

Control of ac magnetic emissions

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Historical Rationale

Mutually Assured Destruction (MAD)
Rationale for RE01



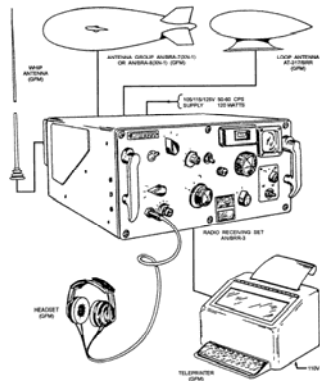
Communication with ballistic missile carrying submarines

- Nuclear subs never have to surface
- Subs are safer the deeper they travel
- Sea water is conductive and attenuates rf through absorption
- Skin depth is a function of frequency
- Lower frequencies penetrate better
- Lower frequencies imply lower information bandwidth

Protocol for broadcasting to submerged vessels

- ELF signal (~30 Hz) gives command to approach surface so VLF signal can be received
- VLF signal received at a low level while still submerged
- VLF signal bandwidth is very narrow; suffices for teletype, not voice

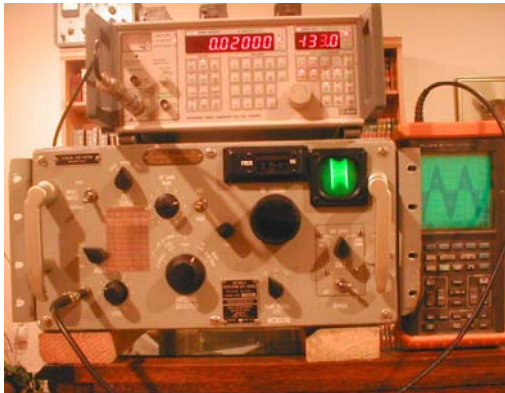
AN/BRR-3 VLF receiver



AN/BRR-3



AN/BRR-3, A Very Sensitive Receiver



AN/BRR-3, A Very Sensitive Receiver, cont.



RE01 Rationale:

Protect AN/BRR-3 from nearby magnetic sources

AN/BRR-3 tunes from 14 - 30 kHz.

It stands to reason a sensitive VLF receiver would not be mounted near a powerful magnetic source such as a PWM capstan drive.

But reason is often a scarce commodity.

RE101

Salient features:

frequency range 30 Hz - 100 kHz
measured at 7 cm from test sample

RE101 sensor is well-defined

13.3 cm coil diameter loop
36 turns of 7-41 Litz wire
electrostatically shielded

Not specified but original configuration, designated AT205, had a twin wire output to drive balanced input of NM-10, modern loops have coax output and drive single-ended receivers



Loop Transducer Factor

$$V_{oc} = -d\phi/dt$$

For a circular loop and a frequency domain requirement, this is:

$$V_{oc} = 2\pi f n A_{loop} B$$

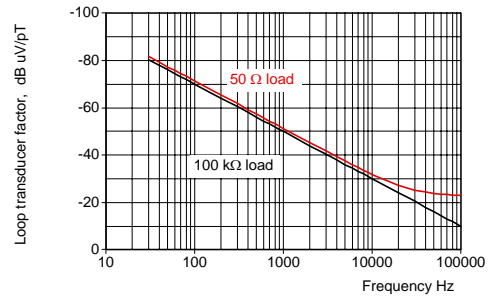
If load on loop is of same order of magnitude as loop source impedance, then loading must be accounted for:

$$Z_{loop} = R_{winding} + XL_{loop}$$

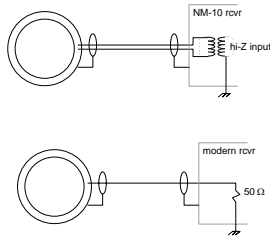
Expression for loaded loop output potential is:

$$V = 2\pi f n A_{loop} B / \sqrt{[(1+(R_{winding}/R_{load}))^2 + (2\pi f L / R_{load})^2]}$$

Loop Transducer Factor



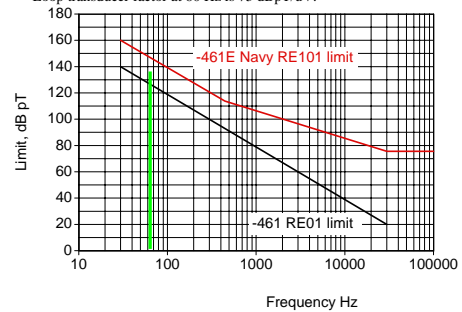
Balanced vs. unbalanced



In a modern RE101 test, single-point grounding is critical.

Ground Loop Effect

Assume 1 mV potential difference between receiver and grounded sensor at 60 Hz. That 1 mV (60 dBuV) of noise is in series with loop output. Loop transducer factor at 60 Hz is 75 dBpT/uV.



RE101 Unique Issue

RE101 is the sole remaining emission requirement not requiring a plot of emissions vs. frequency. A manual listing of (frequency, amplitude) data points is allowed.

This is because of the need to physically scan the sensor over the test sample surface(s).

If a spectrum analyzer with max hold capability is available, an automated data plot may be easily achieved and is superior.