Fi-M digital

Electronic Fuel Injection System
for
eco-marathon
Supermileage

User's Manual
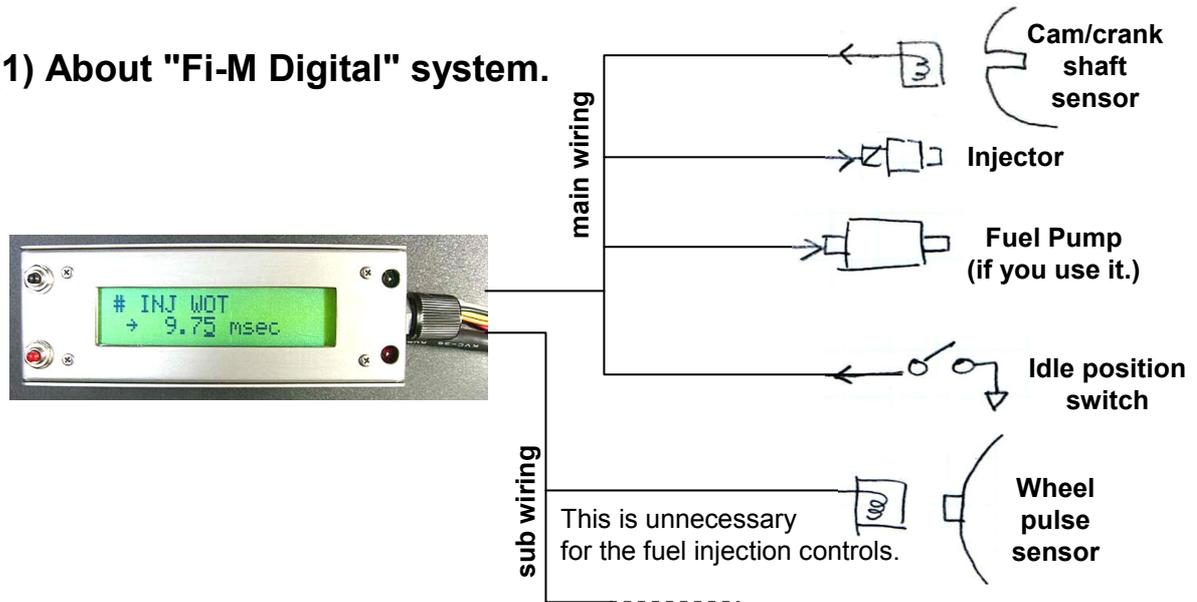
v e r. 1. 0 1. 0 2

Contents

(1) About "Fi-M Digital" system.

[Injection Control]
The new "Fi-M digital controller" controls the fuel injection time to two engine conditions of "Wide open throttle"(WOT) and "idle position"(ID).
This is not "Map control" but "two point control". When "idle position switch" turns to "ON" (throttle close), the controller switches "injection time" from "WOT injection time" to "ID injection time". This control method is completely same as old Fi-M.

This simple control method is designed on the assumption that the engine is driven with the wide open throttle (completely). It is a method of driving the engine to maximize fuel efficiency. This control method has the following advantages.

(1) The setting is easy. (It is only two points.)
(2) It is easy to understand the condition of the engine.
(3) It is easy to find the engine trouble.

[Pump Control]
If you use the fuel pump , it is also possible that the controller controls the fuel pump.
The new "Fi-M digital controller" controls the fuel pump by the following method.
(i) You set the "time width" and the "cycle" of pulse current.
(ii) The controller supplies the pulse current to the pump, according to set time width and cycle.
As a result, you will be able to adjust the fuel pressure to the target pressure without the fuel pressure regulator. We recommend you to adjust the the fuel pressure from 2.5kgf/cm^2 to 3.5kgf/cm^2. The "Cycle" setting can be set according to "WOT" and "ID" as well as the "fuel injection time". In "ID" condition, fuel flow is a little, please set the "Cycle" to longer time.

[Revolution Speed Limitter]
The controller can cut the fuel when the rotational speed of the engine is faster than the rotational speed that you set to "Rev. limitter" setting.

(1) About "Fi-M Digital" system.

[Injection for Starting engine]

To improve the engine starting, the controller can inject the fuel beforehand. The fuel is injected once without engine rotation, when you turn on the "fuel injection function switch". The driver must decide the times of "turn on, and off" (the times of injection=amount of fuel), according to the condition of the engine at that time. The Controller inject fuel once when "injection function switch" is turned on before starting the engine . "One time" is enough usually.For this function,you can set this "start up injection time" to "WOT injection time" or "ID injection time" .

[Meter Function]

"Meter function" is equipped as a new feature in "Fi-M digital controller".
The controller can display the following engine / vehicle data in "Meter function".

(1) Amount of fuel [cc]
(2) Runing Distance(Trip) & Total runing distance(ODO). [*1]
(3) Fuel consumption.(= Runing Distance/Amount of fuel [km/L])
(4) Vehicle speed. [km/h]
(5) Engine speed. [r.p.m.]
(6) Engine hour meter.[h.m.s]
(7) Supplied voltage. [Volts]
(8) Temperature. [degree Celsius] [*2]

[*1] "Trip" is a value used to calculate fuel consumption. When "B switch" is pushed long, this is reset in 0. "ODO" is for the record of the total. It is not used for other calculations. It is possible to reset it in 0 in "Setting mode".

[*2] The temperature sensor is a thermally sensitive resistor (NTC thermister) to use it to control. Because the value was calculated from the sensor spec, the error margin is contained.

(2) Externals

(A) Mode change switch /
Display change switch
Mode change >> push long. (1sec)
Display change >> push short.

Green lamp
(1) It lights when "Injection function switch"
 is turned on.
(2) It blinks when "ID" switch is turned on.

LCD display

Dial
for input

```
# INJ WOT
  →  9.75 msec
```

Red lamp
(1) It light when "Rev. limitter" is working.
(2) It lights short when timer is started or stops.

(B) Timer switch / Reset switch
 (1) Timer start or stop >> push short.
 (2) Reset amount of fuel, distance,timer >> Push long. (3sec.)

Meter function power switch (left side)
 It is necessary to turn on controller's power supply with this switch to use "Meter
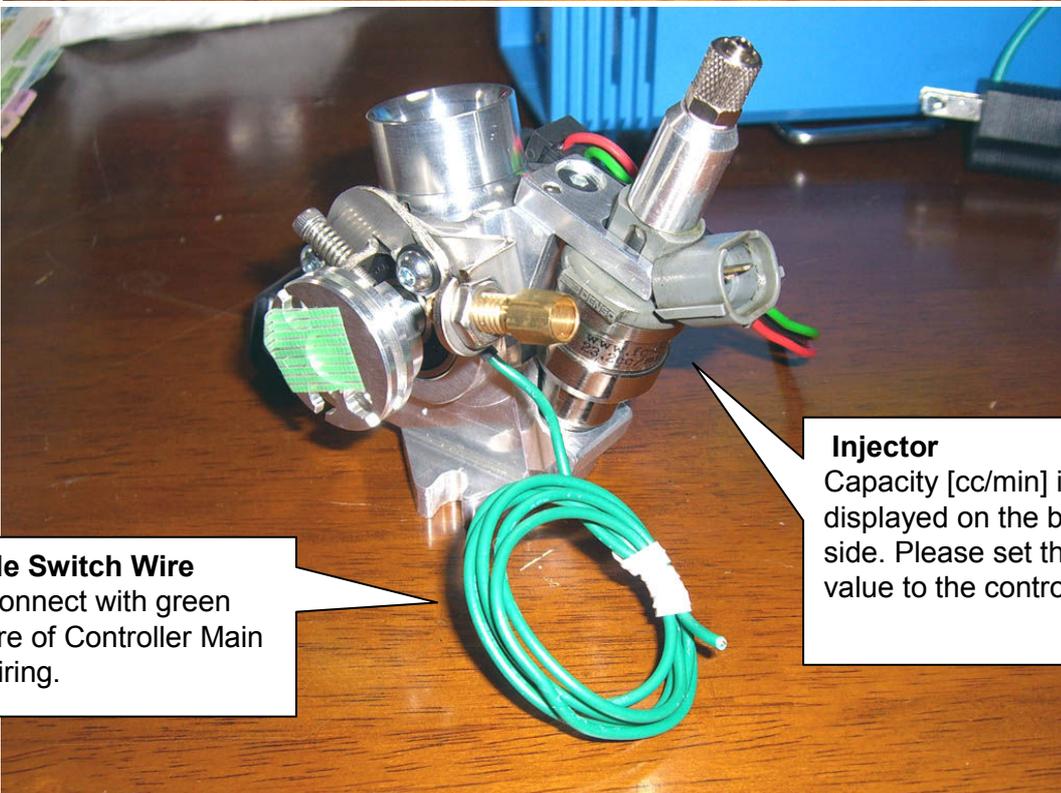function".
(1) ON >> Push over 1sec.
(2) OFF >> Push over 4sec.

