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**NEW** [Re: SB7000US, Multiple Strings, Orientations](#) #1624 - 07/28/08 12:28 PM

**Martin Smirl**  
PV Guru

Simply put, if using ONE inverter each array or paralleled array should be in the same orientation.

Registered: 07/17/08  
Posts: 1365  
Loc: Citrus Heights, Ca

You would need an additional inverter for each additional array orientation. This is because of the MPP tracking each inverter calculates is based solely on 1 single orientation. This is directly tied to the inverters efficiency.



Your designer is correct.

*Edited by Russell.Kyle (07/31/12 02:43 PM)*

You can contact me directly at [Martinleesmirl@gmail.com](mailto:Martinleesmirl@gmail.com) if you still need help after contacting SMA technical support.

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Re: Mixed orientation strings driving single inverter [Re: catman2]

Steve Jefferson



Sr. Technical Service Specialist, Sunny Family Senior Member



Registered: 01/21/09 Posts: 51 Loc: Rocklin CA, 95677

Originally Posted By: catman2

been thinking about this..I have 3 strings i am installing..2 are set up at 16 degrees in a 32 degree latitude and already working, just with them I get enough power even in April, so I have power to burn !

Thinking of setting third string up at 45 degrees, same orientation, just to get more power in winter months...all 3 strings facing true solar south , very unshaded.

good or bad idea? !

Not ideal by any means. Your system will use the lowest voltage and bring anything that is higher voltage to the lowest common. Its the nature of Parallel circuits. Although, the MPPT Unit does compensate for this a little. Usually with differing oreintations you can expect losses of around 1-5%.

Steve Jefferson  
Senior Technical Service Specialist, Sunny Family  
[steve.jefferson@sma-america.com](mailto:steve.jefferson@sma-america.com)

*tilt angle is orientation*

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#1925 - 04/11/09 03:40 PM

[Jim Jenal](#)

New Member

Registered: 07/13/08  
Posts: 6

Greetings --

We have been asked to consult regarding a system with the following configuration: one SMA 6000US (240v) inverter that is driven by three strings of 12 Sharp NT-185U1 panels. All three strings are at 96 degrees azimuth, but two strings are tilted at 5 degrees where the third is tilted at 23 degrees. The location latitude is 34 degrees.

I am interested in knowing if SMA has any modeling that would indicate how the third string at a different tilt angle would impact overall performance.

Thanks in advance.

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#1928 - 04/14/09 10:48 PM

[martin](#)

PV Master

Registered: 08/19/04  
Posts: 96  
Loc: CA

What the motivation for complex designs? Why not keep it simple?

<http://forums.sma-america.com/ubbthreads...h=true#Post1624>

<http://forums.sma-america.com/ubbthreads...ch=true#Post273>

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#1929 - 04/15/09 10:38 AM

[Donald](#)

Junior Member

Registered: 08/21/06  
Posts: 30

I don't think different orientations of strings is a big deal. This is more a PV I/V curve question than an inverter question. The inverter will just select the voltage which produces max power from the multiple strings.

As was noted in one of the message chains, all panels in a particular string must have the same orientation. If one panel is oriented differently, or if it is shaded, that panel will want to produce less current than the rest. The higher current from the others will push it to the max current, zero volt (zero watts produced) point on the IV curve, and the rest will go thru the bypass diode.

On the other hand, if you have two or three identical strings, but each string is oriented differently, all strings are held at the same voltage, and each will produce the current their I/V curve indicates for that voltage.

I don't see the Sharp 185W on their web site, but sol\_dow\_NT175U1.pdf at

<http://solar.sharpsusa.com/solar/downloads/1,2496,0,00.html>

has an IV curve at 1000 W/m sun that peaks around 185W, 5.0A, 37V. For 800 W/m sun, it peaks around 142W, 4.18A, 34V. For 600 W/m sun, it peaks around 98W, 2.97A, 33V. Off-angle will be less sun, and probably greater reflection as well.

Your orientations of 23 vs 5 degrees aren't much difference.  $\cos(23-5) = 0.951$ ; When one array is perpendicular to the sun and generating 185W/panel, the other will be about 176W if separately tracked.

If you have two strings perpendicular to the sun and one off-angle, the peak power point will be fairly close to what the two strings want. If the off-angle array was getting 800 W/m and forced to 37V, output would drop from about 142W to about 137W, a 4.5% decrease. Yours should be closer to 950 W/m. I think you'll lose only about 1% from that one string, when it is off-angle.

When the one string is optimally oriented and the other two are off-angle, MPPT tracking will be a bit closer to the lower voltage preferred by the two strings, so they will be each degraded less than 1%. The single optimally oriented string will operate a bit below optimal voltage, but the curve is more gentle in that direction.

The mis-match will be more dramatic when the sun is off-angle - one string sees  $\cos(\theta)$ , and the other sees  $\cos(\theta + 19)$ . When one sees  $\cos(45) = 0.71$  or 710 W/m, the other will see  $\cos(64) = 0.44$  or 440 W/m.

