PVARRAY: A SOFTWARE TOOL FOR PHOTOVOLTAIC ARRAY DESIGN

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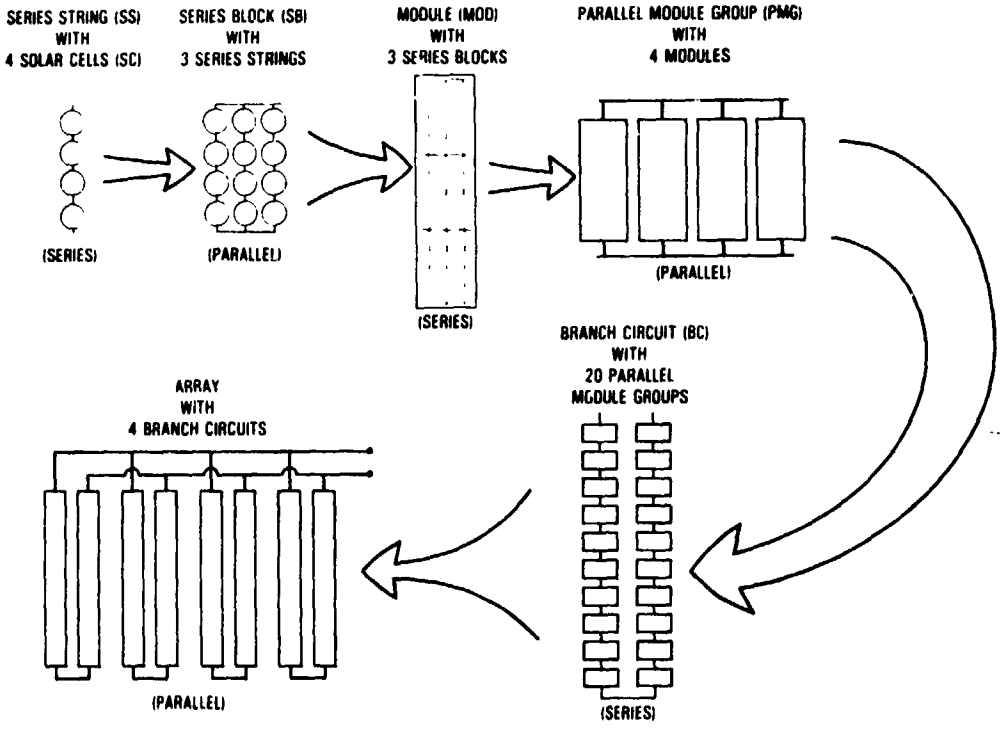
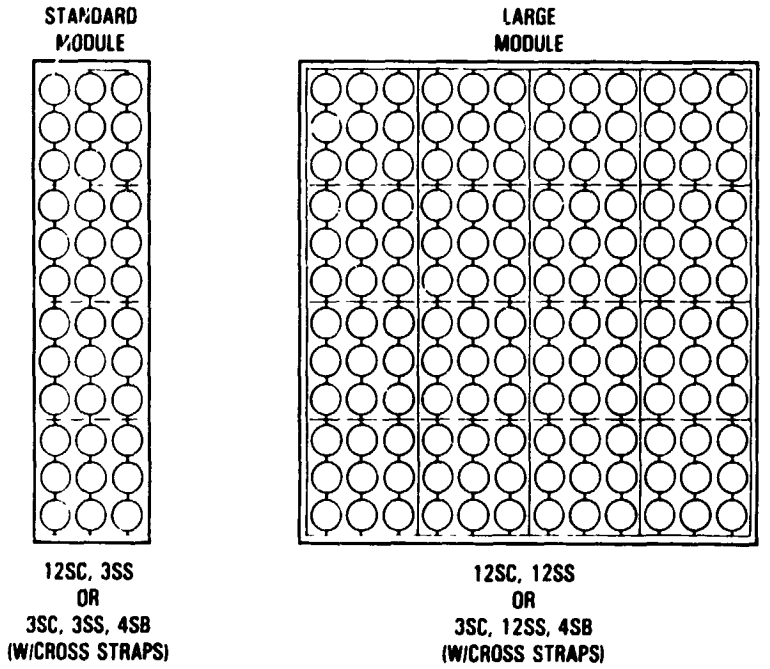
Background

- **Part of a PV costing system**
  - **SAMIS-PC** **(module cost)**
  - **PVARRAY** **(array performance)**
  - **LCP** **(life-cycle cost/performance)**
- **Funded by PA&I**

