
Construction of Power Product Data Management System

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ABSTRACT

Manufacture of the iGX440, the first in the iGX series of next-generation general-purpose engines, began in September 2005. In place of a conventional governor mechanism providing mechanical control, the iGX440 uses an electronic governor that applies control via an ECU. Because the unit is fitted with an ECU, data can be altered, enabling the programming of optimal settings for engine speed and governor characteristics, allowing a diverse range of uses.

The new system makes it possible to ensure that all data is saved when the ECU requires replacement by storing data in one location, and has also made it possible to eliminate unnecessary model types by enabling data to be overwritten during the distribution process. In addition, the data accumulated in the data base enables the use patterns of the engines to be analyzed, enabling future development that will expand operation in entirely new directions.

1. Introduction

General purpose engines are used as power sources for various work equipment, including construction, agricultural, and industrial machinery. These machines generally use a mechanical governor mechanism, but it is necessary to change the springs that comprise the governor, adjust the idle speed, or make other adjustments in accordance with the demands for each work machine. However, there are numerous combinations related to the engine speed setting alone, so this makes it necessary to perform inventory management.

In response to these needs, the iGX440 electronically controlled general purpose engine⁽¹⁾ uses an electronic governor mechanism⁽²⁾, whereby the target engine speed and governor characteristics can

be changed by altering the ECU data. This allows manufacturers using this engine in their products to set target engine speeds suited to their work equipment, and dealers wholesaling the engine to also change the governor characteristics in accordance with customer requests. The governor characteristics can be changed after shipping, so inventory can be reduced and the lead time to the customer can also be shortened by reducing the number of model types. However, even though the same ECU is used, the ability to set different characteristics has created the issue that when an ECU fails and is brought to a service center, the original governor characteristics cannot be restored simply by replacing the ECU. In addition, it has also become necessary to create terms of agreement and other rules concerning characteristic changes after shipping,

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such as change privileges, change methods, division of responsibility, intellectual property rights, legal responses, and so on.

This paper presents technical methods and rules when changing the characteristics of power products equipped with ECU after shipping. In addition, technical aspects are also introduced as an example of database application using the Internet for centralized management of iGX440 change data on a global scale.

2. Development Goals

When an ECU fails and is brought to a service center, the original governor characteristics cannot be restored simply by replacing the ECU. This makes it essential to construct before-sale (B/S) and after-sale (A/S) systems. The following goals were set to realize an ECU management system, starting with an information system.

- (1) Centralized management of data change history from the time of shipping from the factory to the latest overwrite.
- (2) Standardization of equipment and tools used to overwrite data.

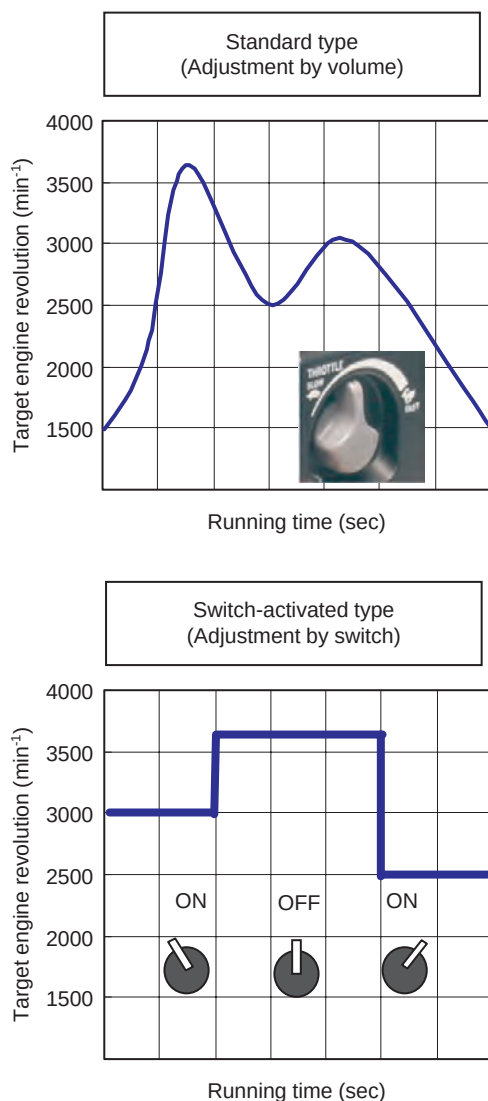


Fig. 1 Operation mode

- (3) Establishment of basic rules for writing and overwriting ECU data.

