Current Renewables Engineering

12-13-2022

Enphase Energy Inc

47281 Bayside Parkway

Attn.: To Whom It May Concern

re job: Sharon Trumble

111 Fairfield Ln, Lillington, NC 27546, USA

The following calculations are for the structural engineering design of the photovoltaic panels and are valid only for the structural info referenced in the stamped plan set. The verification of such info is the responsibility of others.

I certify that the roof structure has sufficient structural capacity for the applied PV loads.

All mounting equipment shall be designed and installed per manufacturer's approved installation specifications.

Design Criteria:

Code: 2018 NCSBC, IBC 2018, ASCE 7-16,
Live Load: 20 psf
Ult Wind Speed: 140 mph
Exposure Cat: B
Ground Snow: 0 psf
Min Snow Roof: 0 psf

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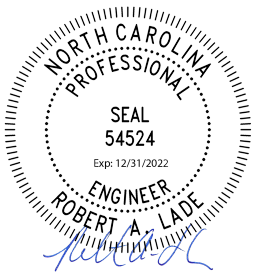

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Roof Properties:

	Roof 1	Roof 2
Roof Type =	Shingle	Shingle
Roof Pitch (deg) =	30.0	29.0
Mean Root Height (ft) =	13.0	13.0
Attachment Trib Width (ft) =	3.25	3.25
Attachment Spacing (ft) =	4.0	4.0
Framing Type =	Truss	Truss
Framing Size =	2x4	2x4
Framing OC Spacing (in.) =	24.0	24.0
Section Thickness, b (in) =	1.5	1.5
Section Depth, d (in) =	3.5	3.5
Section Modulus, Sx (in^3) =	3.062	3.062
Moment of Inertia, Ix (in) =	5.359	5.359
Unsupported Span (ft) =	9.0	9.0
Upper Chord Length (ft) =	16.0	11.0
Deflection Limit D+L (in) =	3.2	2.2
Deflection Limit S or W (in) =	2.133	1.467
Attachments Pattern =	Fully Staggered	Fully Staggered
Framing Upgrade =	No	No
Sister Size =	NA	NA
Wood Species =	DF	DF
Wood Fb (psi) =	900.0	900.0
Wood Fv (psi) =	180.0	180.0
Wood E (psi) =	1600000.0	1600000.0
C_D (wind) =	1.6	1.6
C_d (snow) =	1.15	1.15
C_{LS} =	1.0	1.0
$C_M = C_t = C_L = C_i$ =	1.0	1.0
C_F =	1.5	1.5
C_{fu} =	1.0	1.0
C_r =	1.15	1.15
F'b wind (psi) =	2484.0	2484.0
F'b snow (psi) =	1785.37	1785.37
F'v wind (psi) =	288.0	288.0
F'v snow (psi) =	207.0	207.0
M allowable wind (lb-ft) =	633.94	633.94
M allowable snow (lb-ft) =	455.64	455.64
V allowable wind (lbs) =	1008.0	1008.0
V allowable snow (lbs) =	724.5	724.5
E' (psi) =	1600000.0	1600000.0

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Load Calculation:

Dead Load Calculations:

	Roof 1	Roof 2
Panels Dead Load (psf) =	3.0	3.0
Roofing Weight (psf) =	3.0	3.0
Decking Weight (psf) =	2.0	2.0
Framing Weight (psf) =	0.602	0.602
Misc. Additional Weight (psf) =	1.0	1.0
Existing Dead Load (psf) =	6.602	6.602
Total Dead Load (psf) =	9.602	9.602

Wind Load Calculations:

Ultimate Wind Speed (mph) =	140.0	140.0
Directionality Facto r, kd =	0.85	0.85
Topographic Factor, kzt =	1.0	1.0
Velocity Press Exp Factor, kz =	0.701	0.701
Velocity Pressure, qz (psf) =	29.88	29.88
External Pressure Up, GCp_1 =	-1.499	-1.499
External Pressure Up, GCp_2 =	-1.769	-1.769
External Pressure Up, GCp_3 =	-2.189	-2.189
External Pressure Down, GCp =	0.78	0.78
Design Pressure Up, p_1 (psf) =	-30.904	-30.904
Design Pressure Up, p_2 (psf) =	-36.464	-36.464
Design Pressure Up, p_3 (psf) =	-45.131	-45.131
Design Pressure Down, p (psf) =	16.073	16.073

Snow Load Calculations:

Ground Snow Load, pg (psf) =	0.0	0.0
Min Flat Snow, pf_min (psf) =	0.0	0.0
Sloped Snow, ps_min (psf) =	0.0	0.0
Snow Importance Factor, Ic =	1.0	1.0
Exposure Factor, Ce =	0.9	0.9
Thermal Factor, Ct =	1.1	1.1
Flat Roof Snow, pf (psf) =	0.0	0.0
Slope Factor, Cs =	1.0	1.0
Sloped Roof Snow, ps (psf) =	0.0	0.0

