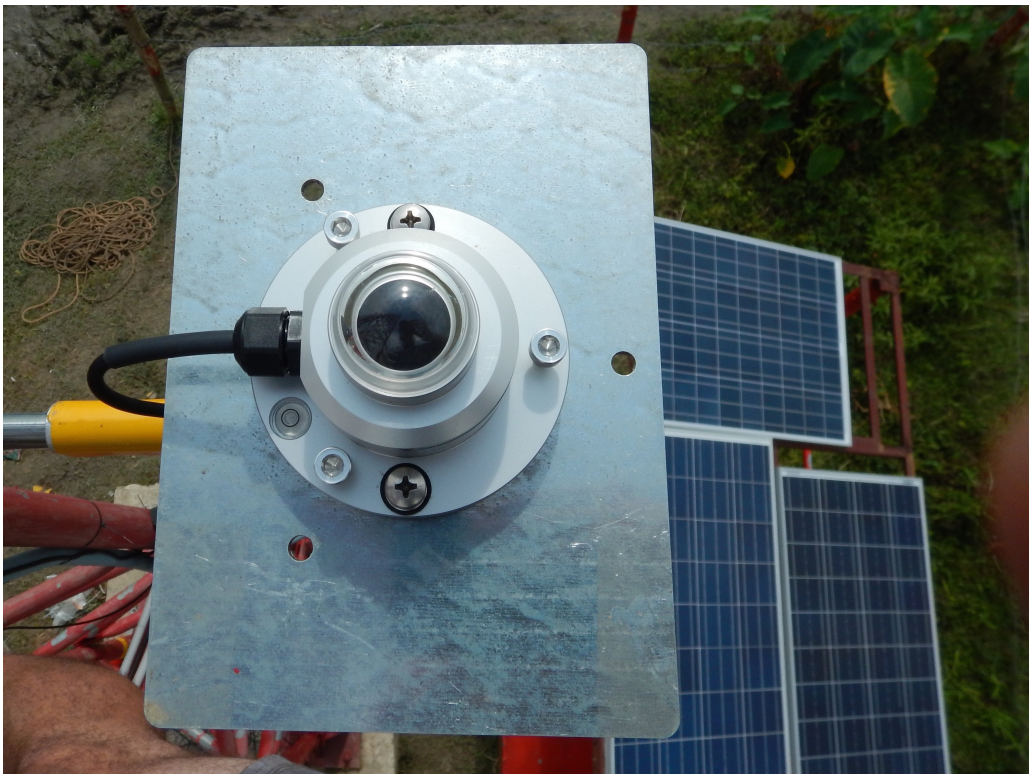
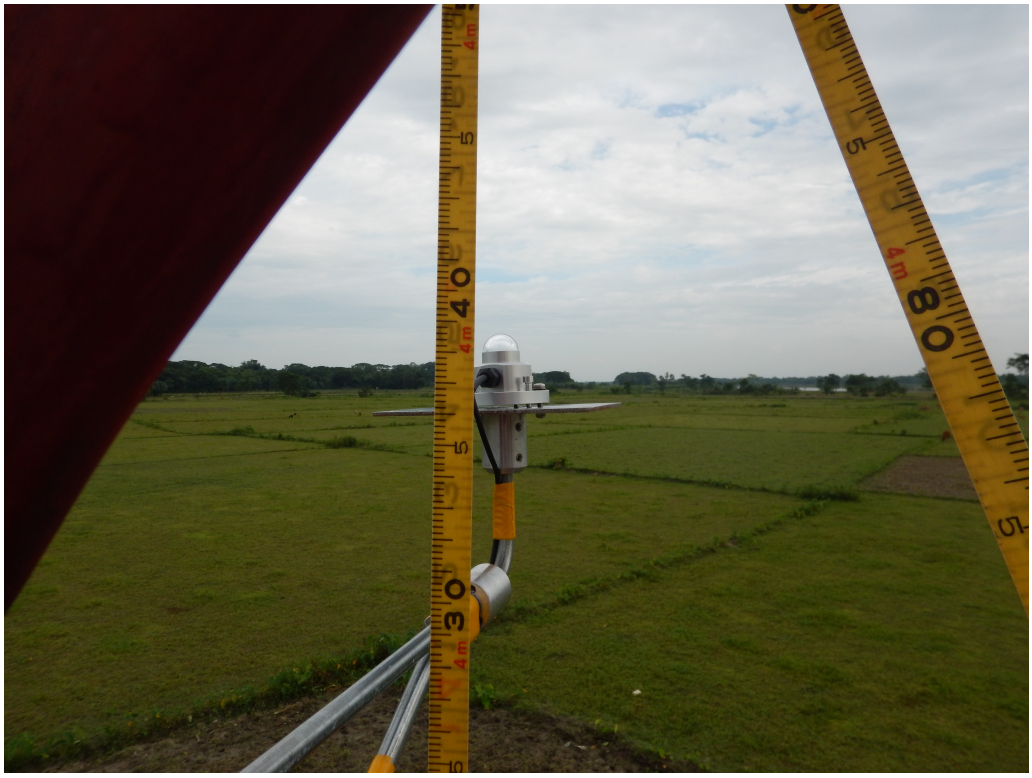
serial no.: 45052
sensitivity: 17.08 µV/(W/m²)




