1380 Watt array Installation, at $1.15 / Watt plus Labor
Labor is:
1. Tourquing 5 augers into the ground.
2. Installing the structure and panels (includes microinverters)
3. Burying 1/2" conduit, to a lockable disconnect and a breaker panel.
4. Flicking on the switch.

The $1.15 is the per watt costs of the components, including the 30% federal discount.

These modules are sold at Ontility, in Houston. 2 Canadian solar panels CS6P - 230P watts each, are mounted in a structure by California Edison. The 2 panel modules include Enphase M190 microenverters, and a ground wire, all attached and ready to go.

This panel is no longer available. Modify the square tube on page 6 to accomodate a different panel.

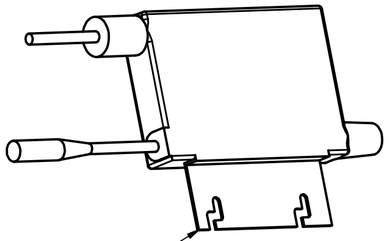
Note:This array has not been certified by a PE for wind loading.

DRAWN Bill Swann	10/31/2012	HS Technology
CHECKED		TITLE: Description
QA		
MFG		
APPROVED		
		SIZE C / DWG NO Array_V1_1302-1 / REV 2
		SCALE / SHEET 1 OF 8

This short document outlines the tasks necessary to build the support structure for the array,
and the steps necessary to get the harvested solar power back onto the grid.

Summary:

The barrier to entry to going solar is the installation cost. That consists of the hardware cost, and the installation cost.
An effort has been made to minimize the racking component cost, and that has been done. The labor cost is minimal. It consist of screwing the ground anchors into the ground, and assembling the components, and digging a trench to bring the harvested energy to the breaker panel.



Description:

This array consists of 1380 watts, 3 each of the module pictured below. It uses microinverters to convert the DC voltage from the panels to 220 volt single phase. What is not shown, is the power path in EMT tube going to a lockable disconnect, and then to a 220 volt breaker. The disconnect is required by Centerpoint Energy in Houston. It is for the benefit of the power company linemen - to not backfeed voltage, in case line repair is being done.

SunEdison "Ready Solar" 460 watt modules
and Enphase Microinverters
are available at Ontility in Houston.

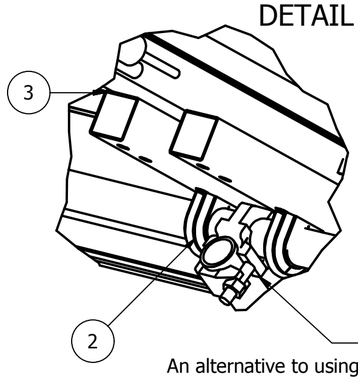
Tools and skills:

An effort has been made to design a support structure which is buildable with hand tools.
Some of the steel components have to be cut with a bandsaw, and drilled with some holes. A drill press is necessary.
Other tools are a shovel to bury the plastic pipe from the array to the transition to electromechanical tube (EMT).
The electrical hookup is as simple as plugging in a 220 volt plug, except the connection is to a 220 volt breaker, instead of an outlet. Flick the breaker, and watch the microinverter's LEDs indicate the status.
Verification that the panels are slowing down the electrical meter can be done with an AC amp-meter, or by seeing a decrease in the electrical bill, or by purchasing a wireless system monitor.

System Monitor from Enphase - Optional

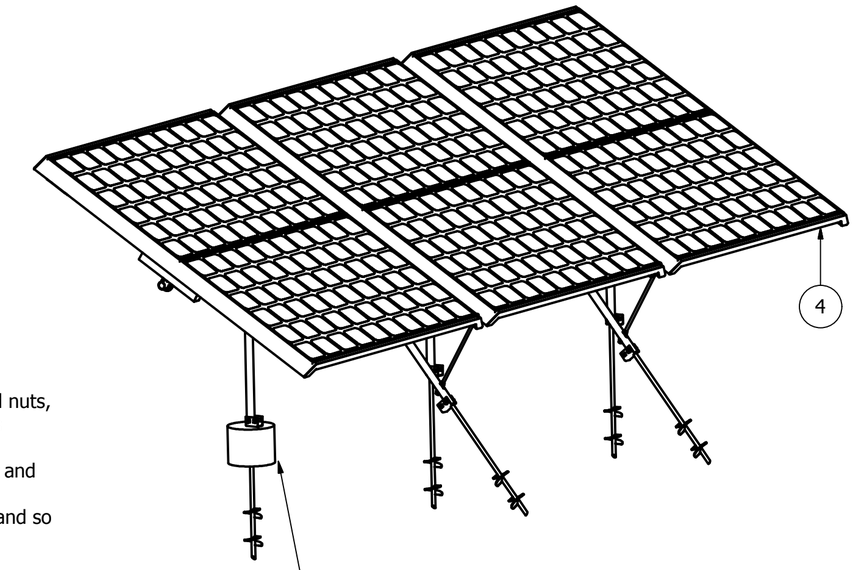
DRAWN Bill Swann	10/31/2012	HS Technology	
CHECKED		TITLE	
QA		More Description	
MFG			
APPROVED			
		SIZE C	DWG NO Array_V1_1302-1 / REV 2
		SCALE	SHEET 2 OF 8

Item 10.

