

Antenna Array Configuration for DDA software

Digisonde® Antenna Arrays

Two different types of antenna arrays can be implemented in the Digisonde® system. 7-antenna array is used for the DGS256 (DISS) system while 4-antenna array is used with the DPS system. Figure 1 shows two types of standard-per-manual antenna configurations.

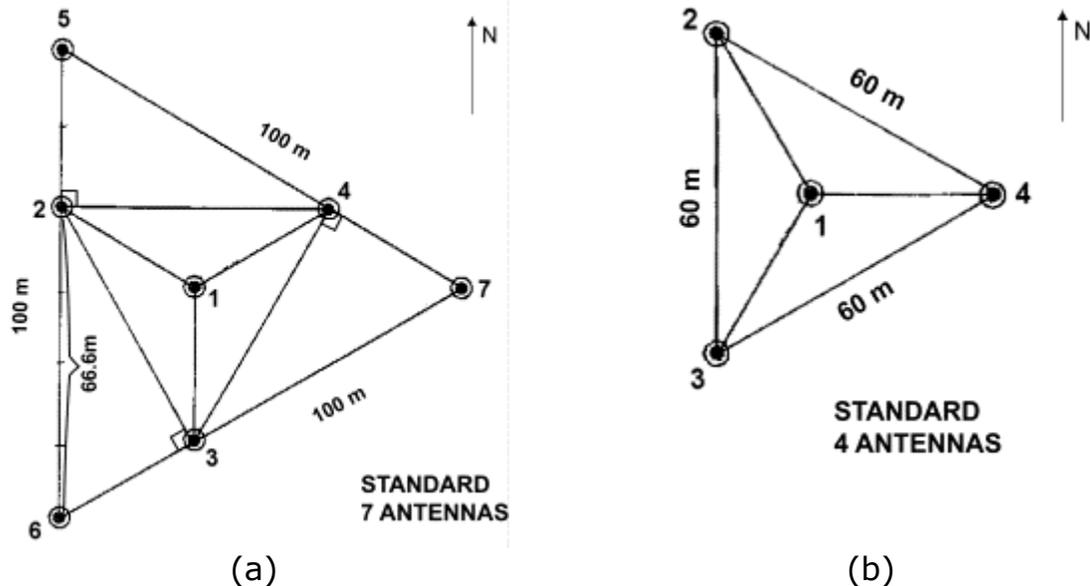


Figure 1. a) Standard Digisonde® 7-antenna array configuration. b) Standard Digisonde® 4-antenna array configuration

Antenna Array Specification for DDA

The DDA software features a generic scheme for antenna array specification that allows any possible antenna configuration to be entered. A variety of "standard" antenna configurations can be defined using DEVN, MAXSEP, and ROTATA parameters, and in a case of "non-standard" antenna setup, each antenna position in the array can be specified individually.

DDA Antenna configuration is specified in the ddasetup.onl file, at the line *185 with the following format:

```
*185 StationName < LAT, LONG, CGPLAT, CGPLONG, COMPN, MAXSEP, DEVN, ROTATA >
```

For example,

```
*185 HAARP < 62.24, 214.91, 80.00, -80.00, 23.8, 103.92, -30.0, 13 >
```

Parameters **LAT, LONG, CGPLAT, CGPLONG, COMPN** referring to the station location are explained below.

LAT - Station Latitude

LONG - Station Longitude

CGPLAT - Corrected Geomagnetic Pole Latitude

CGPLONG - Corrected Geomagnetic Pole Longitude

COMPNTD - Compass North Deviation (a.k.a. Magnetic Declination Angle). Positive angles correspond to the compass north deviation to the East of geographic north.

