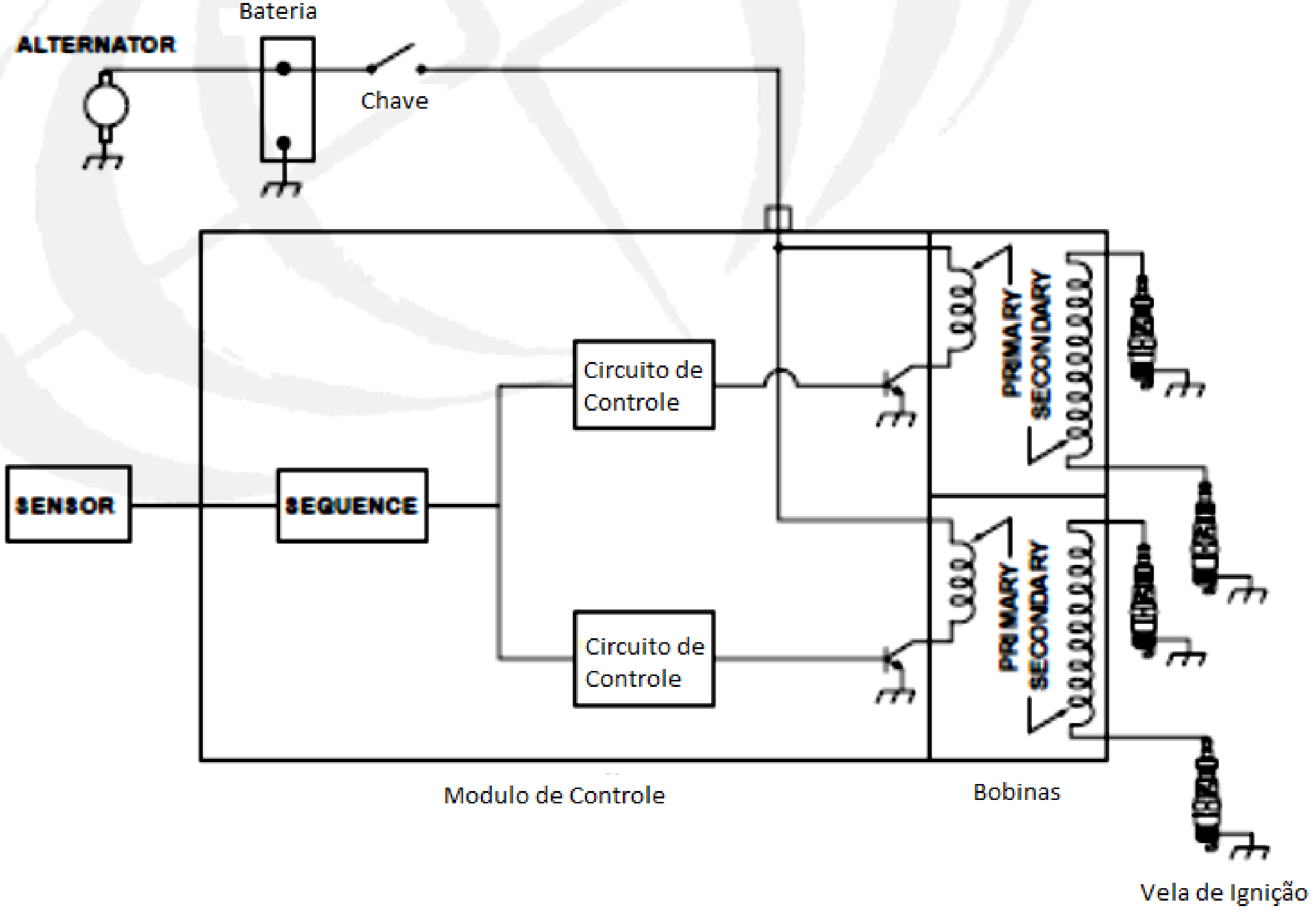
SISTEMA DE IGNIÇÃO

Sistema de Ignição


Bateria
ALTERNATOR
Chave
Circuito de Controle
SENSOR
SEQUENCE
Circuito de Controle
PRIMARY
SECONDARY
PRIMARY
SECONDARY
Modulo de Controle
Bobinas
Vela de Ignição

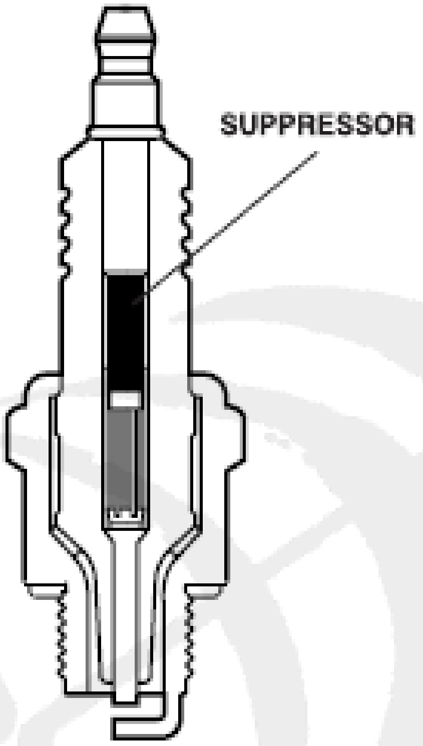

SUPPRESSOR

Figure 2-15. A one-piece integral suppressor reduces RF interference.

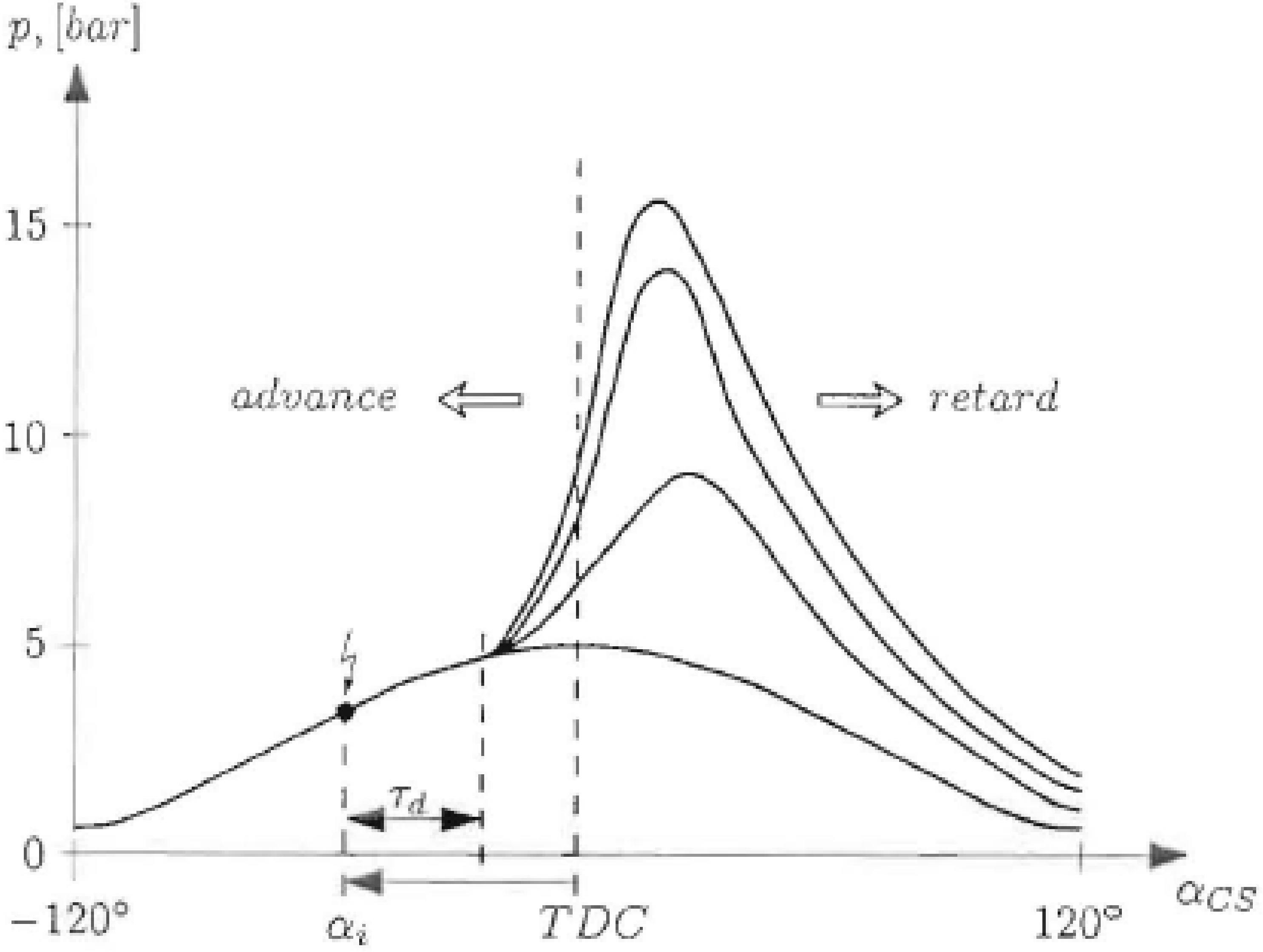
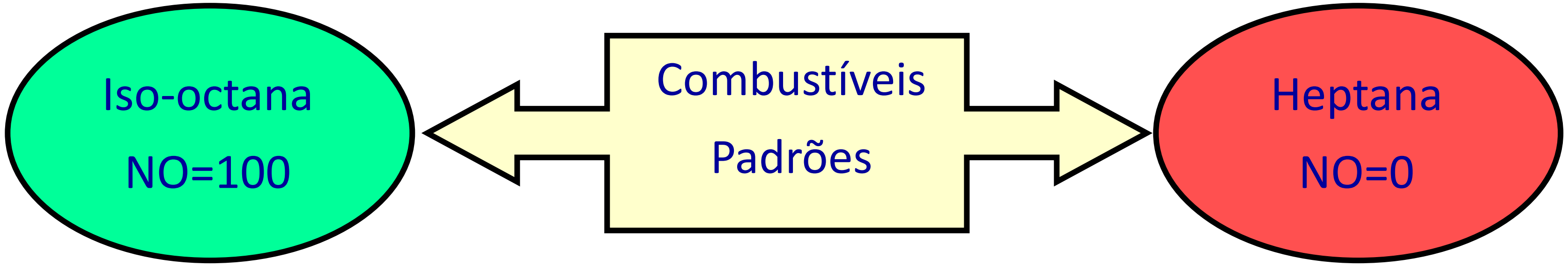


Figure 3.9 In-cylinder pressure p over crankshaft angle α_{CS}.

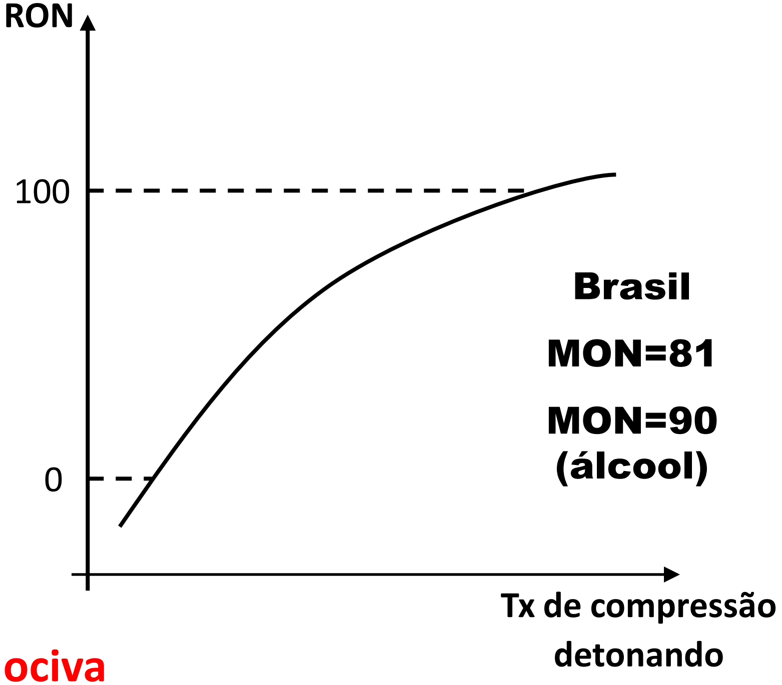
$$w_i = \frac{1}{V_d} \sum_{j=1}^{CYL} \oint \Big(p_j(V_j) - p_0 \Big) dV_j \quad , \qquad ($$

where:

$V_d = CYL \cdot (V_1 - V_2)$	is the displacement volume of all cylinders
CYL	is the number of cylinders
w_i	is the (normalised) **indicated specific work**.


Iso-octana
NO=100
Combustíveis
Padrões
Heptana
NO=0

O combustível comercial que **detona** com a mesma taxa de compressão de uma mistura de x% de Iso-octana e (100-x)% de Heptana, terá um NO = x.



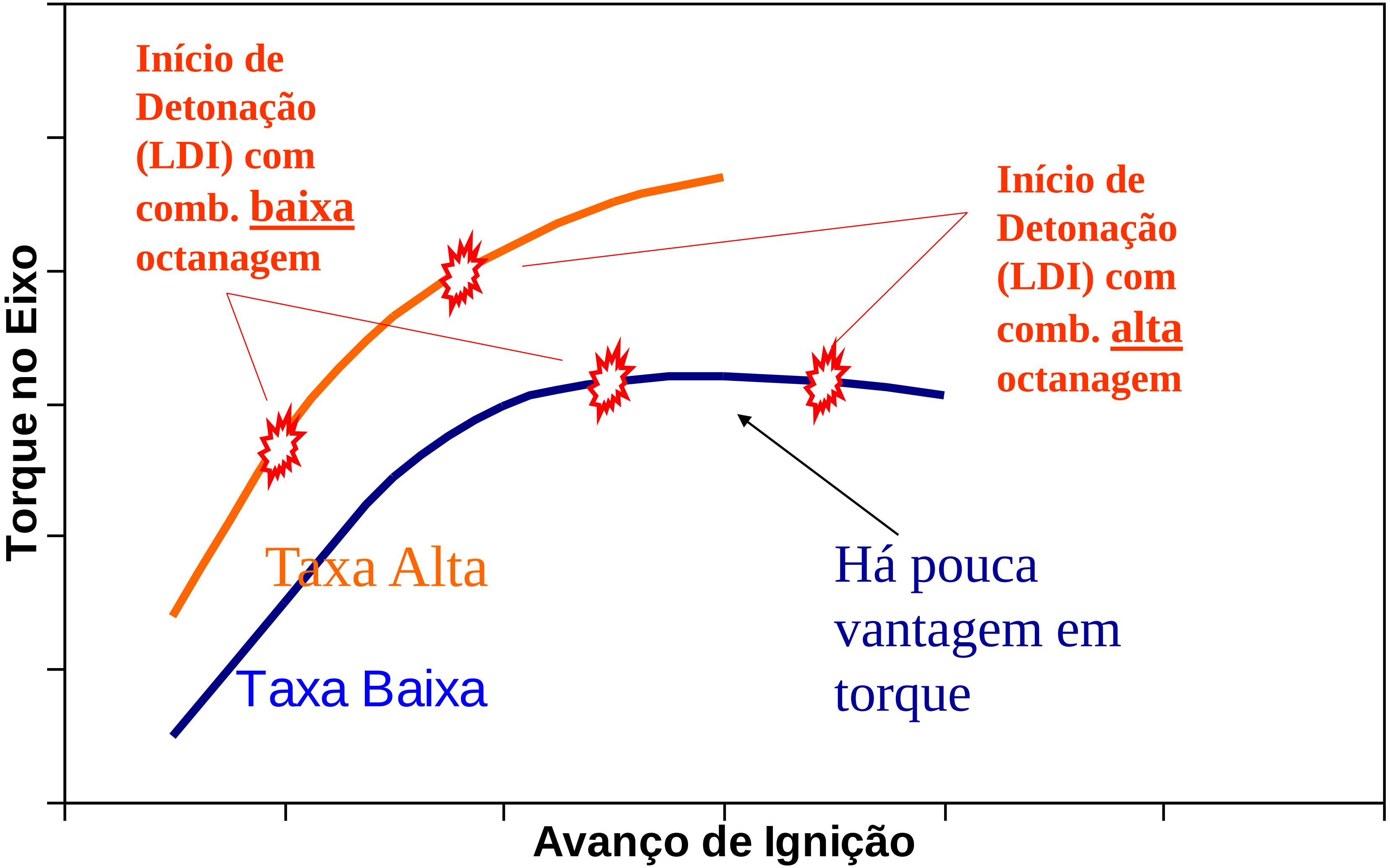
Brasil

MON=81

MON=90 (álcool)

