



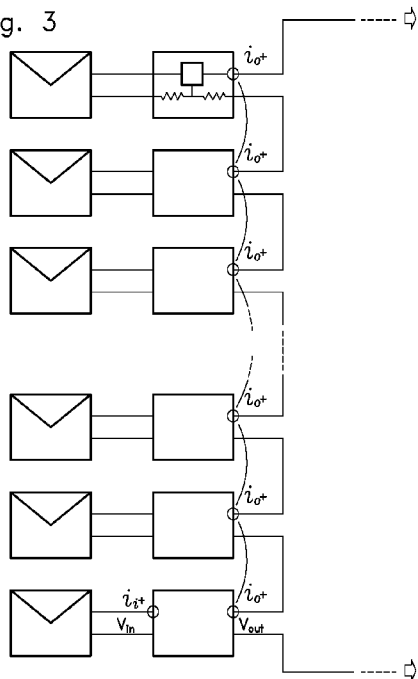
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[Continued on next page]

(54) Title: ABNORMALITY DETECTION ARCHITECTURE AND METHODS FOR PHOTOVOLTAIC SYSTEMS

Fig. 3



(57) Abstract: One aspect of the inventive technology disclosed herein, in certain embodiments, may involve the determination of at least one measured, instantaneous intra-string current difference for each of the power generating string, and the use of such determinations to assess the existence of leakage current, a frequent ground fault predecessor, thereby enabling preclusion of a ground fault that would otherwise result. Certain methods and detection architecture may enable precise abnormality location, e.g., enabling the identification of which solar module assembly in particular is faulty. Another aspect relates generally, in certain embodiments, to detection circuit architecture operable to sequentially impress a leakage current inducing voltage upon each rail of a photovoltaic system. Another relates generally, in certain embodiments, to the use of at least one current interrupter at each end of a string to preclude flow therethrough in the event of, e.g., unintended field reversal.

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INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - H01L 31/042 (2012.01) USPC - 136/244; 361/93.1 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(8): H01L 31/042 (2012.01) USPC: 136/244; 361/93.1 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched IPC(8): H01L 31/042 (2012.01) USPC: 136/243-245,251; 361/1, 42, 54, 57, 93.1-93.9, 115 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PubWEST; PGPB, USPT, EPAB, JPAB; Google Scholar; Google Patent; Search Terms: PV solar photovoltaic string sub-string array module series ground fault failure abnormal leak short arc ammeter current monitor sense switch ground rail negative interconnect positive		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0085670 A1 (Palaniswami et al.) 08 April 2010 (08.04.2010) para. [0022] through [0091], Fig. 1-3, 10	97-123
Y		75-96
Y	US 2011/0005567 A1 (VanderSluis et al.) 13 January 2011 (13.01.2011) para. [0007] through [0022], Fig. 1-7	1-96
Y	US 2009/0141522 A1 (Adest et al.) 04 June 2009 (04.06.2009) para. [0032] through [0067], Fig. 1-7	1-74
A	US 2009/0207543 A1 (Boniface et al.) 20 August 2009 (20.08.2009) entire document	1-123
A	US 2009/0206666 A1 (Sella et al.) 20 August 2009 (20.08.2009) entire document	1-123
A	US 2008/0147335 A1 (Adest et al.) 19 June 2008 (19.06.2008) entire document	1-123
A	US 2010/0078057 A1 (Karg et al.) 01 April 2010 (01.04.2010), para [0009]	1-123
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/>		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 16 July 2012 (16.07.2012)		Date of mailing of the international search report 24 JUL 2012
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/22266

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Extra Sheet (below)

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

Continuation of Box V, Lack of Unity of Invention.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-74 directed to a method of detecting operational abnormality within a solar power array that comprises at least one power generating string, said at least one power generating string comprising a plurality of serially connected solar module assemblies.

Group II: Claims 75-105 directed to an electrical circuit incorporated into a photovoltaic system having at least two rails, and enabling polarity reversal and detection of leakage current from said photovoltaic system,

Group III: Claims 106-123 directed to a solar module array.

The inventions listed as Groups I through III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The Group I claims have a special technical feature of determining at least one measured, instantaneous intra-string current difference for each of said at least one power generating string, wherein each of said at least one measured, instantaneous intra-string current difference is an instantaneous difference in string current between a respective two points on said at least one power generating string, assessing the presence of said operational abnormality between said respective two points based on said measured, instantaneous intra-string current difference, and repeating said steps of determining and assessing.

The Group II claims have a special technical feature of a combination comprising rail disconnect switch componentry able to disconnect said at least two rails, rail ground switch componentry able to independently ground each of said at least two rails, at least one current limiting resistor established so leakage current will pass therethrough, a ground connection with said at least one current limiting resistor, and at least one current measurer established to detect said leakage current;

The Group III claims have a special technical feature of a combination comprising a string of serially connected solar module assemblies, said string connected between a lower potential rail and a higher potential rail, said string having a lower potential end and a higher potential end, wherein one of said serially connected solar module assemblies is nearest said lower potential rail and another of said serially connected solar module assemblies is nearest said higher potential rail, at least one lower potential string end current interrupter established at said lower potential end of said string between said serially connected solar module assembly that is nearest said lower potential rail and said lower potential rail, and at least one higher potential string end current interrupter established at said higher potential end of said string between said serially connected solar module assembly that is nearest said higher potential rail and said higher potential rail; and

The Groups I-III each have a unique special technical feature and none of the groups share any special technical feature with any other group.

Groups I and II lack unity since they do not share any common claim limitations. Groups I and III lack unity, since strings of solar modules are known in the art (see US 2010/0078057 A1 (KARG et al.) 01 April 2010 (01.04.2010), para [0009]). Groups II and III lack unity since solar modules having at least two rails (bus bars) are known (see US 2010/0078057 A1 (KARG et al.) 01 April 2010 (01.04.2010), para [0009]).

Therefore, the inventions of Groups I-III lack unity of invention under PCT Rule 13 because they do not share a same or corresponding special technical feature.