(2) Externals

Throttle Position Sensor
Not using it in this version.
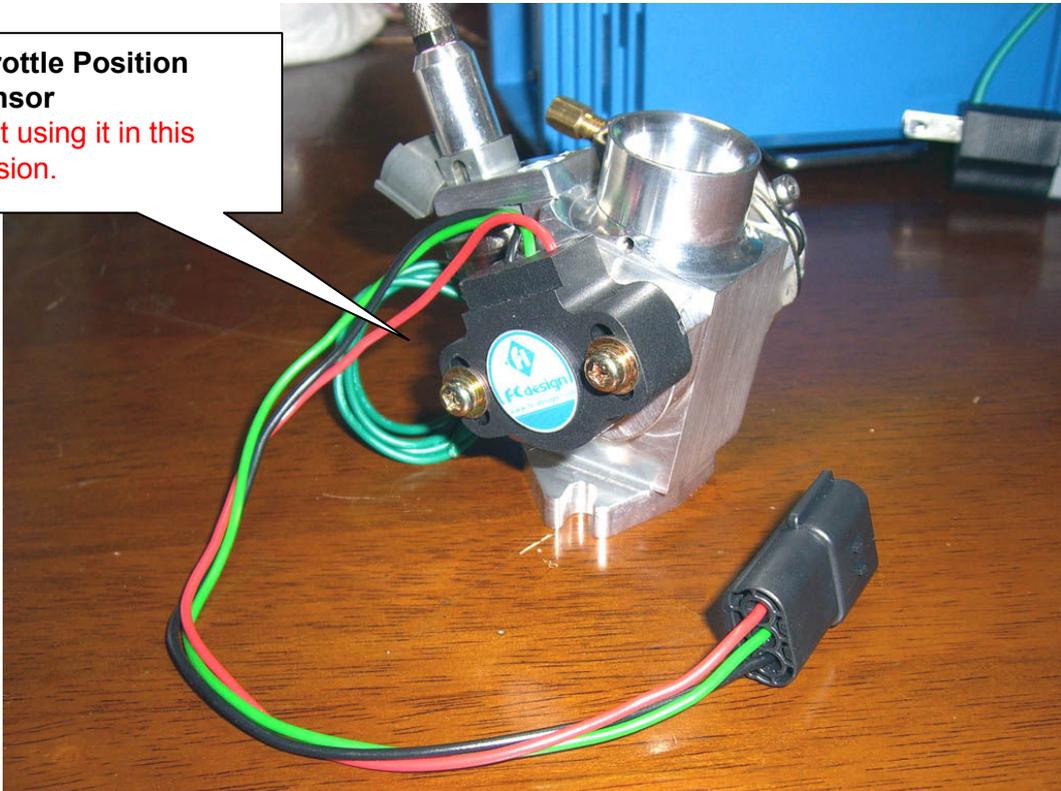
Idle Switch Wire
Connect with green wire of Controller Main Wiring.

Injector
Capacity [cc/min] is displayed on the body side. Please set this value to the controller.
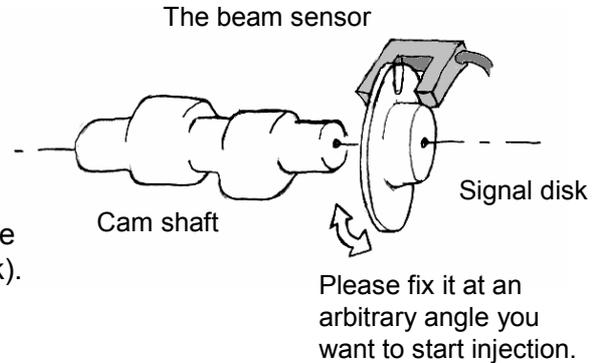
(3) The injection timing sensor installation.

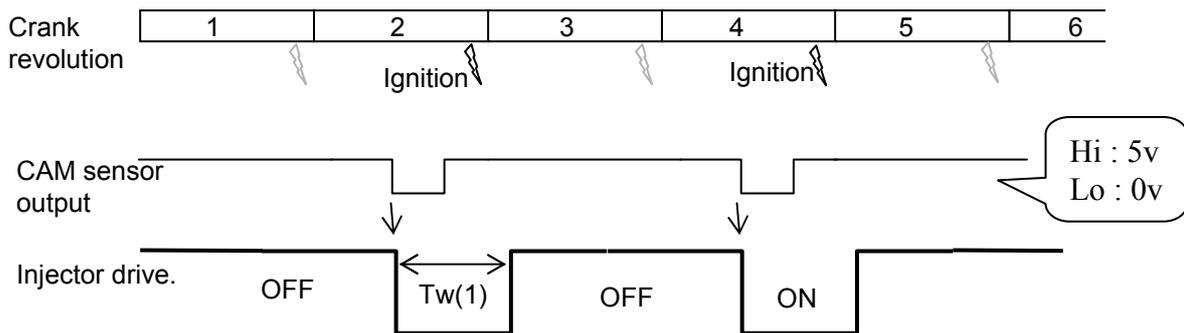**Installation on cam shaft axis.
(standard install.)**

The injection timing is generated with the signal disk and beam sensor installed in the camshaft axis. As a result, you can start the injection with an arbitrary point during the cycle of combustion once (two rotations of the crank).

Please make the setting of the pulse in a set mode [Please refer chapter(7) & (9)] as shown in a right picture.

In this case, the relation between the injection time and the cycle is shown in the figure below.

The beam sensor

Cam shaft

Signal disk

Please fix it at an arbitrary angle you want to start injection.

```
# Pulse cycle
 → CAM CYCLE
```
The pulse cycle setting.

Crank revolution	1	2	3	4	5	6

Ignition   Ignition

CAM sensor output

Hi : 5v
Lo : 0v

Injector drive.   OFF   Tw(1)   OFF   ON

Tw(1) = [The injection time width value（WOT or ID)] + [The injector reaction time]
The timing of starting injection is after the intake valve close in this figure.

The injector is driven with the total of the injection time, and the injector reaction time. [TW(1)] The injector reaction time is required time in responding for turning on and turning off driving current of the injector.
You can set each value in "setting mode" shown in a right picture.
The injector reaction time is about 1msec on the voltage of the battery. (12 to 13V) The value changes depending on the voltage.

```
# INJ WOT
 →   9.75 msec
```

```
# INJ ID
 →   4.00 msec
```
The injection time (WOT / ID)

```
# Inj. reactionT
 →   1.00 msec
```

The injection reaction time

「ex. Installation on cam shaft axis」

フォトセンサ 取付け例.

Photo sensor

cylinder

bracket

ボルトで固定はかと
M.シャフトが こっち向に
脱落する.

M3 大角穴はボルト

M3x0.5のネジ穴を明ける.

2～2.5m

←点火プラグ側り

ボールベアリンク゛

ヘッド

cam shaft

カムシャフト固定方法

吸気弁側が1
タイミング に1なる.

