**Proceedings of the**
**International Conference on Mechanical Engineering 2009**
**(ICME2009) 26- 28 December 2009, Dhaka, Bangladesh**

**ICME09-TH-07**

# DESIGN, CONSTRUCTION AND PERFORMANCE TEST OF A SYNCHRONIZED MULTI-SPARK MODULE FOR ELECTRONIC IGNITION DEVICE

**Mohammad Mashud, M. Mostafizur Rahman and S. Hossain Khan**

Department of Mechanical Engineering Khulna University of Engineering & Technology, Khulna

## ABSTRACT
Synchronized multi spark module can be used for minimizing fuel loss at the starting of engine. The objective of this project was to design, construction & performance test of a synchronized multi spark module. Multi spark module is very useful at low rpm& low temperature range. Due to voltage fluctuation the pulse width of the module will be vary. Breaker point is opening & creating pulses. These pulses go to shaping block, which producing pulse according to engine speed. Clock generator which Produces 2ms pulse, When p2 (gate) is opened then the counter receive pulse s of 1 ms from clock generator .Then it goes 0R Gate that will generate a series of spark.

**Keywords:** Multi-Spark Module, Electronic Ignition Device , Internal Combustion Engine.

## 1. INTRODUCTION

There are many different types of ignition systems. Most of these systems can be placed into one of three distinct groups: the conventional breaker point type ignition systems (in use since the early 1900s); the electronic ignition systems (popular since the mid 70s); and the distributor less ignition system (introduced in the mid 80s). The automotive ignition system has two basic functions: it must control the spark and timing of the spark plug firing to match varying engine requirements, and it must increase battery voltage to a point where it will overcome the resistance offered by the spark plug gap and fire the plug.

### Point-type ignition system:

An automotive ignition system is divided into two electrical circuits -- the primary and secondary circuits. The primary circuit carries low voltage. This circuit operates only on battery current and is controlled by the breaker points and the ignition switch. The secondary circuit consists of the secondary windings in the coil, the high tension lead between the distributor and the coil (commonly called the coil wire) on external coil distributors, the distributor cap, the distributor rotor, the spark plug leads and the spark plugs.

### Electronic ignition systems:

The need for higher mileage, reduced emissions and greater reliability has led to the development of the electronic ignition systems. These systems generate a much stronger spark which is needed to ignite leaner fuel mixtures. Breaker point systems needed a resistor to reduce the operating voltage of the primary circuit in order to prolong the life of the points. The primary circuit of the electronic ignition systems operates on full battery voltage which helps to develop a stronger spark. Spark plug gaps have widened due to the ability of the increased voltage to jump the larger gap. Cleaner combustion and less deposit have led to longer spark plug life.

The Direct Ignition System (DIS) uses either a magnetic crankshaft sensor, camshaft position sensor, or both, to determine crankshaft position and engine speed. This signal is sent to the ignition control module or engine control module which then energizes the appropriate coil.

The advantages of no distributor, in theory, are:

- No timing adjustments
- No distributor cap and rotor
- No moving parts to wear out
- No distributor to accumulate moisture and cause starting problems
- No distributor to drive thus providing less engine drag

The major components of a distributor less ignition are:

- ECU or Engine Control Unit
- ICU or Ignition Control Unit
- Magnetic Triggering Device such as the Crankshaft Position Sensor and the Camshaft Position Sensor
- Coil Packs

Synchronized multi-spark module is very useful especially in the case of starting of the engine at low rpm range. Basic idea, is to apply to spark plugs instead of only one spark, a "spark-burst" having big energy. Multi-spark is generated repeatedly turning the coil current on and off during the spark sequence. At low RPM, during cranking, the DMS generates up to 12 sparks. This assures quick starting even under the most adverse conditions. At idle and cruise, the number of sparks fired is adjusted to maintain total spark duration of about 20 degrees (crankshaft), assuring smooth idle, improved throttle response, and eliminating the lean surge characteristic of some late model emission controlled vehicles. During acceleration at higher RPM levels, the DMS generates a single powerful spark with about twice the spark In this case, combustion of air/fuel mixture is much better and the emissions are more reduced. In addition, through burning improvement, the consumption of fuel can be reduced. The advantage of synchronized multi spark module is reduced starting load system for an automobile engine. According to the engine speeds Spark timing control of multiple fuel engines. The importance of multi spark module is ignition system improvements for internal combustion engines. The application of synchronized multi spark module Late Model Computer Controlled Vehicles with Stock Electronic Ignition, Honda and Acura Integra, Earlier Electronic Ignition Systems without Computer Control

The purpose of this research is to design and construct a Synchronized Multi Spark Module for Electronic Ignition Devices and its performance evaluation.