Detonação: Auto ignição do combustível: Nociva ao motor

Requisito de Ignição, com RPM=Cte

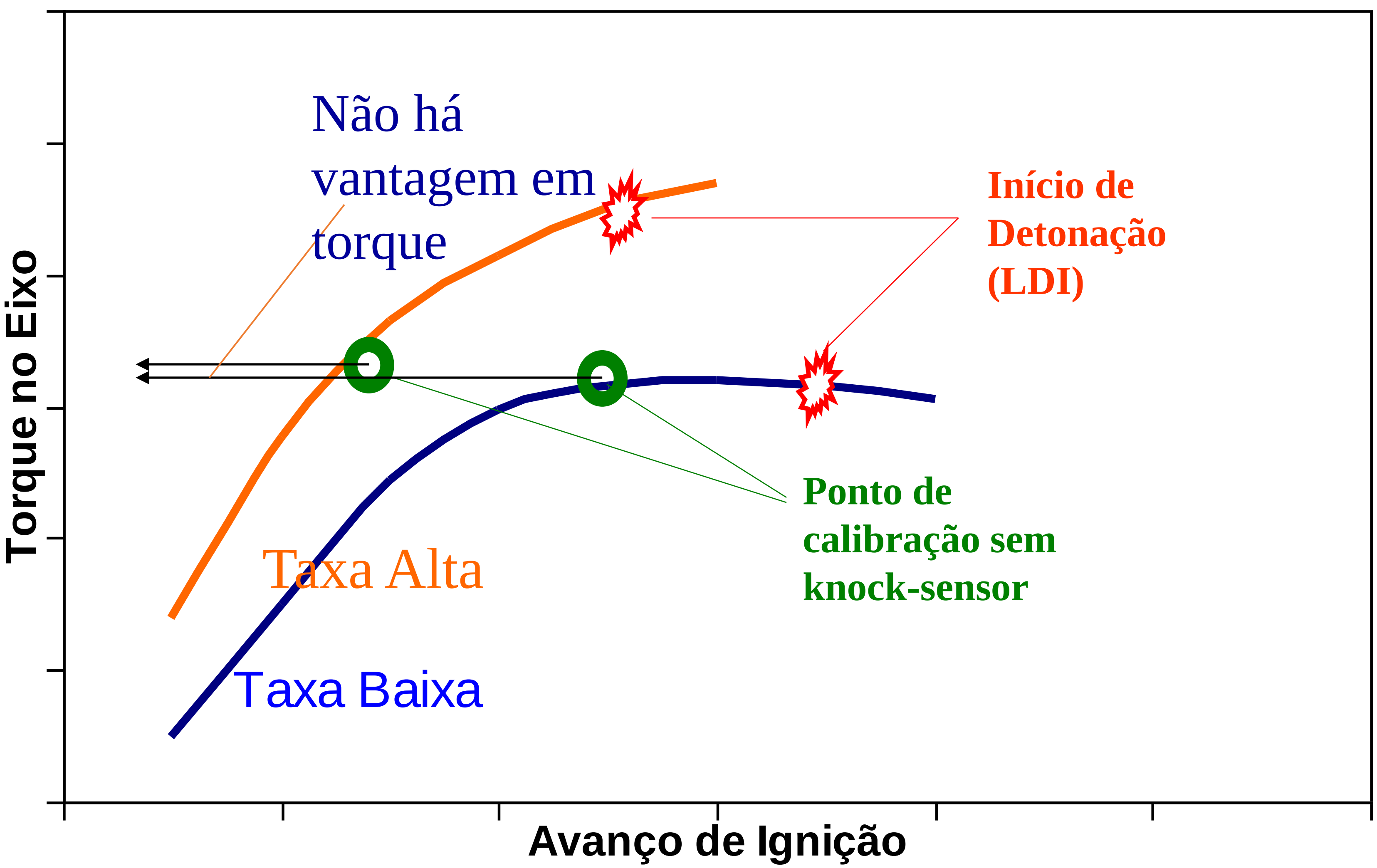


Início de Detonação (LDI) com comb. baixa octanagem

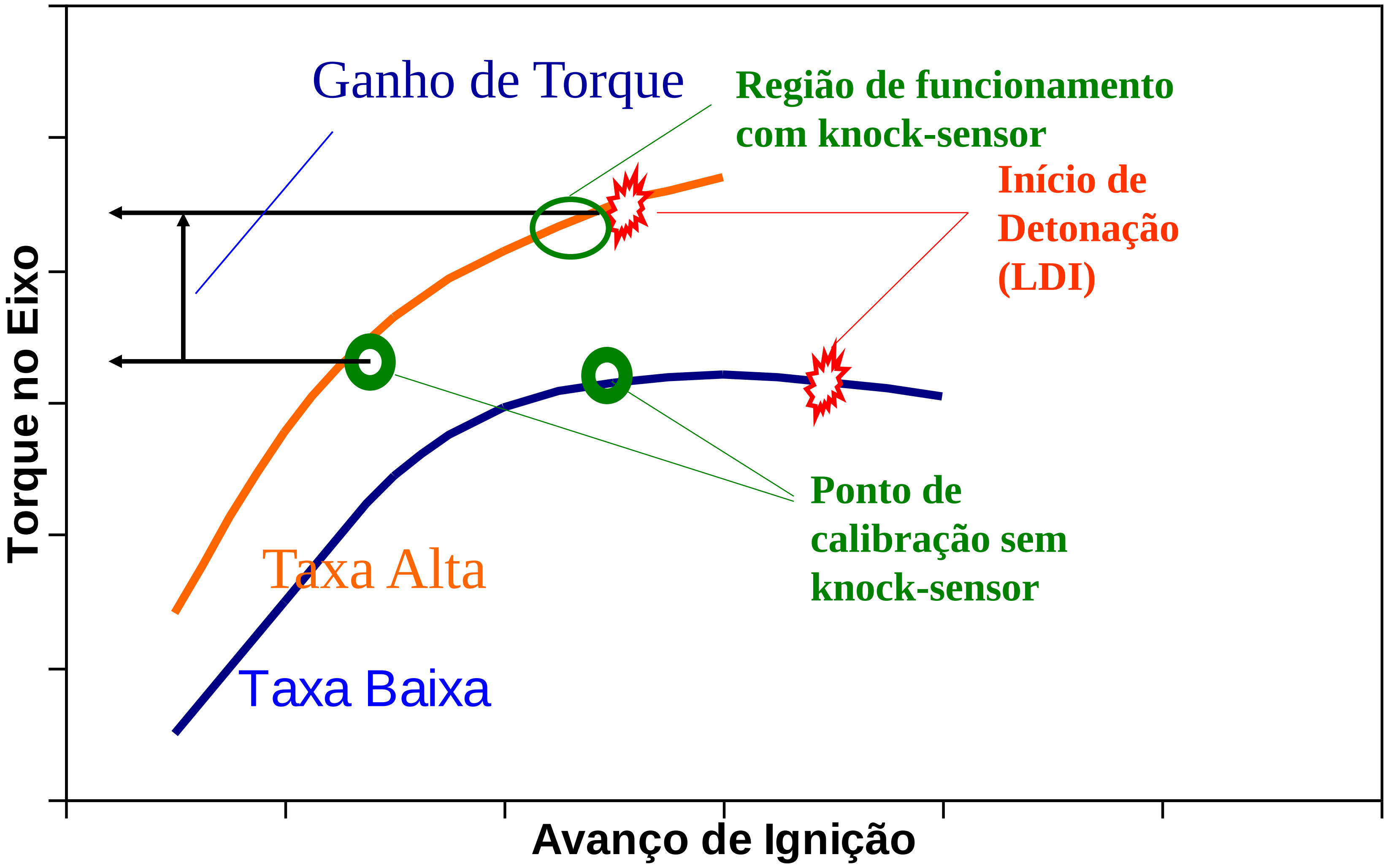
Início de Detonação (LDI) com comb. alta octanagem

Há pouca vantagem em torque

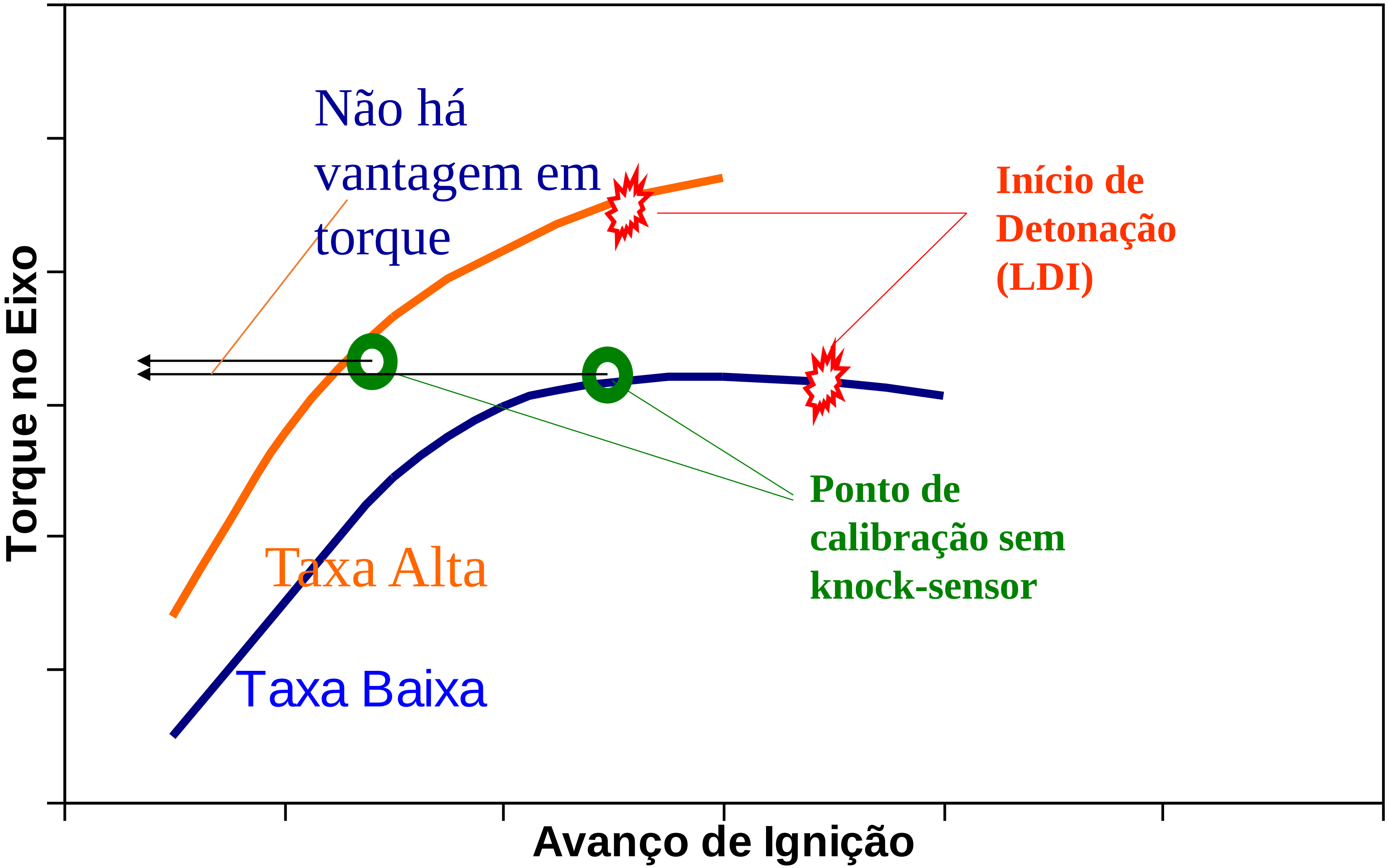
Requisito de Ignição, com RPM=Cte



Requisito de Ignição, com RPM=Cte



Requisito de Ignição, com RPM=Cte

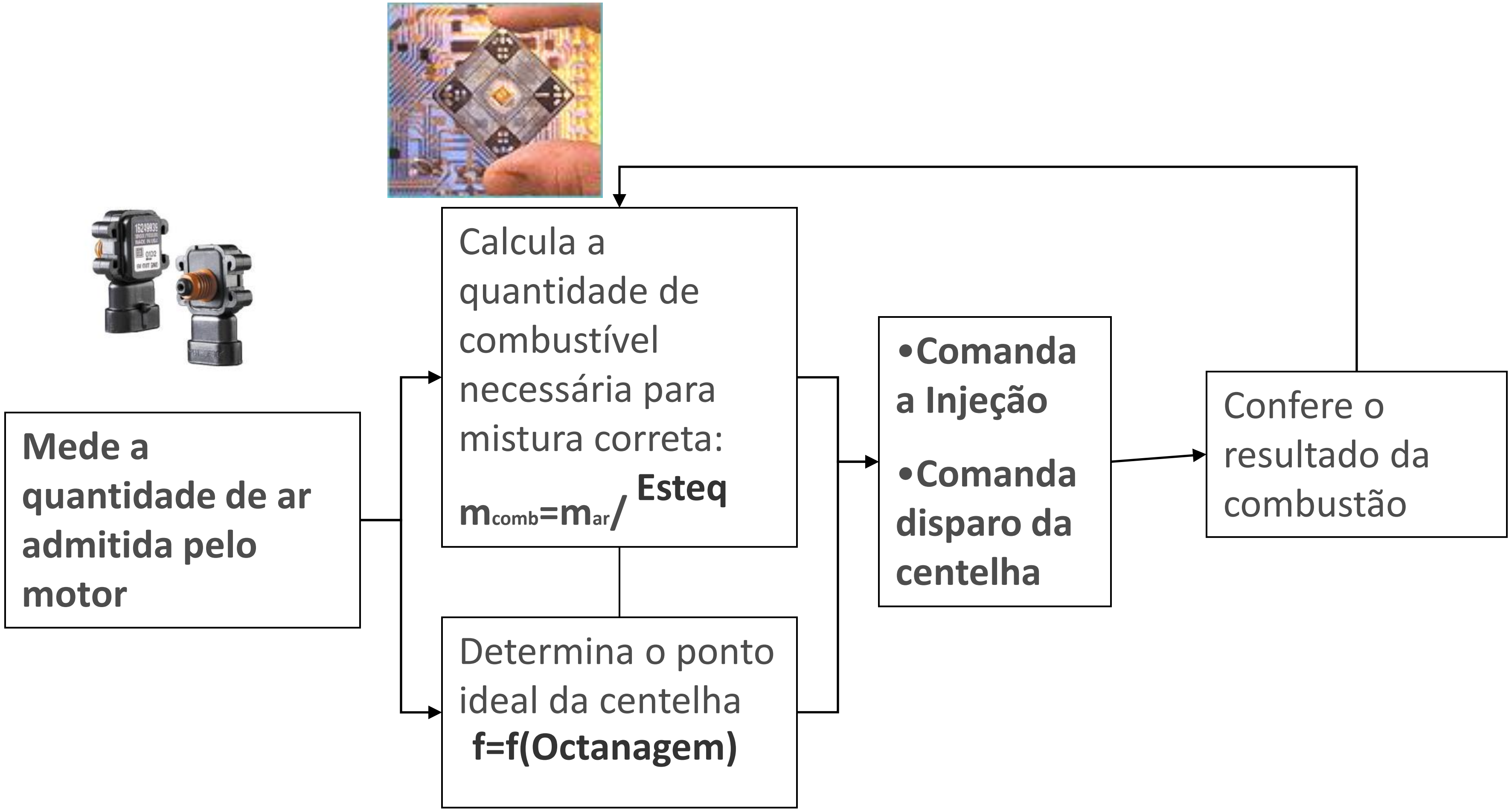


Não há vantagem em torque

Início de Detonação (LDI)

Ponto de calibração sem knock-sensor

Esquema Simplificado do Sistema de Gerenciamento:



Mede a quantidade de ar admitida pelo motor

Calcula a quantidade de combustível necessária para mistura correta:

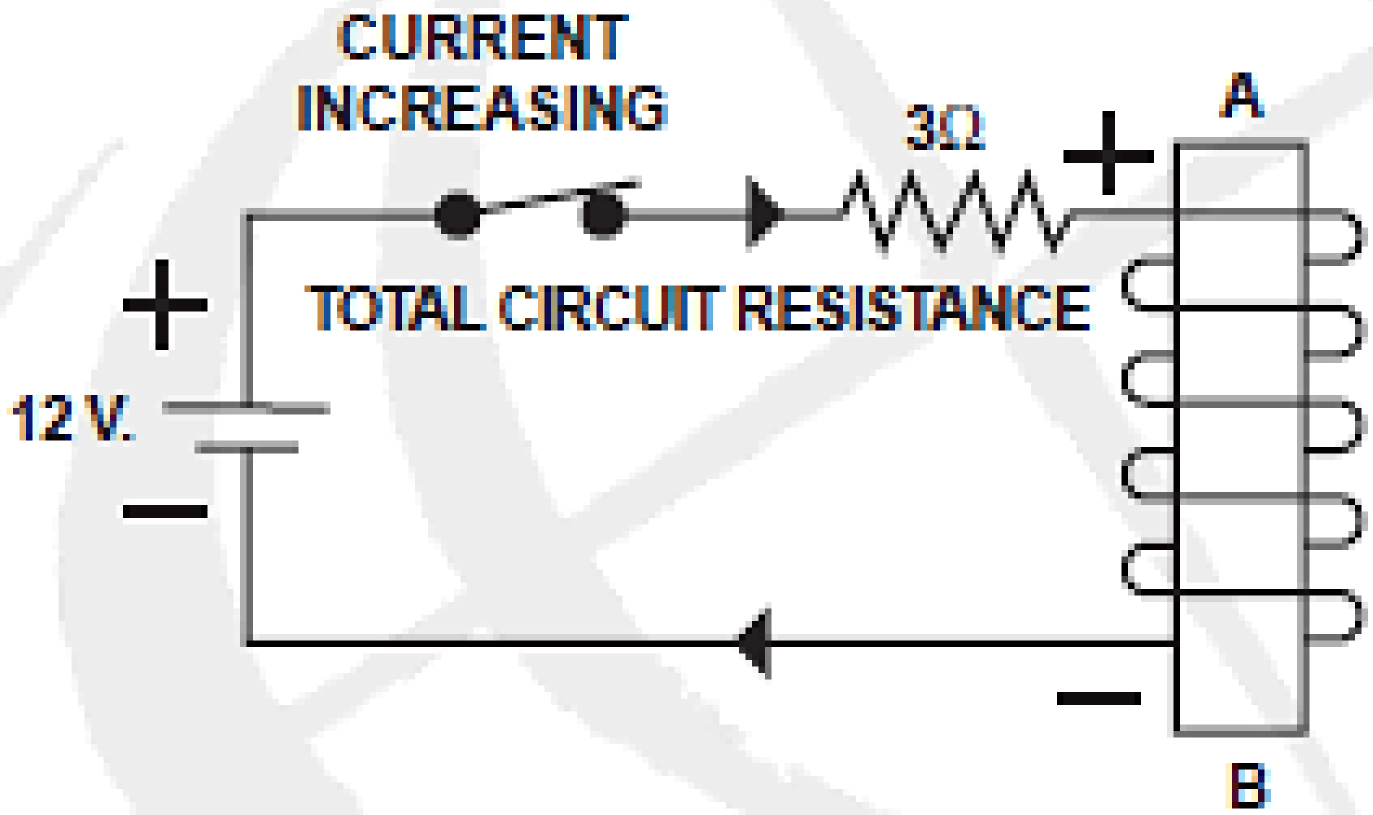
$m_{comb}=m_{ar}/\text{Esteq}$

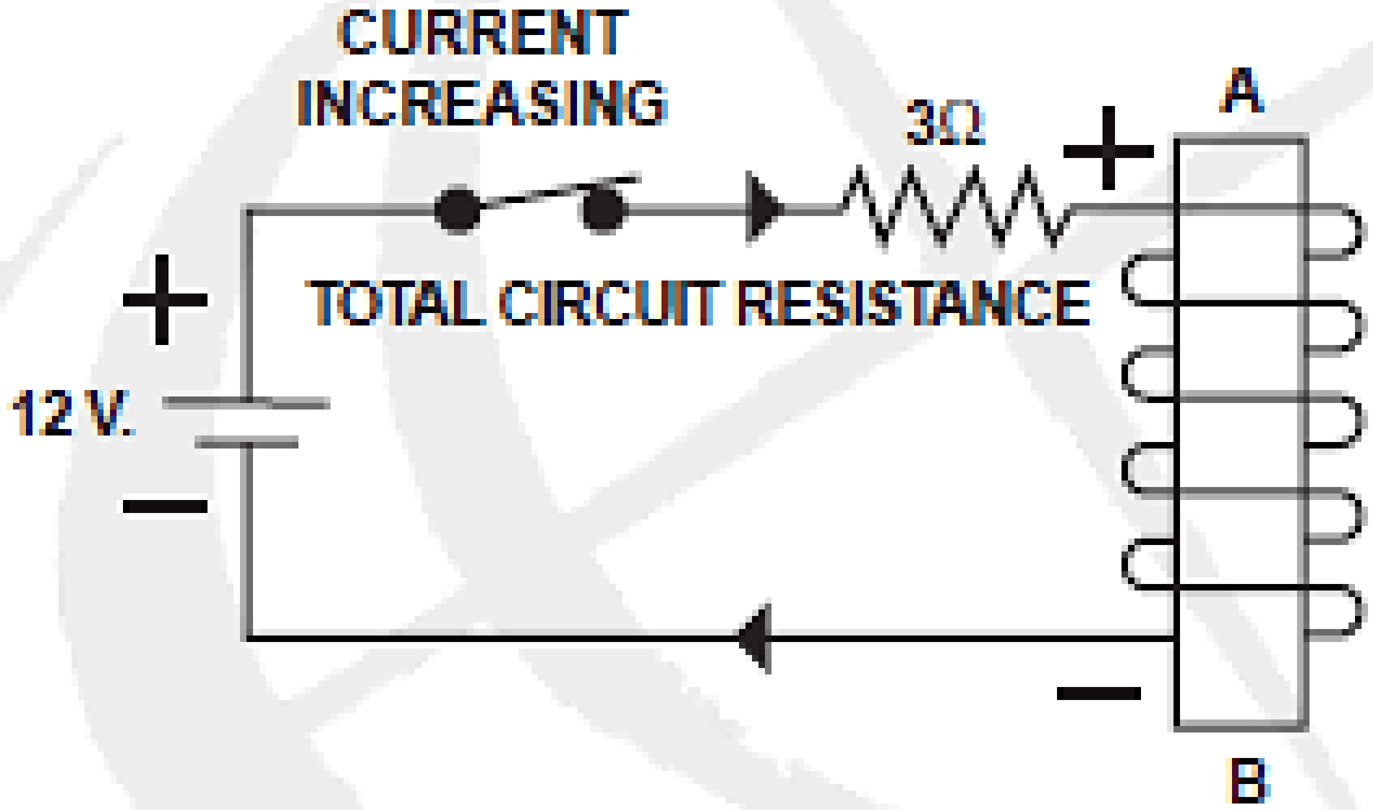
Determina o ponto ideal da centelha

f=f(Octanagem)