3.0°

Ø40
Ø26
Ø8

Ø5

17

1   15

12
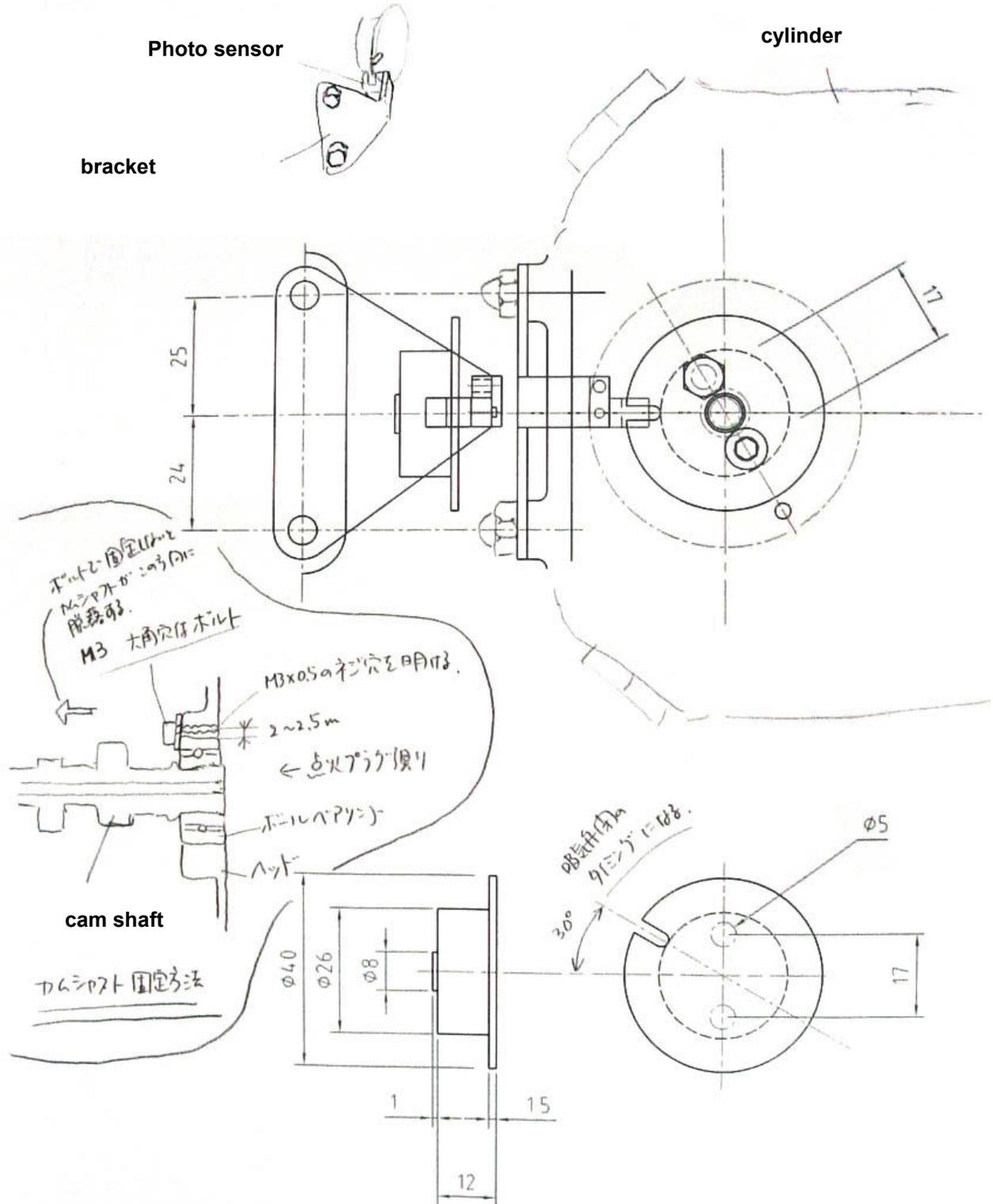
Installation on crank shaft axis

If you can't install the disk and the sensor in the cam shaft axis, the sensor can be installed in the crank shaft.

The ignition is done by every crank rotation in a many kind of single cylinder motor cycles engine. For the signal interface unit (Optional parts), the injection timing can be generated from the primary voltage of CDI. In the DC-CDI igniter for the model aircraft etc. , the ignition timing sensor of an output wave form near the signal wave form of the injection timing sensor for Fi might be used. In this case, it is also possible to use these together. You cannot arbitrarily set the jet timing by these methods.
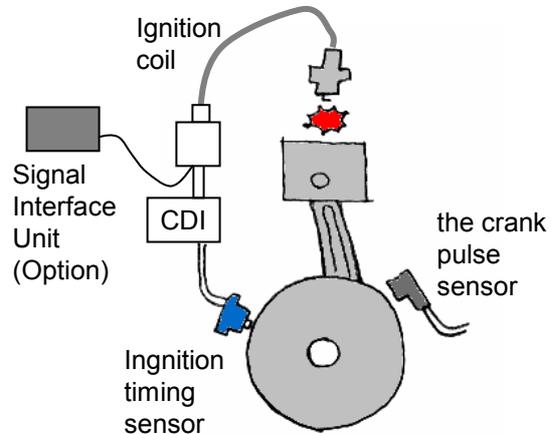
Please make the setting of the pulse in a set mode [Please refer chapter(7) & (9)] as shown in a right picture.

The pulse cycle setting.

In this case, the relation between the injection time and the cycle is shown in the figure below.
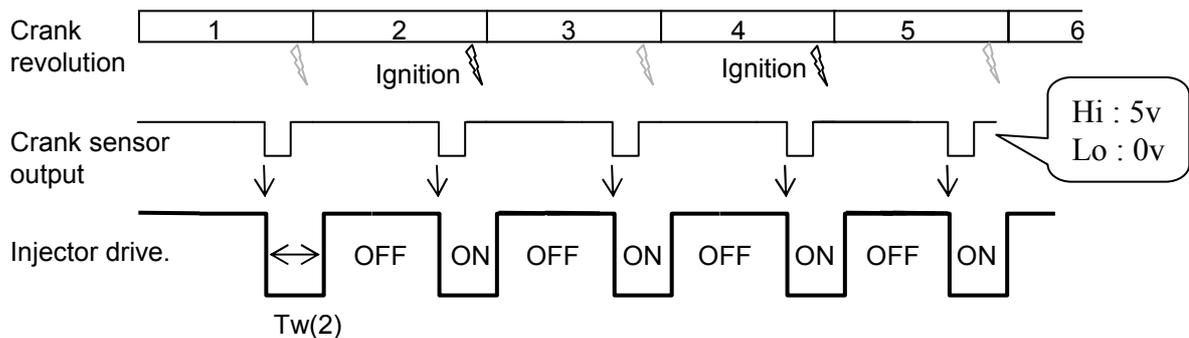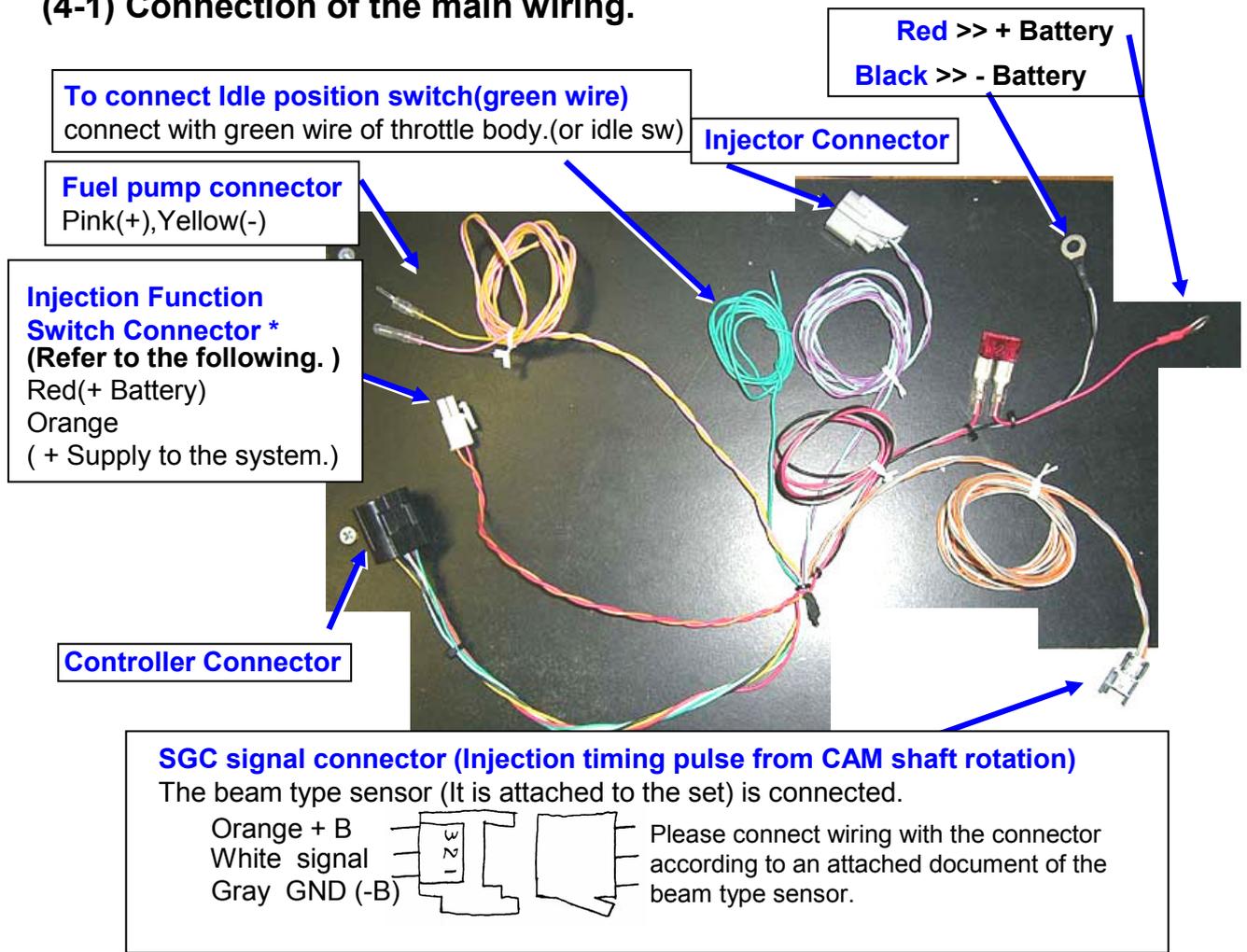

