OPERATION GUIDE FOR PRODYN "AD" SERIES
GROUND PLANE TYPE D-DOT SENSORS

GENERAL DESCRIPTION

The PRODYN "AD" series ground plane type D-Dots are a range of broadband sensors with single ended outputs that were designed to measure time rate of change of electric displacement. They can also be used to measure the time rate of change of surface current density. Electrical and physical specifications for each model can be found on PRODYN data sheet "Electric Field Sensors-Ground Plane".

The sensor consists of one asymptotic sensing element mounted on the top side of a ground plate and held in position by a dielectric support. The sensing element is connected to a transmission line to the 50 ohm output connector.

THEORY AND PRINCIPLES OF OPERATION

Basic Theory

It is recommended that the user review PRODYN application note number 895 before using any of these D-Dot sensors. PRODYN's other application notes (PAN 1195, 192 & 890) are referred to and have useful information on the theory and operation of EM sensors.

The "AD" ground plane type sensor may be thought of as a current generator, which generates a current proportional to D-Dot. On the sensor's sensing element side, the generated current flows through the load impedance (cable termination) and produces the output voltage:

$$V_{out}=R\ Aeq\ \dot{D}$$

Where

R= Load impedance (50 ohms for ground plane sensors)
Aeq= equivalent sensor area in square meters

$\dot{D}$= time rate of change of displacement current in amperes/m^2

If the sensor is being used to measure surface current density the equation is:

$$V_{out}=R\ Aeq\ qs$$

Where

qs= surface current density in Coulombs/m^2

The load resistance is shunted by the sensor capacitance, which bypasses part of the generated current and limits the high frequency response of the sensor. Current flows to the ground through the load resistance and sensor capacitance. The current generated is picked off the sensing element that is connected to a 50 ohm transmission line at the center of the sensor. The transmission line carries the signal to the output connector.

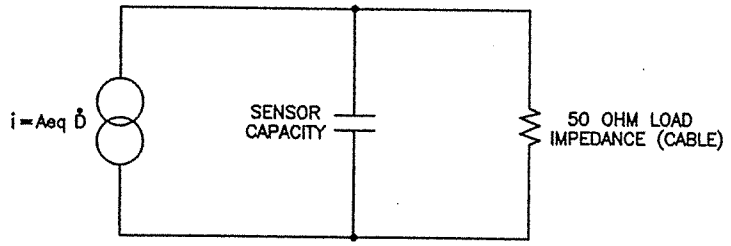
Operation Description

PRODYN's ground plane D-Dot sensors are used on any conducting surface (ground plane) to measure the time rate of change of the electric displacement vector $\left(\frac{d}{dt}[D]\right)$, or the time rate of change of surface current density $\left(\frac{d}{dt}qs\right)$. The electric displacement vector (D) is related to the electric field intensity (E), which is normally the desired measurement quantity; $D=\varepsilon_0 E$