- **Comanda a Injeção**
- **Comanda disparo da centelha**

Confere o resultado da combustão


CURRENT
INCREASING
3Ω
A
+
+
TOTAL CIRCUIT RESISTANCE
12 V.
−
−
B


CURRENT
INCREASING
3Ω
A
+
+
TOTAL CIRCUIT RESISTANCE
12 V.
−
−
B

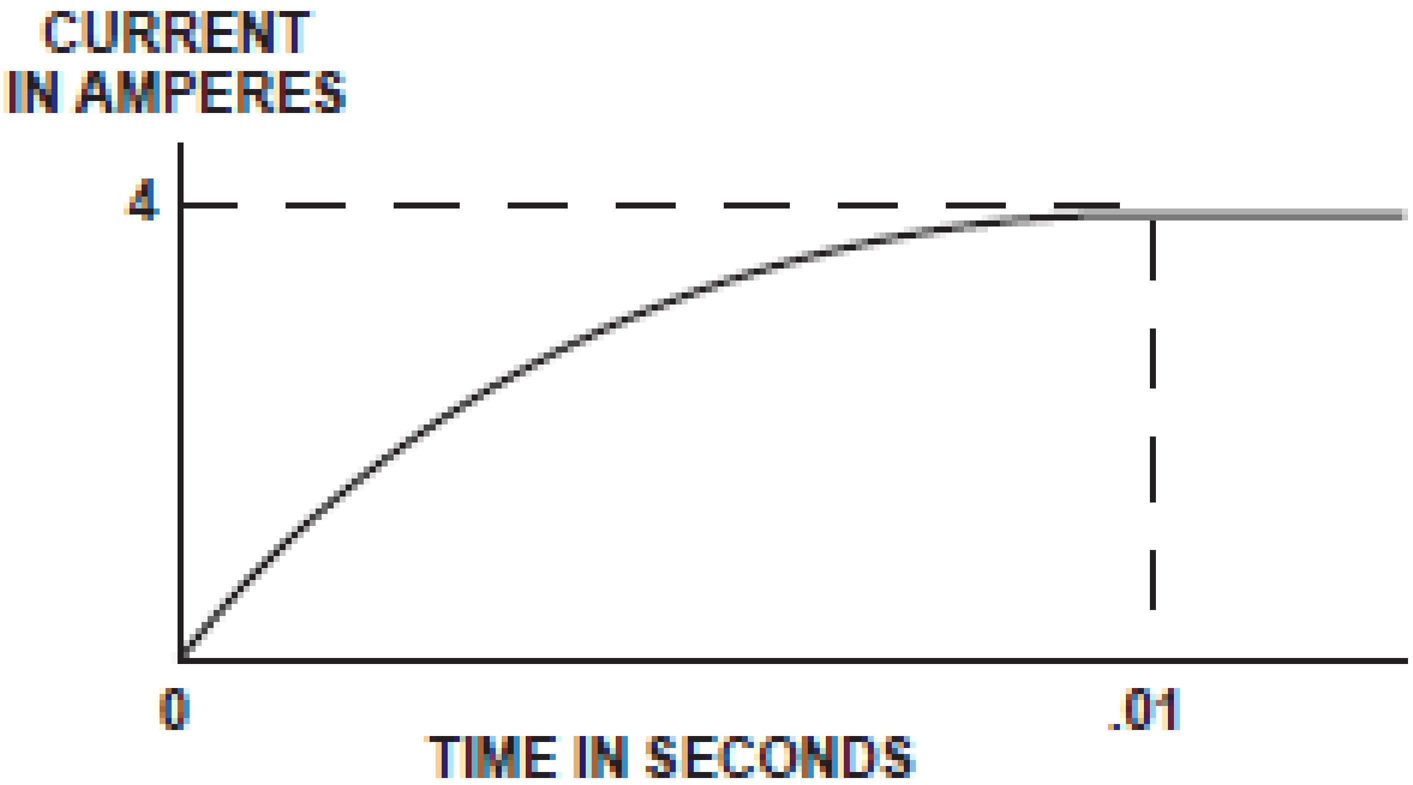
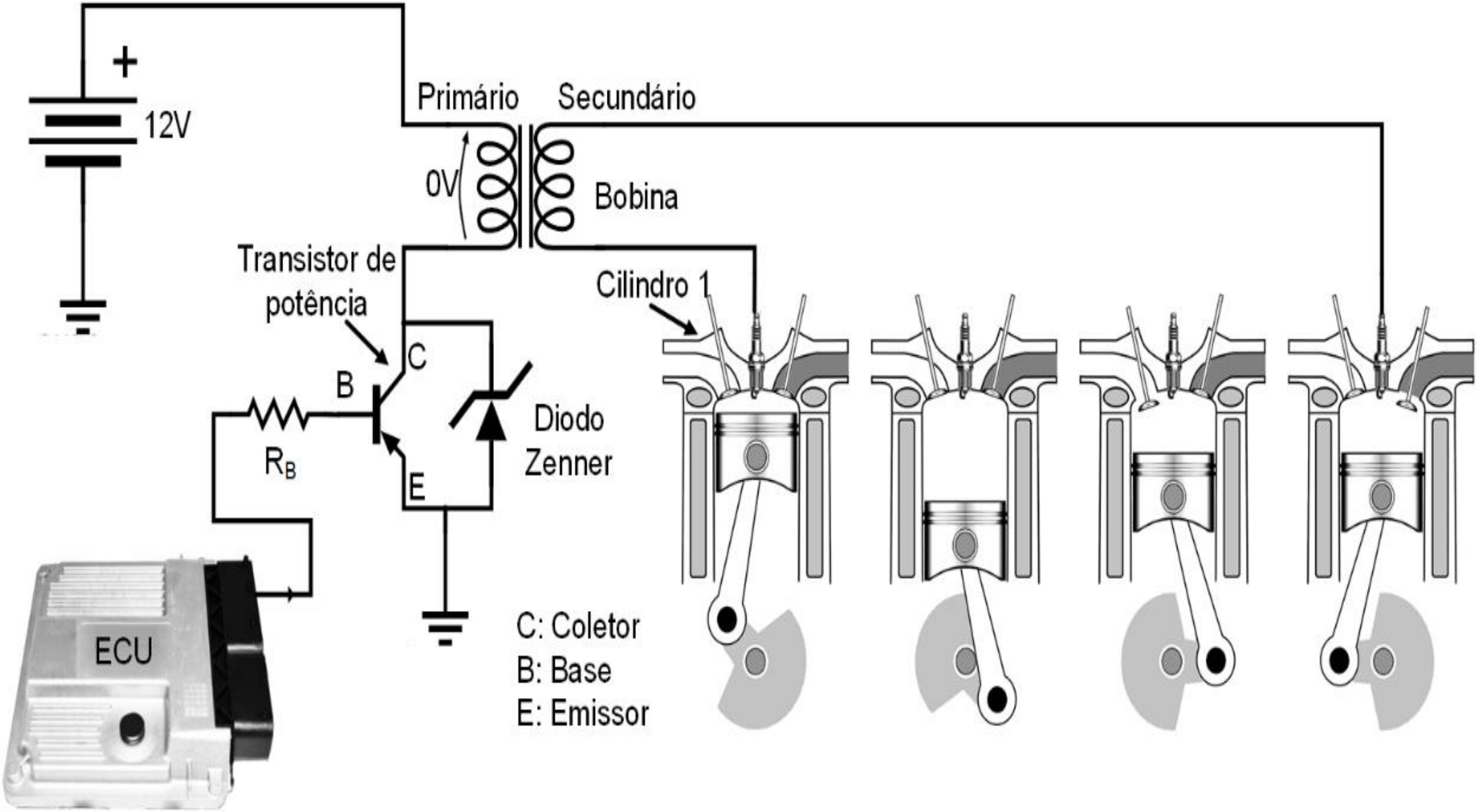
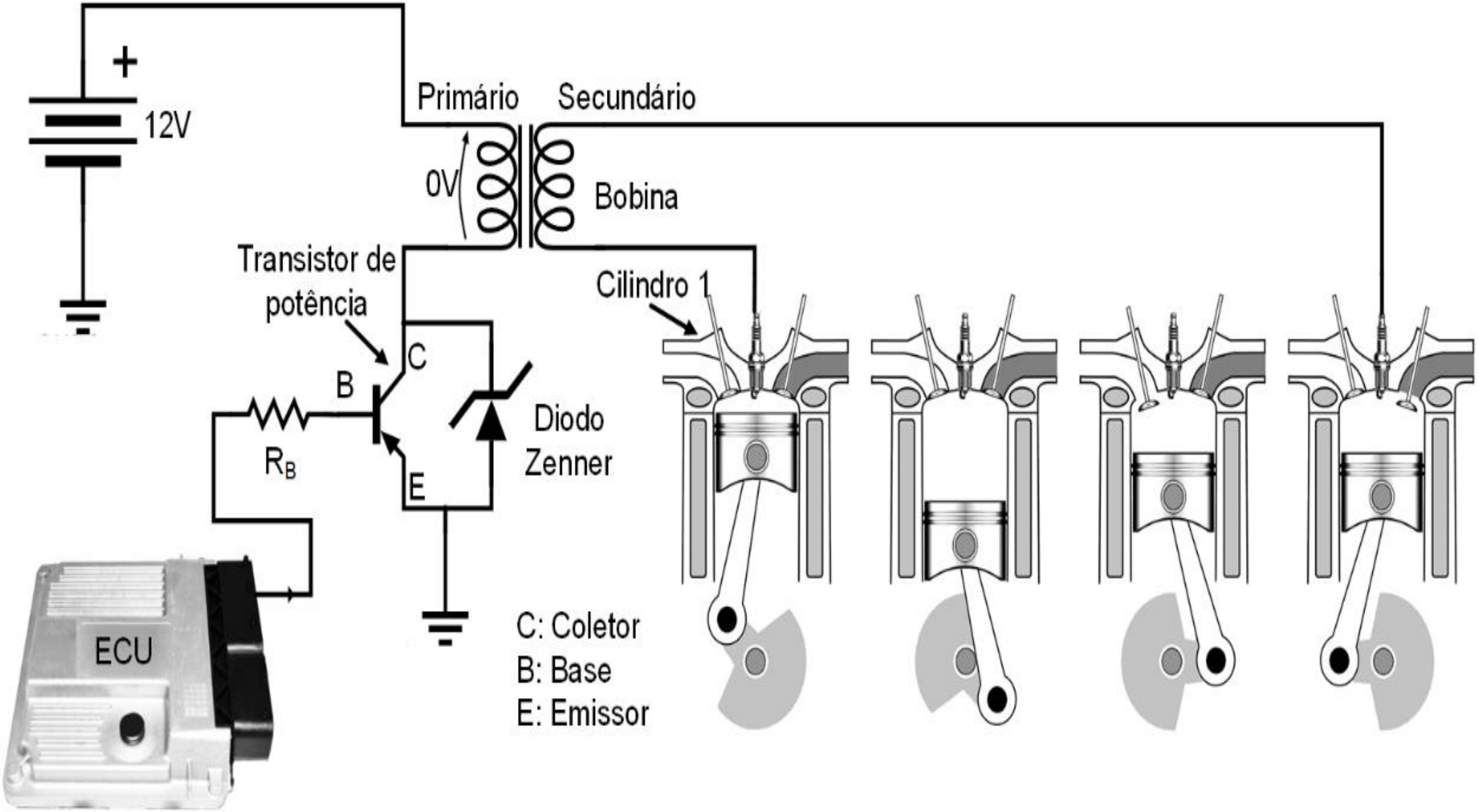
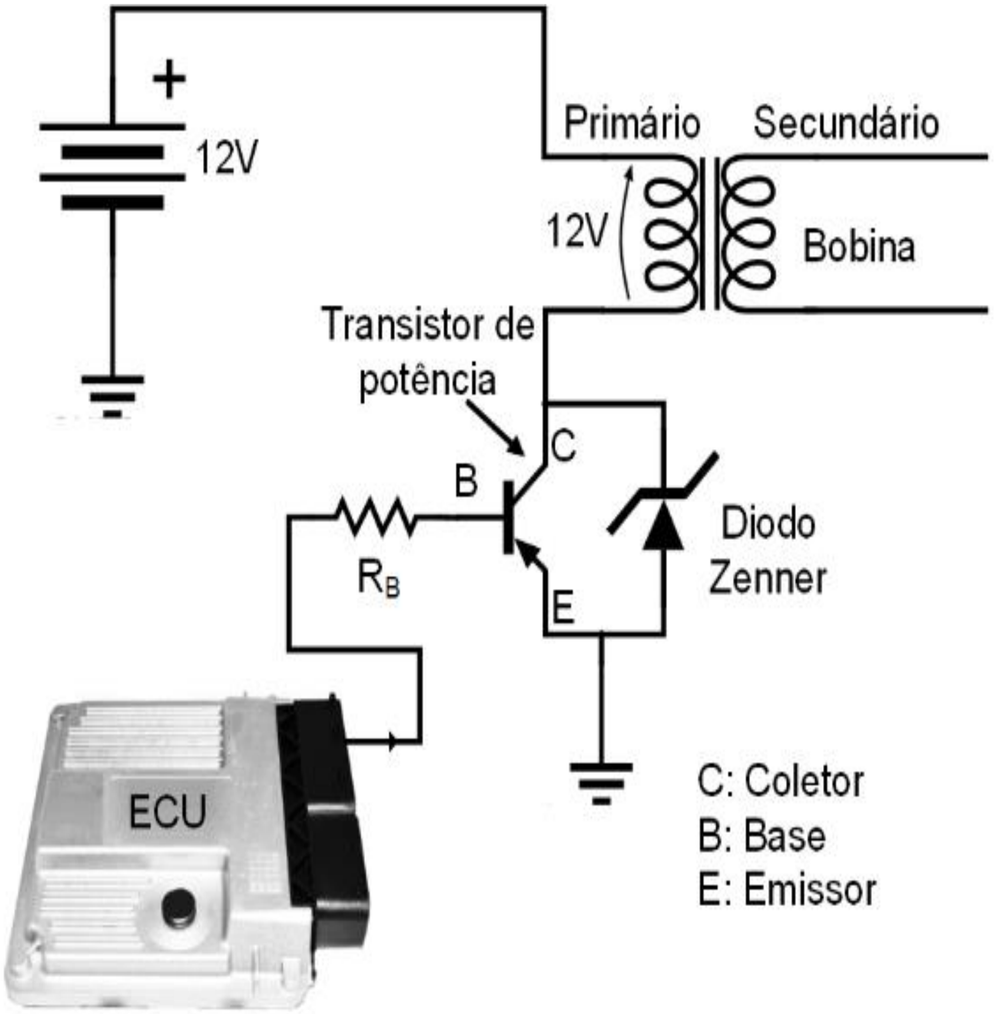


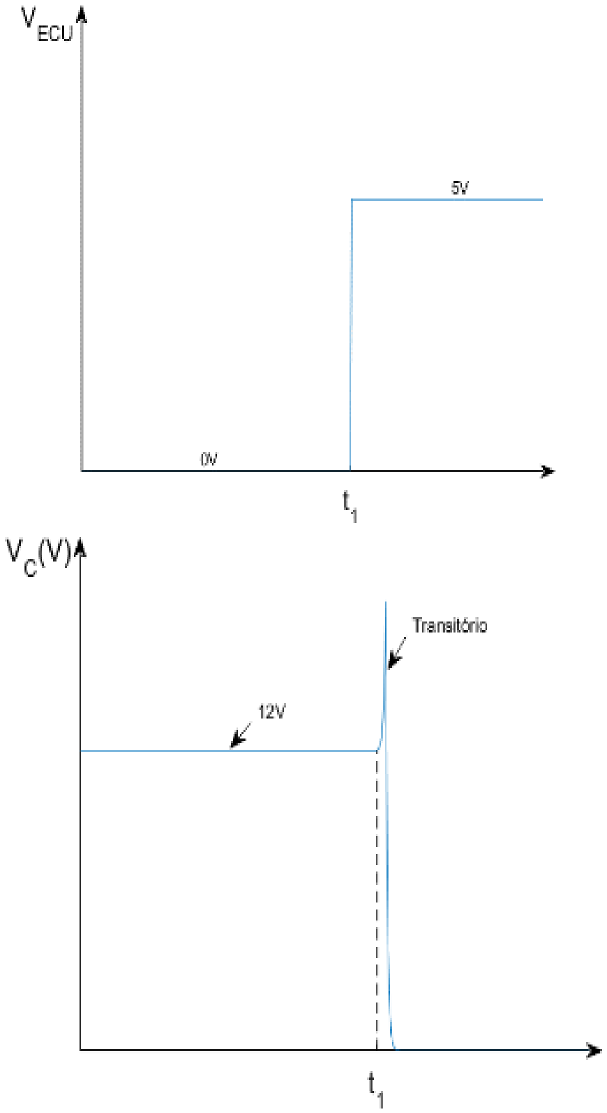
Figure 2-6. Current time lag.

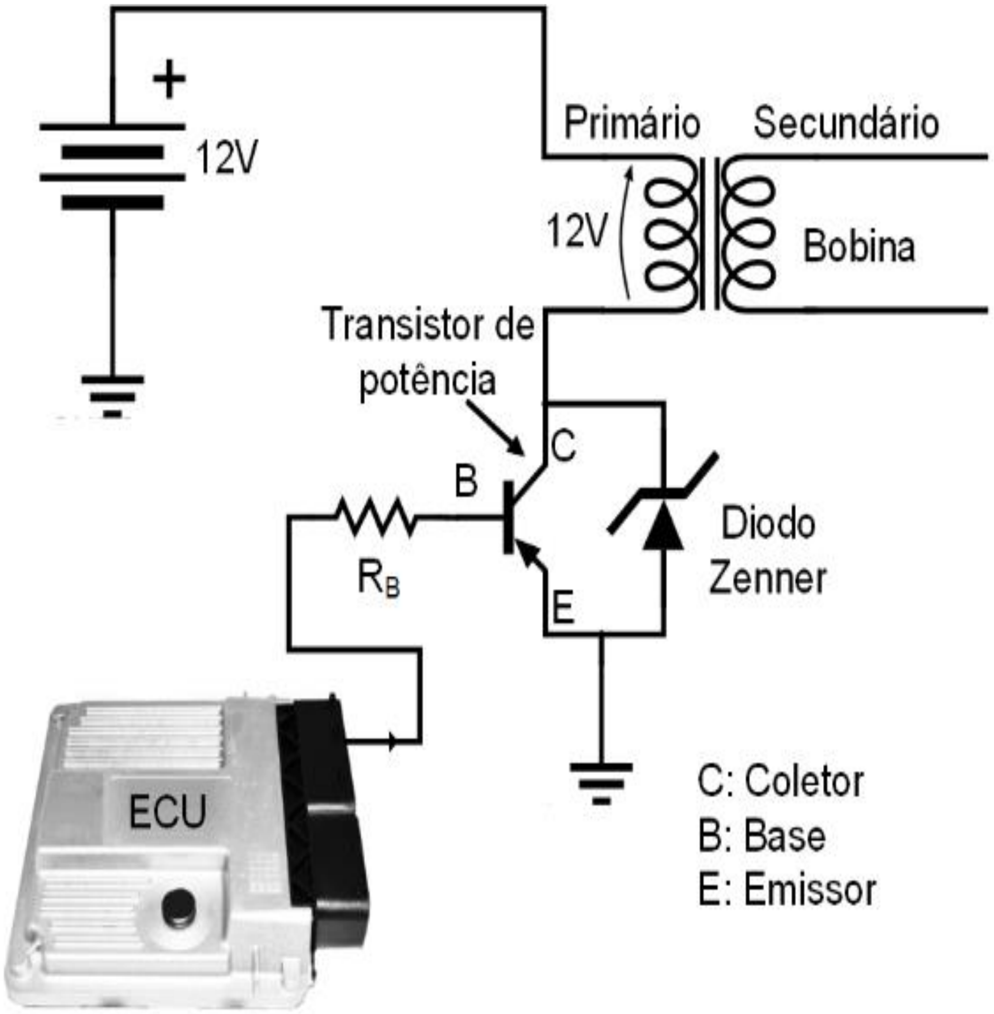

+
12V
Primário
Secundário
0V
Bobina
Transistor de potência
Cilindro 1
C
B
E
R_B
Diodo Zenner
ECU
C: Coletor
B: Base
E: Emissor