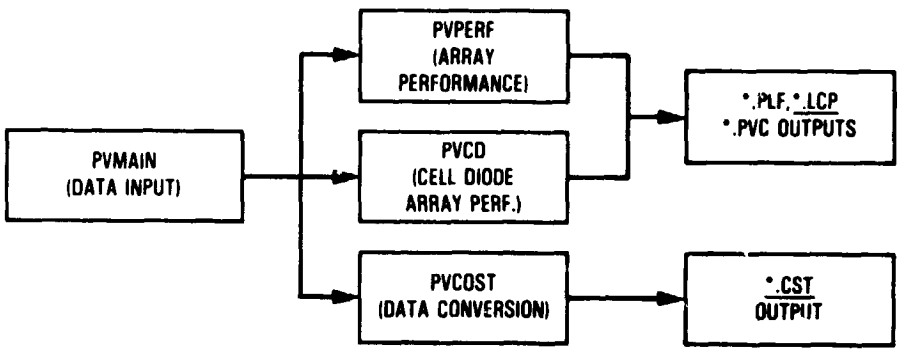
PVARRAY Terminology



PVARRAY Module Configurations



PVARRAY Flow Chart



Array Analysis

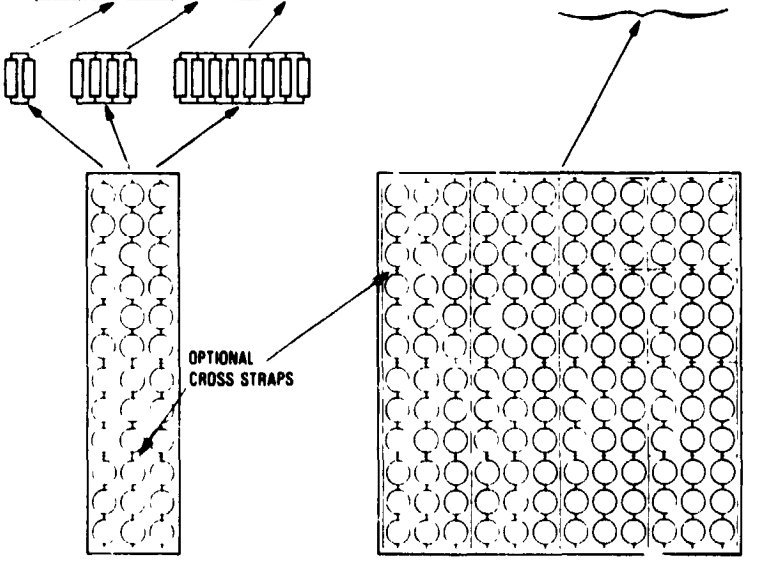
- **Fixed number of cells at 11520**
- **Fixed random number seed as 2560 which gave large number of early failures**
- **Ignored certain array design problems**
  - **Shadowing**
  - **Hot-spot heating**
  - **Shorts**

Assumptions and Caveats

- **Parallel redundancy**
- **Diode placement**
- **Replacement strategy**
- **High-efficiency cells**