40
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Hukseflux Thermal Sensors B.V.
www.hukseflux.com
info@hukseflux.com
MYMENSINGH

Product certificate

Pages: 1
Release date: 29-04-2014

Product code	**LP02-05**
Product identification	**serial number 45052**
Product type	pyranometer
Measurand	hemispherical solar radiation
Classification	second class (ISO 9060), moderate quality (WMO-No. 8)

Calibration result

Sensitivity	**S = 17.08 x 10^{-6} V/(W/m^2)**
Calibration uncertainty	**± 0.21 x 10^{-6} V/(W/m^2)**

the number following the ± symbol is the expanded uncertainty with a coverage factor k = 2, and defines an interval estimated to have a level of confidence of 95 percent

Measurement function: E = U/S
with E irradiance in [W/m^2], U voltage output in [V]

Product specifications

1:	ISO 9060 second class	**verified**
2:	resistance	**72.5 Ω**
3:	insulation resistance	**> 100 x 10^6 Ω**
4:	response time (95 %)	**9.5 s**
5:	cable length	**5 m**

Table 0.1 *connections*

PIN	WIRE	
1		not connected
2		not connected
3		not connected
4		not connected
5		not connected
6		not connected
7	Black	ground
8	White	signal [+]
9	Green	signal [−]

Calibration procedure according to ISO 9847. Traceability of calibration is to the WRR (World Radiometric Reference) maintained at the World Radiation Center in Davos, Switzerland.

Please consult the user manual for information on measurement uncertainty during actual use and for product set up, operation and maintenance instructions.

Calibration performed by:
T. Meskers

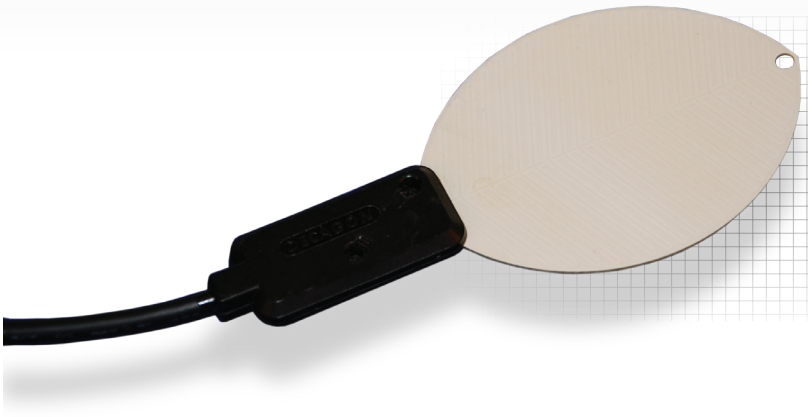
Date:
23-04-2014

Person authorising acceptance and release of product:
G.J. Halve

Date:
29-04-2014

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

LWS
Leaf Wetness Sensor



Sensitive yet Durable

Compatible with all Campbell Scientific dataloggers

Overview

Decagon's LWS can detect small amounts of water or ice on the sensor surface for leaf wetness applications. Because the LWS measures the dielectric constant of the sensor's upper surface, it can detect the presence of water or ice anywhere on the sensor's surface. All of our dataloggers can measure its output signal.

The LWS is designed to be deployed either in the canopy or on a weather station mast. Two holes in the non-sensing portion of the sensor body are provided for attaching the sensor to a pole or branch via twist ties or with 4-40 bolts.

Benefits and Features

- Imitates characteristics of a leaf
- Does not require painting or calibration of individual sensors
- Compatible with the CWS900-series interfaces, allowing it to be used in a wireless sensor network
- Detects trace amounts of water or ice on the leaf surface

Specifications

- Measurement Time: 10 ms
- Power: 2.5 Vdc @ 2 mA to 5 Vdc @ 7 mA
- Output Range: 250 mV to 1500 mV
- Operating Temperature Range: -20° to 60°C
- Expected Lifetime: > 2 years continuous use
- Dimensions: 11.2 x 5.8 x 0.075 cm (4.4 x 2.3 x 0.0295 in.)
- Weight: 0.14 kg (5 oz) with 15-ft cable

Ordering Information

Leaf Wetness Sensor

LWS-L	Decagon leaf wetness sensor with user-specified cable length. Enter cable length, in feet, after -L. The length must be an increment of 5 feet (e.g., 15, 20, 25, 30). Recommended cable length is 25 ft (LWS-L25). Must choose a cable termination option (see below).

Cable Termination Options (choose one)

-PT	Cable terminates in stripped and tinned leads for direct connection to a datalogger's terminals.
-PW	Cable terminates in connector for attachment to a prewired enclosure.
-CWS	Cable terminates in a connector for attachment to a CWS900-series interface. Connection to a CWS900-series interface allows this sensor to be used in a wireless sensor network.

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Dielectric Leaf Wetness Sensor
DECAGON DEVICES
www.decagon.com
Patent 6904789
Model LWS
Rev 03.98 CE
Install This Side Down