Tw(2) = [The injection time width value(WOT or ID)] / 2 + [the injector raction time]

The injector is driven with the total of the half of the injection time, and the injector reaction time. [=TW(2)] The controller jets the fuel for one combustion half dividing into two times.
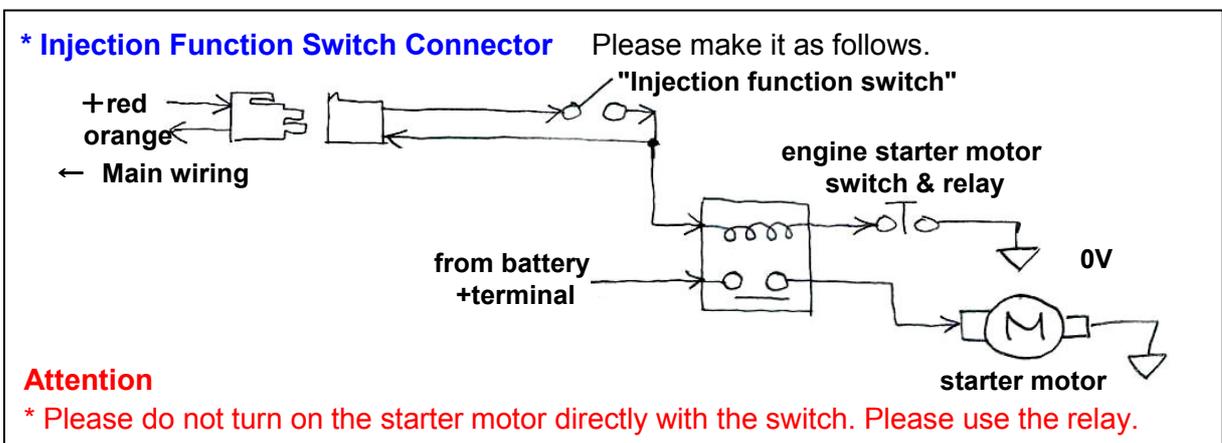

The injection time (WOT / ID)

(4-1) Connection of the main wiring.

Red >> + Battery

Black >> - Battery

To connect Idle position switch(green wire)
connect with green wire of throttle body.(or idle sw)

Injector Connector

Fuel pump connector
Pink(+),Yellow(-)

**Injection Function
Switch Connector ***
(Refer to the following.)
Red(+ Battery)
Orange
(+ Supply to the system.)

Controller Connector

SGC signal connector (Injection timing pulse from CAM shaft rotation)
The beam type sensor (It is attached to the set) is connected.

Orange + B
White signal
Gray GND (-B)

Please connect wiring with the connector according to an attached document of the beam type sensor.

Attention
* Please do not connect a black line with the frame earth(GND,common), and connect it with the battery (-) terminal. (To prevent the error by the noise.)
** It is necessary to connect the battery(-) with the engine earth(GND,common) for normal operation of the idle switch(ID).

* Injection Function Switch Connector   Please make it as follows.

"Injection function switch"

＋red
orange
← Main wiring

**engine starter motor
switch & relay**

**from battery
+terminal**

0V

starter motor

Attention
* Please do not turn on the starter motor directly with the switch. Please use the relay.

(4-2) Connection of sub wiring.

* Please connect the sub power supply line directly with the battery terminal without the switch etc. It is necessary for controller to save the "setting".

Wheel sensor connector.

brown/white 12V
yellow 5V
red/white signal
black/white GND
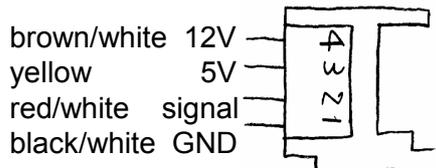
Please connect the inductive proximity sensor (It is attached to the set) with the connector. （12V,signal,GND）

*Please refer to the document of the sensor for wiring.

And, please install metallic parts for the rotation detection in the wheel. Please make it to 1 or two pulses a wheel rotation.
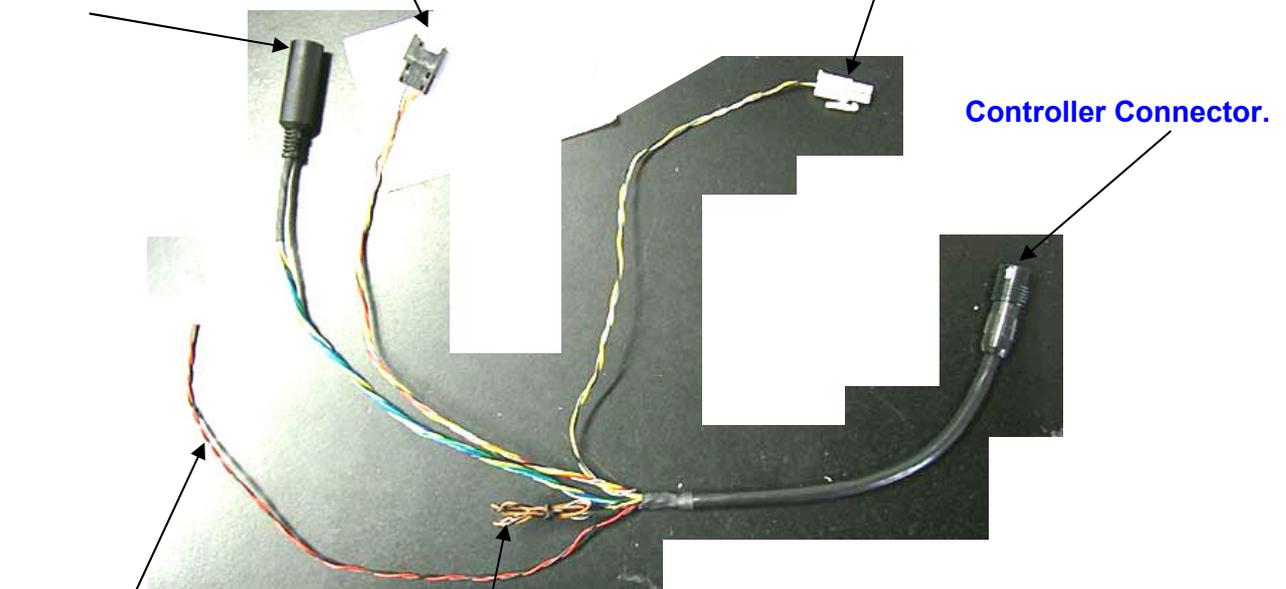
* When you use the magnet switch of the speed meter for the bicycle, please connect it with "Signal" and "GND".

Comunication connector.
[Not using it in this version.]

Temparature sensor connector.
The temperature sensor (It is attached to the set) is connected.

Controller Connector.

Sub power supply wiring.
Red >> + Battery
Black >> -Battery
(without switch.)