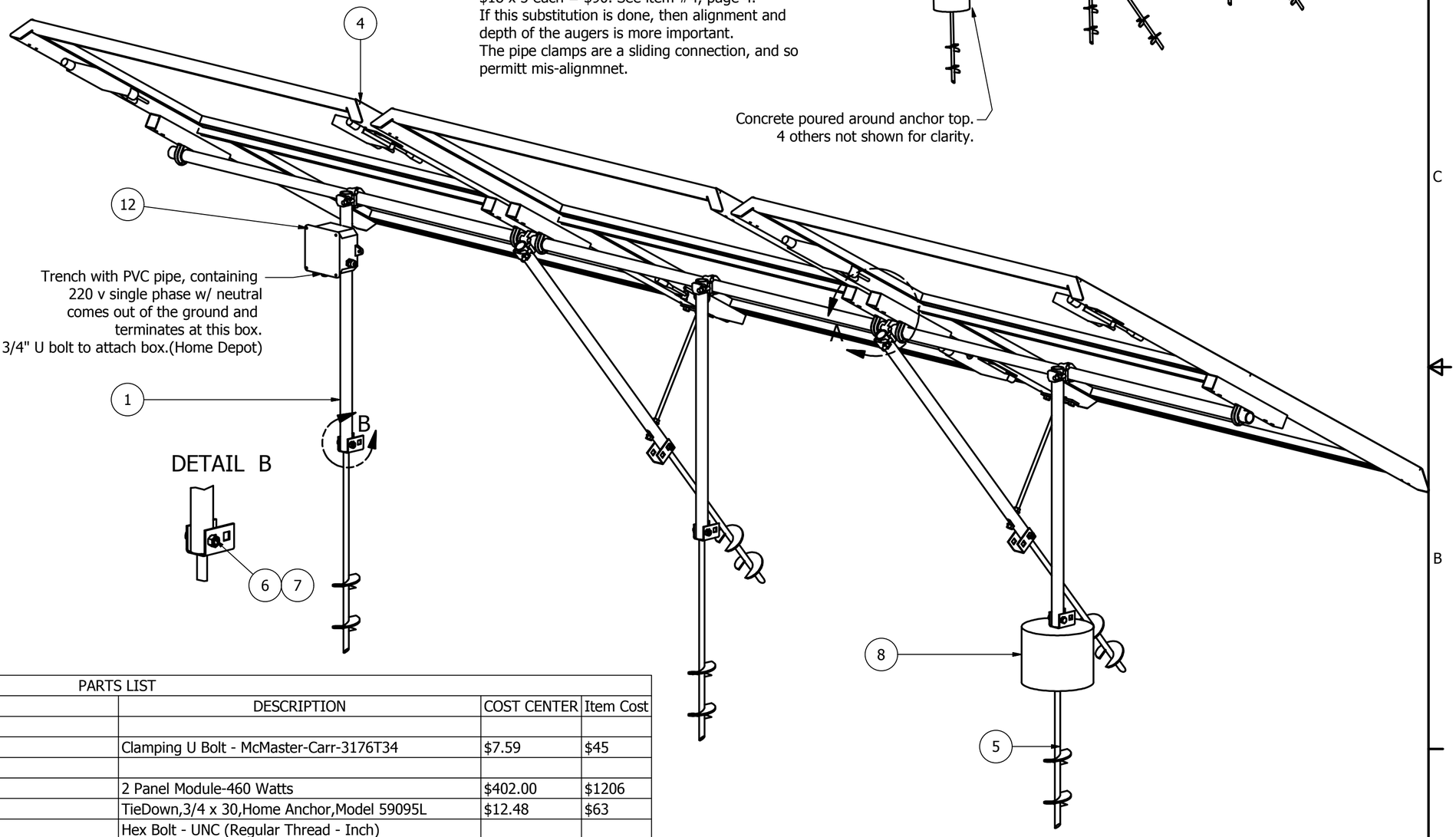


DETAIL A

An alternative to using these pipe clamps,
is to drill clearance holes for 1/2" bolts and nuts,
and bolt the pipes together. The savings is
$18 x 5 each = $90. See item #4, page 4.
If this substitution is done, then alignment and
depth of the augers is more important.
The pipe clamps are a sliding connection, and so
permitt mis-alignmnet.



