Signal Generator Simulates Gas Turbine Speed Signals

Gas turbine engines are complex machines comprised of two rotating sections, generally referred to as the low pressure compressor (N1) and the high pressure compressor (N2). These turbine sections feature separate shafts that produce unique tachometer signals.

Data acquisition systems such as the TSC-4800A programmable tachometer conditioner from MTI Instruments are used to monitor the health and performance of rotating gas turbine engines. The TSC-4800A typically converts the analog signals from the N1 and N2 magnetic resolver pickup sensors into more useable digital signals.

The conditioned signals delivered by the TSC-4800A, in turn, can be used by the company's PBS-4100 Turbine Vibration Analyzer/Balancing System or by other data acquisition systems to help engineers analyze turbine speed, acceleration, and vibration.

Problem

Gas turbine MRO decisions are based on signals from data acquisition systems such as the TSC-4800A. It is critical these systems function properly as faulty signals could lead to catastrophic equipment failure and jeopardize human safety.

Typically, data acquisition systems are tested and calibrated on operating turbines or with specialized rotating gear tooth rigs. These procedures, however, are complicated, time consuming, and expensive.

Solution

MTI's 1510A portable signal generator offers an easier alternative. Configured to simulate signals generated by rotating gas turbine engines, the 1510A can be used to calibrate tachometer signals conditioners with reference to speed and amplitude of the signals generated. When testing data acquisition systems such as the TSC-4800A, for example, the signal generator can simulate the turbine speeding up and slowing down.

To simulate tachometer output pulses, the 1510A features two channels. Users can therefore create a phase shift in the A to B output signals, as may be encountered in a piece of rotating equipment such as a jet engine. Specifically, one channel (A) simulates a vibration signal while the second channel (B) simulates the tachometer speed signal.

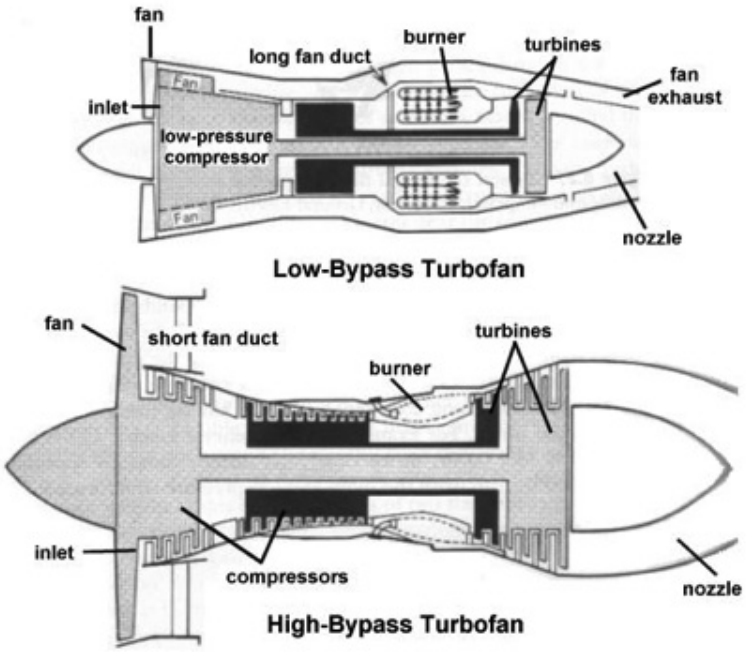
Both channels are capable of sweeping their frequencies over a programmable interval. By sweeping the signals the 1510A can simulate the engine speeding up and slowing down. This function can be used to make sure there are no signal dropouts in the data acquisition equipment. The channel B frequency can be swept synchronously with channel A if the B frequency is set to any ratio of channel A. The phase between the swept channels is preserved during the sweep.

This feature can test the phase tracking capability of the data acquisition equipment and any FFT functions that may be present where the vibration is synchronous with the speed signal.

To learn how to simulate gas turbine tachometer speed signals with MTI's 1510A signal generator, turn to pages 19 and 32 of the 1510A user manual.

