Subject: Application Overview	Product: G7, A1000, G5HHP Drive	Doc#: AO.AFD.54
Title: Engine Load Dynamometer		

Engine Load Dynamometer

Application Overview

Test Stands and Dynamometers are used to test and characterize rotating equipment. An *engine Load dynamometer* (often called *Absorber* or *Load Dyne*) typically uses an electric motor and AC drive to simulate a mechanical load on gasoline and diesel engines. Endurance testing requires that the engine be run under load continuously for days, weeks or months to determine component life and establish preventive maintenance schedules or to 'break-in' a new or re-built engine.

A load dynamometer absorbs a large amount of energy from the engine. Historically, load dynes used an eddy-current brake, fluid (water) brake, or friction brake to load the engine. While eddy-current and fluid brakes produce relatively consistent load torque, these older methods wasted power produced by the engine. Furthermore, these brakes typically require external means to start the engine.

It makes good sense to regenerate the wasted energy back to the power line and recover some of the cost of the fuel.

A load dyne using an induction motor controlled by a Yaskawa drive (A1000, G7, G5HHP) provides very reliable load torque control and a means of starting the engine. Yaskawa line regeneration modules (RC5, DC5) regenerate engine power back to the electrical power line.

Gasoline and diesel engine manufacturers, automotive companies, racecar builders, performance shops, tractor and forklift manufacturers and lawn and farm equipment manufacturers all use load dynes. Basically, load dynes are used by any business that makes, incorporates, or modifies engines. The sizes range from about 5 hp for lawn mower engines to more than 1500 hp for large diesel engines.

Application Challenges:

- The drives and motors must be extremely durable and capable of running for months unattended without breaking down or interrupting the test.
- The drive must function in a system containing very sensitive sensing equipment without causing interference to low-level sensor signals.
- The load dyne system should be capable of regenerating the absorbed mechanical energy back to the power line to recover some the lost fuel cost.
- The drive should be capable of repeatable torque control through the entire speed range.
- The load dyne system should be cost effective.

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Yaskawa Products:

Products	Product Feature	Benefits
A1000	Ratings from 0.75 HP to 1000 HP	Covers the range of most gasoline and small diesel engines.
	Cost effective vector control	Multiple methods of load torque control available through full speed range.
		Full range speed control including 0.0 RPM.
	Six programmable control inputs available	For mode switching and selection
	RS485/422 communications standard	For data logging and control.
		High reliability and endurance.
G7	Ratings from 0.5 HP to 500 HP	Covers the range of most gasoline and small diesel engines.
	G7's 3-level output switching scheme	Extends motor life by reducing shaft and bearing current.
	High performance vector control	Multiple methods of load torque control available through full speed range.
		Full range speed control including 0.0 RPM.
	Ten programmable control inputs available	For mode switching and selection.
	RS485/422 communications standard	For data logging and control.
G5HHP	Ratings from 350 HP to 1600 HP	Covers the range of most diesel and large gasoline engines.
	Modular construction - up to four 400 amp inverters can be operated in parallel to supply one motor.	Flexibility
	Closed Loop Flux Vector Control	Two methods of load torque control available through full speed range.
	Six programmable control inputs available	For mode switching and selection.
RC5 Line Regeneration Unit	6-step line regeneration option	Cost effective, simple, and reliable.
DC5 Bi-directional Converter	4-Quadrant sinusoidal current power converter	IEEE519 compatible for both motoring and regenerating.
		Very low total harmonic distortion.

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Application Details:

Figure 1. illustrates the basic components of an engine dynamometer:

1. Engine under test
2. The dyne motor
3. Dyne motor control
4. Data logger

The operation begins with the dyne motor control in speed mode and ramps the motor up to the *starting speed* of the engine. Fuel is applied to the engine. When the engine is running on its own, the dyne motor control switches to torque control mode. Actual testing begins as the regenerative (braking) unit and AC drive regulates load on the engine.