**Sensor wiring for additional function**
brown,black/white [Not using it in this version.]

* The controller doesn't using wheel sensor and temperature sensor to control the fuel injection.

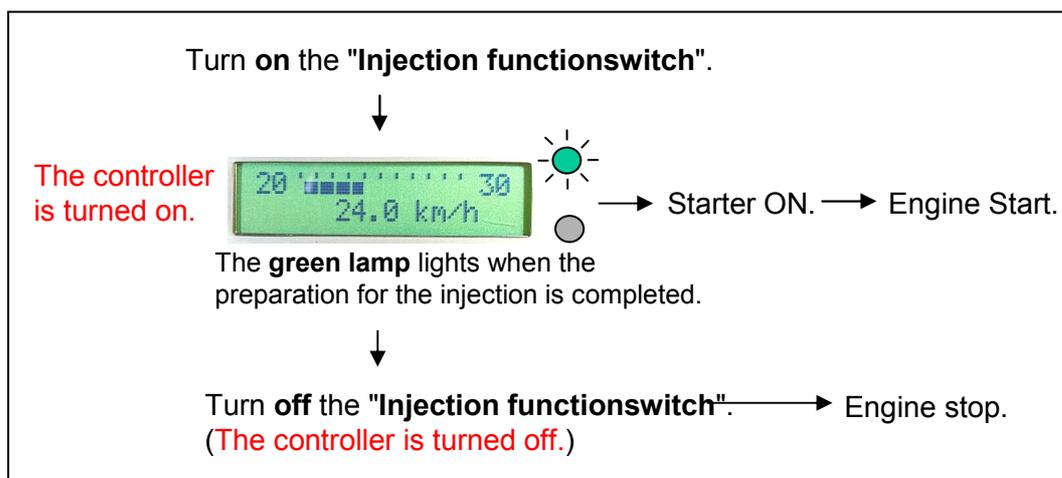## (5) When you use only the "fuel Injection" function.

Only the Injection control function can be used just like the old Fi-M unit. In this case, you use the system without turning on "Meter function power switch". When the "Injection function switch" is turned on, the controller completes the preparation for the injection control.

*In this case, you cannot use the display of the mileage and fuel consumption.

the injection function switch.

main wiring

```
# INJ WOT
→  9.75 msec
```
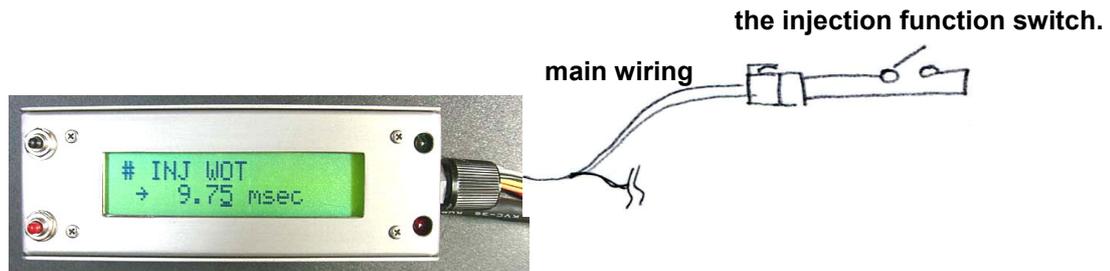
* The injection function switch is power switch for injection control parts.
* Even in this case, please connect the power supply line of the subwiring.

Turn **on** the "**Injection functionswitch**".

↓

The controller is turned on.

```
20 ▪▪▪▪        30
     24.0 km/h
```

→ Starter ON. → Engine Start.

The **green lamp** lights when the preparation for the injection is completed.

↓

Turn **off** the "**Injection functionswitch**". → Engine stop.
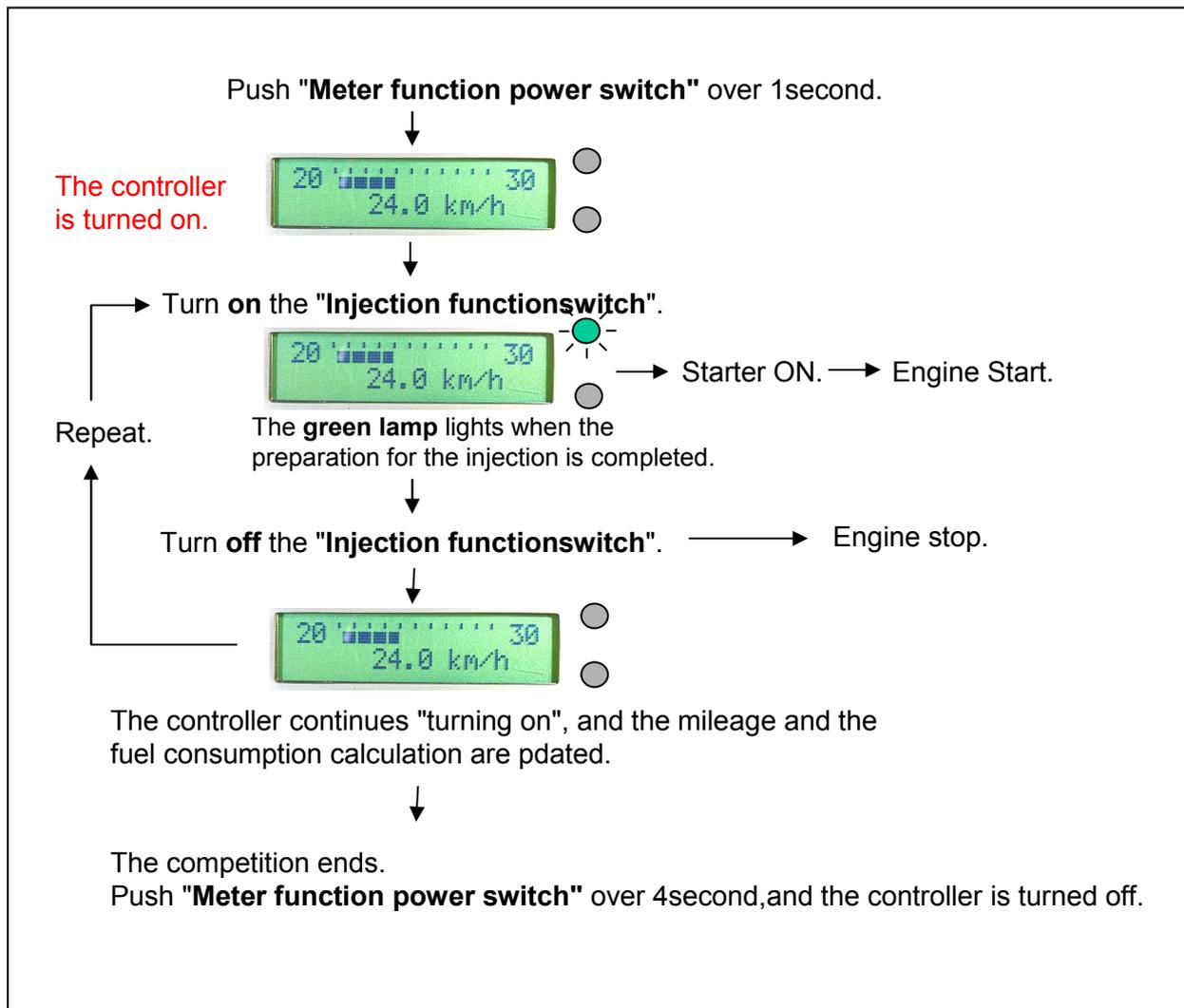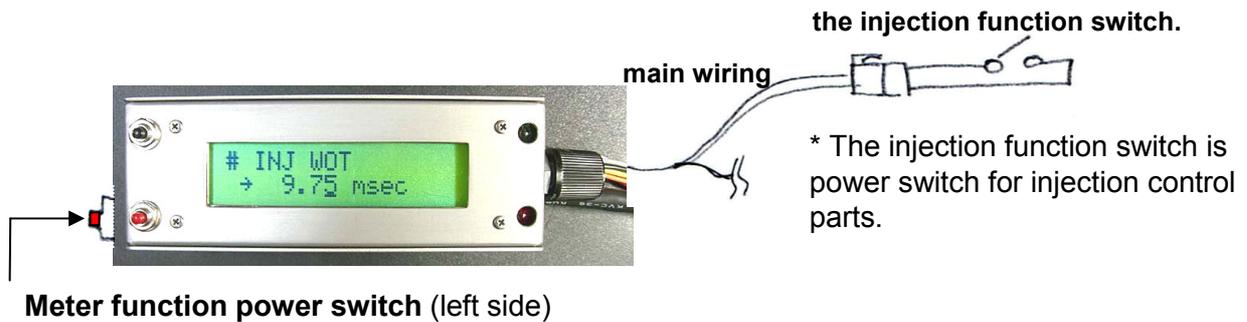(The controller is turned off.)