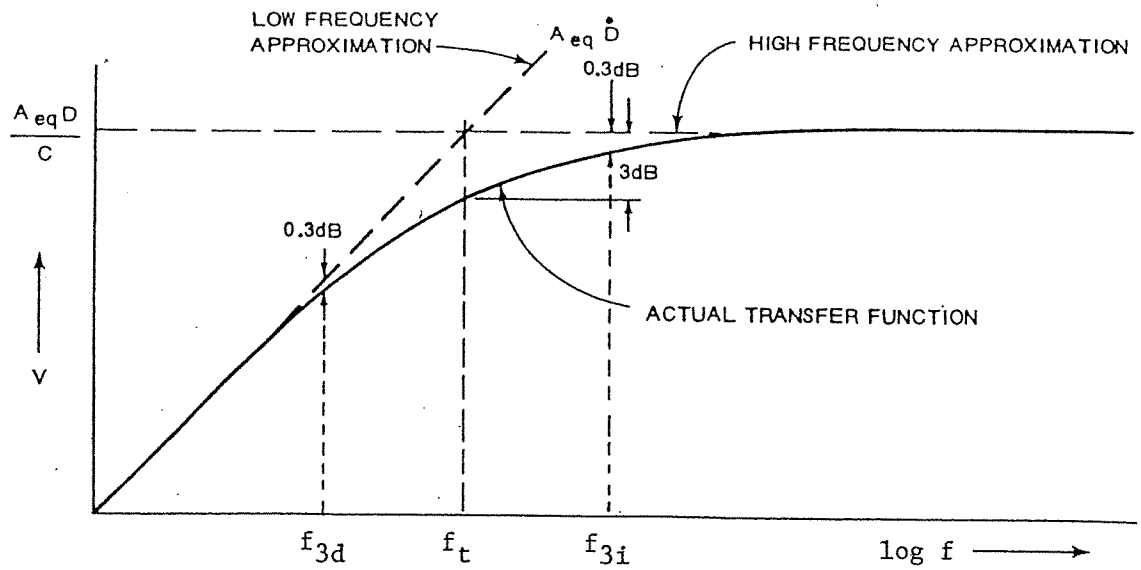
Where ε_0 is the permittivity of free space (8.85×10^{-12} Coulombs/V-m)

The sensor is normally positioned no closer than a few sensor diameters from conducting surfaces above the sensing element and at a distance from the EM source where γ radiation will not affect its operation.

