NASA TECH BRIEF
*NASA Pasadena Office*



# Design and Material Selection for Inverter Transformer Cores

Spacecraft power supplies often incorporate an inverter to obtain high voltage from low-voltage power sources. Typically, dc power from a low-voltage source is fed to the primary of a step-up transformer by a pair of power transistors which are alternately switched on and off by an oscillator drive; the square-wave output of the secondary is subsequently rectified and filtered. Because of the inductive nature of the transformer, excessive voltage spikes often appear if the transformer were to saturate, and when spikes exceed the ratings of the transistors connected to the inverter, there is high probability of system failure. It is desirable to minimize voltage spikes by proper construction of transformers, but the design of reliable, efficient, and lightweight transformers for inverters has been hampered seriously by the lack of engineering data describing the behavior of core materials operating at 2400-Hz square-wave excitation.

A report is now available which describes in detail the results of a program of investigation undertaken to study the magnetic properties of candidate materials for use in spacecraft transformers, static inverters, converters, and transformer-rectifier power supplies, but the information is also applicable to the design of transformers for nonaerospace use. The report includes many illustrations of B-H loop patterns and the output waveforms obtained with various materials in a typical inverter system. Operational parameters are discussed, especially with reference to core saturation and air gap.

The report summarizes the results of a series of tests performed on commercially available magnetic alloys to determine their dc and ac characteristics at 2400-Hz square-wave excitation; the tests were performed on cut and uncut cores (in both toroidal and C forms) for comparison of gapped and ungapped core magnetic properties. The test apparatus consisted of a power oscillator to drive the test transformer (1:1) and a current probe to indicate current waveforms in the primary. The secondary of the transformer was loaded by a suitable resistor in series with a switch and a diode; with switch closed, secondary current was rectified by the diode to produce a dc bias in the secondary winding.

For the investigation of core saturation, cores were fabricated in a basic configuration for toroidal cores. The test transformer consisted of 54-turn primary and secondary windings, with square-wave excitation on the primary. For the investigation of air gap effects, both toroidal and C-types of core configurations were tested in the gapped and ungapped states. As fabricated conventionally, toroidal cores are virtually gapless; to increase the gap, cores were cut in half and the edges were lapped, etched with acid to remove cutting debris, and banded to form the core.

The report includes material characteristics for available alloy compositions in tabular form, including: trade names, saturated flux density, dc coercive force, loop squareness, material density, and watts per pound at 3 kHz.

(continued overleaf)

**Note:**

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP 73-10142

Source: William T. McLyman of Caltech/JPL under contract to NASA Pasadena Office (NPO-11726)