## 2. WORKING PRINCIPLES OF SMSM

As shown in Fig. 1, shaped pulse triggers directly the EID and act as START pulse for multi-spark module. If rpm of engine is under speed limit, the module will generate a series of supplementary pulses that, through an OR gate, will generate supplementary sparks by EID. When speed limit is reached (for example, 2000 rpm), supplementary pulses stop at module output, thus no supplementary sparks will be generated.

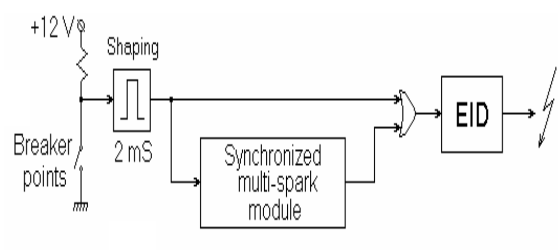


Fig 1. Placement of Synchronized Multi-Spark Module

Fig.2 when 12 V dc power is supplied to the stepup transformer then this transformer is made the power about 40,000 volts & the breaker points open. As a result 2ms puls is generated by shaping block which is produced pulse & sent pulse to EID. As the module parallel with the convectional system. The module is generated a serise of pulse according to engine speed. Sequence timer is used to determine the time interval of pulse generation. Speed sensor is used to sense the speed of crank shaft and sent the sense to the circuit and it is started its work. The pulse is shown in the oscilloscope. The module uses for control the shaped pulses from breaker points. The time between two consecutively pulses depends on rpm engine. From whole T interval, only in the first half of this will be generated supplementary sparks, after the main spark produced by the breaker points.

This is very important, because generating sparks outside of half of the interval, the spinning distributor could apply these sparks to next cylinder, and this could be very harmful for mechanical parts of engine.

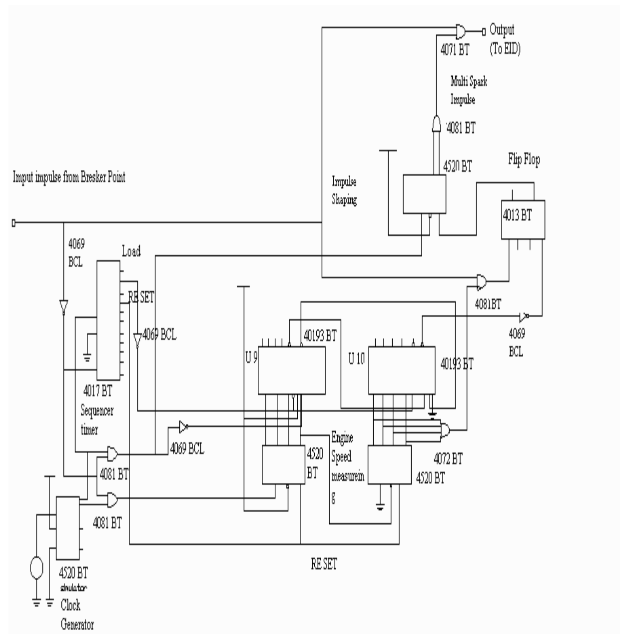


Fig 2. Circuit diagram of Synchronized Multi-Spark Module

At breaker-points opening, the shaping circuit (not shown in drawing) produces a square pulse having 2 m S. This, named BP, is applied to EID by an OR gate and generate the main spark.

In multi-spark module, during 2 msec interval, a sequence timer (a counter with decoded outputs) accomplishes the initialization of circuits (full operations will be detailed later). When impulse BP disappears, the gate P2 is opened and the counter N1 receives pulses with 1 mS period, from clock generator. These 8 bits counter measures, in fact, the duration between two breaker-points pulses. It can count maximum 255 pulses, each having 1 mS (see the table, this correspond to 120 rpm, far below the free running speed!). At next BP pulse, P2 close and the counting stop. The number stored inside N1 is in fact the time length between two BP impulses.

The sequence timer "copy" the number stored in N1 to N2, after this resets counter N1. When BP becomes low level, N1 restarts the counting. In the same time, the up/down counters N2, starts counting the pulses having 0.5 mS period, which comes via gate P1. It counts down, but with double speed. In this way the counter N2 reach to "0" after T/2 time. The counter N4 and gate P5 makes the pulses for supplementary sparks (2 mS length).