In addition, assuring data when ECUs are replaced and eliminating unnecessary model types were also set as development goals.

3. iGX Data Management System

3.1. iGX Engines

Conventional mechanical governor mechanisms set the target engine speed mechanically using a throttle lever. In contrast, iGX engines use an electronic governor mechanism, and can select the means by which the target engine speed is changed. Figure 1 shows an example of modes that can be selected. For example, when standard mode is selected, the target engine speed can be changed by an electrical potentiometer, and when switch-activated mode is selected, the target engine speed can be changed by a switch. In addition, the rate of change when the target engine speed is changed and other characteristics can also be optionally set. In this manner, various demands for each work machine can be supported by changing the governor characteristics.

3.2. ECU Data Management Method

The governor characteristics of iGX engines can be overwritten during the distribution process, so a data management system for centralized management of the ECU overwrite data is essential. The engine ECU data is stored in the database when the engine is shipped from the factory, and it is also mandatory that the changed data be updated to the database when the data is overwritten during the distribution process. This makes it possible to restore the latest data even when an ECU is replaced due to failure or other circumstances. Figure 2 shows the overall system configuration.

3.2.1. Initial registration

The governor characteristics, type code, completed engine inspection date, characteristics change date, person changing the characteristics, failure history, total running time and other data for each engine number are transferred to the database and registered as the initial data when the engine is inspected at the factory.

3.2.2. Uploading

Manufacturers who use iGX engines in their products must overwrite the ECU data when changing the settings to suit their work equipment. This changed data is uploaded to the database via the Internet. When uploading, only the changed portions are updated and stored in the database, so the history can be traced. In addition, when changes are not uploaded within 48 hours after overwriting the data, further overwriting is prevented to ensure that the database contents are constantly updated to the latest data.

3.2.3. Downloading

When an ECU fails and is brought to a service center, the service center downloads the ECU data from the database based on the engine number. The governor characteristics can then be restored to the original state by writing the downloaded data to the new ECU.

3.3. Web Features

The Internet is used when uploading and downloading data, so the database can be accessed from anywhere in the world regardless of time differences. In addition, a dedicated Web site is provided so that user information can also be checked in addition to uploading and downloading data.

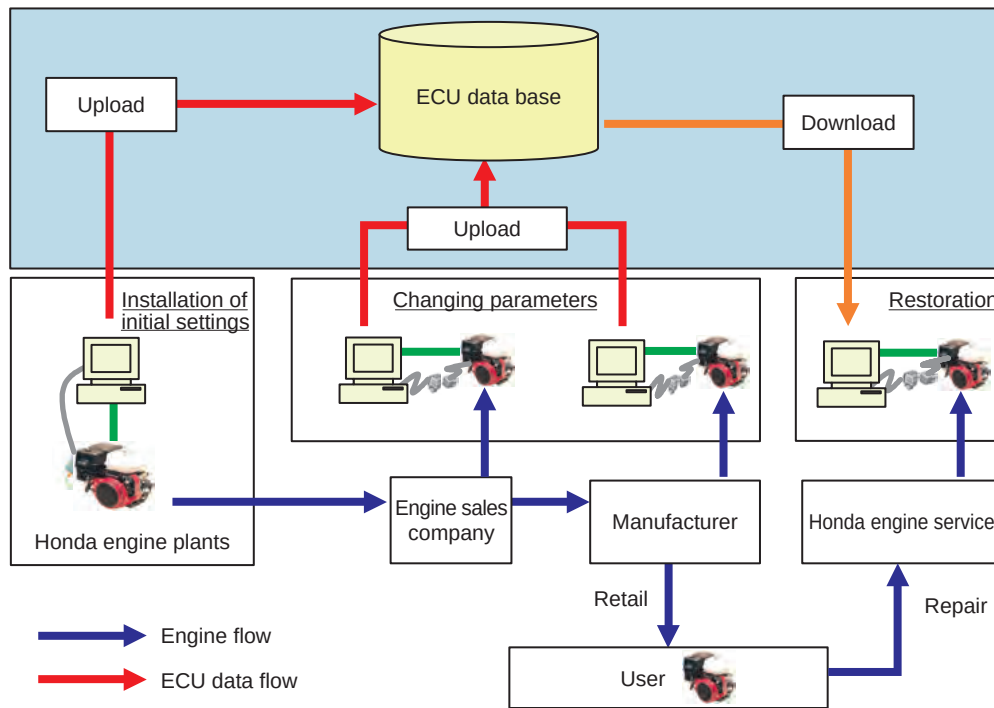


Fig. 2 System diagram

3.4. Database Features

The database server is located in Japan, where the data is centrally managed. Only the changed data is backed up on a daily basis, and all of the data is backed up once per week to prevent data loss. The data storage period is 20 years in consideration of general purpose engine life cycles. Basic security is protected by ID and password entry when accessing the database, and to further ensure safety, the Web operation history of all users also remains in the database so that administrators can understand who performed what operations when.