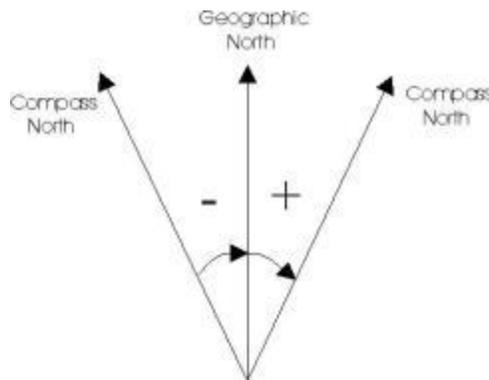


Figure 2. Definition of the COMPN parameter

Parameters **MAXSEP, DEVN, ROTATA** specify the antenna configuration itself.

MAXSEP: This variable specifies the maximum antenna separation of the largest triangle in the seven antenna array configuration (Figure 1a). Namely, MAXSEP is the distance in meters from antenna 5 to 6, 6 to 7, or 7 to 5. MAXSEP always refers to the outer antennas of the seven-antenna system, even if they are not present (as for the 4-antenna setup of the DPS). In the case of the DPS where only four antennas are available, the MAXSEP is specified as the distance between the virtual antennas 5, 6, and 7. For example, in the standard DPS antenna layout, with 60 m long triangle side (distance between antennas 2 and 3) MAXSEP should be set to 103.92 m. In this case, the DPS antennas 2, 3, and 4 are referred to as the *inner antennas* of the 7 antenna array.

DEVN:

Parameter DEVN ("deviation") is defined as an angle between the direction to Compass North and the line passing through the antennas #3 and #1. This angle is counted counter-clockwise from the Compass North toward the "3-1" line (see Figure 3), taking values from -180 to 180.

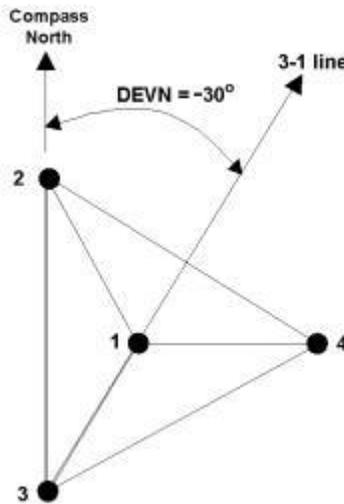


Figure 3. Specification of the DEVN parameter.

ROTATA. This parameter (a) defines the antenna array configuration, and (b) also specifies the output coordinate system for skymap and velocity data calculated by the DDA software. Possible values for the ROTATA parameter are defined in the following table.

ROTATA			Antenna setup
0	3	6	Clockwise rotating 7 antenna setup
1	4	7	Clockwise rotating 4 Inner antenna setup
2	5	8	Clockwise rotating 4 Outer antenna setup
9	12	15	Counter-clockwise rotating 7 antenna setup
10	13	16	Counter-clockwise rotating 4 Inner ant. setup
11	14	17	Counter-clockwise rotating 4 Outer ant. setup
-1	-2	-3	Non-standard antenna setup
Corrected	Geomagnetic	Geographic	
Geomagnetic			
Output coordinate system			

Rotation Sense: This specifies the actual position of the antennas in the triangular array. In a seven-antenna setup, antennas 6, 2, and 5 are located west of antenna 1, while antennas 4 and 7 are located east of antenna 1. This antenna field is said to be a counter-clockwise rotating field since spiraling from antenna 2, 3, 4, 5, 6 to 7 the spiral is in a counter-clockwise direction. For the mirror image array where antennas 7 and 4 are located west of antenna 1 and antennas 6, 2, and 5 are located east of antenna 1, the spiraling from antenna to antenna goes in a clockwise direction.

