BITS Pilani
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Control Systems

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Lecture 07 - Control System Design Part 3
Spark & Other Strategies

Scope

Engine Control Systems

- Calculation of Spark Advance
- Hardware Diagnosis
- Idle Speed Control

Spark Advance Calculation

Angle vs mS

- Advance calculated based on soft TDC count down
- Parameters to be resolved
  - Base Spark Advance
  - Dwell Time compensation
- Spark Advance Map
- Dwell Time map
- Spark Advance Map – Only for RUN
- Separate Advances for “Stall” & “Idle”
- Stall – From Cranking requirements
- Idle – Closed loop control
- Spark advance & retard based on
  - IAT
  - ECT
  - Knock Control
  - Failure Scenarios

Spark Advance Calculation

Spark Mode

- Wasted Spark setup
- Sequential setup
- Failure mode scenarios
- Ignition diagnosis

Hardware Diagnosis

Hardware

- Ignition / Injection Drivers
- Injectors & Coil Packs
- Sensors
- Actuators
- Gauges
- Pump & Fan

Hardware Diagnosis

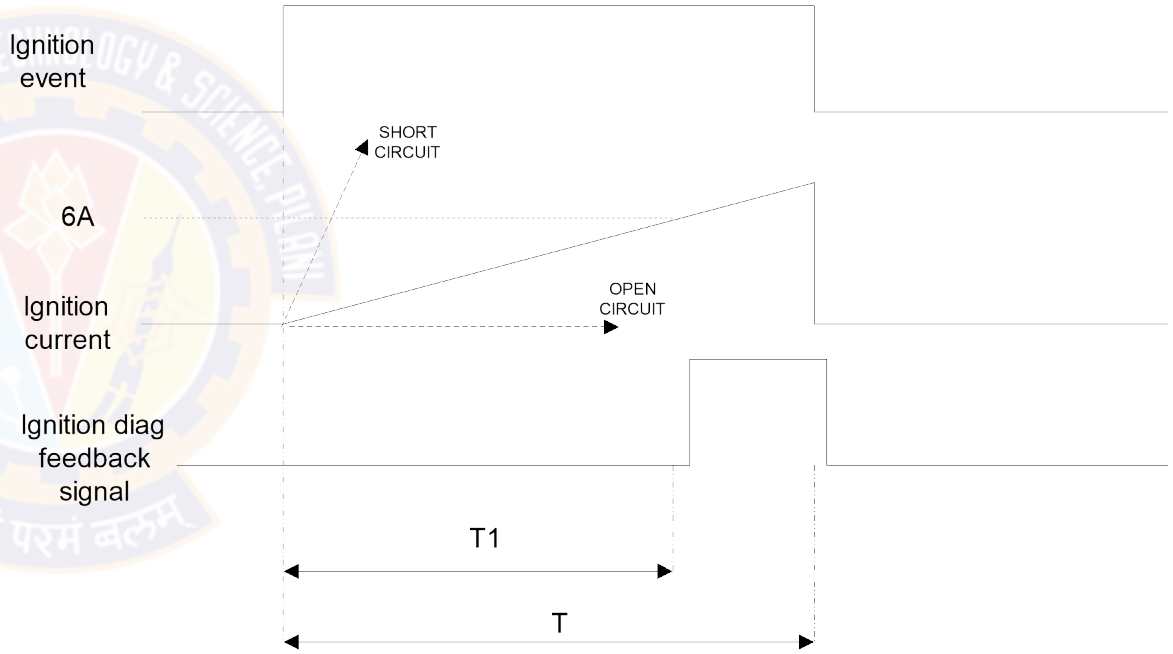
Errors & Faults

- Errors – A value is out of range
- Fault – Unacceptable number of consecutive errors
- Raw Value – Sensor value
- Filter – Clear noises
- All analog inputs
  - Calibratable number of errors to cause a fault
  - Calibratable default value to revert to, when in fault
  - When fault clears, value is changed from “Default” to “Measured”

Hardware Diagnosis

Errors & Faults

- Ignition driver diagnosis
- Depending on system, current is measured – 6A in this case
- If all is normal, a feed back signal is sent
- If time T1 is very less – Short Circuit
- If time T1 is more or no feedback is received – Open Circuit
- Diagnosis performed only during Stall and Cranking
- Voltage threshold to prevent inconsistencies due to low voltage
- Kickstarting vs Cranking



T1: Time taken for the ignition current to reach the nominal 6A threshold.
T: Extended ignition dwell duration.