+
12V
Primário
Secundário
0V
Bobina
Transistor de potência
Cilindro 1
C
B
E
R_B
Diodo Zenner
ECU

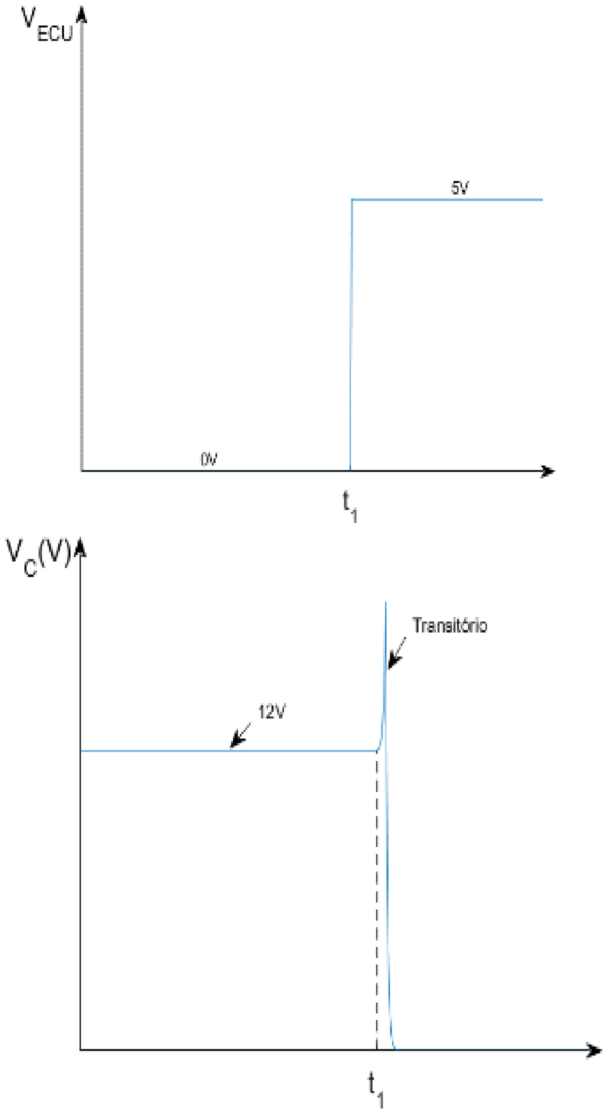
C: Coletor
B: Base
E: Emissor

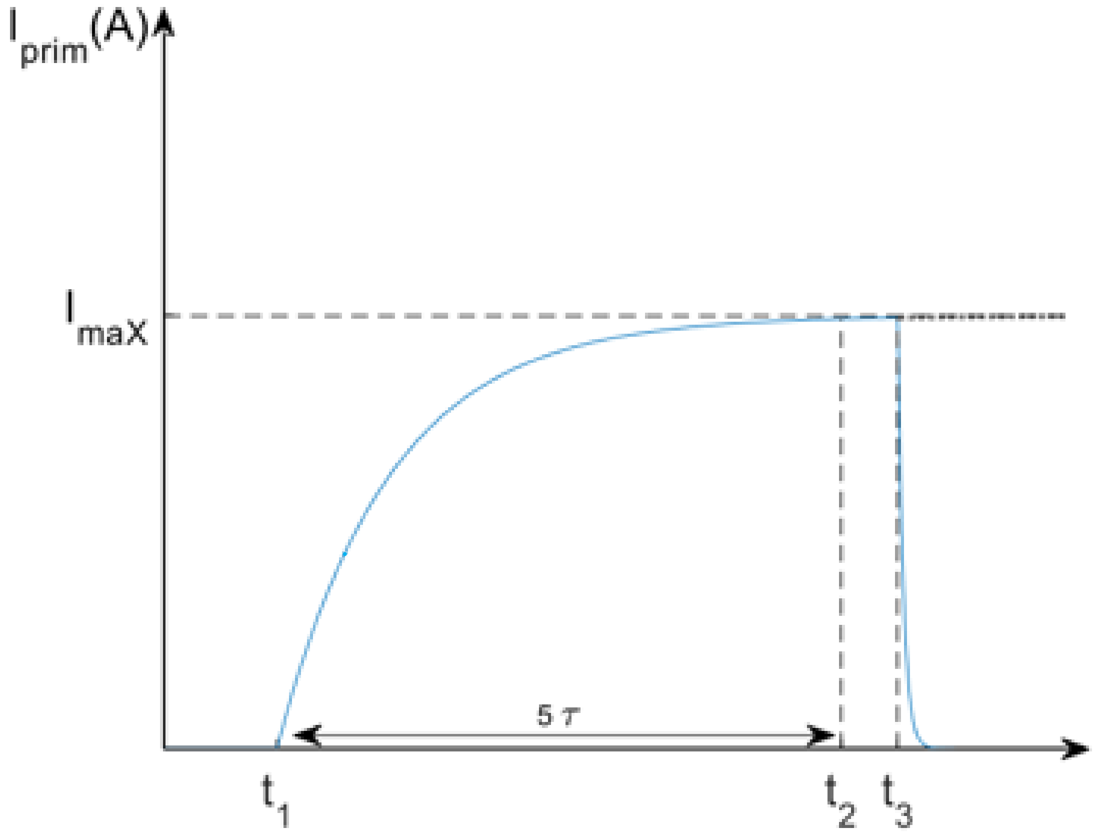

+
12V
Primário
Secundário
12V
Bobina
Transistor de potência
C
B
E
R$_B$
Diodo Zenner
ECU
C: Coletor
B: Base
E: Emissor


V$_{ECU}$
5V
0V
t$_1$
V$_C$(V)
Transitório
12V
t$_1$


+
12V
Primário
Secundário
12V
Bobina
Transistor de potência
C
B
E
R_B
Diodo Zenner
ECU

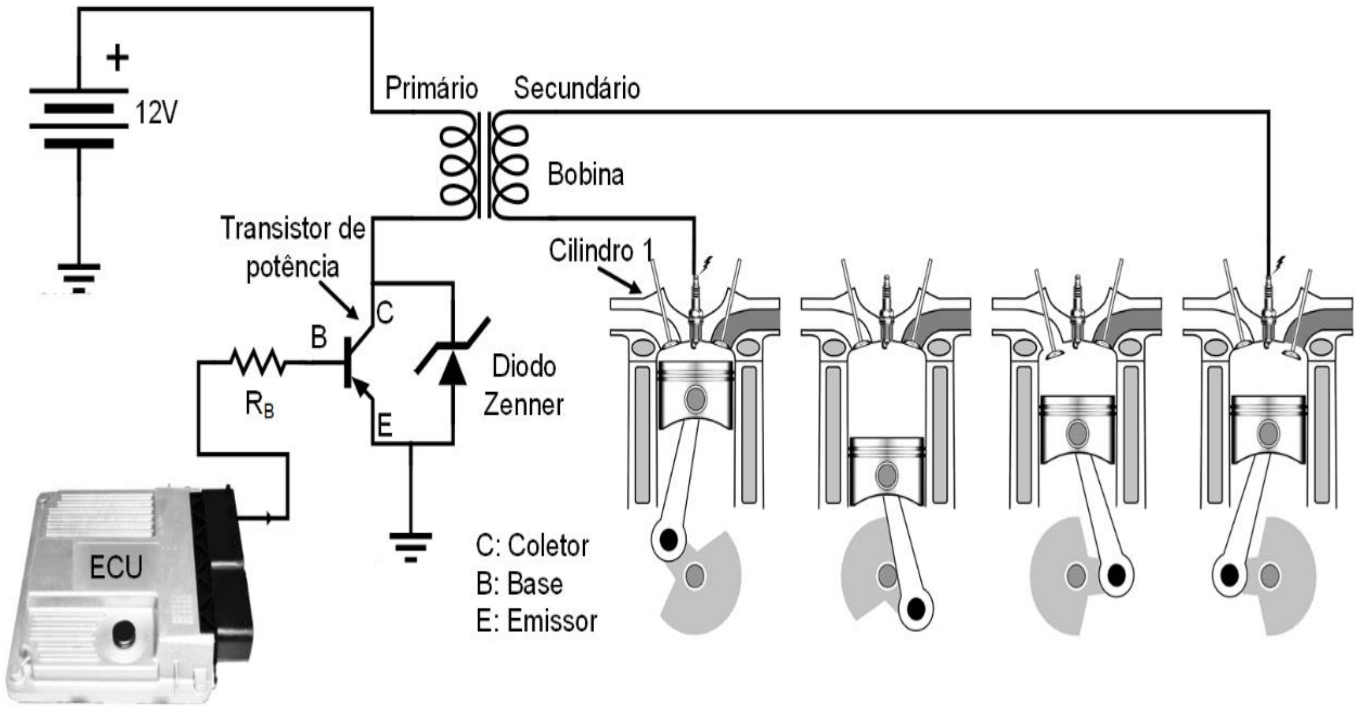
C: Coletor
B: Base
E: Emissor

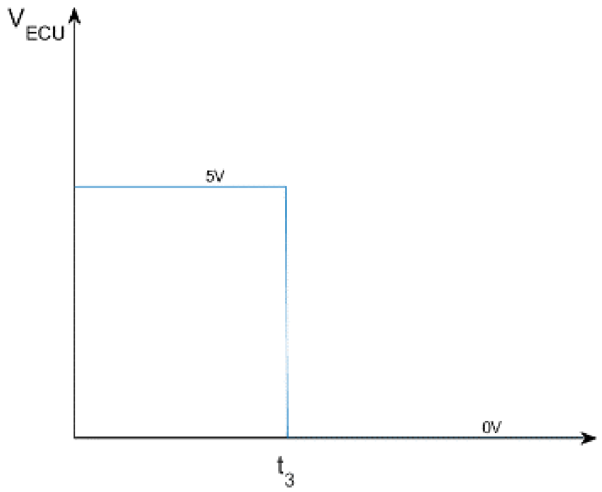


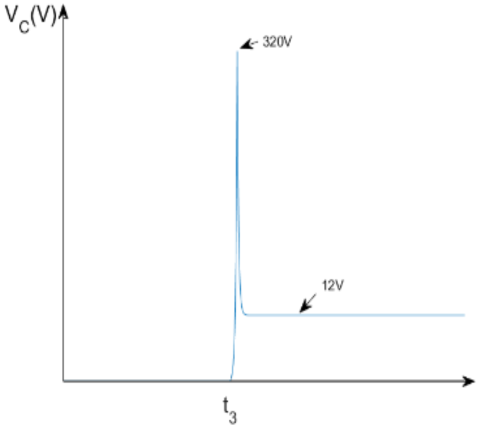


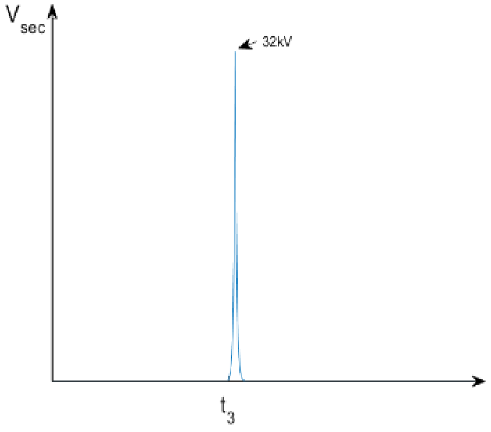
$$I_{bobina}(t) = I_c(t) = I_{max} \cdot \left(1 - e^{\frac{-(t-t_1)}{\tau}}\right)$$

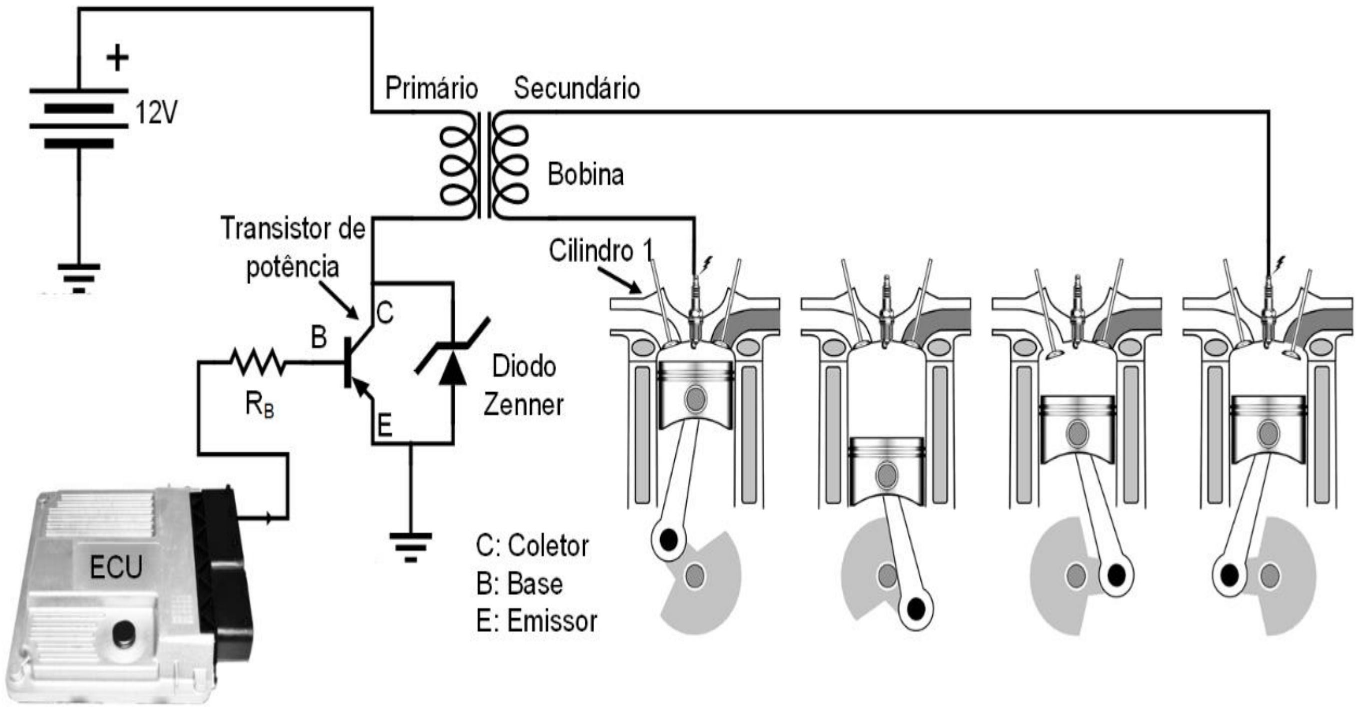
$$E_{bobina} = \frac{1}{2} \cdot L \cdot (I_{bobina})^2 = k \cdot (I_{bobina})^2$$

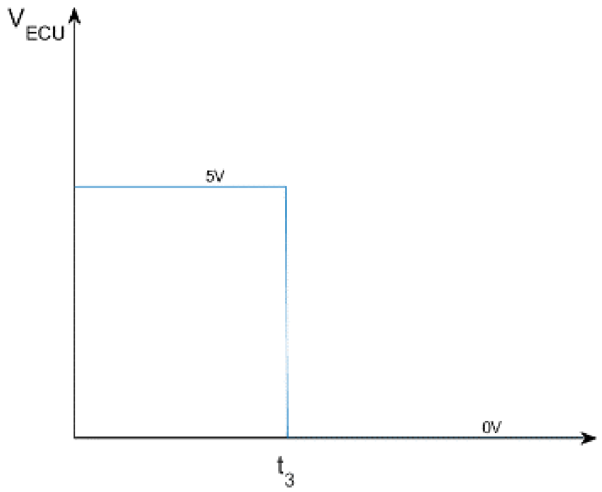

+
12V
Primário
Secundário
Bobina
Transistor de potência
Cilindro 1
C
B
E
R_B
Diodo Zenner
ECU
C: Coletor
B: Base
E: Emissor

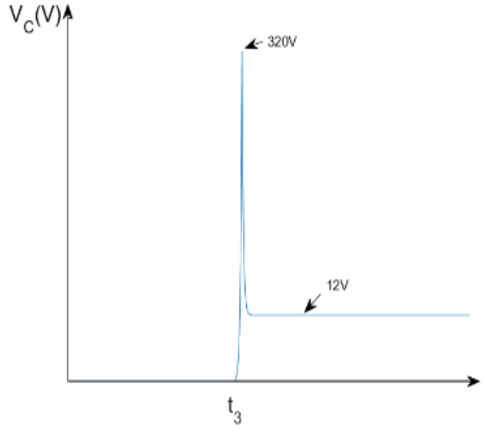

V_{ECU}
5V
0V
t_3

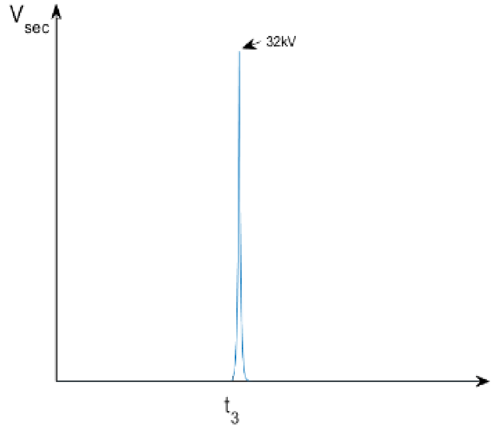

V_C(V)
320V
12V
t_3


V_{sec}
32kV
t_3


+
12V
Primário
Secundário
Bobina
Transistor de potência
Cilindro 1
C
B
E
R_B
Diodo Zenner
ECU
C: Coletor
B: Base
E: Emissor


V_{ECU}
5V
0V
t_3


$V_C(V)$
320V
12V
t_3


V_{sec}
32kV
t_3

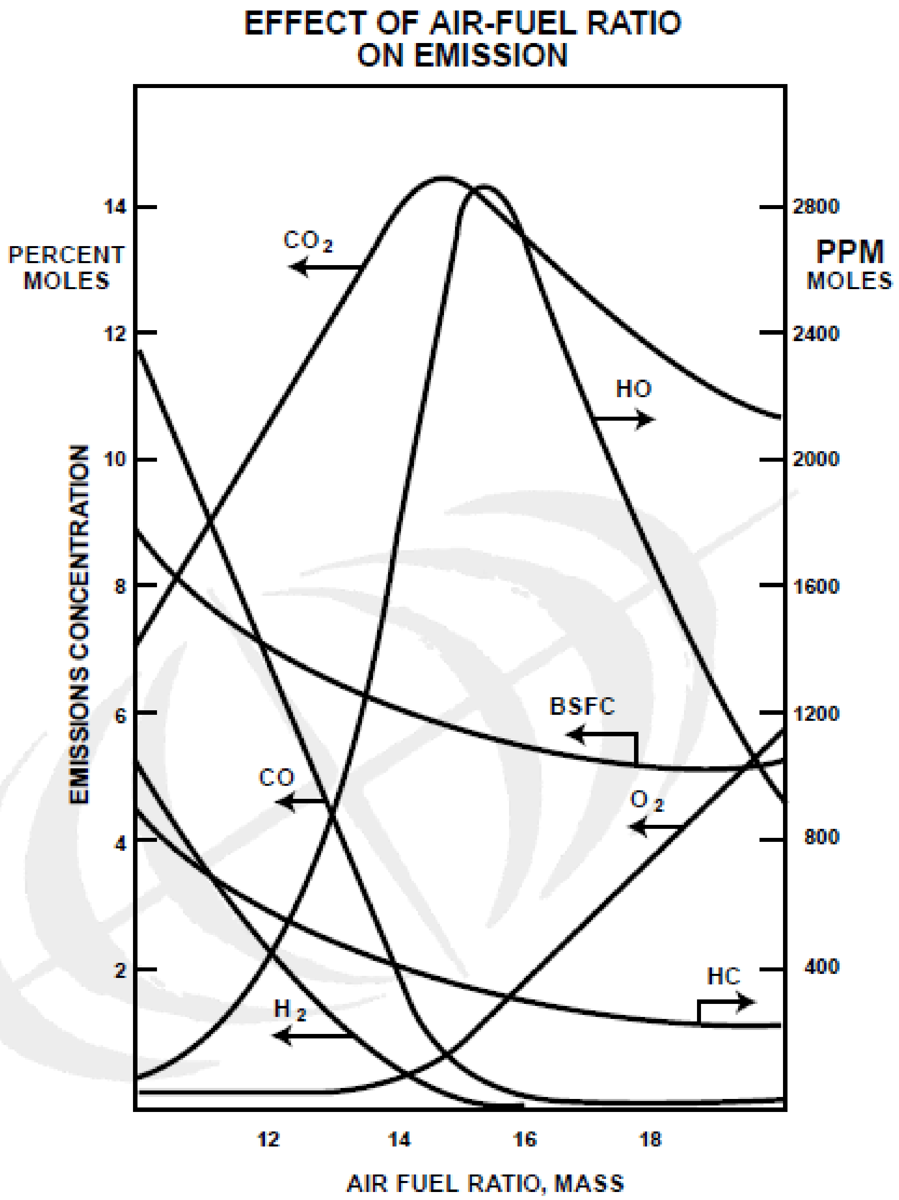


Figure 2-2. Engine out emissions vs. air/fuel ratio.