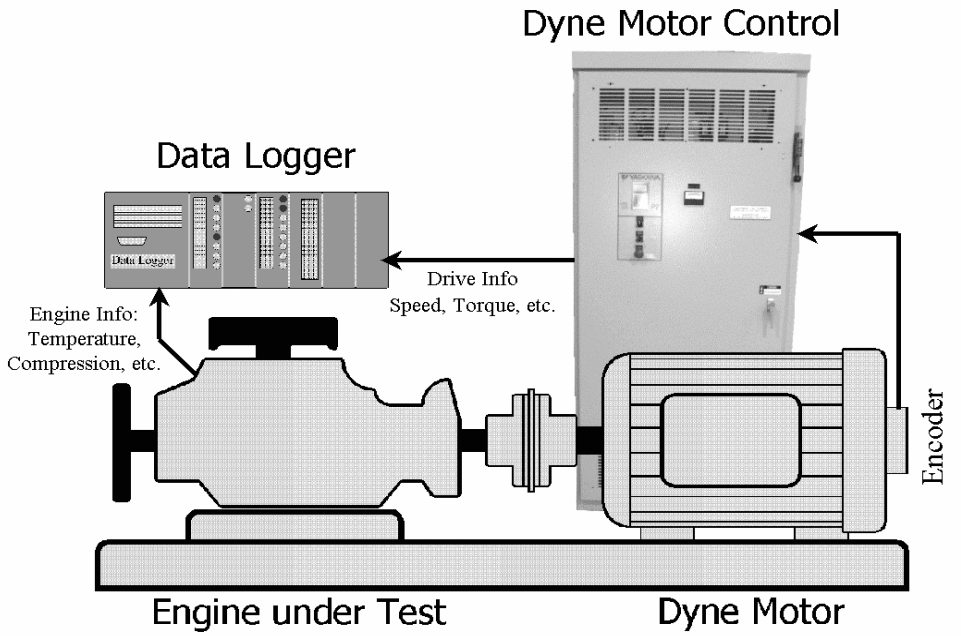

Figure 1

The dyne motor is an induction motor with a shaft-mounted encoder for speed feedback. The dyne motor control consists of a **Yaskawa Flux Vector Drive** (A1000, G7, G5HHP) and the line regeneration module (RC5, DC5).

Figure 2. illustrates a typical engine load dynamometer using a G7 drive. The power flow during operation is indicated in red. The dyne motor acting as a brake absorbs power generated by the engine under test. The G7 AC drive transfers the power from the motor to the drive's DC Bus. The RC5 line regeneration unit converts DC to AC at the power line voltage and frequency.

Motor longevity is a major consideration when performing long-term engine endurance testing. The G7 uses a 12-IGBT, 3-level inverter configuration that reduces stress on the motor by reducing peak motor voltages. Long term studies have measuring motor vibration indicate that the G7 produces significantly lower bearing currents which can increase bearing life by four times.

Figure 3 illustrates the different output power section of a conventional 2-level control and a G7 3-level control section.

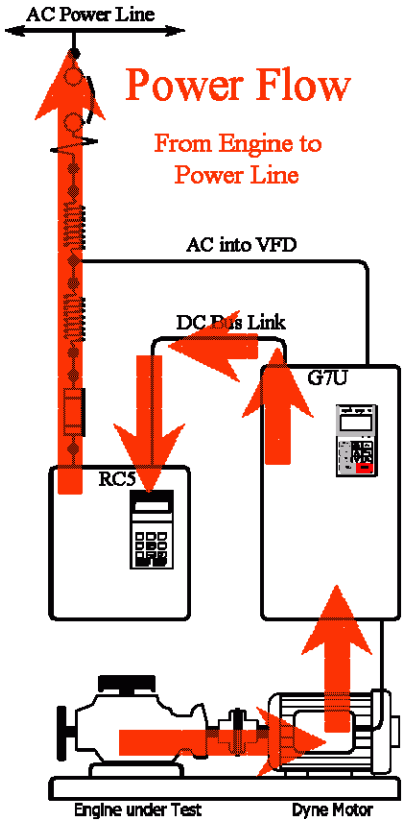

Figure 2

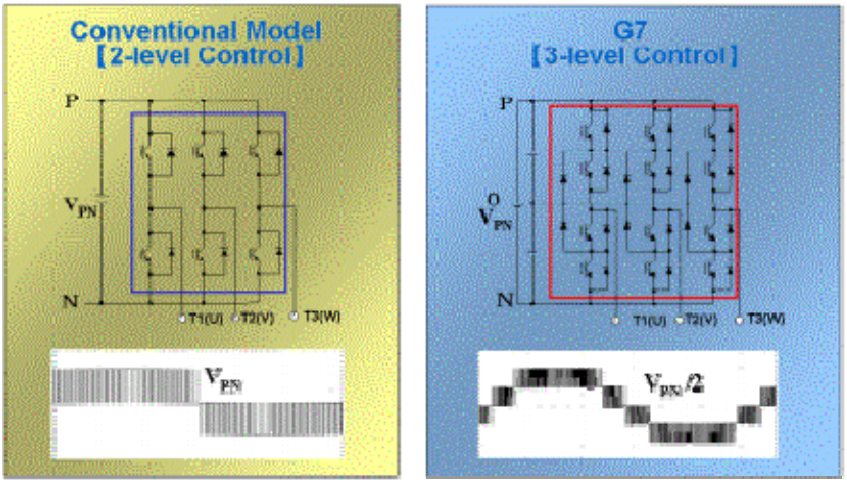

Figure 3