You should be able to curve-fit to reproduce Sharp's graphs, and interpolate for various levels of sun. Then, you can graph the separate vs. joined MPPT. You should look for data on power production vs. angle, because I'm sure it isn't just the cosine function. (Sharp and others feature processing to capture off-angle light more effectively.) And, of course, the sunlight is reduced off-angle due to the atmosphere, so you aren't losing as many watt-hours due to the sub-optimum orientation.

I think you'll find that combining multiple strings of different orientations on the best available inverter will produce more watt-hours than either smaller, older model inverters or a different brand inverter with multiple MPPT inputs. Or at least more watt-hours per dollar.

The SB6000US-240V is CEC rated 95.5%, the other SBnnnnUS-240V models range from 94% to 96%, while the older Sharp JH-3500U is 91%

<http://eosolarcalifornia.org/equipment/inverter.php>

OK, so you might get 0.5% higher ratings from select models, but it won't be enough to make up for the premium paid for two separate inverters or the extra hookup costs.

Note that the inverter efficiency curves (link in California inverter web page) shows you'll lose 2% by running the inverter input around 450V rather than 250V. DC wiring loss is also typically 2%. Each of these is much more than losing 1% from 1 out of 3 strings.

On a positive note: My Sharp polycrystalline 165W + SB2500U frequently produces predicted AC power, while my Astropower 120W system usually peaks 15% below predictions. Whether the difference is specsmanship, process control, or different MPPT voltage, I'm not sure.

Da

.. Re: Mixed orientation strings driving single inverter[[View Forum Post](#)]

#1936 - 04/24/09 08:05 PM

[catman2](#)  
New Member

Registered: 03/13/09  
Posts: 8

been thinking about this..I have 3 strings i am installing..2 are set up at 16 degrees in a 32 degree latitude and already working, just with them I get enough power even in April, so I have power to burn !

Thinking of setting third string up at 45 degrees, same orientation, just to get more power in winter months...all 3 strings facing true solar south , very unshaded.

good or bad idea? !

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**Re: Mixed orientation strings driving single inverter** [Re: [catman2](#)]

#1944 - 05/04/09 10:15 AM

[Steve Jefferson](#)

 Sr. Technical Service Specialist, Sunny Family Senior Member



Registered: 01/21/09  
Posts: 51  
Loc: Rocklin CA, 95677

Originally Posted By: [catman2](#)

been thinking about this..I have 3 strings i am installing..2 are set up at 16 degrees in a 32 degree latitude and already working, just with them I get enough power even in April, so I have power to burn !

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Not ideal by any means. Your system will use the lowest voltage and bring anything that is higher voltage to the lowest common. Its the nature of Parallel circuits. Although, the MPPT Unit does compensate for this a little. Usually with differing orientations you can expect losses of around 1-5%.

Steve Jefferson  
Senior Technical Service Specialist, Sunny Family  
[steve.jefferson@sma-america.com](mailto:steve.jefferson@sma-america.com)

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**Re: Mixed orientation strings driving single inverter** [Re: [martin\\_](#)]

#1948 - 05/13/09 12:27 PM

[Jim Jenal](#)   
New Member

Registered: 07/13/08  
Posts: 6

No motivation on our part at all! Rather, we were being asked to come in and do a forensic examination of an existing system. We knew that the two orientations was not good design and were interested in how much degradation one would expect to see.

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Moderator: [Dane Forsberg](#), [Nick Borowiec](#), [Russell.Kyle](#)

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For the third inverter, all panels would have the same azimuth, but because they are located on 2 separate panel arrays, eight panels would be at 25 degrees tilt and thirteen would be at 15 degrees tilt. Sounds like it meets your "10 degree rule"?

As far as string sizing goes for that third inverter, that would mean three strings of 7:

- 1 string of 7 at 25 degrees.
- 1 string of 7 15 degrees.
- 1 string with 6 panels @15 degrees & 1 panel @ 25 degrees.

I assume the last string's single 25 degree panel will yield as if it was 15 degrees (lowest common denominator). My main concern is confirming it shouldn't really hurt my overall efficiency/MPPT operation beyond that single panel as best as anyone can tell?

*PER SMA Dave Johnson*  
*Up to 1-5% losses*  
*Maximum efficiency is installed on same tilt angle*

Originally Posted by **Naptown**

*Changing tilt would be the same as changing orientation The panels will have a different angle of incidence and the inverter will track to the lowest common denominator. There will be some loss of performance regardless in this situation how much is anyone's guess.*

*loss of performance*

When the inverter tracks to the lowest common denominator, is that within a single string, or within all strings? In other words, if I have 2 equal strings on an inverter, one with panels at 15degrees, the other with panels at 25degrees, do I get the benefit of 25 degrees for that 1 string or do ALL panels on the inverter act as if they are at 15 degrees when it comes to output?

Thanks!