Concrete poured around anchor top.
4 others not shown for clarity.



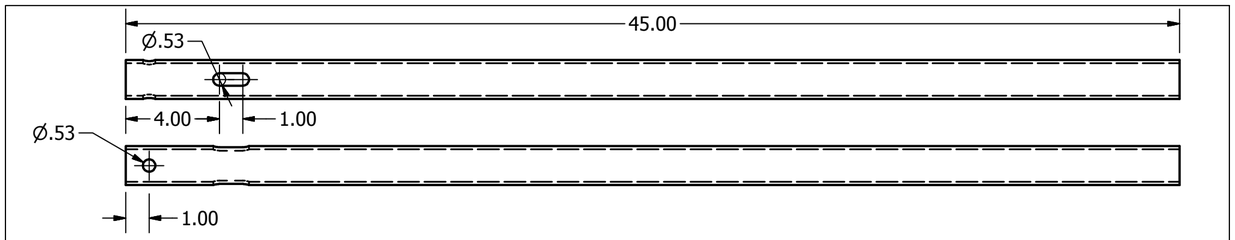
Trench with PVC pipe, containing
220 v single phase w/ neutral
comes out of the ground and
terminates at this box.
Use 1 3/4" U bolt to attach box.(Home Depot)

Item 2.

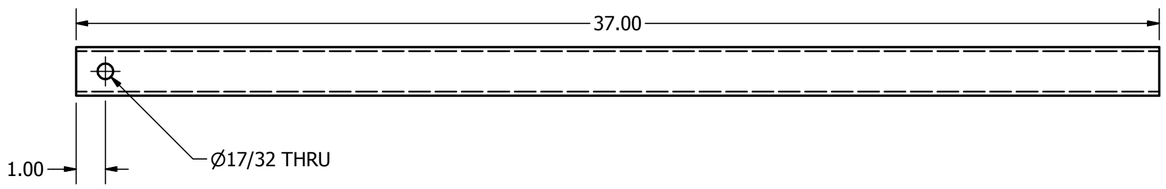
DETAIL B

PARTS LIST					
ITEM	QTY	PART NUMBER	DESCRIPTION	COST CENTER	Item Cost
1	1	StaticFrame1			
2	6	3176T34	Clamping U Bolt - McMaster-Carr-3176T34	$7.59	$45
3	6	SqTube_2x14Gauge			
4	3	Frame with 2 PV Modules	2 Panel Module-460 Watts	$402.00	$1206
5	5	GroundAnchor_HomeDepot	TieDown,3/4 x 30,Home Anchor,Model 59095L	$12.48	$63
6	5	ANSI/ASME B18.2.1 - 1/2-13 UNC - 2.5	Hex Bolt - UNC (Regular Thread - Inch)		
7	13	ANSI B18.2.2 - 1/2 - 13	Hex Nuts (Inch Series) Hex Nut		
8	1	Concrete	Poured Concrete		
9	1	1/2" Conduit(PVC & EMT),Wire(10 gauge Stranded),Fittings,		Length?	
10	1	Enphase Energy AC Interconnect cable	Interface cable betweenn Inverters and AC connection - Ebay		$44
11	24	ANSI B18.3 - 5/16 - 18 UNC - 3/4 HS HCS	Hexagon Socket Head Cap Screw		
12	1	Power box	Contains 220 v,Plastic watertight connectors		$10
13	2	TiltBracket			
14	2	AllThread_p5	1/2"All thread x 21" Long		
15	1	U Bolt-See page 5.	From Home depot - Requires drilling J box.		<$2
15	4	ANSI B18.22.1 - 1/2 - narrow - Type B	Plain Washer (Inch)Type A and B		
16	4	ANSI/ASME B18.2.1 - 1/2-13 UNC - 0.75	Hex Bolt - UNC (Regular Thread - Inch)		

