

Development of Electrical Systems for 2018 Gold Wing -Idling Stop System and Honda SMART Key System-

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ABSTRACT

The 2018 Gold Wing represents the first full model change in seventeen years. It was developed with a broad age range and a variety of use scenes in mind. TBW control was combined with the DCT-equipped model to achieve an idling stop system, the first time ever for a large Honda motorcycle. The Honda SMART Key system was made compact enough for a motorcycle by integrating the tire pressure monitor into the control unit. With these technologies, advanced functions designed for usage unique to motorcycles was achieved.

1. Introduction

The 2018 Gold Wing described in this paper represents first full-model change in seventeen years with a broad age range and a variety of use scenes in mind⁽¹⁾. In the electrical equipment system, cooperative control of Throttle By Wire (TBW), Dual Clutch Transmission (DCT), and Integrated Starter Generator (ISG)⁽²⁾ is developed to create the first idling stop system for large Honda motorcycles (for the DCT type only). Furthermore, to enhance convenience in daily use, the Honda SMART Key system including the tire pressure monitor (Tire Pressure Monitoring System: TPMS) was created uniquely as a single unit. This paper describes in outline the idling stop system, Honda SMART Key system, and TPMS.

2. Idling Stop System

For automobiles, the idling stop system has come to be widely applied mainly for the purpose of improving fuel economy. With the growth of automobiles equipped with the system, the collateral effect of vehicle quietness is obtained by reducing engine noise and vibration. The application of this system to Gold Wing aimed at providing high quality feel. Additionally, in order to enhance quietness at restart, the helical gears were applied to the ISG driving gears used for starting the engine, and mechanical noise was reduced compared to the existing configuration of the

starter motor and spur gear.

However, there were two sets of technical issues in applying idling stop system to Gold Wing.

2.1. Issues Relating to Application to Large Motorcycle

When a motorcycle comes to a stop, the rider may take a variety of postures such as gripping the front or rear brake lever, stepping only on the rear brake pedal while supporting the motorcycle with one foot, or standing with both feet without applying the brakes.

Therefore, in the case of a motorcycle, the very act of opening the throttle grip is detected and judged as the rider's intention to start the motorcycle. Unlike in the case of an automobile, the time period from releasing the brake to opening the throttle grip cannot be used to prepare for engine start. Therefore the transition from idling stop to engine start had to be completed within a short time interval to help prevent rider discomfort.

2.1.1. Time lag when starting

Currently, the use of idling stop system is expanding on scooter type models within the small motorcycle category. Such a bike is easy to support with the hands and feet, whereas Gold Wing is heavy and large. Therefore, it is necessary to satisfy the starting performance responding to gripping the throttle, which is expected by a rider in situations such as starting in the middle of a slope. In order to realize this, the earliest possible generation of the driving

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force, that is, the earliest engine start is required. Also, when starting the engine while opening the throttle grip, if the rate of grip opening causes a difference in engine start time, this will cause the variation of the time lag until the vehicle starts to move. In order to help prevent rider discomfort, it was necessary to create a control method that was able to realize a consistent time lag at the start.

2.1.2. Reduction of unexpected driving force

When riders feel that the generation of driving force is delayed, they tend to open the throttle more. Accordingly, it is necessary to reduce the sudden driving force caused by the additional throttle opening.

2.2. Issues Addressing Methods -Combination with TBW Control-

In order to address the two issues described in the preceding paragraph, we tried to solve the issues by combining with the TBW control (Fig. 1).

During the initial operation time to start the vehicle, the throttle opening after operation by the rider was fixed

to a preset value. Consequently, until the vehicle starts, the engine speed is not affected by the throttle opening performed by the rider. The engine speed is controlled by the control unit until right before the vehicle is accelerated for a start, and until the vehicle starts to accelerate. In addition, the engine speed is controlled according to a fixed rising sequence. By adopting this method, stable engine start is realized.

After cranking at a constant speed when starting, the control unit carries out control in accordance with the following procedures:

- (1) Raise the engine speed to the idling speed after the engine is started (I in Fig. 1).
- (2) Raise the engine speed gradually to follow the value that corresponds to the actual throttle grip opening. At this time, the engine speed is suppressed to help avoid sudden increase (II in Fig. 1).
- (3) In the DCT system, the oil pressure in the clutch is raised to the required value beforehand by using the cranking start time as the starting point for control. By doing so, the time to engage the clutch is reduced (III in Fig. 1).

