

```
//University of Tulsa Caterpillar ECM Power Loss Testing
```

```
//24 Aug 2015
```

```
//Jeremy Daily and Amila Perera
```

```
/*
```

```
+-----+-----+-----+
|Run #          |          | VSPY Log for Event:
+-----+-----+-----+
|Code           |          | VSPY Log for CatET:
+-----+-----+-----+
|              |          | VSPY Log for FLA:
+-----+-----+-----+
|Powr Loss Start Time |          |
+-----+-----+-----+
|VSS Freq Change Step |          |
+-----+-----+-----+
|CAT ET Snapshot retrieval |          |
+-----+-----+-----+
|FLA Snapshot retrieval |          |
+-----+-----+-----+
|              |          |
+-----+-----+-----+
|              |          |
```

```
*/
```

```
//Test Constants
```

```
unsigned long testDuration = 25000;
```

```
unsigned long speedChangeStartTime = 10000;//Milliseconds after start time.
```

```
int VSSfreqChangeStep=21;//adjust for quickstop
```

```
unsigned long powerLossStartTime = 11000;
```

```
unsigned long powerLossDuration = 100;
```

```
//coolant level power loss
```

```
unsigned long CLpowerLossStartTime = 13000;//ms
```

```
unsigned long CLpowerLossDuration = 14000;
```

```
unsigned long boostPressStartTime = 12000;
```

```
unsigned long boostPressDuration = 13000;
```

```
unsigned long appStartTime = 11000;
```

```
unsigned long appDuration = 12000;
```

```
unsigned int pulsesPerMile = 29541;// pulses per mile
```

```
int quickStopRate = 10;//Miles per hour per second
```

```
int VSStimeChangeStep = 48;//ms
```

```

//Vehicle Speed Sensor
int speedAmp = 50;//tenths of a mph
float speedFreq= 0.2;//Hz
int originalVSSspeed = 500;//tenths of a mph

//Accelerator Pedal Position
int originalPedalPos = 24;//%
int pedalAmp = 10;//%
float pedFreq = .4;

//Oil Pressure
int originalboostPress = 25;
int oilAmp = 10;
float oilFreq = .6;

//Changing or calculated variables
int VSSfreq;

int VSSspeed;
int pedValue;
byte appByte;
int appValue;
int boostPressValue;

//board setup constants
const int pinButton1 = 8;// Push Button Input Pin
const int powerRelayPin = 2;// ECM Power3
const int faultRelayPin = 3;// Sensor Power
const int LEDpin = 13;
const int appPin = 6;//Accelerator Pedal Position
const int boostPressPin = 9;
const int simulatedVSSpin = 5;

//These variables get reset
unsigned long lastSensorChangeTime=0;
unsigned long VSSfreqChangeTime = 0;
unsigned long startTime = 0;
unsigned long CLstartTime = 0;
unsigned long currentMillis=0;
unsigned long displayTime = 0;

boolean testStarted =false;
boolean powerOff =false;

```

```

boolean faultRelayPinOn =false;
boolean sensorState =false;
boolean stateButton1 =false;

void setup() {
    pinMode(appPin,OUTPUT);
    pinMode(pinButton1, INPUT);
    pinMode(powerRelayPin, OUTPUT);
    pinMode(faultRelayPin, OUTPUT);
    pinMode(simulatedVSSpin, OUTPUT);
    pinMode(boostPressPin,OUTPUT);
    pinMode(LEDpin, OUTPUT);

    VSSfreqChangeStep;
    VSSspeed = originalVSSspeed;
    setVSSspeed(VSSspeed);

    setboostPress(originalboostPress);
    setAPP(originalPedalPos);

    Serial.begin(115200);
    Serial.println("University of Tulsa");
    Serial.println("Engine Control Module (ECM) Power Loss Testing");
    Serial.println("Test parameters are as follows:");
    Serial.print("Speed Change Start Time:\t");
    Serial.print(speedChangeStartTime);
    Serial.println("\tmilliseconds");
    Serial.print("Power Loss Start Time:\t");
    Serial.print(powerLossStartTime);
    Serial.println("\tmilliseconds");
    Serial.print("Test Duration:\t");
    Serial.print(testDuration);
    Serial.println("\tmilliseconds");
    Serial.print("boostPressStartTime:\t");
    Serial.print(boostPressStartTime);
    Serial.println("\tmilliseconds");
    Serial.print("boostPressDuration:\t");
    Serial.print(boostPressDuration);
    Serial.println("\tmilliseconds");
    Serial.print("StartingVSSfrequency:\t");
    Serial.print(originalVSSspeed);
    Serial.println("\tmph");

```

```

Serial.print("VSStimeChangeStep:\t");
Serial.print(VSStimeChangeStep);
Serial.println("\tmilliseconds");
Serial.print("VSSfreqChangeStep:\t");
Serial.print(VSSfreqChangeStep);
Serial.println("\tmph");

// Starting conditions
currentMillis =millis();

powerOff =false;
faultRelayPinOn =false;

digitalWrite(powerRelayPin, powerOff);
digitalWrite(faultRelayPin, faultRelayPinOn);
// VSSfreq = map(VSSspeed,0,100,0,820.58);
// tone(simulatedVSSpin,VSSfreq);
// analogWrite(boostPressPin,originalboostPress);
// analogWrite(appPin,originalPedalPos);

delay(5000);
Serial.println("Time [ms]\tVSSfreq. [Hz]\tSensorFreq\tpowerRelayPin [1=on,0=off]\tfaultRelayPin [1=on,0=off]");
}

int getSpeed() {
    int speedVal = originalVSSspeed + speedAmp*sin(2*speedFreq*3.1415927*(currentMillis-speedOffset));
    return speedVal;
}

void setVSSspeed(int VSSspd) {
    int VSSfreq =map(VSSspd,0,1000,0,820.58);
    if (VSSfreq <= 31){//Constrain for negative VSSfrequencies.
        pinMode(simulatedVSSpin,INPUT);
        digitalWrite(simulatedVSSpin,0);
    }
    else tone(simulatedVSSpin,VSSfreq);
}

int getboostPress() {
    return originalboostPress + oilAmp*sin(2*oilFreq*3.1415927*(currentMillis-oilOffset));
}