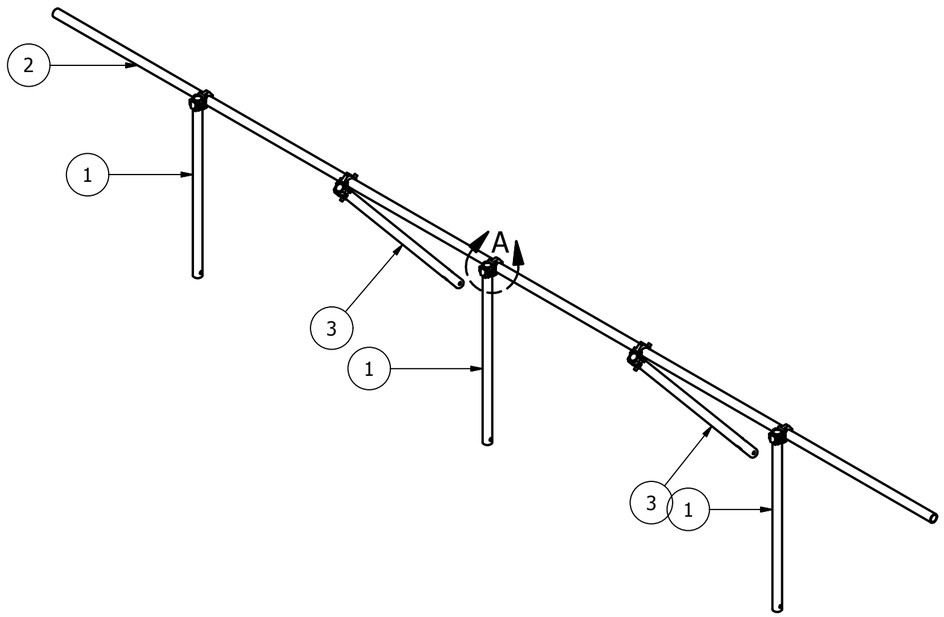
DRAWN Bill Swann	10/31/2012	HS Technology	
CHECKED		TITLE	
QA		Parts List	
MFG			
APPROVED		SIZE C	DWG NO Array_V1_1302-1 REV 2
		SCALE	SHEET 3 OF 8



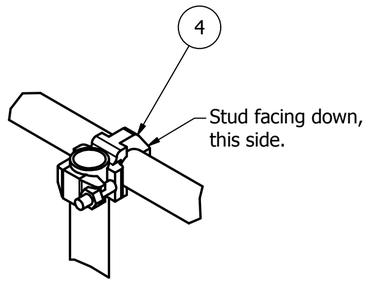
Typical of brace pieces of 1 1/4" pipe, Schedule 40. For bolting to ground anchor and all-thread connection.

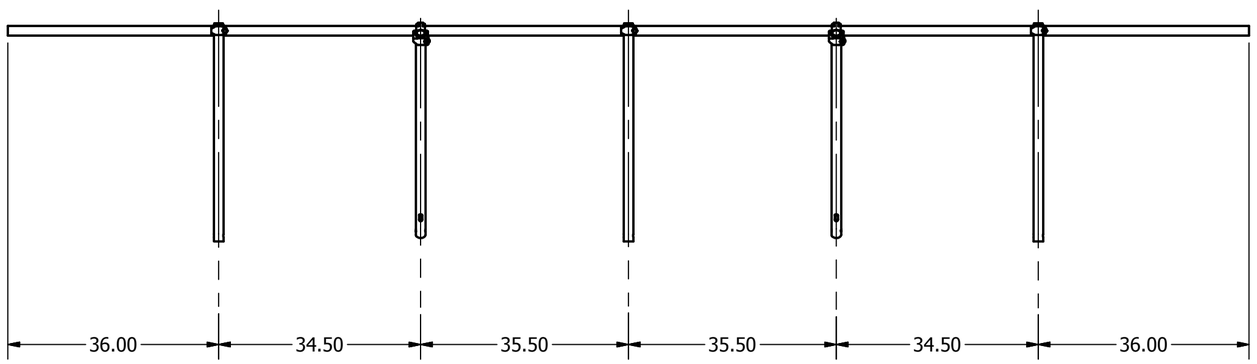


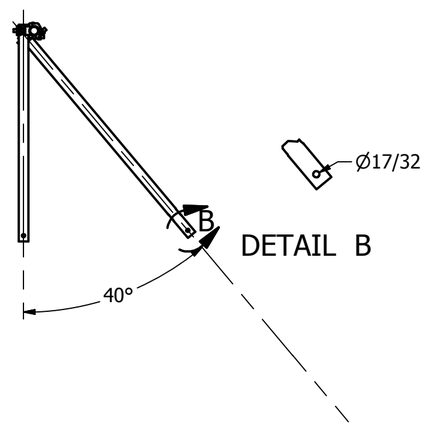
Typical of column pieces of 1 1/4" pipe, Schedule 40. For bolting to ground anchor.



Scaffold Pipe Clamp for 1 1/4" pipe.