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05-16-2011, 07:04 PM

**Naptown**

Administrator



Join Date: Feb 2011  
 Location: Annapolis Md  
 Posts: 2,592

Originally Posted by **solarsocal**

*The plan is still changing but the current one should allow 2 of the 3 inverters to be paired with panels that all have the exact same orientation (azimuth & tilt).*

*For the third inverter, all panels would have the same azimuth, but because they are located on 2 separate panel arrays, eight panels would be at 25 degrees tilt and thirteen would be at 15 degrees tilt. Sounds like it meets your "10 degree rule"?*

*As far as string sizing goes for that third inverter, that would mean three strings of 7:*

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*When the inverter tracks to the lowest common denominator, is that within a single string, or within all strings? In other words, if*

*Final angle of panel arrays in two different areas was known. To ensure max power efficiency 2 separate inverters were installed*

*I have 2 equal strings on an inverter, one with panels at 15degrees, the other with panels at 25degrees, do I get the benefit of 25 degrees for that 1 string or do ALL panels on the inverter act as if they are at 15 degrees when it comes to output?*

*Thanks!*

Have you confirmed strings of 7 with SMA for trigger voltage?

Rich  
[WWW.solarsaves.net](http://www.solarsaves.net)

Reply With Quote

05-17-2011, 02:10 PM

#7

**[solarsocal](#)**

Junior Member

Join Date: Mar 2011  
Location: Van Nuys, CA  
Posts: 14

Originally Posted by **Naptown**  
*Have you confirmed strings of 7 with SMA for trigger voltage?*

Not personally (and haven't learned about trigger voltage yet), I figure the installer would take care of things like that. They are CSI 295W panels, voltage specs are here: <http://www.solarhub.com/pv-modules/5...Canadian-Solar>

I think the 7-string (21 panel) setups would likely be on SB 7000US's and the 9 string (27 panel) setup would be on an SB 8000US. Specs on the 2nd page here: <http://www.wholesalesolar.com/pdf.fo...000US-spec.pdf>

Does that generally sound ok?

Thanks

Reply With Quote

05-17-2011, 05:08 PM

#8

**[Mike90250](#)**

Moderator



Join Date: May 2009  
Location: Los Angeles, CA, off grid retirement in Northern Calif  
Posts: 5,630

when strings are off-axis, the harvest will decrease. How much is unknown, because this is not a normal condition, and can vary by panel mfg, angle differences, heat.

Just impossible to predict except it will be less than optional.

Since the dawn of time it has been mankind's dream to blot out the sun.  
Montgomery Burns

"Always listen to experts. They'll tell you what can't be done and why. Then do it."

spreadsheet based voltage drop calculator:

<http://www.solar-guppy.com/download/...calculator.zip>  
<http://www.solarpaneltalk.com/showth...oss-calculator>

[http://www.mike-burgess.org/PVinfo\\_2.html](http://www.mike-burgess.org/PVinfo_2.html)

solar: <http://tinyurl.com/LMR-Solar>  
gen: <http://tinyurl.com/LMR-Lister> ,  
battery lugs <http://tinyurl.com/LMR-BigLug>  
Setting up batteries <http://tinyurl.com/LMR-NiFe>

gear :  
Powerfab top of pole PV mount | Listeroid 6/1 w/st5 gen head | XW6048  
inverter/chrgr | Iota 48V/15A charger | Morningstar 60A MPPT | 48V, 800A NiFe  
Battery (in series)| 15, Evergreen 205w "12V" PV array on pole | Midnight  
ePanel | Grundfos 10 SO5-9 with 3 wire Franklin Electric motor (1/2hp 240V  
1ph ) on a timer for 3 hr noontime run - Runs off PV || || VEC1093 12V  
Charger | Maha C401 aa/aaa Charger | SureSine | Sunsaver MPPT 15A

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05-17-2011, 07:13 PM

#0

**Naptown**

Administrator



Join Date: Feb 2011  
Location: Annapolis Md  
Posts: 2,592

Originally Posted by **solarsocal**

*Not personally (and haven't learned about trigger voltage yet), I figure the installer would take care of things like that. They are CSI 295W panels, voltage specs are here:*

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*<http://www.wholesalesolar.com/pdf.fo...000US-spec.pdf>*

*Does that generally sound ok?*

*Thanks*

No start voltage on that inverter is 300V VOC is 45  
45x7=315  
Once you add a load the voltage will drop  
36.3 is optimum load x7=256V  
That is at NOCT in hot weather the voltage will be lower.

Rich  
[WWW.solarsaves.net](http://WWW.solarsaves.net)

Reply With Quote

05-25-2011, 02:00 PM

#10

**solarsocal**

Junior Member

Join Date: Mar 2011  
Location: Van Nuys, CA  
Posts: 14

Update: I gave up on trying to keep an area of the roof clear of solar (for a future roof deck that I'll probably never build) and now have the space to get the yield we are after using more common 230 watt panels (still Canadian Solar, CS6P series) instead of those 295w panels.

All panel tilts are uniform at 15 degrees now (and all panels continue



to have the same azimuth).

Current string plan has 3 x 12 panels on inverter1, 3 x 11 panels on inverter2, and 2x10 panels on inverter 3. Hopefully that sounds more workable.

Thanks!

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