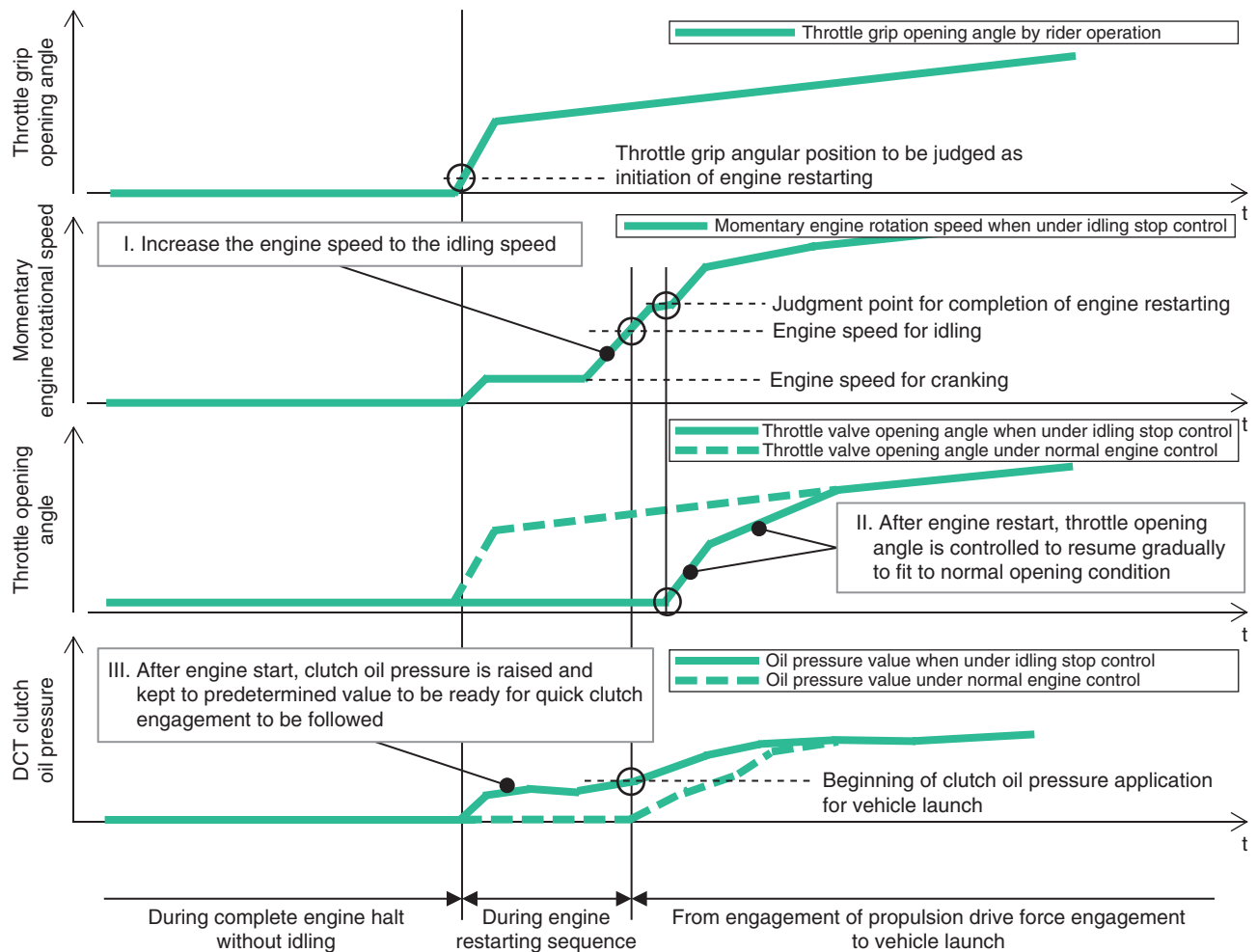


Fig. 1 Vehicle launching control sequence when started from idling stop condition

With the controls described at (1), (2), and (3) above, it is possible to start with a little time lag compared to the rider's intention to start and moreover, with reduced speed variation. By repeating the sensory evaluation and settings, the continuity of the driving force from the idling stop state through the engine start to the vehicle starting to move becomes smooth without causing any discomfort, thus achieving the desired high-quality start.