DETAIL B

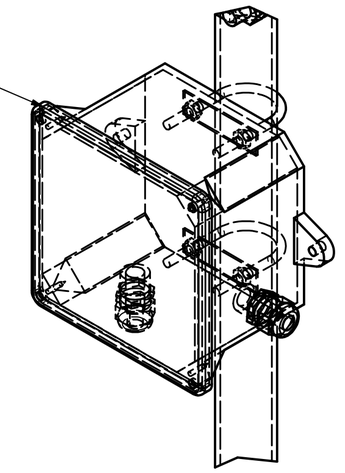
DETAIL A
SCALE 1 / 5

PARTS LIST

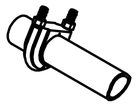
ITEM	QTY	PART NUMBER	DESCRIPTION	COST CENT	Extended Co
1	111.000 in	ANSI - 1 1/4 x 0.140 - 37	Pipe	*Varies*	$22
2	212.000 in	ANSI - 1 1/4 x 0.140 - 212	Pipe		$42
3	90.000 in	ANSI - 1 1/4 x 0.140 - 45	Pipe		$18
4	5	Scaffold Pipe Clamp	Check Online for suppliers	$18	$90

DRAWN Bill Swann	10/31/2012	HS Technology
CHECKED		TITLE: Spar Alignment
QA		
MFG		
APPROVED		
		SIZE C | DWG NO Array_V1_1302-1 | REV 2
		SCALE | SHEET 4 OF 8

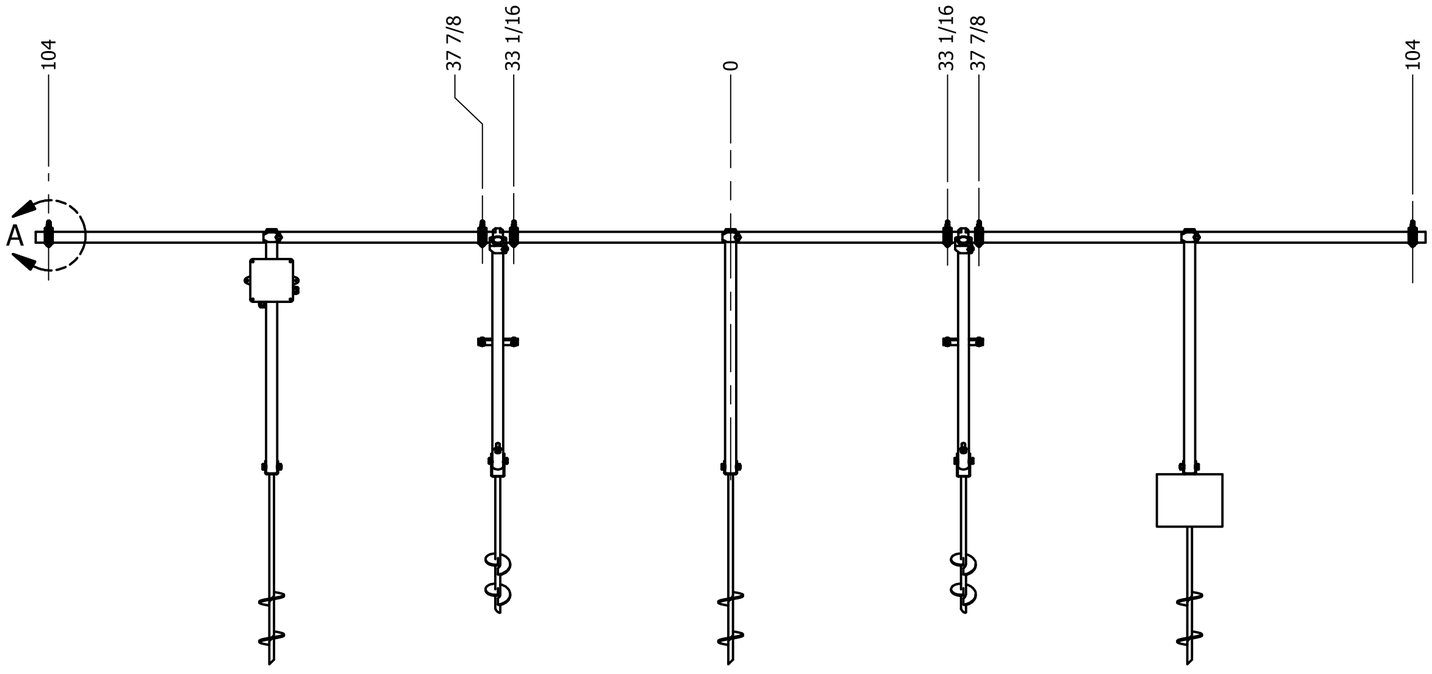
J Box drilled for 2 watertight connectors. One is for the 1/2" PVC, the other is for the electrical output chord. Additionally, drill the back of the junction box for 2 sets of U bolts.