*** The controller doesn't calculate the mileage among turning off it.
Please turn on "meter function power switch" before starting when you want to use the display of the mileage and fuel consumption.**

* The "meter function power switch" cannot be turned on while the power supply has been turned on with the "injection function switch". Please do the operation that turns on "meter function power switch" when controller's power is off.

(6) When you use "Meter" function.
   (using both functions. "Meter" and "fuel injection".)

Please turn on "meter function power switch" before starting when you want to use the display of the mileage and fuel consumption.

the injection function switch.

main wiring

```
# INJ WOT
→ 9.75 msec
```

* The injection function switch is power switch for injection control parts.

Meter function power switch (left side)

Push "**Meter function power switch**" over 1second.

↓

The controller is turned on.

```
20 '▪▪▪▪' ' ' ' ' ' 30
     24.0 km/h
```

↓

Turn **on** the "**Injection functionswitch**".

```
20 '▪▪▪▪' ' ' ' ' ' 30
     24.0 km/h
```

→ Starter ON. → Engine Start.

The **green lamp** lights when the preparation for the injection is completed.

Repeat.

↓

Turn **off** the "**Injection functionswitch**". —————→ Engine stop.

↓

```
20 '▪▪▪▪' ' ' ' ' ' 30
     24.0 km/h
```

The controller continues "turning on", and the mileage and the fuel consumption calculation are pdated.

↓

The competition ends.
Push "**Meter function power switch**" over 4second,and the controller is turned off.

(7) How to switch display mode.
(Meter mode < > Setting mode)

(A) Mode change switch / Display change switch

Meter mode

The controller starts in a display mode.

Display change
>> push short.

Mode change
>> push long.
(1sec)

Setting mode

"# INJ WOT" is displayed when becoming a set mode.

Display change
>> push short.
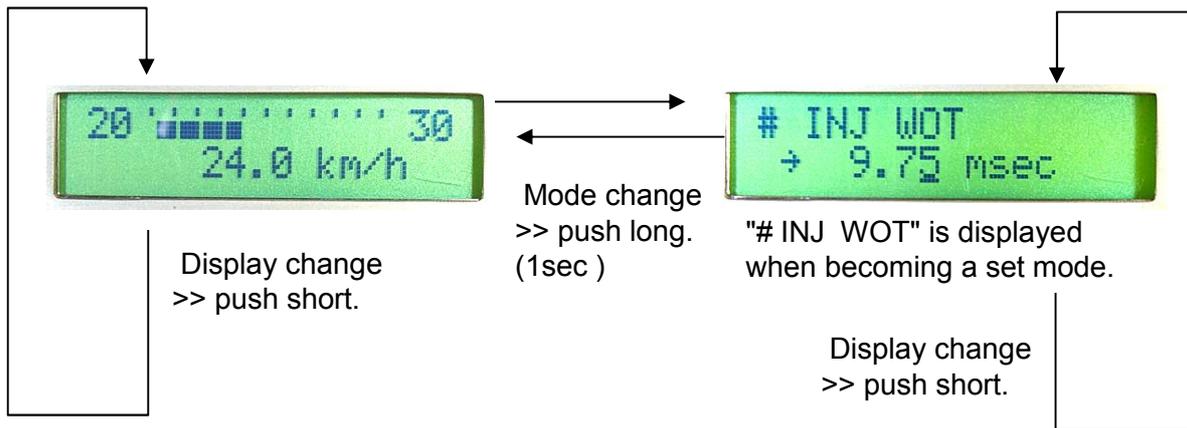
* When the controller is turned on next time, it becomes a screen that had been selected at the end when it is turned off. (Last "Meter Mode" display.)

(8) How to change fuel injection setting.
(Setting mode.)

the Green lamp

**(A) Mode change /
Display change**

Cahnge value by dial.

"Preparation"

 Please turn on the injection switch after confirming the connection. The pump begins to move, and the injector is normal if it moves once , with a click.
 If the idle switch turns on(idle position), a green lamp becomes blinking every one second. When idle switch turns off(Opening throttle), a green lamp becomes a continuous lighting.

"Change Settings"

[Injection Control]
   The new "Fi-M digital controller" controls the fuel injection time to two engine conditions of "Wide open throttle"(WOT) and "idle position"(ID).
This is not "Map control" but "two point control". When "idle position switch" turns to "ON" (throttle close), the controller switches "injection time" from "WOT injection time" to "ID injection time". This control method is completely same as old Fi-M.

Please push the "mode change switch" for one second or more. The screen changes into "Setting mode". A left photo is a screen of the fuel injection time at "WOT". The time can be increased and decreased by turning a right side dial. The fuel flow increases by increasing of the injection time.

 Next, the display changes to the left photo screen when the mode change (display cahnge)switch is pushed short. You can change the fuel injection time of "idle position" in this display.

 The display changes whenever the mode switch is pushed short. The following of the last "Controller softwear version " return to the first "♯INJ WOT".


[Pump Control]

If you use the fuel pump , it is also possible that the controller controls the fuel pump. The new "Fi-M digital controller" controls the fuel pump by the following method.
(i) You set the "time width" and the "cycle" of pulse current.
(ii) The controller supplies the pulse current to the pump, according to set time width and cycle.
 As a result, you will be able to adjust the fuel pressure to the target pressure without the fuel pressure regulator. We recommend you to adjust the the fuel pressure from 2.5kgf/cm^2 to 3.5kgf/cm^2. You can set the "cycle" value of each case of "WOT" and "ID",like the "fuel injection time". In "ID" condition, fuel flow is very little, and please set the "cycle" value to longer time.

 # PUMP DRV T
→   31.232 msec
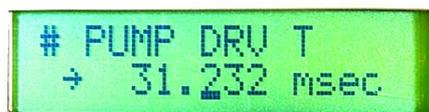
 You can set driving time width of pump on the screen of " # PUMP DRV T " shown in a left photo.

 # PUMP CYC WOT
→   440 msec
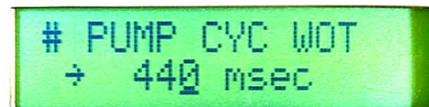
 You can set driving cycle of the pump at "WOT" on the screen of " # PUMP CYC WOT " shown in a left photo.

 # PUMP CYC ID
→ 1000 msec

 You can set driving cycle of the pump at "Idle" on the screen of " # PUMP CYC ID " shown in a left photo.

[Revolution Speed Limitter]
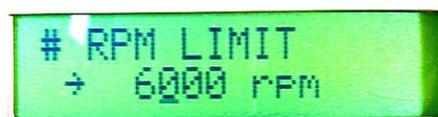
 # RPM LIMIT
→   6000 rpm

 You can set the "rotation speed limiter" on the screen of " # RPM LIMIT" shown in a left photo. When the rotational speed of the engine exceeds a set value, the fuel injection is cut.

[Injection for Starting engine]

  To improve the engine starting, the controller can inject the fuel beforehand. The fuel is injected once without engine rotation, when you turn on the "fuel injection function switch". The driver must decide the times of "turn on, and off" (the times of injection=amount of fuel), according to the condition of the engine at that time.

 # START INJ
→ WOT
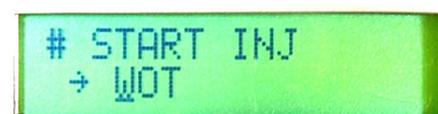
Start up Injection Time.
You can set either of WOT time width or Idle time width to it. The Fuel is injected once,when the the "fuel injection function switch" is turned on
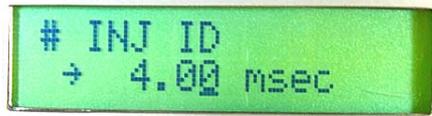
WOT: Time width of injection in "WOT"
ID: Time width of injection in "ID"

(9) "Setting mode" display & the other settings.