Standard Antenna Array Configurations

Historically, three standard Digisonde® antenna array configurations were considered in the UMLCAR software for ionogram processing (ADEP, Viewer, SAO Explorer):

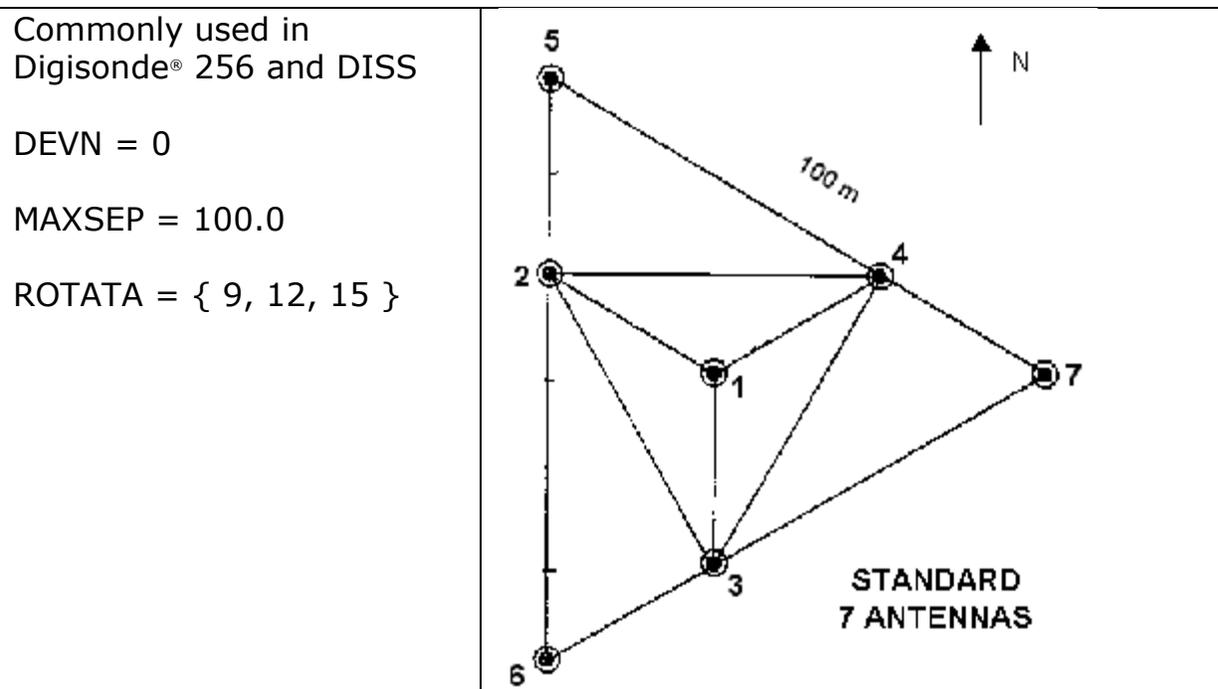
- Standard per manual
- Mirrored (rotated 180° about the X axis)
- Rotated (rotated 180° about the Z axis)

Recently, in support of our DIDBase (Digital Ionogram DataBase) development, we have introduced a new scheme for specification of the Digisonde® antenna array configurations. The following antenna array nomenclature is now used:

- Seven antennas standard
- Seven antennas mirrored
- Four antennas standard
- Four antennas mirrored

DDA antenna specification examples for some of commonly used antenna layouts can be found in the tables below.

Four Standard Antenna Array Configurations



Known installations:

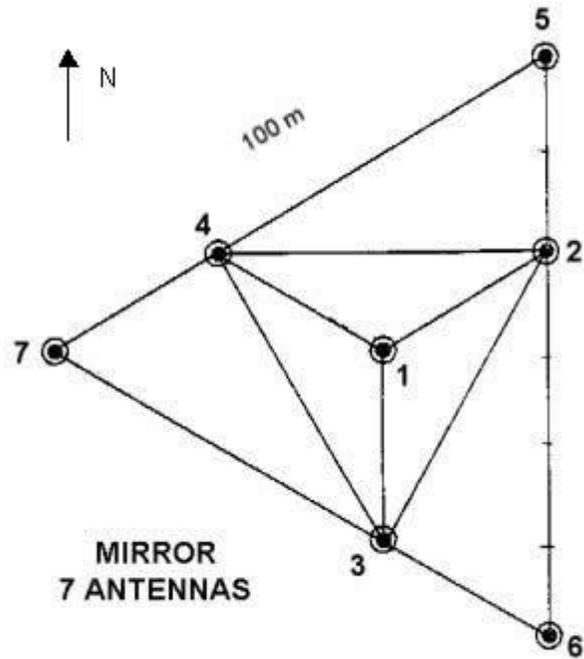
Millstone Hill

Goose Bay DISS

DEVN = 0

MAXSEP = 100.0

ROTATA = { 0, 3, 6 }



In the "standard" configuration, antenna 1 to antenna 7 are walked counter-clockwise.

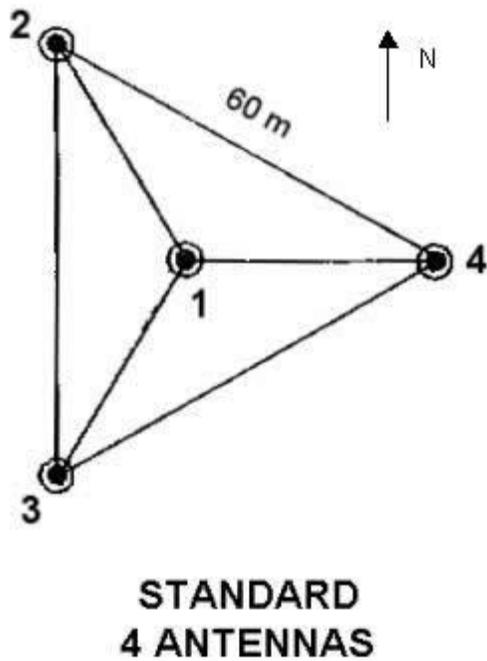
In the "mirror" configuration, antenna 1 to antenna 7 are walked clockwise.

Commonly used in DPS.

DEVN = -30

MAXSEP = 103.92

ROTATA = { 10, 13, 16 }



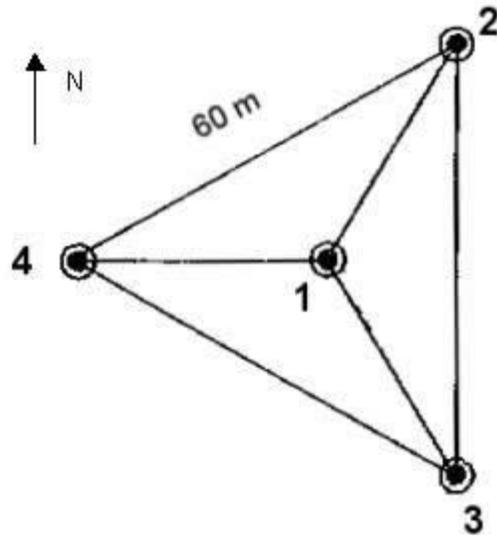
Known installations:

Rome
LaTrobe U. ?

DEVN = 30

MAXSEP = 103.92

ROTATA = { 1, 4, 7 }



**MIRROR
4 ANTENNAS**

Other known cases

Here's more examples of existing Digisonde® antenna arrays configurations in the new encoding scheme:

Formerly "ROTATED DGS-256".

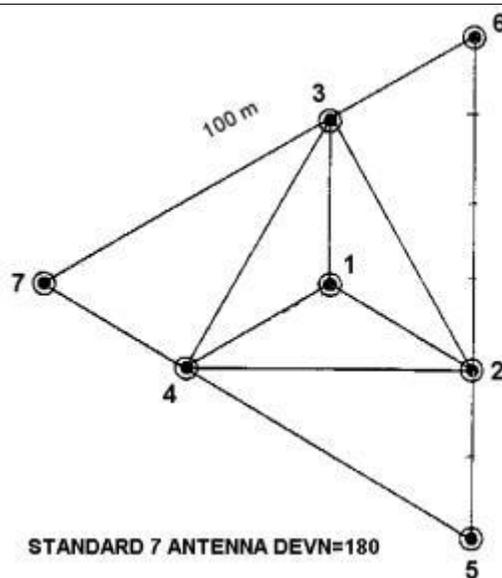
Known installations:

- Karachi
- Kokubunji
- Beijing

DEVN = 180

MAXSEP = 100.0

ROTATA = { 9, 12, 15 }



STANDARD 7 ANTENNA DEVN=180

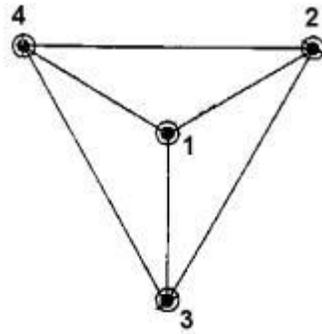
DPS working on the internal loop of the array configuration "MIRRORED 7 ANTENNA DEVN=0"

- Millstone Hill

DEVN = 0

MAXSEP = 103.92

ROTATA = { 1, 4, 7 }



MIRROR 4 ANTENNA DEVN=0

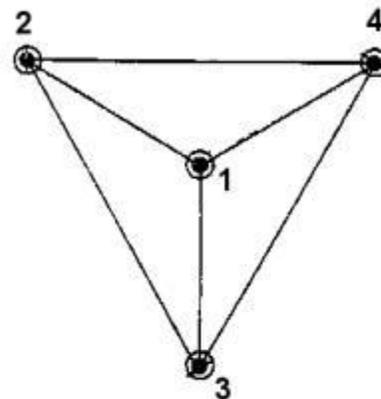
DPS working on the internal loop of the array configuration "STANDARD 7 ANTENNA DEVN=0"

- Sondestrom
- Ramey AFB

DEVN = 0

MAXSEP = 100.0

ROTATA = { 10,13, 16 }



STANDARD 4 ANTENNA DEVN=0

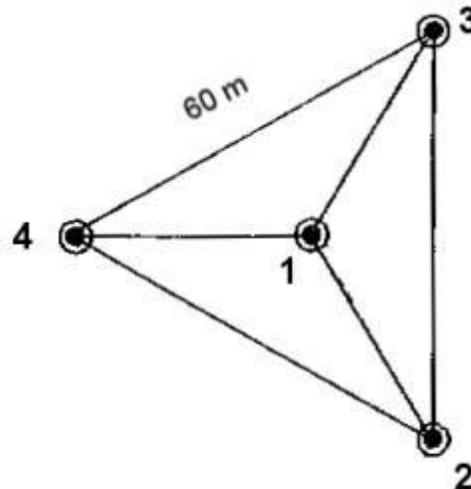
Formerly known as "DPS ROTATED"

- Juliusruh?

DEVN = 150

MAXSEP = 103.92

ROTATA = { 10,13, 16 }



STANDARD 4 ANTENNA
DEVN=150

Non-standard Antenna Array Configurations

If the antenna array configuration is not one of the standard (listed above), such a non-standard setup is described by direct specification of each antenna coordinates in the lines 170-183 of the ddasetup.onl file or lines 080-082 of the Station UDD file.

The ROTATA parameter shall be set negative in this case:

ROTATA = -1 DDA output is in Corrected Geomagnetic coordinates

ROTATA = -2 DDA output is in Compass coordinates

ROTATA = -3 DDA output is in Geographic coordinates

Individual antenna specifications should made in the system of coordinates (Figure 4), where

- X points to the Compass North at the time of installation
- Z is the local vertical pointing up, and
- Y forms the right-hand system (i.e., points to the West).



Figure 4. Coordinate system used in DDA for antenna orientation

Note: For non-standard antenna configurations, there is no need to specify parameters MAXSEP, COMPN, DEVN in ddasetup.onl file.