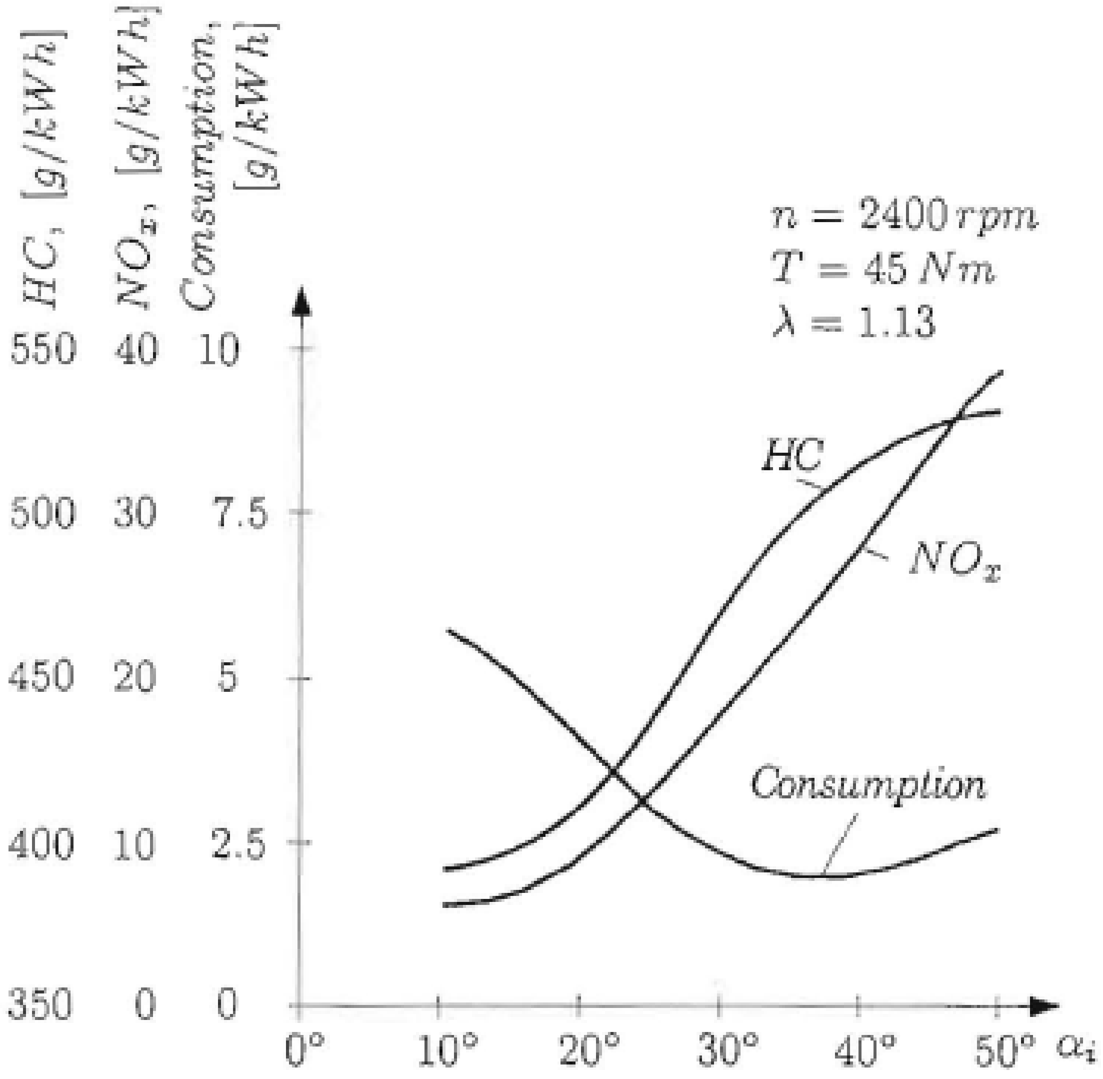


Figure 3.22 Fuel consumption and emission levels over ignition angle α_i.

Parameter	Compression Pressure	Spark Plug Gap	A/F Ratio	Ignition Polarity	Electrode Shape	Operating Temperature
Higher Required Secondary Voltage	High	Wide	Lean or Rich	Positive	Rounded Massive	Cold
Lower Required Secondary Voltage	Low	Narrow	Stoichiometric	Negative	Sharp	Hot

Table 2-1 — System Parameters

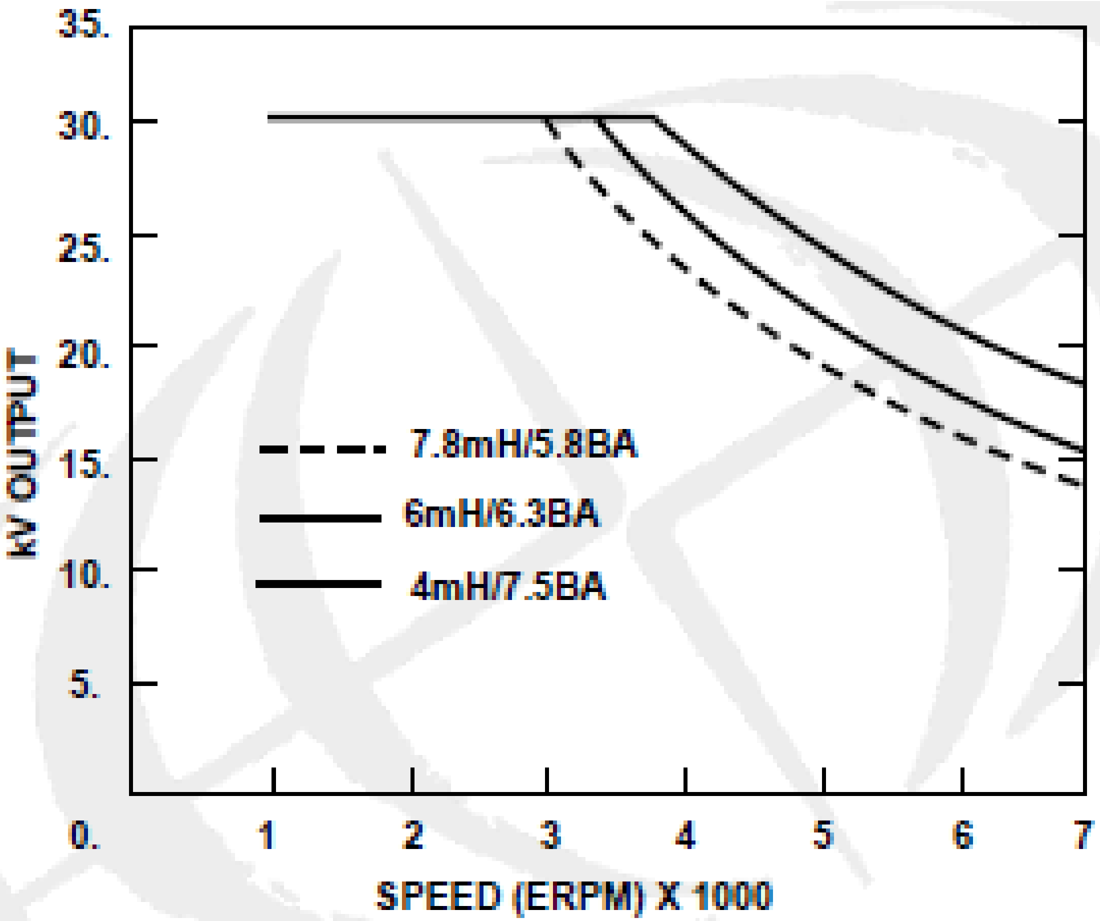


Figure 2-9. Available kV output vs. ERPM.

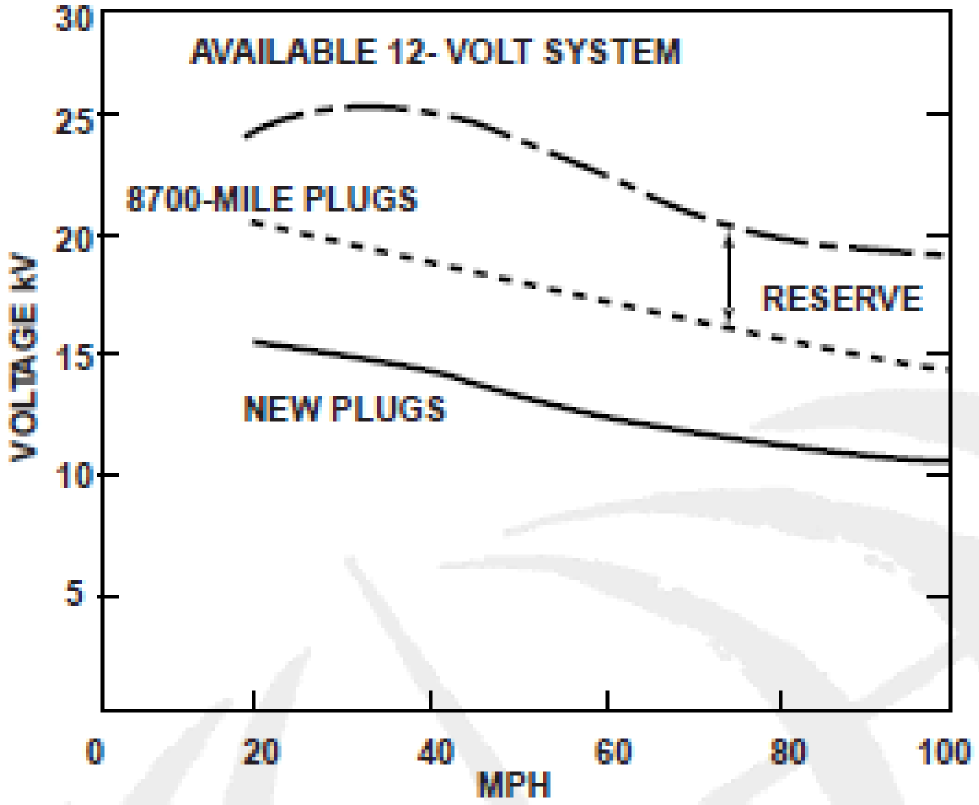


Figure 2-10. Ignition performance on a 10:1 compression ratio engine.

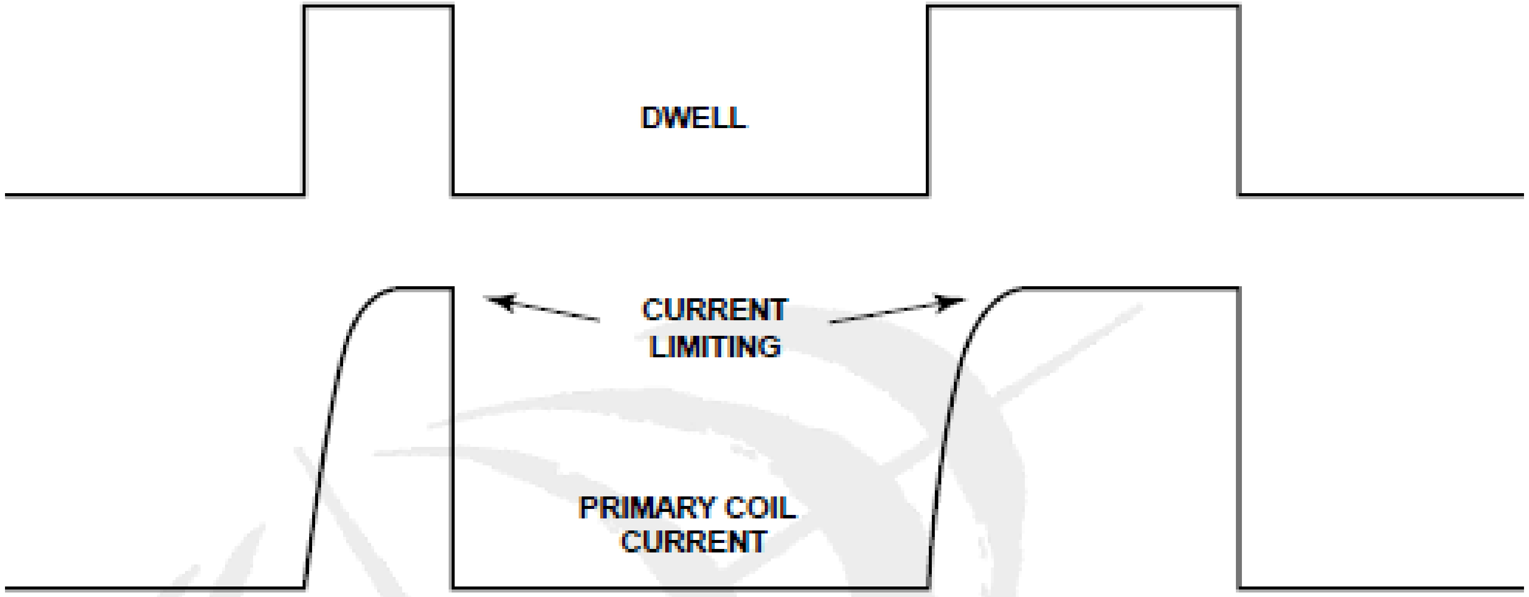
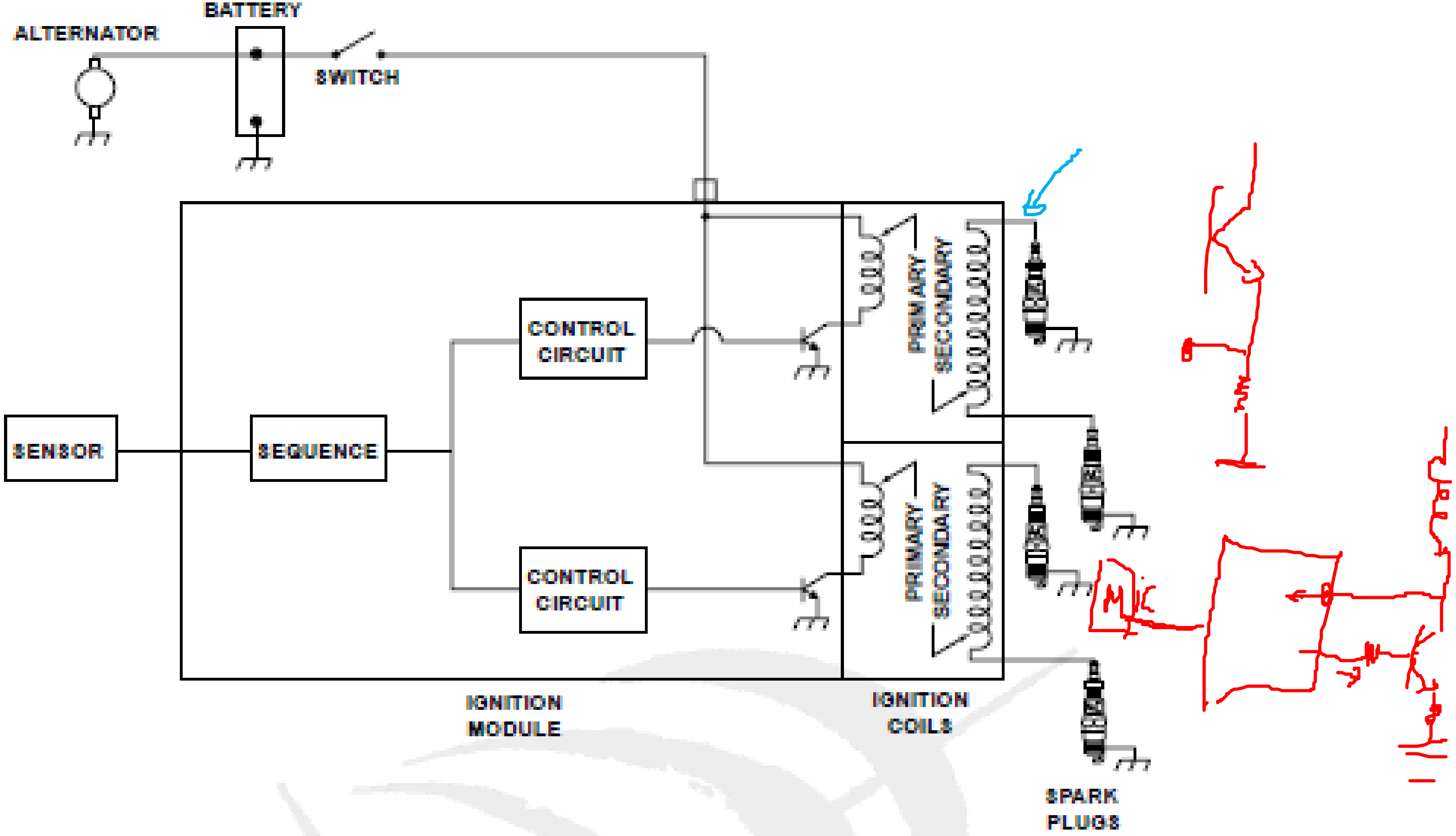
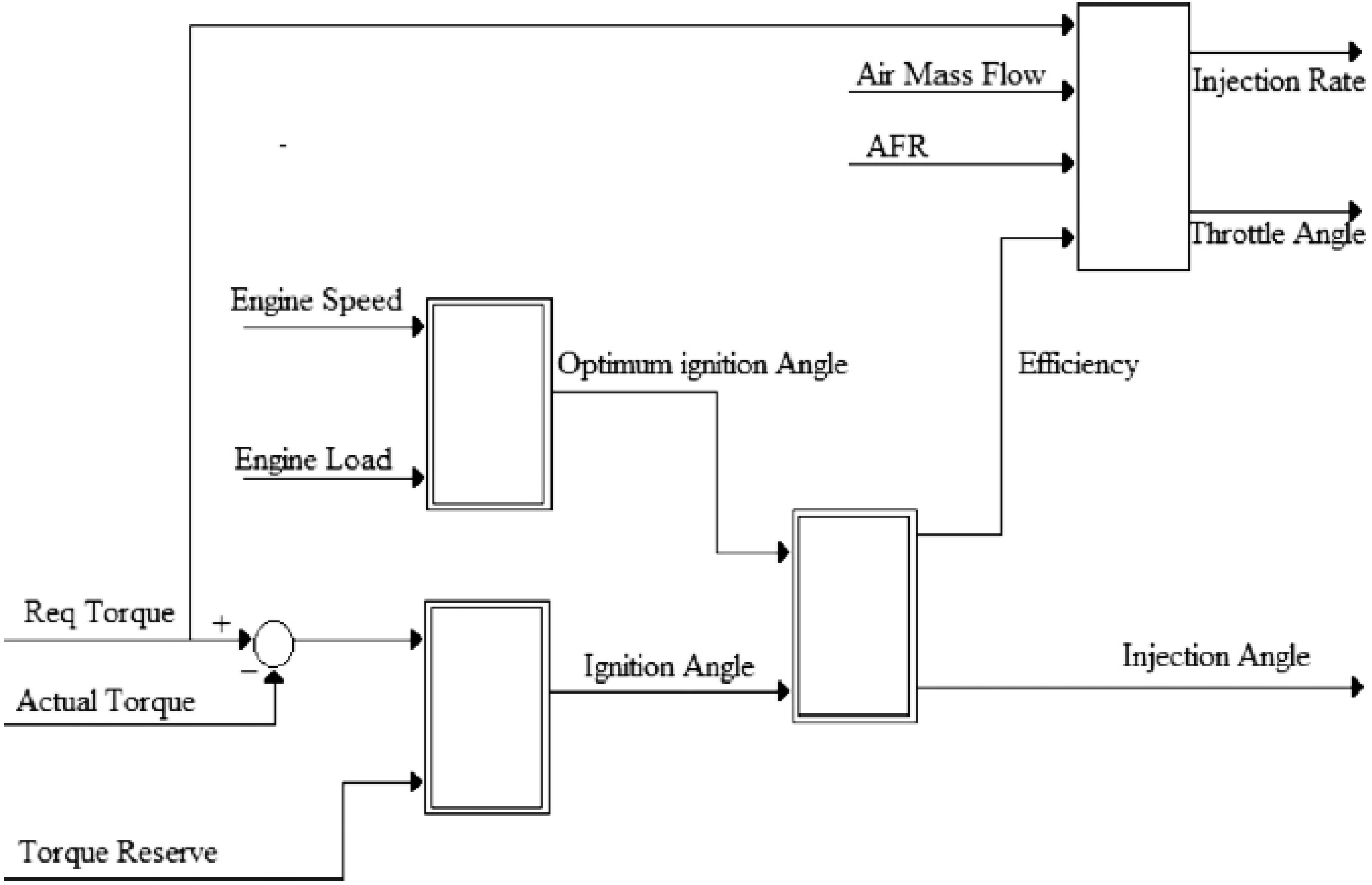
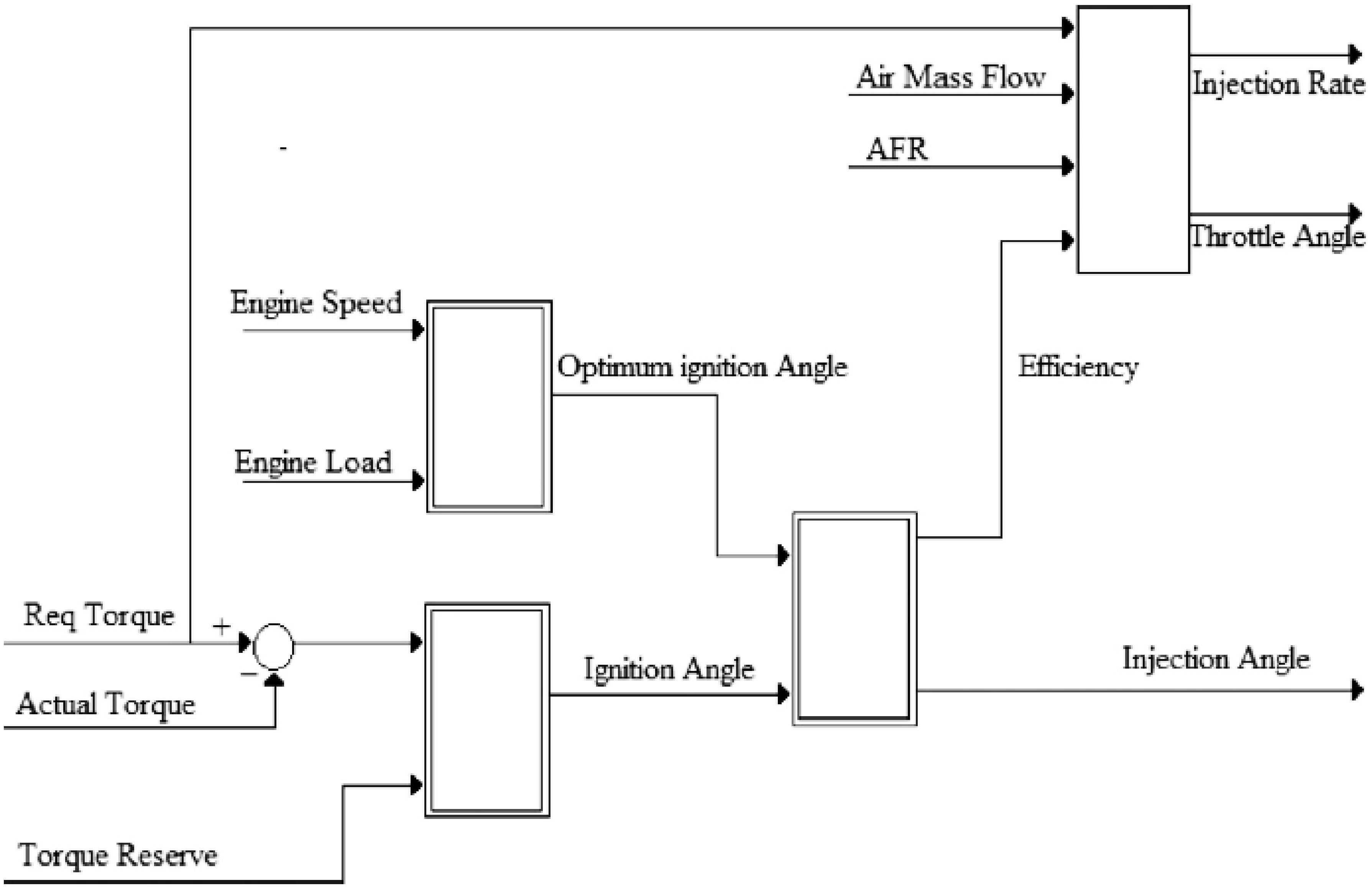