```

```

}

void setboostPress(int boostPress) {
    int boostPressVal =map(boostPress,23,50,100,200);
    analogWrite(boostPressPin,boostPressVal);
    //analogWrite(boostPressPin, boostPress);
}

int getAPP() {
    return originalPedalPos + pedalAmp*sin(2*pedFreq*3.1415927*(currentMillis-s
}

void setAPP(int appPercent) {
    int appVal =map(appPercent,10,72,70,150);
    analogWrite(appPin,appVal);
    //analogWrite(appPin,appPercent);
}

void loop() {
    currentMillis =millis();
    digitalWrite(LEDpin,testStarted);
    stateButton1 =digitalRead(pinButton1);

    //Start the test
    if(stateButton1 == HIGH && testStarted ==false) {
        testStarted =true;
        startTime = currentMillis;
        pinMode(simulatedVSSpin,OUTPUT);
        VSSspeed = originalVSSspeed;
        setVSSspeed(VSSspeed);

        powerOff =false;
        digitalWrite(powerRelayPin, powerOff);
    }

    if (testStarted) {

///Speed      Change
        if (currentMillis - startTime >= speedChangeStartTime) {
            if (currentMillis - VSSfreqChangeTime >= VSStimeChangeStep) { //change
                VSSfreqChangeTime = currentMillis;
                VSSspeed -= VSSfreqChangeStep; //change this number to change d
                if (VSSspeed <= 0) VSSspeed =0;

```

```

        setVSSspeed(VSSspeed);
        Serial.println(VSSspeed);
    }
}
else{
    VSSspeed = getSpeed();
    setVSSspeed(VSSspeed);
}

/*+++++ Start ECM Power Loss ++++++

    if (currentMillis - startTime >= powerLossStartTime && !powerOff){
        powerOff =true;
        //Serial.println("Power Off.");
        digitalWrite(powerRelayPin, powerOff);
    }
    else if (currentMillis - startTime >= powerLossStartTime + powerLossDurati
        powerOff =false; //Turn power back on
        digitalWrite(powerRelayPin, powerOff);
    }
    else {
        powerOff =false;
    }

/*+++++ Start Coolent Power Loss ++++++

    if (currentMillis - CLstartTime >= CLpowerLossStartTime && !faultRelayPinO
        faultRelayPinOn =true;
        //Serial.println("Coolant Off.");
        digitalWrite(faultRelayPin, faultRelayPinOn);
    }
    else if (currentMillis - CLstartTime >= CLpowerLossStartTime + CLpowerLoss
        faultRelayPinOn =false; //Turn power back on
        digitalWrite(faultRelayPin, faultRelayPinOn);
    }
    else {
        faultRelayPinOn =false;
    }

/*+++++ Start Oil Pressure ++++++

    if (currentMillis - startTime >= boostPressStartTime && boostPressValue >
        pinMode(boostPressPin,INPUT);
        digitalWrite(boostPressPin,0);
        //boostPressValue = 0;
        //setboostPress(boostPressValue);

```

```

    }
    else if (currentMillis - startTime >= boostPressStartTime + boostPressDura
        pinMode(boostPressPin,OUTPUT);
        boostPressValue = getboostPress();
        setboostPress(boostPressValue);
    }
    else {
        boostPressValue = getboostPress();
        setboostPress(boostPressValue);
    }

    /*+++++ End Oil Pressure ++++++

    /*+++++ Start Accelerator Pedal Position ++++++
        if (currentMillis - startTime >= appStartTime && appValue > 0){
            pinMode(appPin,INPUT);
            digitalWrite(appPin,0);
        }
        else if (currentMillis - startTime >= appStartTime + appDuration && appVal
            pinMode(appPin,OUTPUT);
            appValue = getAPP();
            setAPP(appValue);
        }
        else {
            appValue = getAPP();
            setAPP(appValue);
        }

    /*+++++ End Accelerator Pedal Position ++++++

    }

    if (currentMillis - startTime > testDuration){
        testStarted=false;
        startTime = currentMillis;

        //pinMode(simulatedVSSpin,OUTPUT);
        Serial.println("Test Stopped.");
    }

    // if (currentMillis - displayTime >= 100){
    //     displayTime = currentMillis;
    //     Serial.print(currentMillis-startTime);
    //     Serial.print("\t");
    //     Serial.print(VSSfreq);

```

```
//      Serial.print("\t");  
//      Serial.print(appValue);  
//      Serial.print("\t");  
//      Serial.print(boostPressValue);  
//      Serial.print("\t");  
//      Serial.print(!powerOff);  
//      Serial.print("\t");  
//      Serial.println(!faultRelayPinOn);  
//  }
```

```
}
```