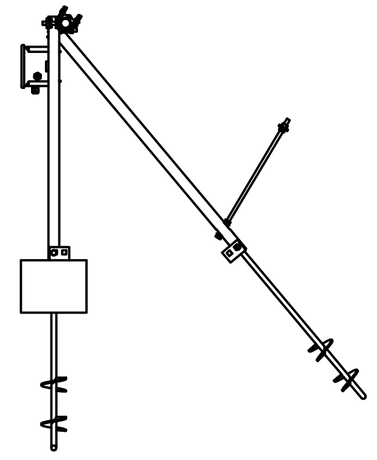


DETAIL C



DETAIL A

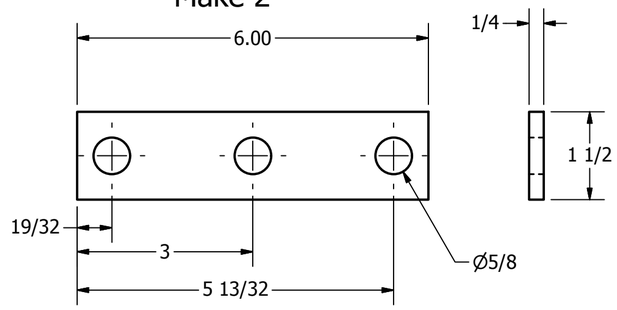


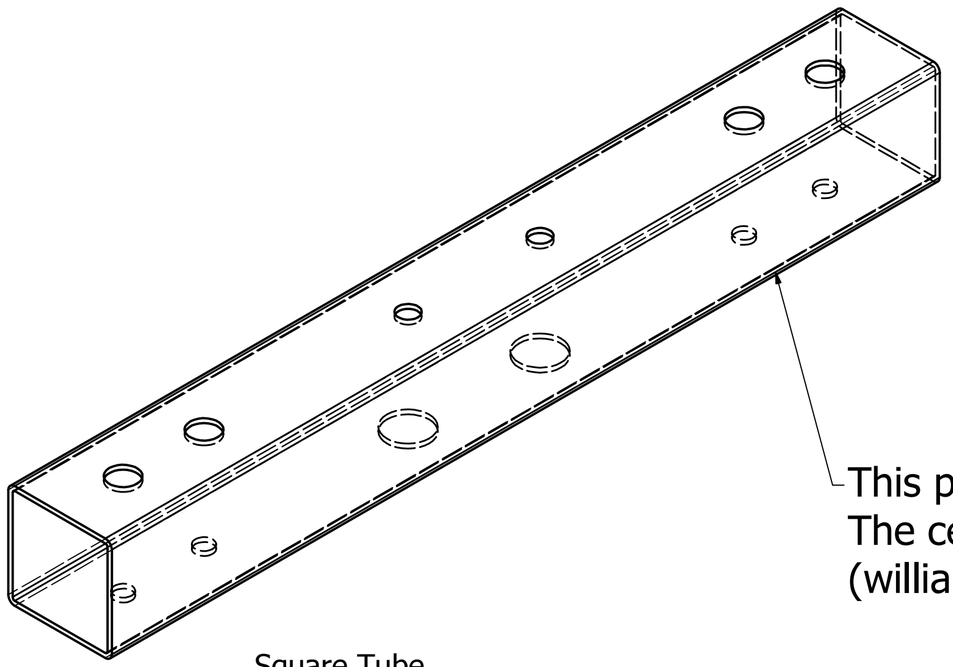


The u bolts connect to the square tube (sheet 5) , and the square tube connects to the panels.

DRAWN Bill Swann	10/31/2012	HS Technology
CHECKED		TITLE: U Clamp Placement
QA		
MFG		
APPROVED		
SIZE C	DWG NO Array_V1_1302-1	REV 2
SCALE	SHEET 5 OF 8	