INJ WOT
→ 9.75 msec

(1) **Injection time at "WOT".**
   (wide open throttle)
   Please refer to section (8).

INJ ID
→ 4.00 msec

(2) **Injection time in "ID" .**
   (idle)
   Please refer to section (8).

PUMP DRV T
→ 31.232 msec

(3) **Pump drive.**
   "Time width"
   Please refer to section (8).

RPM LIMIT
→ 6000 rpm

(4) **Rotational speed limitter.**
   You can set it in 100 rpm.
   Please refer to section (8).

PUMP CYC WOT
→ 440 msec

(5) **Pump drive.**
   "Cycle" in "WOT"
   Please refer to section (8).

PUMP CYC ID
→ 1000 msec

(6) **Pump drive.**
   "Cycle" in "ID" (= Idle)
   Please refer to section (8).

START INJ
→ WOT
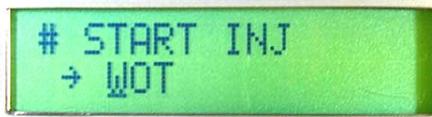
(7) **Start up Injection Time.**
   "WOT" or "ID"
   Please refer to section (8).

INJECTOR
→ 18.00 cc/min

(8) **Injector capacity. [cc/min]**
   This value is used to calculate the amount
   of the fuel. Please change by the dial.

---

amount of injected fuel [CC]
   = Sum of the injection time[msec] / 1000 ∗ The Injector capacity[cc/min] / 60

---

(9) "Setting mode" display & the other settings.

DIST / PULSE
→ 1490 mm

(9) **Distance per wheel pulse. [mm]**
This value is used to calculate the velocity and runinng distance. Please adjust it to your car.

Velocity [km/h] = wheel pulse frequency * Distance pre pulse [mm] / 1000 * 3.6

Running distance [m] = Wheel pulse counts * Distance per pulse [mm] /1000

VEL BAR MIN
→ 20 km/h

(10) **Velocity bar left limit. (minimum)**

VEL BAR MAX
→ 30 km/h

(11) **Velocity bar right limit. (maximum)**

When the vehicle velocity is lower than left limit, the left value changes to the velocity at that time .

20 ▮▮▮▮ 30
24.0 km/h

The bar graph changes when the speed is between a left limit and right limit.
10 scales (50segments)

When the vehicle velocity is higher than right limit, the right value changes to the velocity at that time .

RPM BAR MAX
→ 6000 rpm
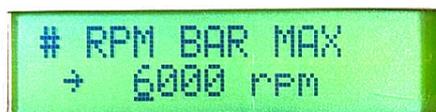
(12) **Engine r.p.m. bar graph setting.**
6000 r.p.m or 12000 r.p.m
shown in 12 scales.(60 segments)

0 ▮▮▮▮▮▮▮▮ 6
3610 rpm ▮

The revolutional speed is shown by 6000 r.p.m max. and 500 r.p.m. /scale.
or
12000 r.p.m. max. and 1000 r.p.m. /scale.

(13) Injector reaction time
The injector reaction time is required time in responding for turning on and turning off driving current of the injector. The injector reaction time is about 1msec on the voltage of the battery. (12 to 13V) The value changes depending on the voltage.

(14) Pulse cycle
The setting of the injection start timing pulse. You can set this value "CAM CYCLE" or "CRANK CYCLE".
Please see [(3)The injection timing sensor inatllation.] section for details.

(15) Engine hour meter reset.
Engine hour is set to zero when you push "(B)reset switch" long(3seconds) in this display.

(16) Total runing distance reset.
"Total runing distance"(ODO) is set to zero when you push "(B)reset switch" long(3seconds) in this display.

(17) Setting default.
All settings are set to the factory default value when you push "(B)reset switch" long(3seconds) in this display.

(18) Controller softwear version.
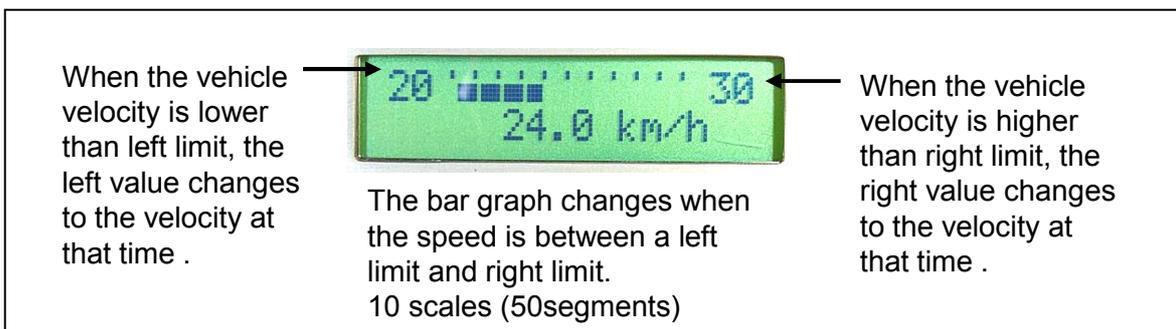
(10) "Meter mode" display

(1) **The velocity bar graph &
the velocity value.**

Upper: The bar graph & the value of both side display the vehicle velocity.

[see section (9)-(10),(11)]

Lower: The value display the vehicle velocity.

When the vehicle velocity is lower than left limit, the left value changes to the velocity at that time .

When the vehicle velocity is higher than right limit, the right value changes to the velocity at that time .

The bar graph changes when the speed is between a left limit and right limit.
10 scales (50segments)

(2) **The velocity bar graph &
the fuel consumption value.**

Upper: The bar graph & the value of both side display the vehicle velocity. (see section (9))

Lower: The value display the fuel consumption[km/L].

The fuel consumption (km/L) = "the runing distance"(6) [m] / "amount of injected fuel"(4)[cc].

The both values are set to zero when you push "(B)reset switch" long (over 3seconds) in "Meter mode" screen displayed. (The timer & Engine Hour are set to zero at the same time.)

(3) **The velocity bar graph &
the timer display.**

Upper: The bar graph & the value of both side display the vehicle velocity.

[see section (9)-(10),(11)]

Lower: Display of time after start/stop switch is pushed.[hours:minutes:seconds]

When you want to start or stop timer, please push "(B)start/stop switch(reset switch) short. At this time, a red lamp lights short.

When you want to reset the timer,please push the (B) switch long in "Mode" screen displayed. (The running distance & amount of fuel value are set to zero at the same time.)
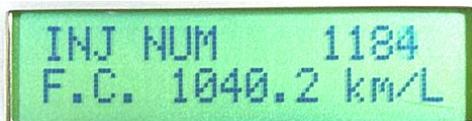
(10) "Meter mode" display

```
INJ NUM      763
FUEL   2.0081 cc
```

(4) **Number in which fuel is injected & the amount of injected fuel.**

Upper: Injection number.(= rotation total.)

Lower: amount of injected fuel [CC].

---

amount of injected fuel [CC]
= The sum of injection time[msec] / 1000 ∗ The Injector capacity[cc/min] / 60

```
INJ NUM     1184
F.C. 1040.2 km/L
```

(5) **Number in which fuel is injected & the fuel consumption value.**

Upper: Injection number.

Lower: The value display the fuel consumption [km/L].   (same as the displayed value of (2).)

```
TRIP   3333.1 m
ODO   10.025 km
```

(6) **Runing distance[m] & Total runing distance[km].**

Upper: Trip,The distance for calcurate the fuel consumption.

Lower: ODO,The total runing distance.

You can set "Total runing distance" to zero in "Setting mode". [see section(9)-(14).]

(7) **Engine R.P.M. bar graph &**
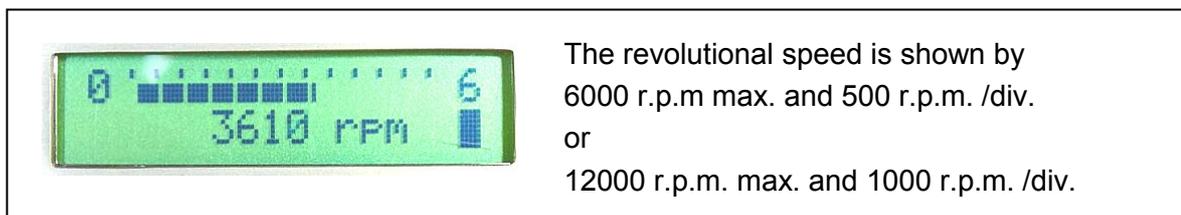   **engine R.P.M. value.**

Upper: The bar graph shows engine speed.
    Left value >> left limit = 0rpm
    Right value >> right limit = 6000rpm
    You can change it to 12000rpm.
Lower: The engine speed value.