3. Honda SMART Key System and TPMS

Since a motorcycle is ridden with gloves on, not having to use a key is more beneficial than in the case of an automobile. This chapter describes the features of the Honda SMART Key system and the TPMS system, both of which share the same control unit.

3.1. Function of Honda SMART Key System

3.1.1. Ignition operation

With Honda SMART Key carried by the rider, the ON/OFF operation of the ignition and handlebar locking/unlocking is possible by rotating the main switch at the front end of the center panel. The engine is started by pushing the starter switch placed on the switch housing of the right handlebar. The push operation for the ON/OFF of the ignition to start and stop the engine is widely adopted for automobiles. However, it was not applied to a motorcycle due to the FMVSS123⁽³⁾ regulation stating that ignition OFF must operate in counterclockwise direction. Therefore, for the main switch, the rotary and momentary structure was adopted, and the counterclockwise rotation operation to turn the ignition OFF was applied (Fig. 2).

From the state of the handlebars being locked, turning the main switch in the clockwise direction releases the handlebar lock. Then, each time the switch is rotated in the clockwise direction, the ignition comes ON, and then the accessory mode is engaged. During the accessory mode, in order to help avoid the battery going flat, the mode turns OFF automatically after 60 minutes when the

communication with the Honda SMART Key is enabled, and 30 minutes when the communication is disabled. The exterior design of the Honda SMART Key is shown in Fig. 3.

3.1.2. Handlebar lock and unlock

The electric handlebar lock "Electric Steering Lock (ESL)" was adopted for the first time for Honda motorcycles (Fig. 4). While stationary, the handlebar is locked by rotating the main switch in the counterclockwise direction and steering the handlebar. In the locked state, turning the main switch in the clockwise direction will unlock the handlebar.

Generally, handlebar lock is achieved by fixing the steering system including the whole unit from the top bridge to the area around the front wheel with the handlebar steered to the left or right. Therefore, for this operation, both



Fig. 3 Appearance of Honda SMART Key



Fig. 2 Main switch layout

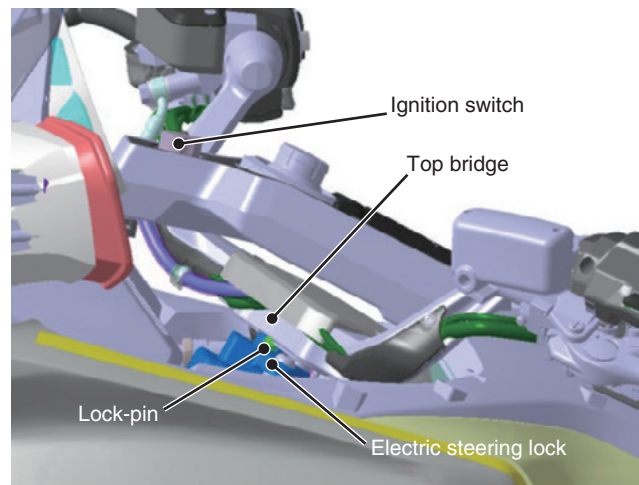


Fig. 4 ESL layout

hands are required, steering the handlebar with one hand while rotating the key with the other hand to look for the position to lock. In order to make it possible to operate with one hand, this model has adopted the mechanism where during the lock operation, the lock pin is pushed against the top bridge until the handle bar is steered and the pin fits in the insertion hole to complete the locking procedure (Fig. 5). Furthermore, a mechanism has been added to notify the rider by a buzzer and indicator to complete the operation, if the locking or unlocking process is interrupted midway.

3.1.3. Quick start operation (ignition ON operation)

In addition to the existing operability, in order to realize the same ignition operability as the smart system for automobiles, the quick start mode was adopted which enables the rider to start the engine while seated. By long pressing the engine starter switch with the brakes applied when the handlebar is locked or the ignition is OFF, the engine starts and is ready to launch as soon as the gear is shifted. In case such as the brake is not applied during the quick start mode, the engine starter inhibitor is engaged which will prohibit the engine to start and maintain the ignition ON state.

3.1.4. Illumination function

The function to light the ignition knob when a rider approaches the vehicle is installed (Fig. 6). When a rider with a Honda SMART Key approaches the vicinity (about 2 meters) of the vehicle, the knob glows for 30 seconds. Since this function continuously searches for the Honda SMART Key and the power is consumed during standby, this function is enabled for 3 days only to maintain the battery state of charge for starting the engine. Also, an LED entry light for lighting the feet is installable as an option (Fig. 7). These functions contribute to make riders or passengers feel welcome.