Hardware Diagnosis

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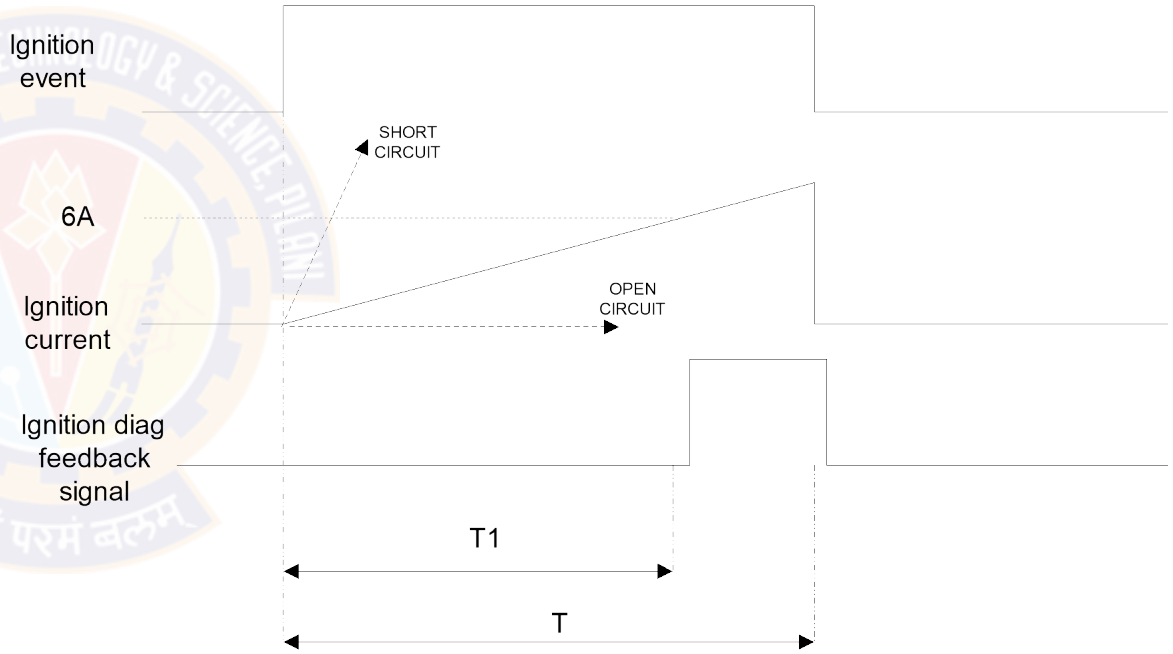

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Hardware Diagnosis

Errors & Faults

- Other actuators
  - Short to ground
  - Short to positive
  - Open circuit
  - Samples drive signals
  - Open circuits – Needs 2x the signal pulsewidths
- Diagnosis continuously run – Raises error flags
- Fuel injector diagnosed during stall and crank
- IAC only during idle
- Sensors – Values checked for range as well

Idle Speed Control

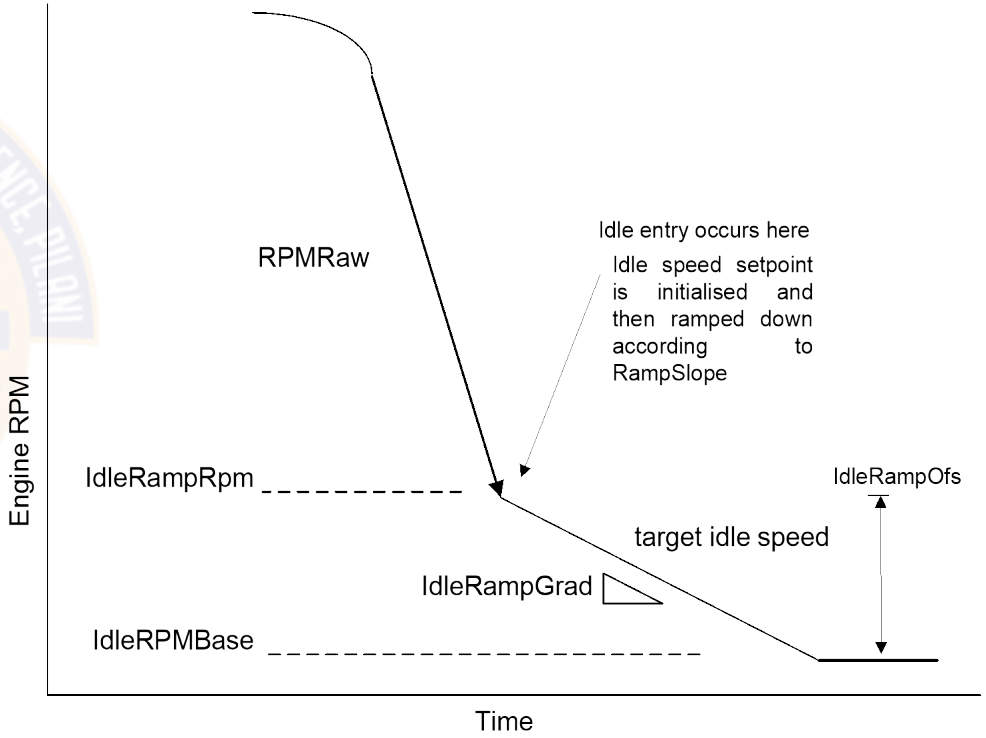
IAC

- Closed loop control using solenoid or valve
- Required for smooth running of engine
- Warm-up conditions – needs more air
- Static loads – More air
- Simple On-Off control – PWM determines amount of air
- On during STALL
- Mapped values during CRANK
- Can control engine braking – Throttle closed in ORC
- Higher air flow – Reduces Engine Braking
- Primary function is to ensure idle speed meets set point

Idle Speed Control

IAC

- Idle Ramp – How quick the set point rpm is achieved
- Idle stability control – how much the RPM varies from set-point eg 680 +- 50 rpm
- Valve open time – Synchronize with valve timing
- Delay between electric signal and operation



Thank You!

In our next session:

Diesel Control Strategies