The revolutional speed is shown by
6000 r.p.m max. and 500 r.p.m. /div.
or
12000 r.p.m. max. and 1000 r.p.m. /div.

(8) **Engine hour meter.**

 Engine On (> 700rpm) time.
Upper: Engine hour.

Engine hour is seto to zero when you push
"(B)reset switch" long (over 3seconds) in "Meter
mode" screen displayed. ("the runing distance"
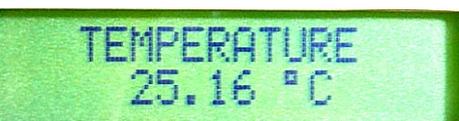& "amount of fuel" and "Timer" are set to zero at
the same time.)

Lower: Total engine hour.
 You can set "Total engine hour" to zero in
"Setting mode". [see section(9)-(13).]

(9) **Power supply voltage.**
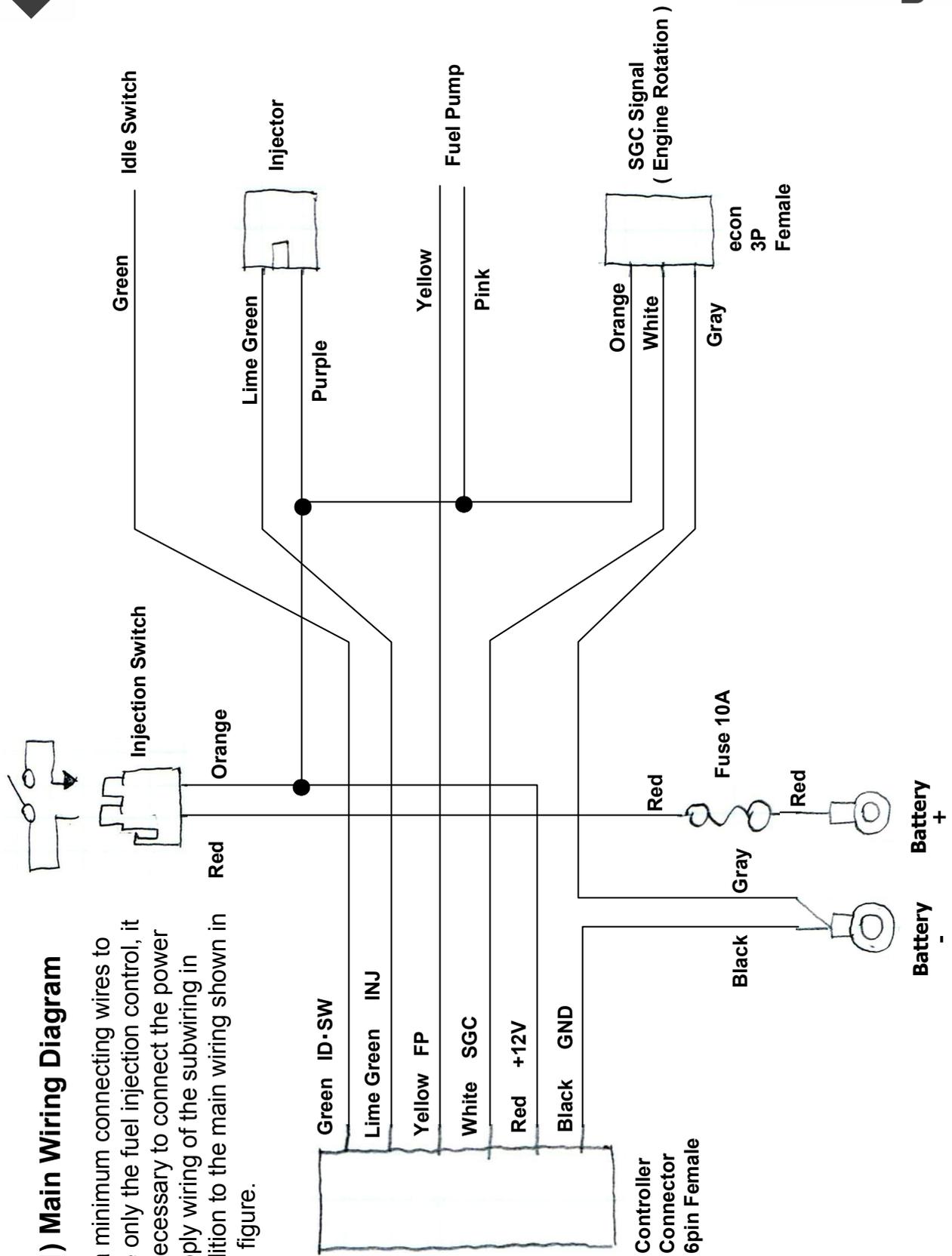
 The power supply voltage is displayed.

(10) **Temperature.**

 The temperature of sensor is displayed.
The sensor is the thermally sensitive resistor
sensor, and the value of the temperature is
calculated from the specification of the resistor.

(11) Main Wiring Diagram

In a minimum connecting wires to use only the fuel injection control, it is necessary to connect the power supply wiring of the subwiring in addition to the main wiring shown in this figure.

Idle Switch

Green

Injector

Lime Green

Purple

Fuel Pump

Yellow

Pink

SGC Signal
(Engine Rotation)

Orange

White

Gray

econ
3P
Female

Injection Switch

Orange

Red

Fuse 10A

Red

Red

Battery
+

Gray

Black

Battery
-

Green   ID·SW

Lime Green   INJ

Yellow   FP

White   SGC

Red   +12V

Black   GND

Controller
Connector
6pin Female

(12) Specifications

[Throttle Body]

(1) Product number   FIM-B
(2) Type   Rotary valve, with the fuel injector holder. bore16mm
(3) Material   Aluminum
(4) Weight   About 450g
(5) Applicable engine   The small displacement engine for eco-competition, HONDA C50 etc.
(6) Appended goods   Injector X 1、air filter X 1

[Contrtoller]

(1) Product number.   FIMD-C
(2) Control.   16bit micro-controller.

(3) Injection time width.   Wide open throttle(WOT) and idle(ID). 2points.
Setting by dial. Displaying on LCD.

Range = WOT/5 to 25ms Idle/1 to 6ms
Start up copensation(injection) = Injected once at starting control.

(4) Injection timing   The injection starts at CAM CYCLE or CRANK CYCLE pulse sensor input.(1pulse to 1 injection.)

(5) Fuel pump control.   Controlled by the cycle and driving time width.
The cycle can be switched with WOT/ID.
Adjustment range 0-500ms and continuously drive at driving time.

(6) Revolution speed limitter.   Input set value with the dial. The injection is cut, when the rotational speed of the engine exceeds a set rpm.

(7) Display.   Amount of fuel[cc], Runing Distance&Total runing distance.(2 values*), Fuel consumption.(= Runing Distance/Amount of fuel [km/L]), Vehicle speed. [km/h], Engine speed. [r.p.m.], Engine hour meter.[h.m.s], Supplied voltage. [Volts], Temperature. ** [degree Celsius]

(8) Size weight   W X H X D ： 107mm X 40mm X 41mm
About 200g （only controller.）

(9) Appended goods   Wiring harnness, cam sensor, wheel sensor, temperature sensor, users manual

(13) Fi-M digital controller version history.

ver.1.00.01
 1st. release.

ver.1.01.01
 26/03/2007
 The injection timing function by the signal from the crankshaft is added.
 The range of the Revolution speed limitter is changed.

Fi-M digital Electronic Fuel Injection System
User's Manual

Update history of Users Manual.

October,2006   ver. 1.00.00 release.
December,2006 ver. 1.00.01 release.
January,2007   ver. 1.00.02 release.
    Editing "About Fi-m digital... ".
March,2007   ver. 1.00.03 release.
    The explanation of the throttle body is added.
March,2007   ver. 1.01.01 release.
    The explanation of the controller version ver.1.01.01 is added.
January,2008   ver. 1.01.02 release.
    The example figure of cam shaft sensor installation is added.