DWELL
CURRENT LIMITING
PRIMARY COIL CURRENT

Figure 2-11. Coil Primary Current Controlled By Current Limiting Circuitry.


ALTERNATOR
BATTERY
SWITCH
SENSOR
SEQUENCE
CONTROL CIRCUIT
CONTROL CIRCUIT
PRIMARY
SECONDARY
PRIMARY
SECONDARY
IGNITION MODULE
IGNITION COILS
SPARK PLUGS


Air Mass Flow
AFR
Injection Rate
Throttle Angle
Engine Speed
Engine Load
Optimum ignition Angle
Efficiency
Req Torque
+
−
Actual Torque
Ignition Angle
Injection Angle
Torque Reserve


Air Mass Flow
AFR
Injection Rate
Throttle Angle
Engine Speed
Engine Load
Optimum ignition Angle
Efficiency
Req Torque
+
−
Actual Torque
Ignition Angle
Injection Angle
Torque Reserve

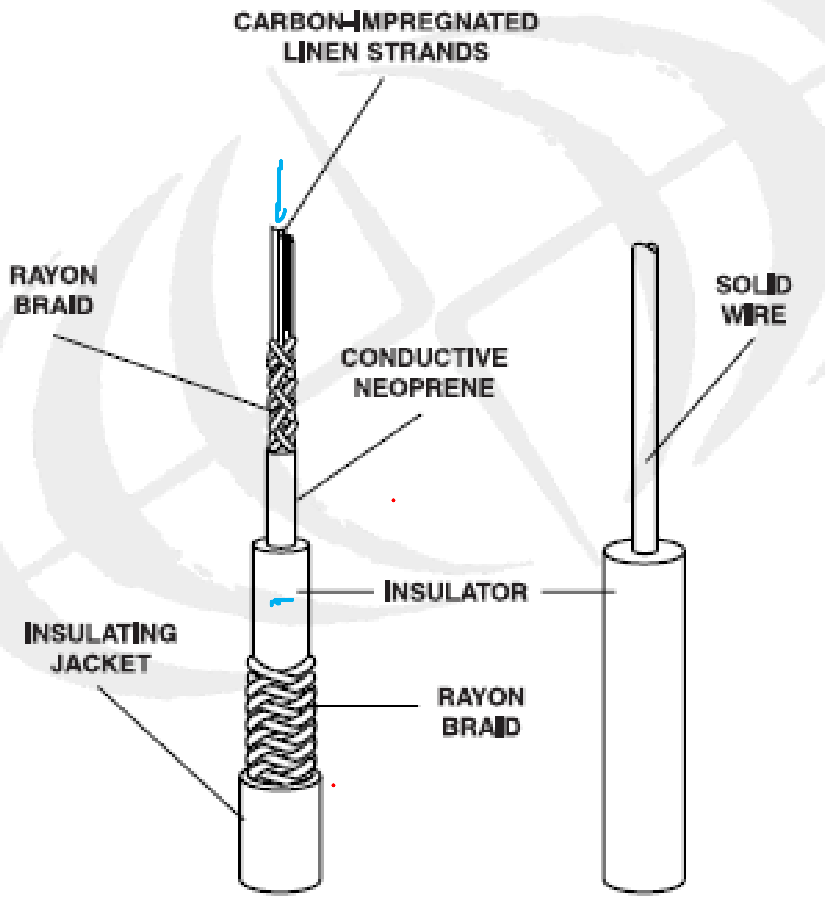

CARBON-IMPREGNATED LINEN STRANDS
RAYON BRAID
CONDUCTIVE NEOPRENE
SOLID WIRE
INSULATOR
INSULATING JACKET
RAYON BRAID

Figure 2-14. TVRS cable and solid conductor cable.

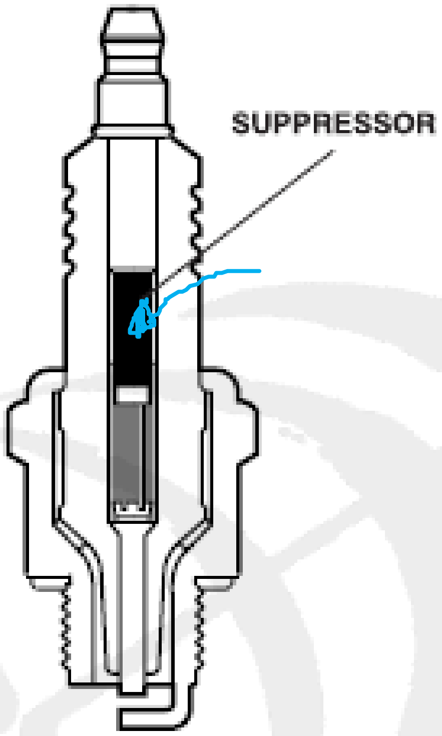

SUPPRESSOR

Figure 2-15. A one-piece integral suppressor reduces RF interference.

4 Ciclos

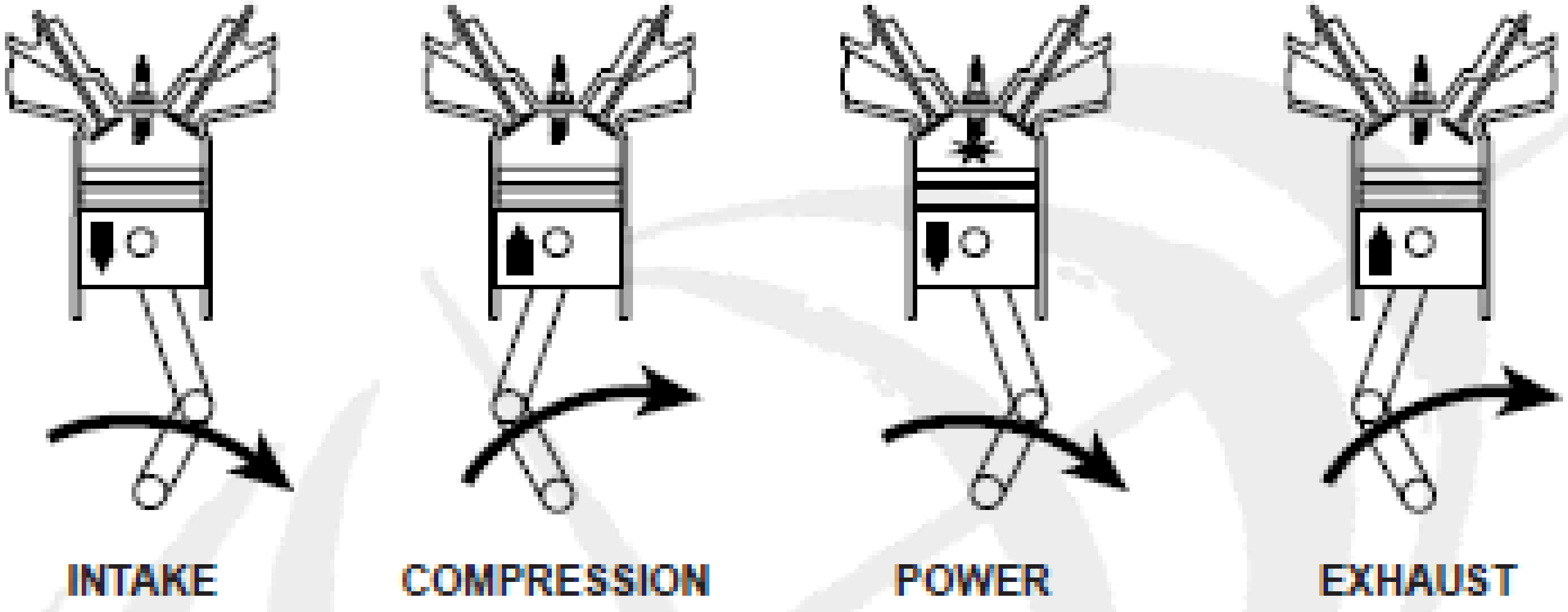

INTAKE
COMPRESSION
POWER
EXHAUST

Figure 2-15. Four Stroke Combustion Process.

3.5.2.2 High Value Ignition Performance

Measurement Description	Typical Value	
Energy (mJ)	70	#
Peak secondary current (mA)	74	#
Secondary voltage available (kV)	32.0	*
Spark duration (mS)	2.6	#
Secondary resistance (Ohm)	5800	
Primary resistance (Ohm)	0.20	
Primary charge time @ 14V (mS)	2.50	
Weight (gr)	600	
Primary Current (A)	9.20	
Sample Availability	production	

= 800 Volt Zenor test, no secondary load.

* = with 50 PF Secondary Load

Table 3-1. High Voltage Ignition System Specifications.

Measurement Description	**Typical Value**
Energy (mJ)	69
Peak secondary current (mA)	97
Secondary voltage available (kV)	37 *
Spark duration (mS)	1.1
Secondary resistance (Ohm)	5100
Primary resistance (Ohm)	0.50
Primary charge time @ 14V (mS)	2.6
Weight (gr)	950
Primary Current (A)	9.5
Sample Availability	current

= 1500 Volt Zener test with no secondary load.

* = with 50 PF Secondary Load

Table 3-2. I.C.E. Specifications.

Segunda geração de bobinas integradas e eletrônicas

- Metade do numero de drivers de bobinas.
- Redução do tamanho e massa.
- Redução das emissões RFI.
- Núcleo de ferro, encapsulado.
- Uma bobina para cada par de cilindro.
- O potencial é distribuído para a vela através de cabos.

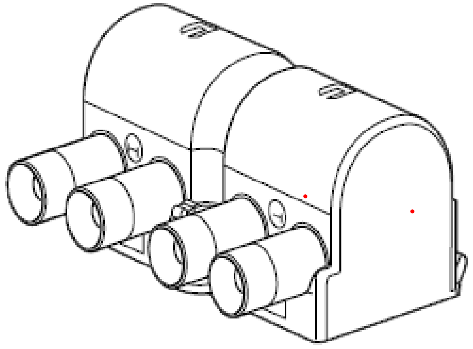
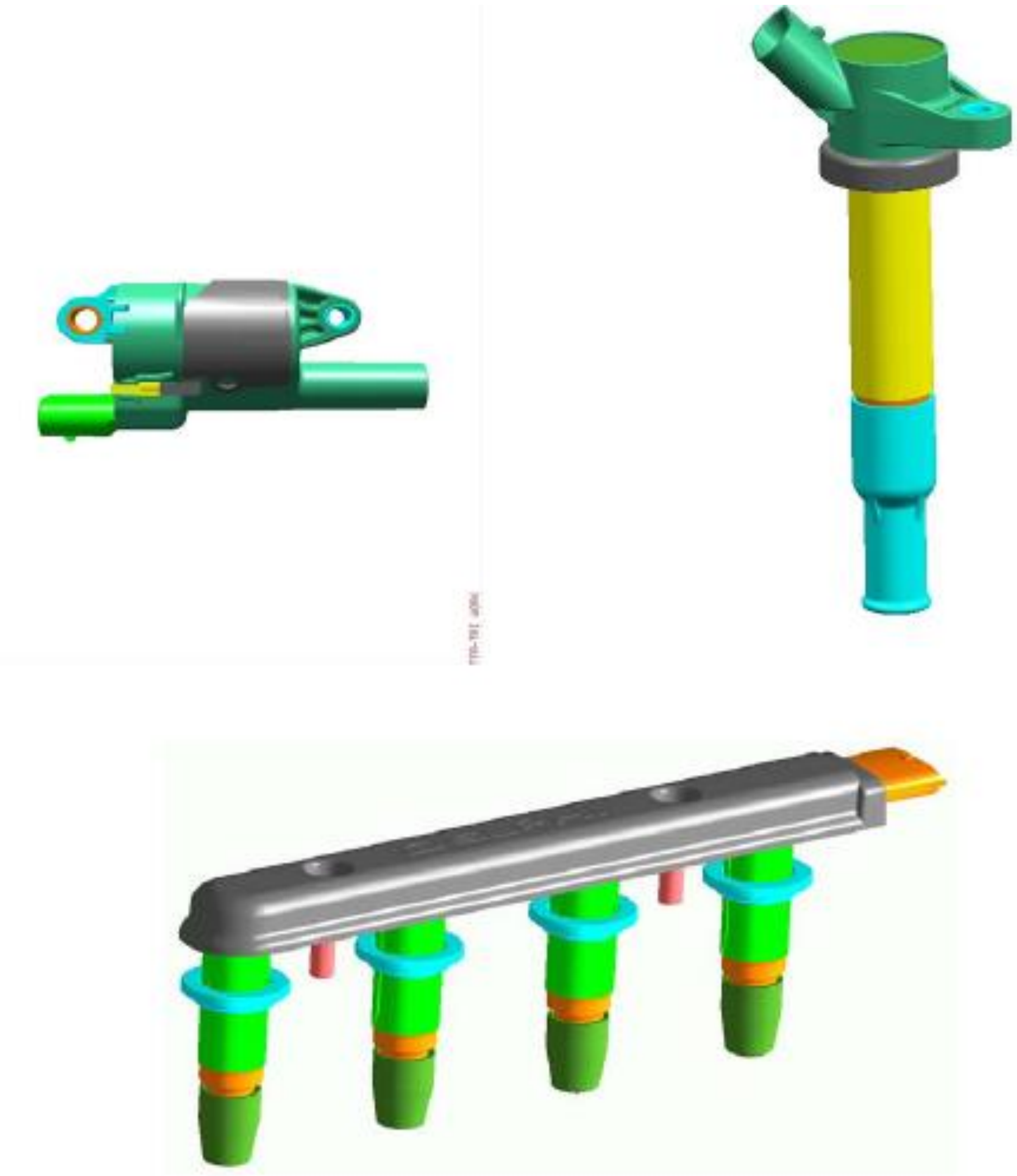
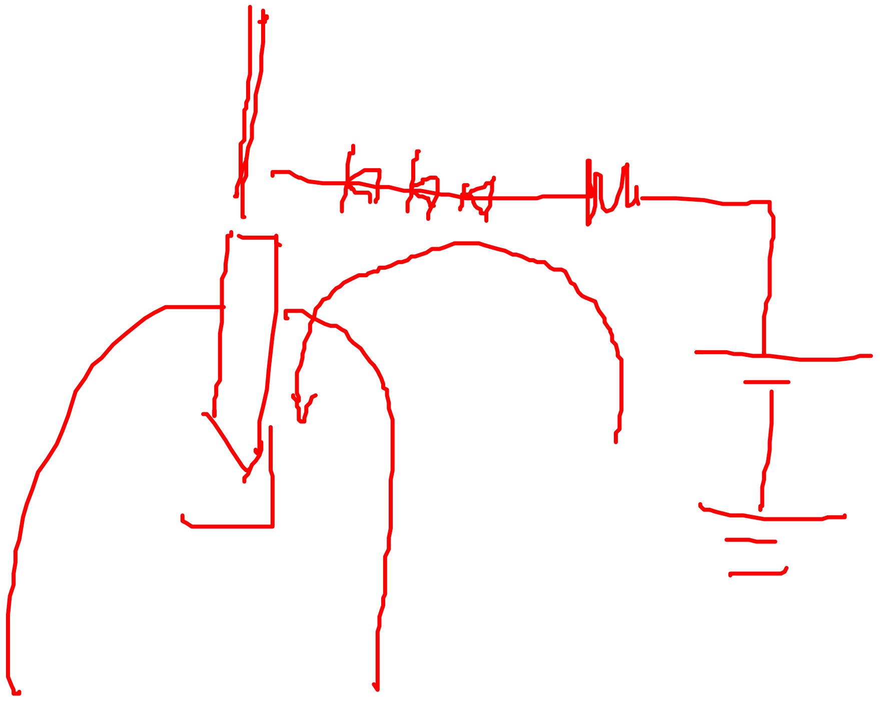