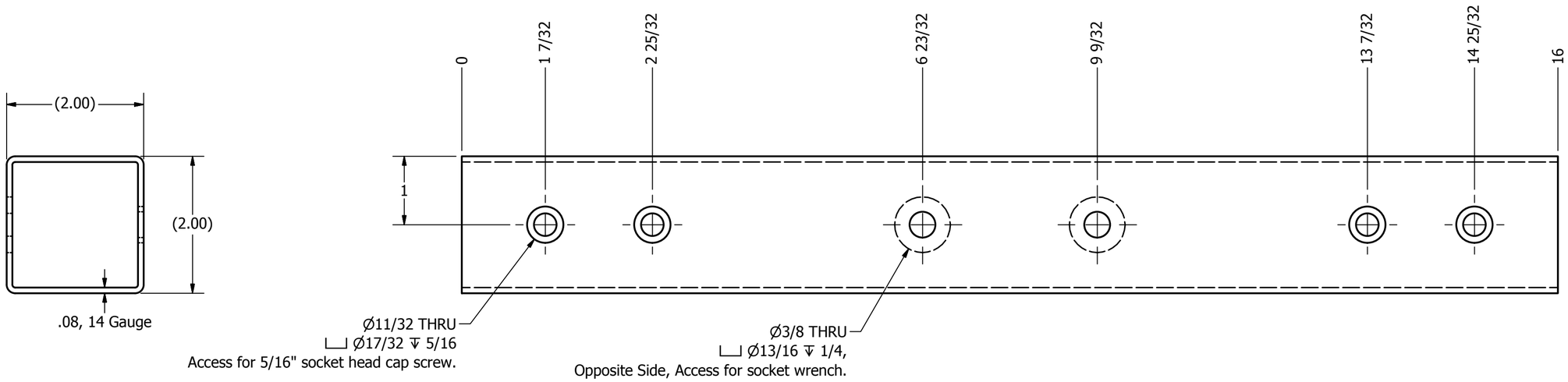
Tilt Bracket
Make 2





Square Tube,
Make 6

This part needs to be modified to accomodate a different size panel. The center holes remain, but the outer holes will be different. E-mail me (william.swann2@gmail.com) and I will design a replacement bracket.

