Solar Tracker: Optimizing the Offset of the Sun-Monitors 4-Quadrant Detector

I. Purpose:

INTRAs firmware-monitor includes a menu which allows to specify the offset of the Sun-Monitor. (See Parameter-menu of the Sun monitor menu). Two values, one for the offset of the primary and one for the offset of the secondary axis may be entered. This text describes a step by step procedure which allows to optimize these values, in case you feel that your instruments are not perfectly aligned with the sun-monitor.

II. Cautions and Hazards:

- ***Warning***: Do not relay on observations made while sky conditions are less then perfect. A hazy sky may result in a "diffuse" definition of the target (the sun).

III. Requirements:

- None.

IV. Procedure:

A. Steps:

1. While the tracker is locked on the sun (sun-mode!) you observe some misalignment with respect to your instrument. Convert observed misalignments into degrees for both axis - e. g. you find that the sun leads the instrument (or tracker) by da degrees and is higher by de degrees (than the pointing of the instrument).
2. Enter the parameter menu of the sun monitor, then type P to show the parameters. Note the parameters "offset quadr. Primary", "offset quadr. Secondary" and "Factor to arc".
3. You compute the new offsets using the following formulas:

$$ao_2 = ao_1 + \frac{Arc(da)}{factor}$$

where
ao_i is the old (1) and new(2) offset (primary axis) for the sun-monitor
Arc() Converts argument from degrees to arc (units).
da observed misalignment (azimuth, in degrees). **da positive if sun leads the tracker**.

factor see cor. value in the parameter menu of the sun monitor (typically 0.125).

$$eo_2 = eo_1 + \frac{Arc(de)}{factor}$$

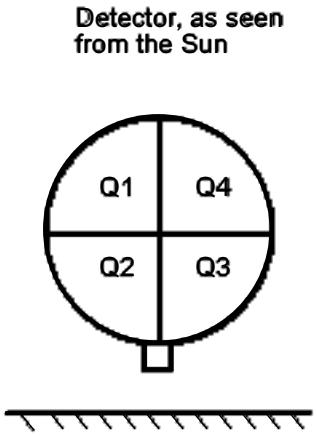
where
eo_i is the old (1) and new(2) offset (secondary axis) for the sun-monitor
Arc() Converts argument from degrees to arc (units).
de observed misalignment (elevation, in degrees). **de positive if sun is higher than the tracker**.
factor see cor. value in the parameter menu of the sun monitor (same for both axis).

4. Use the "Offsets quadr"-menu of the parameter menu (password-protected) to enter the new values.

    a) Verify alignment, then use the saVe command to render settings "nonvolatile".

B. Hardware and a Window into INTRAs Firmware

1. The sunmonitor is a 4-quadrant silicon cell (C30843 by EG&G). INTRAs electronics includes circuits to convert the photo-currents of these 4 elements into voltages. A on-board 8-bit ADC samples these signals and the resulting 8-bit integers are finally converted into Volts.
2. The layout of the 4 quadrants is as follows:



3. INTRAS firmware converts voltages of the sun monitor into angles using the MODULA-2 routine shown below:

```
PROCEDURE Make4QAngle(    Q1, Q2, Q3, Q4:REAL; (* in volt *)
                  VAR a, e : REAL);       (* as angle in arc units *)
VAR sum : REAL;
BEGIN
  sum := Q1 + Q2 + Q3 + Q4;
  IF sum > 0.0 THEN
    a := ((Q1 + Q2) - (Q3 + Q4)) / sum;
    e := ((Q1 + Q4) - (Q2 + Q3)) / sum;
    WITH eeprom DO
      a := (a - quadrantoffset[Primary]) * Factor;
      e := (e - quadrantoffset[Secondary]) * Factor;
      IF eeprom.mounting=turned180 THEN a := -a END;
    END; (* with *)
  ELSE
    a := 0.0; e := 0.0;
  END; (* if sum *)
END Make4QAngle;
```

The parameters "quadrantoffset" and "Factor" are the corresponding parameters accessible using the sunmonitor menue of INRAs firmware.

In the context of the firmware, the results a and e are termed "pointing error of azimuth" or "elevation" resp. Of course, this is not realy true and is a sloppy use of terms. Its correct only, if the elevation is zero.

V. References:

1. Brusag Manual: **INTRA/DOC/881-BRU**, Version 1.00, 10/Dec/97, pp. 1-2.

VI. Attachments:

None.