Equivalent Circuit

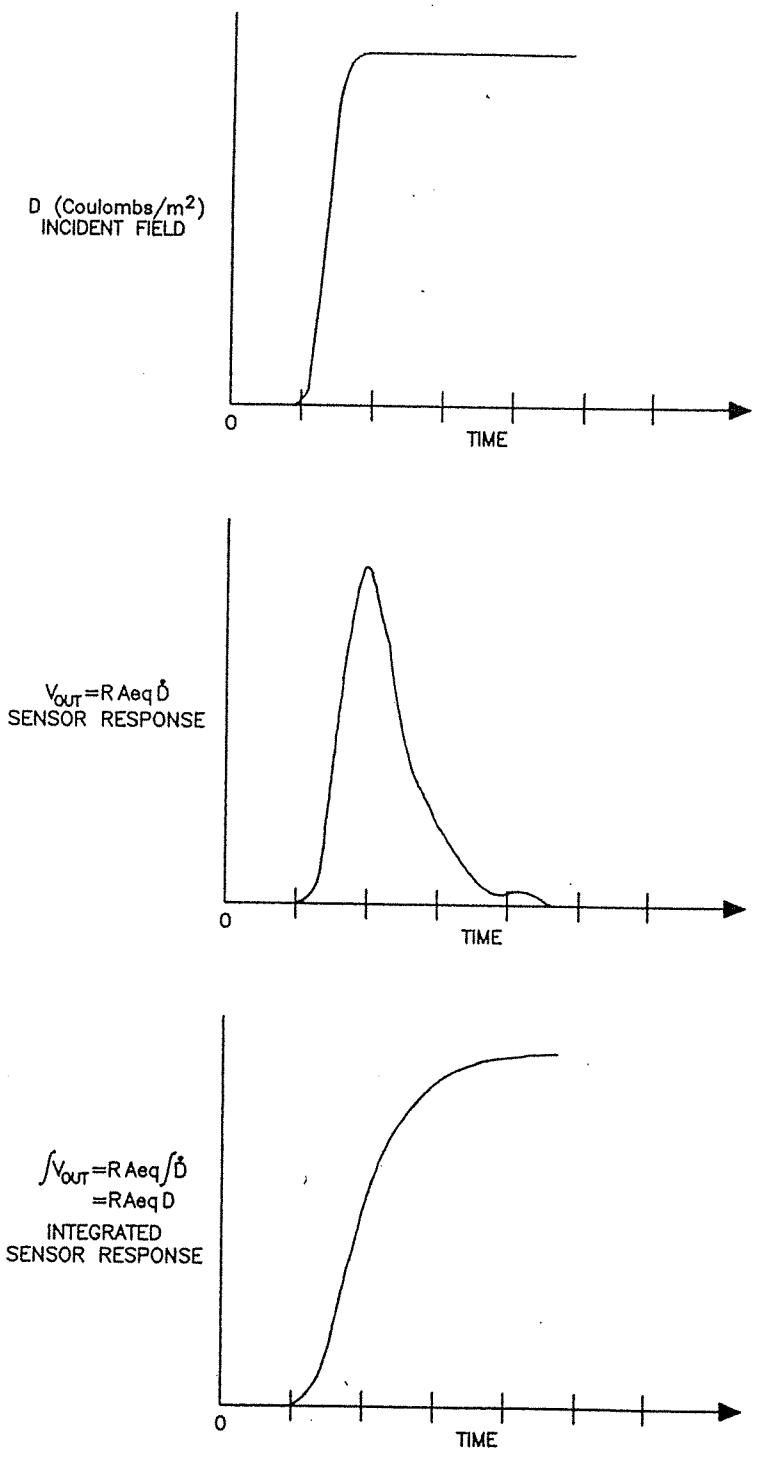


Frequency Response of D-Dot Sensor



Sensor Response To Step Function

Following is a typical expected sensor response to a step function. The time base will vary, depending on the sensor's equivalent area.



Sensor Directivity

The axis of greatest sensitivity is normal to the ground plate. When measuring fields with direction deviating from normal, the effective area Aeq becomes Aea · Cosθ, where θ is the angle between the mounting plate normal and the incident.

Positive voltage is developed at the output center conductor when the incident E-field generates positive potential above the sensor element (E-field pointing toward ground plate).

Amplitude Range

The sensor output voltage limitation typically is directly related to that of the output connector, which is rated by the connector manufacturer. The voltage rating is listed on the data sheet.

Accuracy

The accuracy of PRODYN's ground plane sensors is based on precise manufacturing tolerances (see Measurements Report) and assembly procedures. This relates to less than ± 1% of the sensor equivalent area, excluding high frequency effects.

Calibration

The "AD" series D-Dot sensors are not encumbered by an energy transformation mechanism, since they are not transducers. Transducers depend on some transformation mechanism, which usually has some nonlinearity and variability over time. The

equivalent area of a sensor is not subject to change, so it only needs verification of its equivalent area. Once the equivalent area of a given model is established, the variance between units is insignificant, so periodic calibration is unnecessary.

Electrical integrity of a sensor can be checked using a time domain reflectometer. Pulse or sweep measurements from a sensor can be done in various types of test fixtures, such as TEM cells. It should be noted every test fixture will produce results unique to itself and the measurement should be considered as typical.

Handling

Prodyn's Ground Plane Type D-Dot sensors should be handled with care paying close attention not to hit or jar the area of the Sensing Elements (dipoles). This is especially true of models AD-10(A) and AD-S10(R). When connecting a balun or cables to the sensor output do not overtorque the connectors. The recommended torque specifications for SMA connectors is 7-10 in.lbs. and "N" connectors 6-10 in.lbs.

MAINTENANCE

Environmental

The PRODYN ground plane D-Dot sensors can typically be used over the temperature range of -20°C to 55°C. For continued outdoor use, models that are equipped with gas pressure valves, it is recommended that a positive pressure of .5 to 1 psi of dry air or nitrogen be maintained. Since the connector is not weatherproof, it should be protected to maintain a dry condition.

Storage

When not in use, PRODYN's D-Dot sensors should be stored in a dry, dust free area. It is recommended that the sensors be stored in their original foam packaging to protect the sensing elements from any impact. This is especially important for the high frequency models, such as AD-10(A), AD-S10(R), AD-180(A), AD-S180(R), AD-110(A) and AD-S110(R).