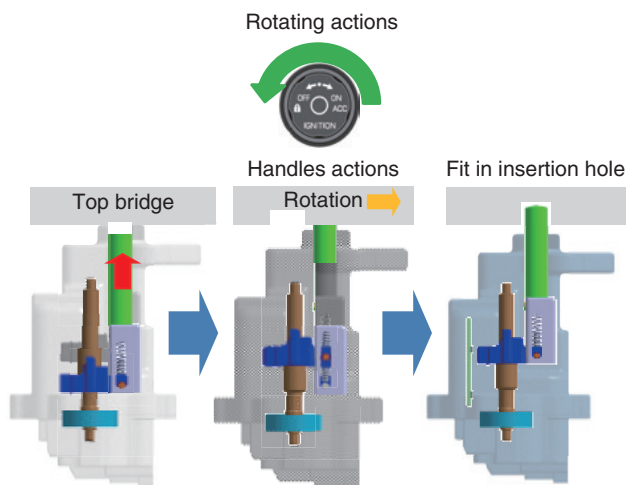


Fig. 5 ESL operation detail

3.1.5. Honda SMART Key authentication OFF mode

Honda SMART Key has the function to switch ON and OFF the authentication for the Honda SMART Key system when the wing mark button in the middle is long pressed. The LED light flashes once by long pressing the button for 1 second to switch the authentication OFF, and the light flashes 3 times by long pressing once more for 1 second to switch the authentication ON. This is effective to reduce the power consumption during standby, or to help avoid unintentional authentication when the bike is parked outside near the window and the key is placed inside near the window.

3.1.6. Opening and closing of trunk and saddlebag

In the previous model, the lock was released when the latch knob was pulled by hand, which required a heavy operating load. To enhance the experience, a mechanism has been adopted which allows the lock to be released by an actuator pulling the latch when a rider carrying the smart key presses the open switch near the trunk or saddlebag.

When a smart key is within communicable range, locking is done by closing the trunk or saddlebag. Since there is no operation to lock the key by closing the door like an automobile, the lock is automatically unlocked when the smart key is not nearby, and the rider or user is made aware



Fig. 6 Entry light image of ignition switch

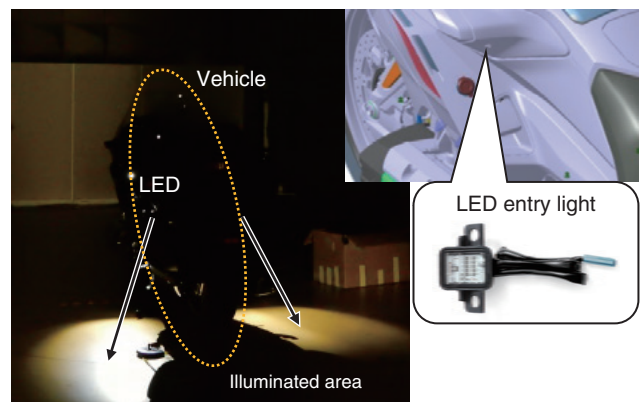


Fig. 7 Optional entry light image

with the lid not being closed that the locking operation had failed. However, if the closing is desired even in such a case, it is possible to close the lid forcibly by retaining the closed state while the opening actions are performed 5 times continuously.

3.2. Integration of Honda SMART Key System and TPMS

TPMS has been installed from the previous model for North America as a standard equipment. It detected reduced tire pressure and gave warning to the rider with an indicator, blinking or lighting up depending on the reduced air pressure. For the new model, in addition to these warning, the numerical value of the tire pressure is shown for the Gold Wing Tour model, which is equipped with a trunk with a large weight difference between empty and fully loaded condition. Moreover, the number of units is reduced by using the same frequency as Honda SMART Key system and by integrating the receiving function. In this model, the signal receiving process to detect the location of the Honda SMART Key and to receive the tire pressure value transmitted by the TPMS sensor is performed under the same frequency. In order to achieve this, it was necessary to realize systems whose communications do not interfere with each other.