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Lag Screw Checks:

	Roof 1	Roof 2
Ref. Withdrawal Value, W (lb/in) =	266.0	266.0
(C_m = C_t = C_{eg} = 1.0) CD =	1.6	1.6
Adjusted Withdrawal Value, W' (lb/in) =	425.6	425.6
Lag Penetration, p (in.) =	2.5	2.5
Allowable Withdrawal Force, W'p (lbs) =	1064.0	1064.0
Applied Uplift Force (lbs) =	-188.224	-225.528
Uplift DCR =	0.177	0.212
Ref. Lateral Value, Z (lbs) =	266.0	266.0
(C_m = C_t = C_Δ = C_{eg} = 1.0) CD =	0.9	0.9
Adjusted Lateral Value, Z' (lbs) =	243.0	243.0
Applied Lateral Force (lbs) =	19.5	18.908
Angle of Resultant Force, α (deg) =	1.468	1.487
Adjusted Interaction Lateral Value, Z'α (lbs) =	1027.149	1039.488
Lateral DCR =	0.019	0.018

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Roof Framing Checks:

Force Checks:

LC1: D+S

	Roof 1	Roof 2
Applied Moment (lb-ft) =	161.0	161.0
Applied Shear (lbs) =	103.0	103.0
Allowable Moment (lb-ft) =	456.0	456.0
Allowable Shear (lbs) =	724.0	724.0
Moment DCR =	0.353	0.353
Shear DCR =	0.143	0.143

LC2: D+0.6W

Applied Moment (lb-ft) =	322.0	322.0
Applied Shear (lbs) =	207.0	207.0
Allowable Moment (lb-ft) =	634.0	634.0
Allowable Shear (lbs) =	1008.0	1008.0
Moment DCR =	0.508	0.508
Shear DCR =	0.206	0.206

LC3: D+0.75(S+0.6W)

Applied Moment (lb-ft) =	282.0	282.0
Applied Shear (lbs) =	181.0	181.0
Allowable Moment (lb-ft) =	634.0	634.0
Allowable Shear (lbs) =	1008.0	1008.0
Moment DCR =	0.445	0.445
Shear DCR =	0.18	0.18

LC4: 0.6D+0.6W

Applied Moment (lb-ft) =	258.0	258.0
Applied Shear (lbs) =	166.0	166.0
Allowable Moment (lb-ft) =	634.0	634.0
Allowable Shear (lbs) =	1008.0	1008.0
Moment DCR =	0.407	0.407
Shear DCR =	0.165	0.165

Deflection Checks (Service Level):

LC1: D+L

Deflection (in.) =	0.627	0.635
Deflection Limit (in.) =	3.2	2.2
Deflection DCR =	0.196	0.289

LC2: S

Deflection (in.) =	0.0	0.0
Deflection Limit (in.) =	2.133	1.467
Deflection DCR =	0.0	0.0

LC3: W (Down)

Deflection (in.) =	0.119	0.119
Deflection Limit (in.) =	2.133	1.467
Deflection DCR =	0.056	0.081

LC4: W (Up)

Deflection (in.) =	0.229	0.229
Deflection Limit (in.) =	2.133	1.467
Deflection DCR =	0.108	0.156

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Seismic Check:

Existing Weight:

Wall Weight (psf) =	17.0
Tributary Wall Area (ft^2) =	1110.0
Total Wall Weight (lbs) =	18870.0
Roof Weight (psf) =	6.602
Roof Area (ft^2) =	2990.0
Total Roof Weight (lbs) =	19738.672
Total Existing Weight (lbs) =	38608.67

Total Additional PV Weight (lbs) = 1415.7

Weight Increase:

(Existing W + Additional W)/(Existing W) = 1.037

The increase in weight as a result of the solar system is less than 10% of the existing structure and therefore no further seismic analysis is required.

Limits of Scope of Work and Liability:

Existing structure is assumed to have been designed and constructed following appropriate codes at time of erection, and assumed to have appropriate permits. The calculations produced are only for the roof framing supporting the proposed PV installation referenced in the stamped planset and were completed according to generally recognized structural analysis standards and procedures, professional engineering and design experience, opinions and judgements. Existing deficiencies which are unknown or were not observable during time of inspection are not included in this scope of work. All PV modules, racking, and mounting equipment shall be designed and installed per manufacturer's approved installation specifications. The Engineer of Record and the engineering consulting firm assume no responsibility for misuse or improper installation. This analysis is not stamped for water leakage. Framing was determined based on information in provided plans and/or photos, along with engineering judgement. Prior to commencement of work, the contractor shall verify the framing sizes, spacings, and spans noted in the stamped plans, calculations, and cert letter (where applicable) and notify the Engineer of Record of any discrepancies prior to starting construction. Contractor shall also verify that there is no damaged framing that was not addressed in stamped plans, calculations, and cert letter (where applicable) and notify the Engineer of Record of any concerns prior to starting construction.