Benefits

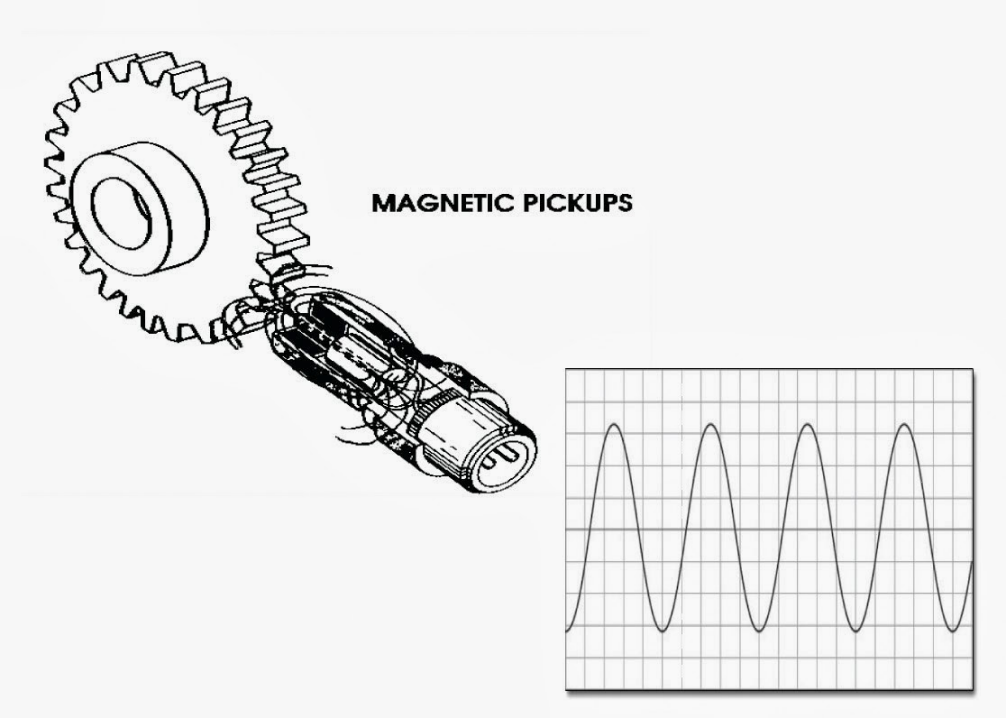
- Voltage, charge, and machinery speed signals
- Sine, square, triangle, and pulse waveforms from Hz to 100 kHz in 0.1 Hz increments
- Jog function
- Voltage and charge signals with accuracies to 0.05%



Gas turbine engines have multiple rotating sections generally referred to as the low pressure compressor (N1) and the high pressure compressor (N2). These turbine sections have separate shafts that produce unique tach signals. They can be long tooth (1/ rev high pulse), short tooth (1/rev low pulse), or a simple sinusoidal pulse train.

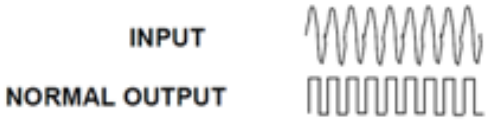
Image source: https://www.aopa.org

The shaft speeds monitored in aircraft cockpits are also referred to as N1 and N2.

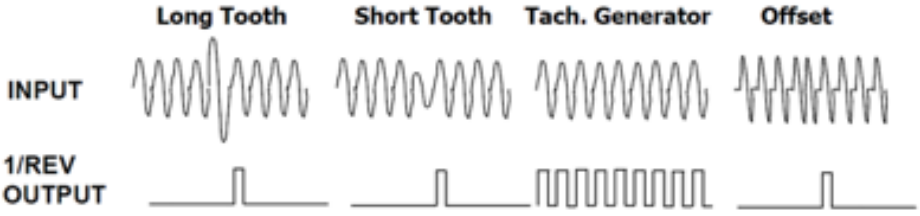


N1/N2 magnetic reluctance sensors read the gear teeth to generate a corresponding sinusoidal speed signal. The TSC-4800A converts analog signals from the N1 and N2 magnetic resolver pickup sensors into more useable digital signals.

Pulses coincident with the input signal – The TSC-4800A provides many different output signals for use with other test cell equipment. One of the signals that is produced is called the ***normal*** pulse output. This output is a series of TTL level pulses that are coincident with every input pulse of the speed signal. The ***normal*** output is illustrated below.



Pulses coincident with the 1/revolution signal – The TSC-4800A provides many different output signals for use with other test cell equipment. One of the signals that is produced is called the ***1/revolution*** pulse output. This output is a series of TTL level pulses that are coincident with only the unique 1/revolution pulse of the speed signal. The ***1/rev*** outputs are illustrated below.



Both the low pressure (N1) and high pressure (N2) shafts of a gas turbine engine carry a gear with multiple teeth. Each gear features a single tooth that is longer, shorter, or offset from the other teeth. This tooth provides a 1/Rev phase reference to help a service mechanic know where to place balance weights when servicing the turbine. The output signals can resemble those shown here.

Excerpt from the MTI TSC-4800A manual showing the appearance of the various phase marker signals also called a 1/Rev (odd tooth)

MTI's 1510A Portable signal generator can reproduce the specialized N1 and N2 speed signals generated by gas turbine engines, distinguishing between multiple teeth of same height and the one odd tooth.

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