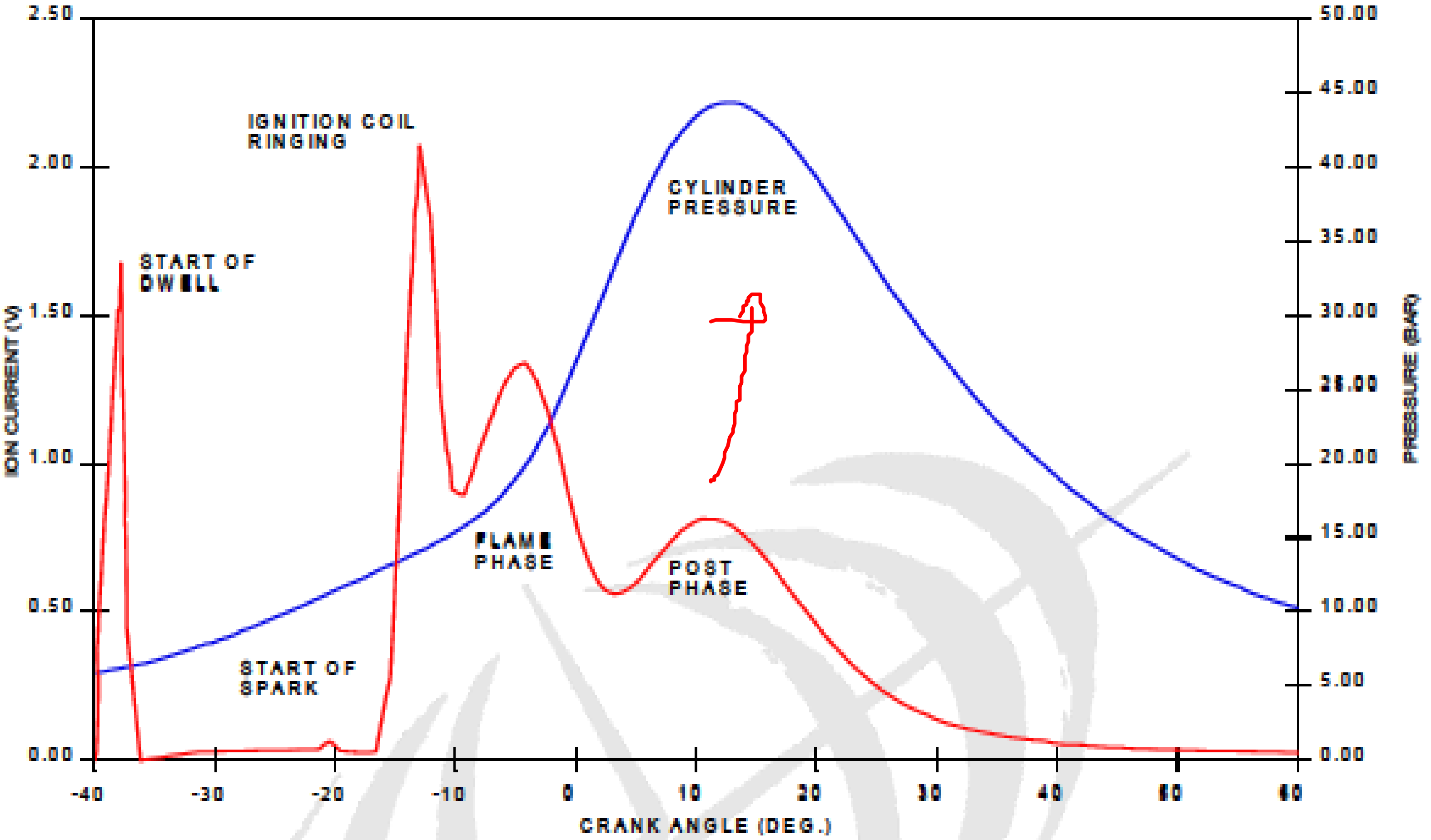
Figure 3-4. Integrated Coil and Electronics Assembly.



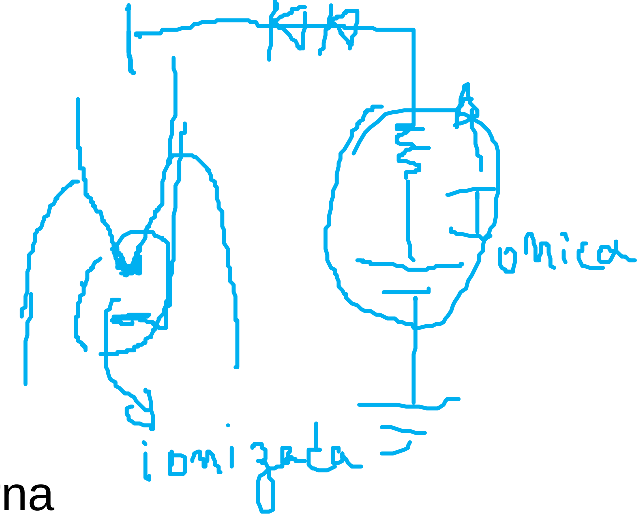
Ignition Systems
Delphi Energy and Chassis Systems

CORRENTE IÔNICA

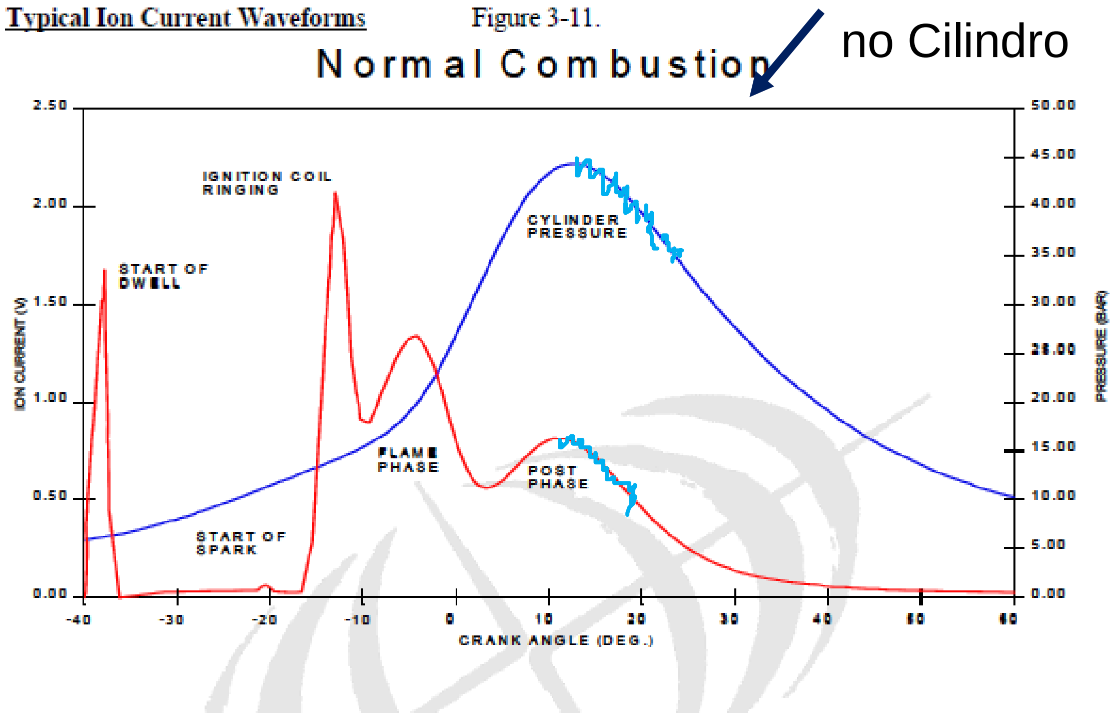



IGNITION COIL RINGING
START OF DWELL
CYLINDER PRESSURE
FLAME PHASE
POST PHASE
START OF SPARK
ION CURRENT (V)
2.50
2.00
1.50
1.00
0.50
0.00
PRESSURE (BAR)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-40
-30
-20
-10
0
10
20
30
40
50
60
CRANK ANGLE (DEG.)

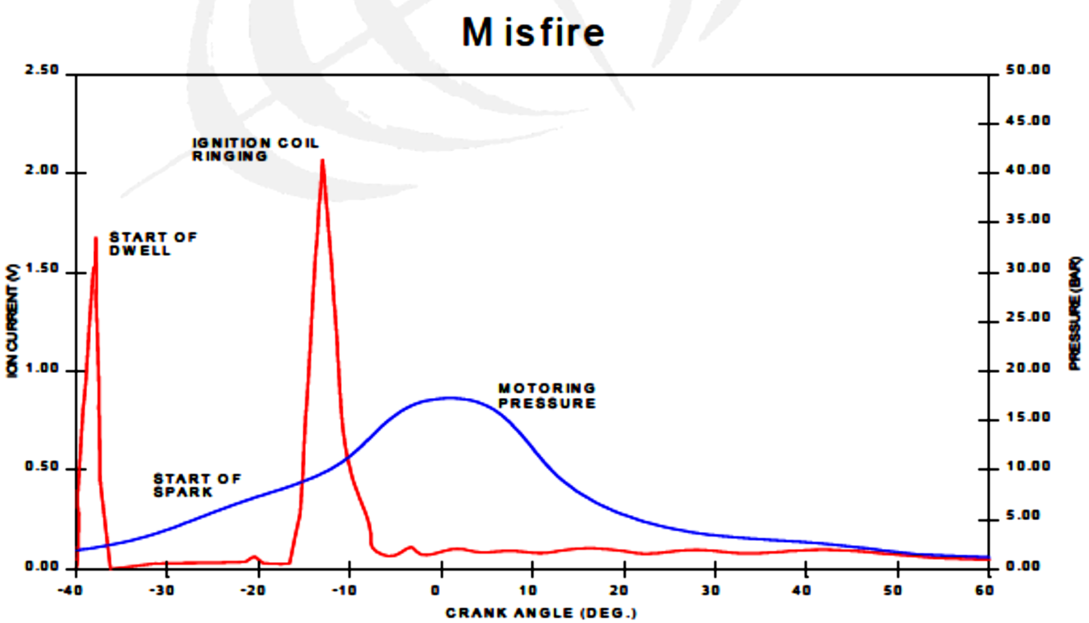
Combustão Normal


ionizada
ohmica

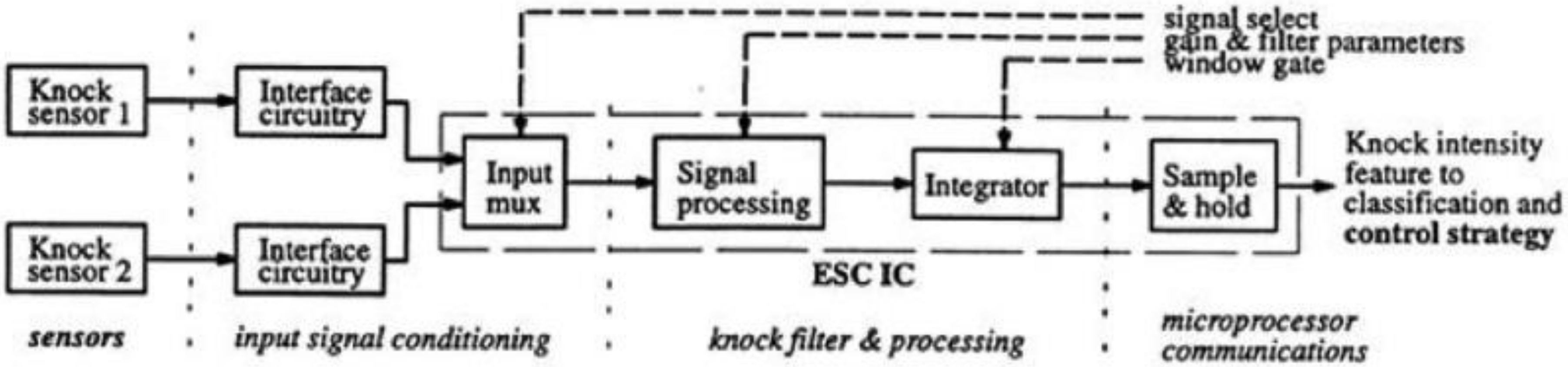
Pressão Interna no Cilindro



Misfire

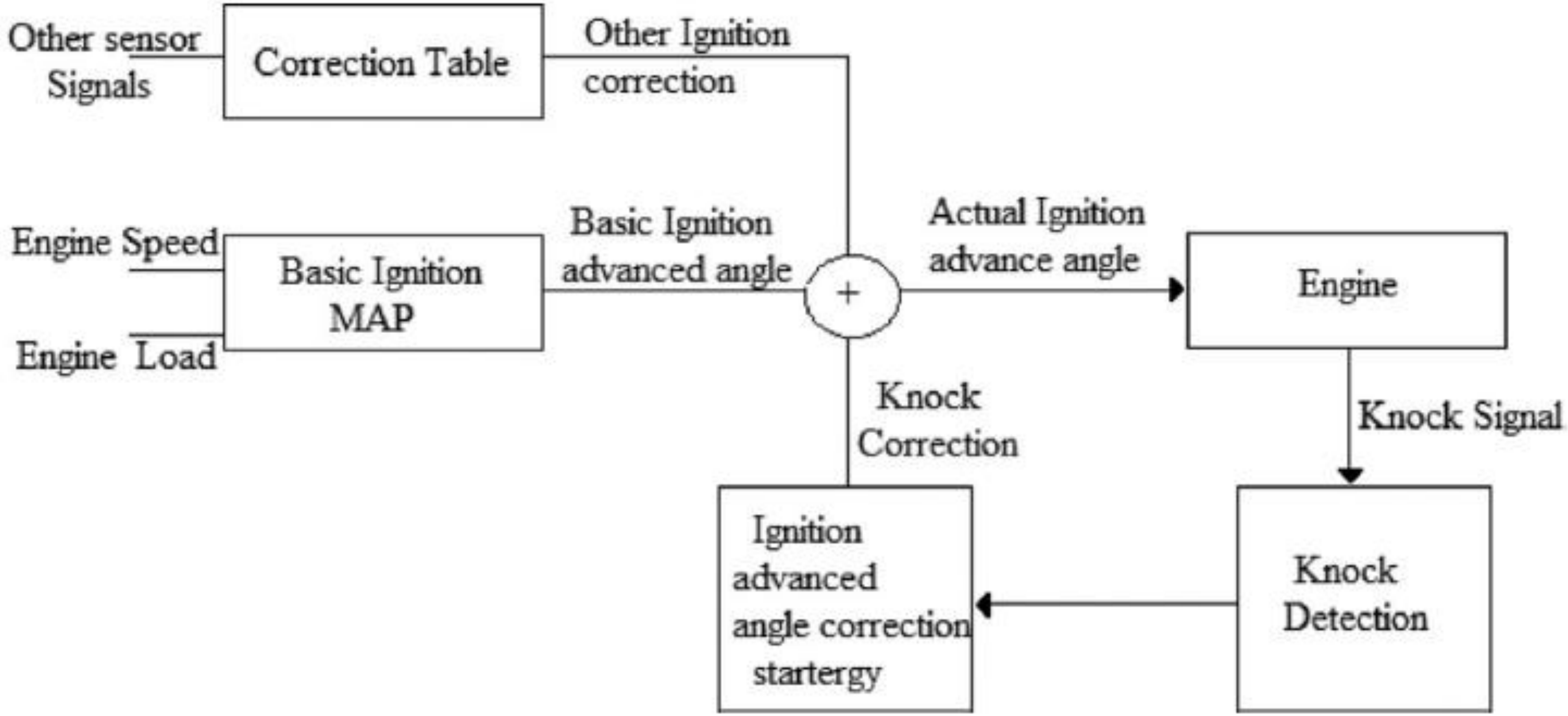

Misfire
IGNITION COIL RINGING
START OF DWELL
START OF SPARK
MOTORING PRESSURE
ION CURRENT (V)
PRESSURE (BAR)
CRANK ANGLE (DEG.)
2.50
2.00
1.50
1.00
0.50
0.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-40
-30
-20
-10
0
10
20
30
40
50
60