In addition, the ECU data accumulated in the database can be used to analyze the failure histories of general purpose engines and trends in the usage of work equipment with these engines. This makes it possible to obtain extremely useful data for the development of future general purpose engines.

3.5. ECU Character Management Tool

3.5.1. Interface unit

Personal computers (PC) are used to overwrite the target engine speed and other ECU data. The protocol between the PC and the ECU must be converted to write or overwrite data. Therefore, power products equipped with ECU must use a standardized protocol. This study designed the new interface unit shown in Fig. 3 for communication with external equipment. Design requirements for interface units are as follows.

- (1) The interface unit should be compact
- (2) The interface unit should have shock resistance capable of withstanding falls if dropped
- (3) The interface unit should have a general compatibility that allows connection with an optional PC

Compact size and shock resistance were realized by hot melt molding⁽³⁾, and general compatibility was ensured by using a USB connector to allow connection with almost all PCs currently



Fig. 3 Interface unit

available. In addition, DC 12 V can be supplied to the ECU by connecting a DC jack to the interface unit so that data communication is possible even when a battery is not connected.

3.5.2. Overwriting software

Conventional general purpose engine settings cannot be overwritten during the distribution process, and ECU character management tools also did not exist. Therefore, the ECU overwriting software (hereafter “iGX Creator”) shown in Fig. 4 was created to allow governor characteristic changes and access to the database server. Other functions include real-time monitoring, a failure diagnosis function, and a logging function.

3.6. Overwriting Rules

Illegal access and overwriting are prevented by requiring an encrypted ID and password that are issued according to the respective user privileges. IDs are ranked from higher to lower privileges, and lower privilege IDs are unable to perform higher privilege operations or view higher privilege ECU information. In addition, the IDs of people performing operations are written in the ECU to allow traceability of who performed what processes.

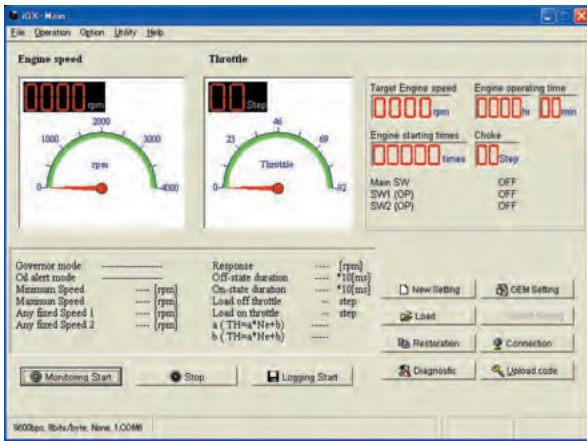


Fig. 4 iGX Creator (Main window)

3.6.1. Five basic principles

Five basic principles for writing and overwriting data to the ECU were established as follows:

- (1) ECU operations must be performed using the distributed tools and software.
- (2) ECU operations are restricted to the range that can be changed by the respective privileges.
- (3) Overwrite operations must be reported immediately.
- (4) ECU operations should be performed only by persons who have received the specified training, and operations should follow rules that are prescribed as necessary.
- (5) Confidentiality contracts or equivalent agreements must be concluded when non-employees are to perform ECU operations.

4. Conclusion

Data management methods and rules were constructed to allow ECU data to be changed and restored by the Sales Department, local subsidiaries, completed unit manufacturers, distributors and others during the distribution process.

- (1) The general purpose engine industry's first system for storing, viewing and updating engine change data in a database was realized, and operation rules were established.
- (2) The ability to change governor characteristics after shipment from the factory made it possible to eliminate unnecessary model types and reduce the lead time to the customer.
- (3) A data assurance system for ECU replacement was established by providing the ability to search for the governor characteristic information needed for restoration from the engine number and restore the data to the original condition.
- (4) Formerly unavailable data resources for future development were realized, such as the ability to analyze trends in general purpose engine usage from data that is accumulated on a daily basis.

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