This counter works only if INH signal is at low level. The flip-flop FF1 "marks" the interval T/2 in which will be generated supplementary sparks. It is rested when N2 reach "0". The gates P3 and P4 unlock the flip-flop and start supplementary sparks. Also, these gates switch-off the multi-spark function when engine speed limit is reached (in this case, ~ 2000 rpm). In the upper table we can see at about 2000 rpm, the time length between two BP pulses is 15 mS.

This means as after a counting cycle, the first 4 bits of counter N1 will be 111 and next 4, 0000. In this case, P3 gate output will be at low level, and the same value for P4 output. The flip-flop FF1 will be not set, and as result, no supplementary sparks. If the speed engine decrease (time length T increase), the last 4 bits of N1 will have at least one 1 and the flip-flop will be set. This allow to appear supplementary sparks until flip-flop will be rested by borrow pulse of N2. The module can be made like a plug-in adapter for an EID.

## 3. EXPERIMENTAL SET-UP

To evaluate the performance of the constructed SMSM a simple experimental set-up, as shown in Fig. 3, has been made and perform the experiment. The key point of our project is to SMSM for electronic ignition device. The disc between sensor and LED define as rpm of crank shaft of the engine. The disc is coupled with a wiper motor. This motor is controlled by an electrical circuit, using regulator.

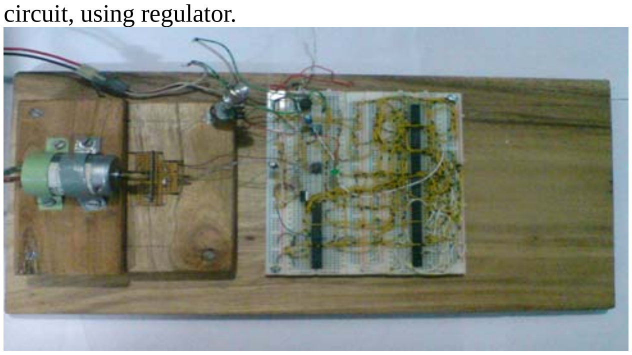

Fig 3. Photograph of the experimental Set-Up

The table 1 shown the relationship between engine speed & spark frequency. The spark frequency is detected by LED. The shape of the pulse is shown in the oscilloscope & also shown the spark frequency. With the varying of variable resistor the spark frequency also changed. According to the circuit characteristics, when rpm of the engine increases, then the spark frequency increases.
The module can be controlled under a given speed limit.

| No. of observation | Revolution speed (rpm) | Spark Frequency (Hz) | Time between impulse (ms) |
|---|---|---|---|
| 1 | 400 | 14 | 50 |
| 2 | 800 | 26 | 30 |
| 3 | 1200 | 40 | 20 |
| 4 | 1600 | 56 | 15 |
| 5 | 2000 | 68 | 9 |
| 6 | 2400 | 86 | 7 |
| 7 | 2800 | 104 | 4 |

Table-1: Experimental Data

The crankshaft velocity of an internal combustion engine is given by following formula:

$$n = \frac{30 * N * M * B}{C}$$

Where:
n = revolution speed of engine crankshaft (rpm)
M = strokes number (2 or 4)
N = number of sparks per second (sparks frequency, in Hz)
B = number of ignition coils
C = cylinder number

For conventional four stroke engines, with 4 cylinders and a single ignition coil, the formula becomes:

$$n = 30 * N$$

From where:

$$N(sparks / \sec) = \frac{n(rpm)}{30}$$

## 4. CONCLUSION

This research work is performed with the most primary technological facilities. Multi spark module is at first Designed and it is constructed successfully. The objective is to start the engine at low temperature & low rpm range. From the experimental data which has found, in the developed rpm is suitable for required output. We get accurate rpm of the crank shaft, as because of coupling propeller with shaft which cuts sensor properly.

## 5. REFERENCES


1. William H. Crouse, Automotive Engine Design, 4th edition, McGraw-Hill, NY.
2. Book of Narang, G. B. S., Automobile Engineering, 2nd edition, Khanna Publishers, India.
3. Book of Joseph Heitner, Automotive Mechanics, 5th edition, McGraw-Hill, NY.


## 6. MAILING AADDRESS


Mohammad Mashud
Department of Mechanical Engineering
Khulna University of Engineering & Technology,
Khulna, Bangladesh