3.2.1. Smart key location search communication

In the Honda SMART Key system, when the ignition is ON, the location of the smart key is being searched by periodic communication with the smart key. In the case of automobiles, the search communication of the smart key is performed as a warning that the smart key is taken outside the cabin with the ignition ON and the door or the trunk is closed. This is because the situation where the smart key is taken outside the cabin with the ignition ON is considered to be the case that the key is carried out by a person after the door is opened. It is assumed that the possibility of dropping the smart key outside the vehicle while driving is low for

automobiles. However, in the case of motorcycle that has no cabin, it is assumed that it is possible to drop the key while driving. Moreover, the rider may leave the vehicle momentarily to get a forgotten item with the ignition ON and even come back without the smart key. Therefore, it is necessary to monitor the situation where the rider does not have the smart key when riding and give a warning to the rider.

3.2.2. Compatibility of signal receiving processes for smart key and TPMS

In smart key location search communication, the system processes reception at regular intervals that can be determined reliably not long after the time the smart key is dropped or left behind. On the other hand, the communication with TPMS is performed in a different period from the smart key search process, and the transmission period is constant and decided by the sensor which is a restriction that cannot be changed. Therefore, it was necessary to develop a processing method for those two signals having different periods to be compatible without interfering with each other.

The signal from TPMS sensor is transmitted from front and rear wheel multiple times each at regular intervals of few minutes during driving, and it is necessary to receive the signal without fail. For this reason, the smart key must be searched when the signal from the TPMS sensor is not being transmitted.

Accordingly, a function that predicts the signal transmission timing from the TPMS sensor based on the previous reception timing and the known cycle has been provided. The process of searching for the smart key is performed based on the timing decided by this prediction. In addition, the key will be searched at the next earliest possible timing when communication is possible. In this way, two communication functions were realized with the same control unit (Fig. 8).

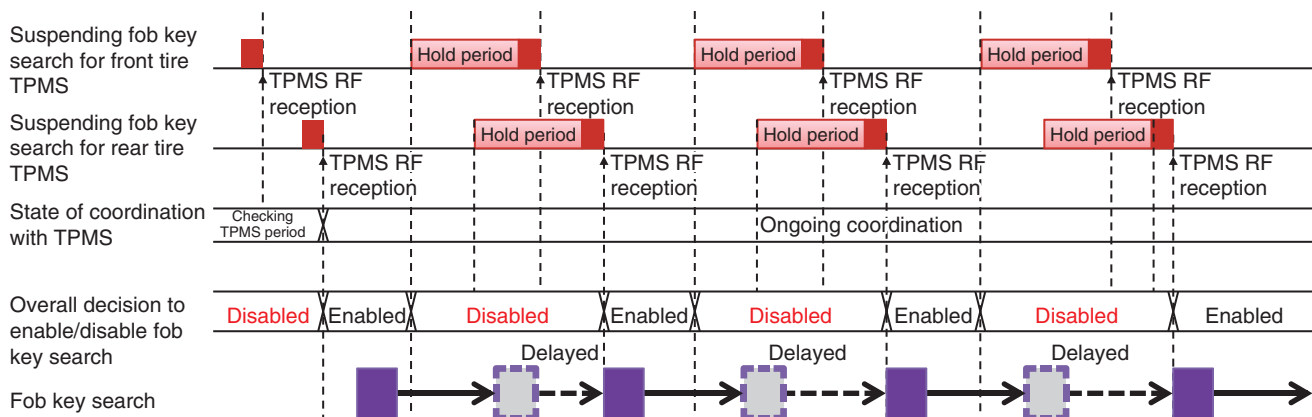


Fig. 8 Suspending fob key search in coordinated control process

4. Conclusion

The idling stop system for a large motorcycle has been realized in the DCT-installed model for the very first time for Honda. Accordingly, the two issues of reducing the time lag at vehicle launch and suppressing the unexpected driving force have been resolved by combining with TBW control.

In addition, the Honda SMART Key system including ESL has been adopted, in consideration of the motorcycle specific possibility of losing or misplacing the key, in order to enhance the convenience of riders. Moreover, it has contributed to downsizing by integrating the TPMS functions into the same control unit.

The adoption of these technologies has contributed to the realization of these advanced functions in consideration of the motorcycle specific ease of use that were required for the development concept of the new Gold Wing.

References

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- (3) FMVSS123: Standard No. 123; Motorcycle controls and displays: Table 1 - Motorcycle Control Location and Operation Requirements

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