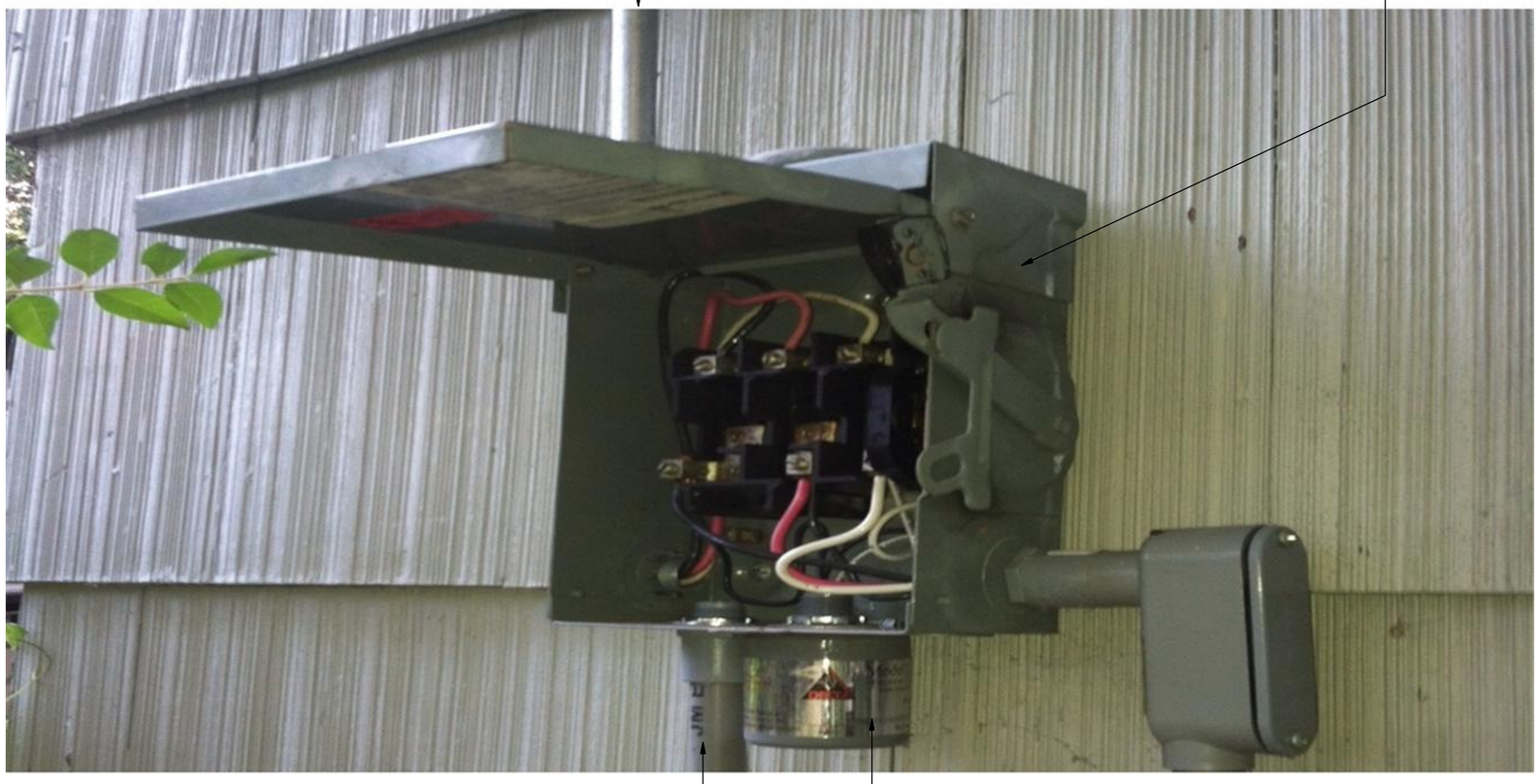


These are used to bolt to the Ready Solar modules to the frame.
This hole alignment needs to be accurate, as they mate to the hounting holes on the PV modules.
If the Ready Solar modules are not available, then use Unistrut to mount individual panels.

DRAWN Bill Swann	10/31/2012	HS Technology
CHECKED		TITLE: Square Tube Drilling
QA		
MFG		
APPROVED		
SIZE C	DWG NO Array_V1_1302-1	REV 2
SCALE	SHEET 6 OF 8	

To breaker box.
1/2" EMT

Lockable Disconnect
for 3 wires.
($45 from Affordable Solar)



From junction
box on array

Lightening Arrestor
($33 from Affordable Solar)

Other source of hardware -> Ebay.

DRAWN Bill Swann	10/31/2012	HS Technology
CHECKED		TITLE: Lockable Disconnect
QA		
MFG		
APPROVED		
		SIZE C · DWG NO Array_V1_1302-1 · REV 2
		SCALE · SHEET 7 OF 8

Assembly:

The location of the array should be in the lee of a building, facing south. It is not recommended that the array be cited in an open field, because of high wind loads. The array has not been certified for wind loading at any speed. Observe local building code requirements. In the Houston area, high wind speeds during hurricanes, is a design criteria. It is recommended that the panels be taken down, or oriented horizontally for high wind conditions.

For optimal energy harvest, the angle of the panels, from horizontal, can be adjusted to latitude minus 23° in the summer, and latituide plus 23° in the winter.

1. Lay out the location of the columns, and drill the anchors into the ground. Use a long steel bar to apply some torque, thru the saddle. If underground utilities are present (gas,electric feed,sewer lines,water lines) note the location. The depth should have the saddles 4" above the ground. Use a string to make the anchor heights equal. The same steps should be taken with the lateral braces
2. Bolt the columns and lateral braces to the saddles with 1/2" bolts and nuts. Attach the u-bolts to the horizontal 1 1/4" pipe. Attach the pipe clamps to the columns. Place the long pipe.
3. With a suitable concrete form, pour sak-crete around the tops of the anchors. Leave the auger saddle exposed. 10" of concrete should be mostly underground.
4. Attach the panel mounts, which are fabricated from square steel tube. See sheet 4.

Wiring:

From a junction box on the house to another junction box on the array. Home Depot has modestly priced PVC boxes. The smallest box will work.

1. Choose the proper gauge for the 3 wires, which will burried in PVC, assuming you have 16 microinverters (You might add more panels). Enphase has a chart for wire sizing, depending on the run length.
2. In Houston, the wires are buried 12", and contained in 1/2" grey pvc. In my backyard, the soil is very hard, so I use a 1" dia x 16" long drill bit to perforate the soil and a sharp shooter shovel. If the soil is too hard, soak it overnight with water.
3. Do not forget to ground the #8 bare copper wire to the frame.
4. Make up the proper lengths of PVC pipe, including long sweep elbows. make sure you can push/pull the 3 wires before you glew the joints.
5. The microinverters will have to be re-positioned on the frames, in order to connect them serially. The microinverters have 2 AC connection plugs. The short one is connected to the interconnect cable, Item 10 on page 3. The long one is connected to the next microinverter. It is OK to disconnect and re-connect the AC connection plugs, but not OK to disconnect the plugs between the panels and microinverters while the panels are generating voltage. Do this at night, or cover the panel with a blanket, if necessary.

DRAWN Bill Swann	10/31/2012	HS Technology
CHECKED		TITLE: Assembly and Wiring Notes
QA		
MFG		
APPROVED		
SIZE C	DWG NO Array_V1_1302-1	REV 2
SCALE	SHEET 8 OF 8	