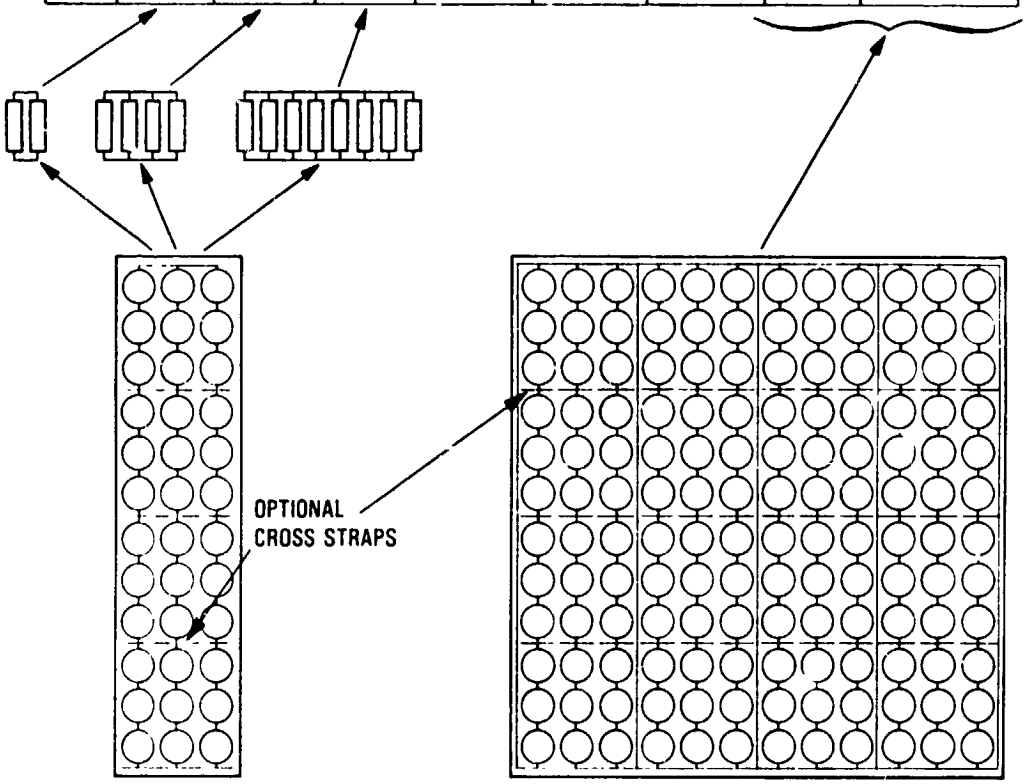
Parallel Redundancy, No Diodes

Rep	Small Module						Large Module	
	Plain			Cross Strapped				
	Low	Mod	High	Low	Mod	High	Plain	Strapped
R	8898	.9980	9137	8828	.9884	.8191	.8895	.9289
	5	0	0	4	1	0	0	0
MR	.7893	.8980	9137	.8337	9811	9191	.8895	.9289



Parallel Redundancy, Module Diodes

	Small Module						Large Module	
	Plain			Cross Strapped (4D)				
Rep.	Low	Med	High	Low	Med	High	Plain	Strapped (4D)
R	1.000 34	.8912 1	.9144 0	(Note 1)	(Note 1)	(Note 1)	.8915 1(4)	(Note 1)
NR	.8684	.8900	.9144	.8793	.9071	.9243	.8902	.9385



Diode Placement

Diode Location	Rep.	Small Module						Large Module	
		Plain			Cross Strapped				
		Low	Med	High	Low	Med	High	Plain	Strapped
Around Group	R	1.000 34	.8931 2	.9144 0	1.000 34	.9369 4	.9217 0	.8166 4(16)	.9299 0
	NR	.8655	.8900	.9144	.8744	.9011	.9217	.8895	.9299
Around Module	R	1.000 34	.8912 1	.9144 0	(Note 1)	(Note 1)	(Note 1)	.8915 1(4)	(Note 1)
	NR	.8684	.8900	.9144				.8902	
Around Block	R	(NA)	(NA)	(NA)	1.000 34	1.000 34	.9783 17	(NA)	.9658 3(12)
	NR				.9131	.9361	.9438		.9531
Around Cell	R	.9520 0	.9608 0	.9657 0	.9580 0	.9663 0	.9731 0	.9601 0	.9667 0
	NR	.9520	.9608	.9657	.9580	.9663	.9731	.9601	.9667
NO Diode	R	.8899 5	.8900 0	.9137 0	.8928 4	.9084 1	.9191 0	.8895 0	.9299 0
	NR	.7993	.8900	.9137	.8337	.9011	.9191	.8895	.9299

Note 1: Module diode has no effect on cross strapped modules.

Replacement Strategy

Replacement Fraction	Small Module						Large Module	
	Plain			Cross Strapped (4D)				
	Low	Med	High	Low	Med	High	Plain	Strapped (4D)
1.00 D	1.000 34	.8912 1	.9144 0	1.000 34	1.000 34	.9783 34	.9166 4(16)	.9658 3(12)
ND	.8899 5	.8900 0	.9137 0	.8928 4	.9084 1	.9191 0	.8895 0	.9299 0
.98 D	1.000 34	.8931 2	.9144 0	.8928 32	.9817 32	.9783 17	.8915 1(4)	.9658 3(12)
ND	.8899 5	.8900 0	.9144 0	.8928 8	.9084 1	.9191 0	.8895 0	.9299 0
.95 D	.9711 29	.8931 2	.9144 0	.9505 17	.9516 7	.9632 8	.8915 1(4)	.9531 0
ND	.8879 3	.8900 0	.9137 0	.8793 0	.9084 1	.9191 0	.8895 0	.9299 0
.00 D	.8684 0	.8900 0	.9144 0	.8793 0	.9071 0	.9243 0	.8902 0	.9385 0
ND	.7993	.8900	.9137	.8337	.9011	.9191	.8895	.9299

Effect of High-Efficiency Cells

Diode Location	Rep.	Low Redundancy		Large Module			
				Plain		Cross-Strapped	
		STD I-V	HEFF I-V	STD	HEFF	STD	HEFF
No Diode	R	.8899 5	.8572 7	.8895 0	.9030 0	.9299 0	.9493 3(12)
	NR	.7993	.7515	.8895	.9030	.9299	.9241
Around Module	R	1.000 34	1.000 34	.8915 1(4)	.9042 1(4)	(NA)	(NA)
	NR	.8684	.8612	.8902	.9031		
Around Block	R	1.000 34	1.000 34	(NA)	(NA)	.9658 3(12)	.9677 23(92)
	NR	.9131	.9094			.9531	.9445
Around Cell	R	.9520 0	.9512 0	.9601 0	.9537 0	.9667 0	.9657 0
	NR	.9520	.9512	.9601	.9537	.9667	.9657

Conclusions

- **PVARRAY could simulate a variety of configurations**
- **Results were consistent with previous parametric study results**