Knock Detection

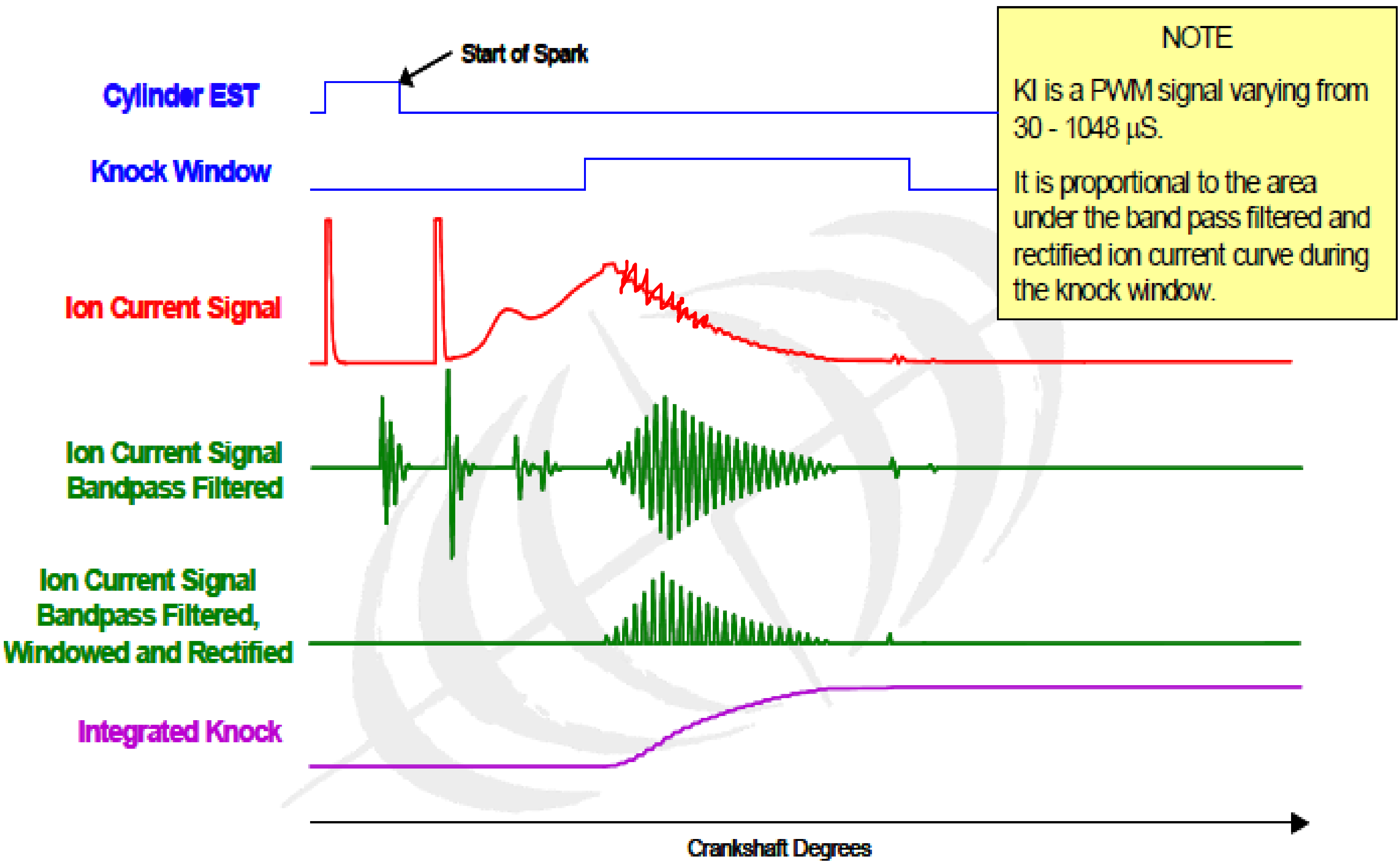

signal select
gain & filter parameters
window gate
Knock sensor 1
Knock sensor 2
Interface circuitry
Interface circuitry
Input mux
Signal processing
Integrator
Sample & hold
Knock intensity feature to classification and control strategy
ESC IC
sensors
input signal conditioning
knock filter & processing
microprocessor communications

B. Ashok 2016

Knock Control


Other sensor Signals
Correction Table
Other Ignition correction
Engine Speed
Engine Load
Basic Ignition MAP
Basic Ignition advanced angle
+
Actual Ignition advance angle
Engine
Knock Signal
Knock Correction
Ignition advanced angle correction startergy
Knock Detection

B. Ashok 2016

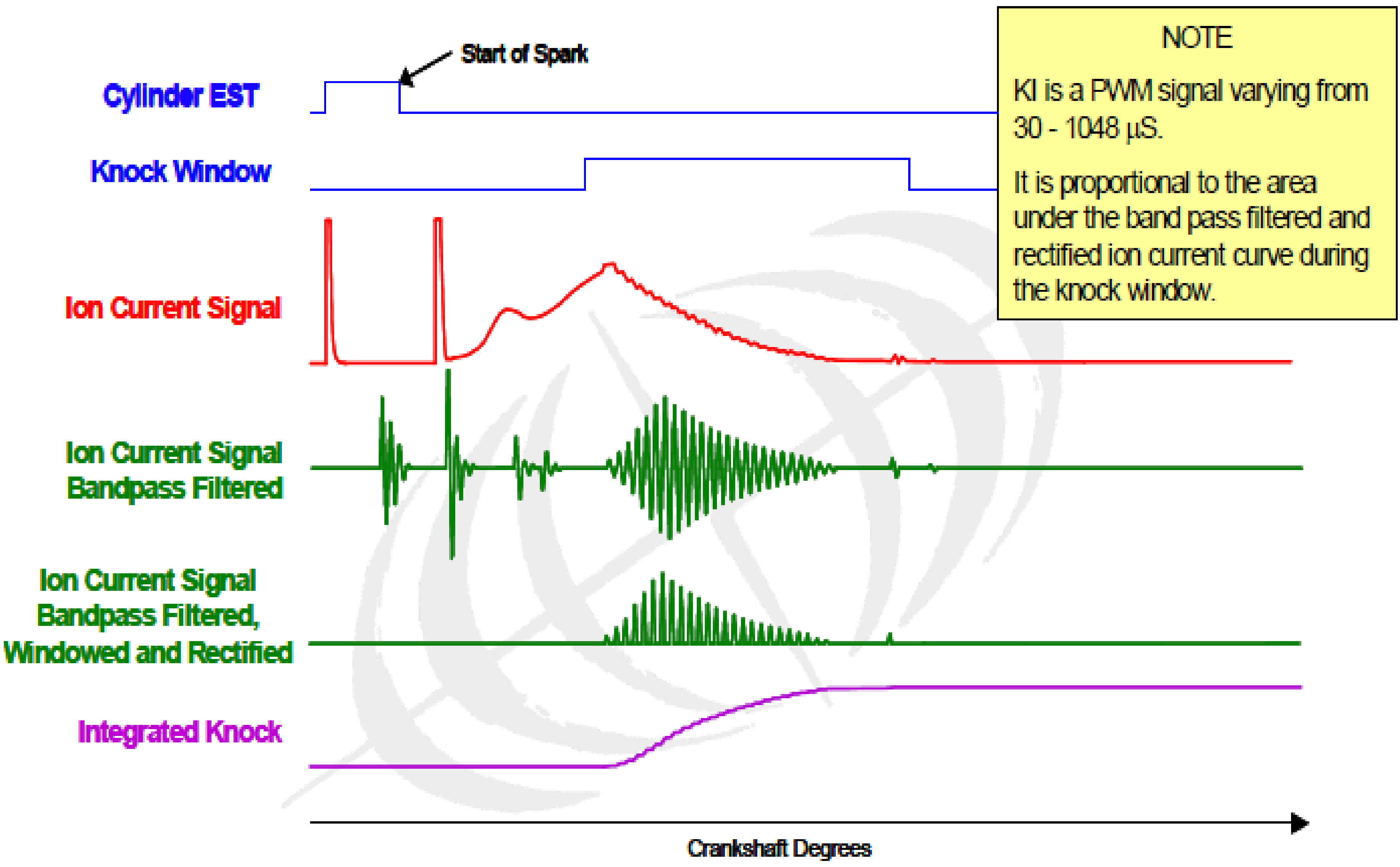

Start of Spark
Cylinder EST
Knock Window
Ion Current Signal
Ion Current Signal Bandpass Filtered
Ion Current Signal Bandpass Filtered, Windowed and Rectified
Integrated Knock
Crankshaft Degrees

NOTE

KI is a PWM signal varying from 30 - 1048 µS.

It is proportional to the area under the band pass filtered and rectified ion current curve during the knock window.

Figure 3-12.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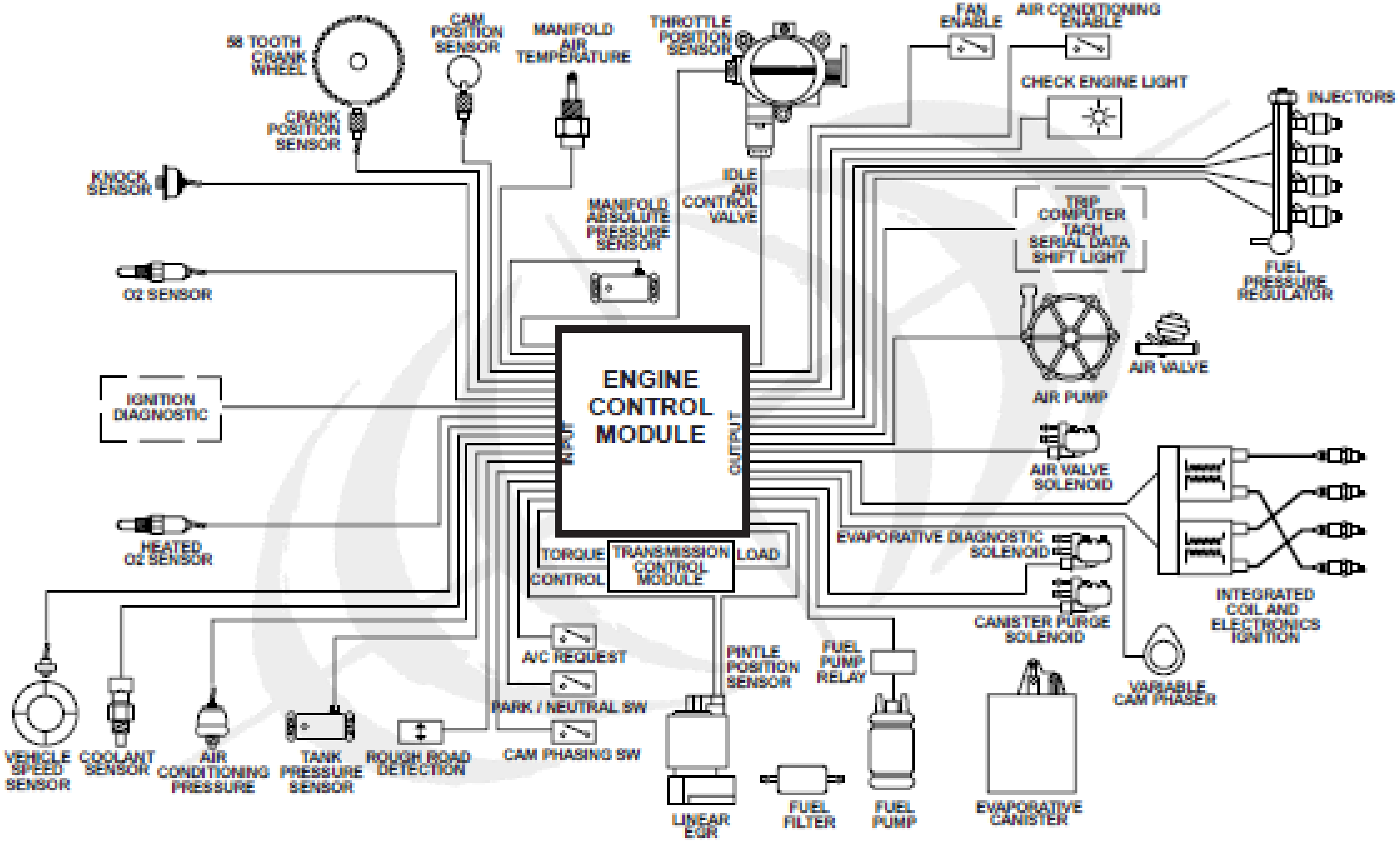
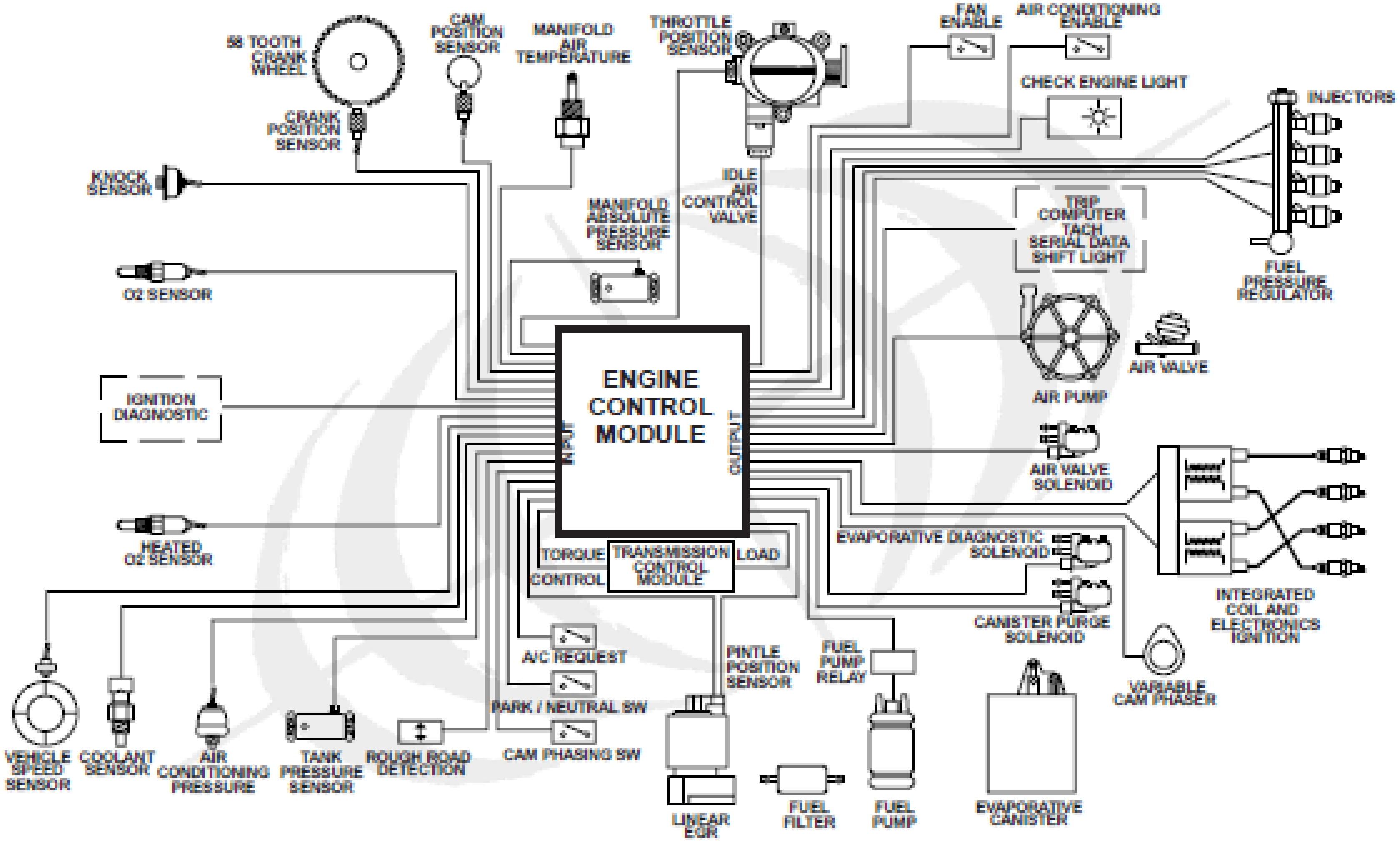

58 TOOTH CRANK WHEEL
CRANK POSITION SENSOR
CAM POSITION SENSOR
MANIFOLD AIR TEMPERATURE
THROTTLE POSITION SENSOR
FAN ENABLE
AIR CONDITIONING ENABLE
CHECK ENGINE LIGHT
INJECTORS
KNOCK SENSOR
IDLE AIR CONTROL VALVE
MANIFOLD ABSOLUTE PRESSURE SENSOR
TRIP COMPUTER TACH SERIAL DATA SHIFT LIGHT
FUEL PRESSURE REGULATOR
O2 SENSOR
AIR PUMP
AIR VALVE
IGNITION DIAGNOSTIC
ENGINE CONTROL MODULE
INPUT
OUTPUT
AIR VALVE SOLENOID
HEATED O2 SENSOR
TORQUE CONTROL
TRANSMISSION CONTROL MODULE
LOAD
EVAPORATIVE DIAGNOSTIC SOLENOID
INTEGRATED COIL AND ELECTRONICS IGNITION
CANISTER PURGE SOLENOID
A/C REQUEST
PINTLE POSITION SENSOR
FUEL PUMP RELAY
VARIABLE CAM PHASER
PARK / NEUTRAL SW
CAM PHASING SW
VEHICLE SPEED SENSOR
COOLANT SENSOR
AIR CONDITIONING PRESSURE
TANK PRESSURE SENSOR
ROUGH ROAD DETECTION
LINEAR EGR
FUEL FILTER
FUEL PUMP
EVAPORATIVE CANISTER

Figure 4-1. Ignition System Interfaces.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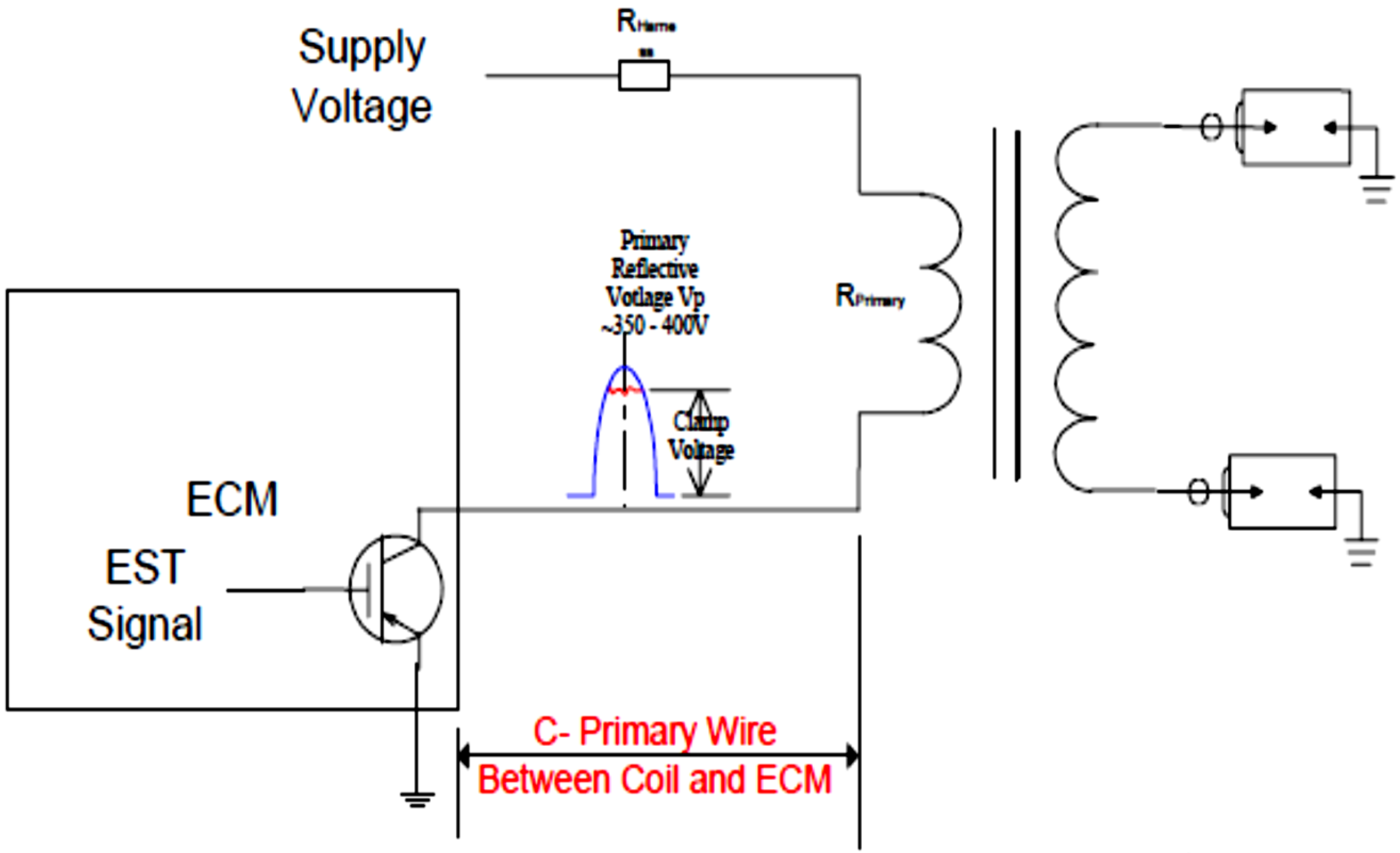
Supply Voltage
$R_{Harness}$
Primary Reflective Votlage Vp ~350 - 400V
$R_{Primary}$
Clamp Voltage
ECM
EST Signal
C- Primary Wire
Between Coil and ECM

Figure 4-4. A typical reflected primary voltage for a coil where the driver is in the ECM