HongKe 虹科

# 基于CANLIN总线的汽车零部件测试方案


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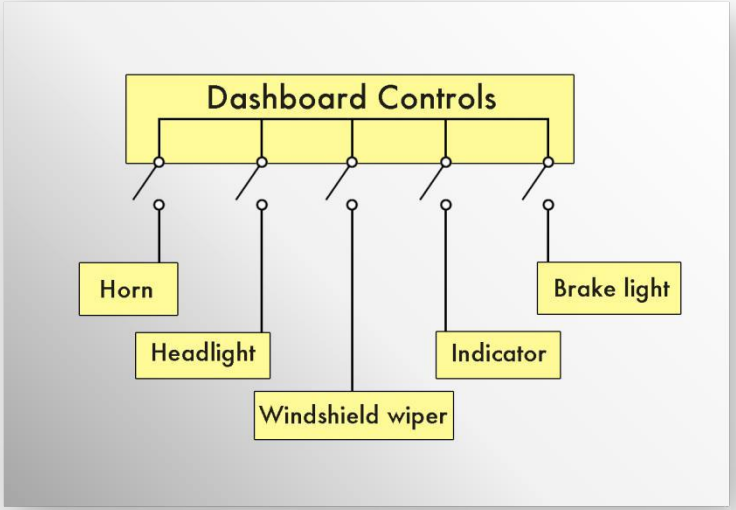
PART 01

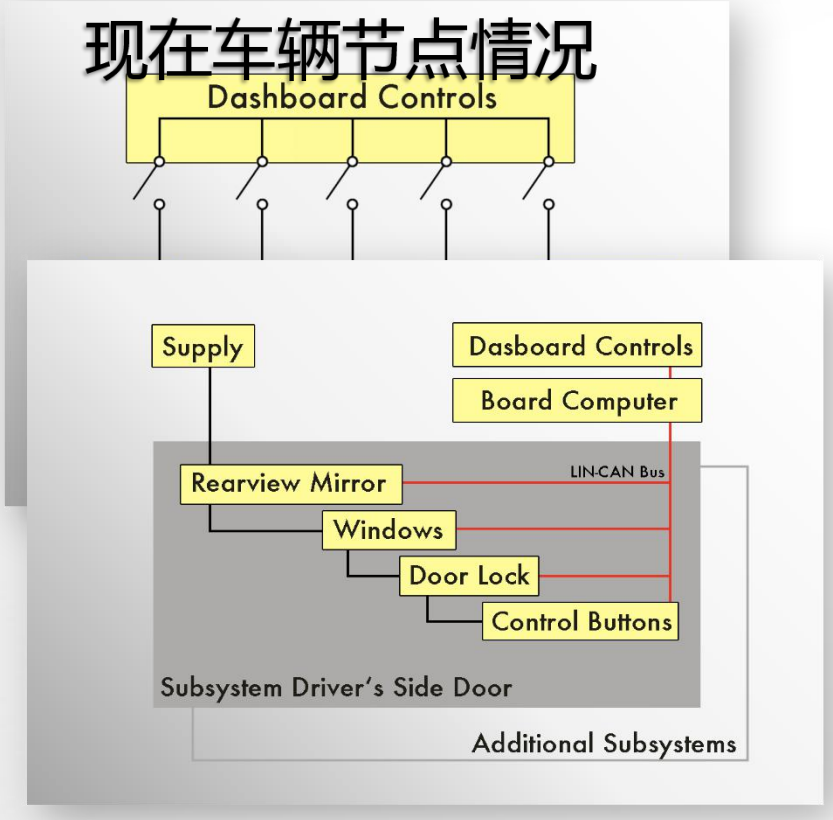
# 车辆节点ECU的变化

# 早期车辆节点情况



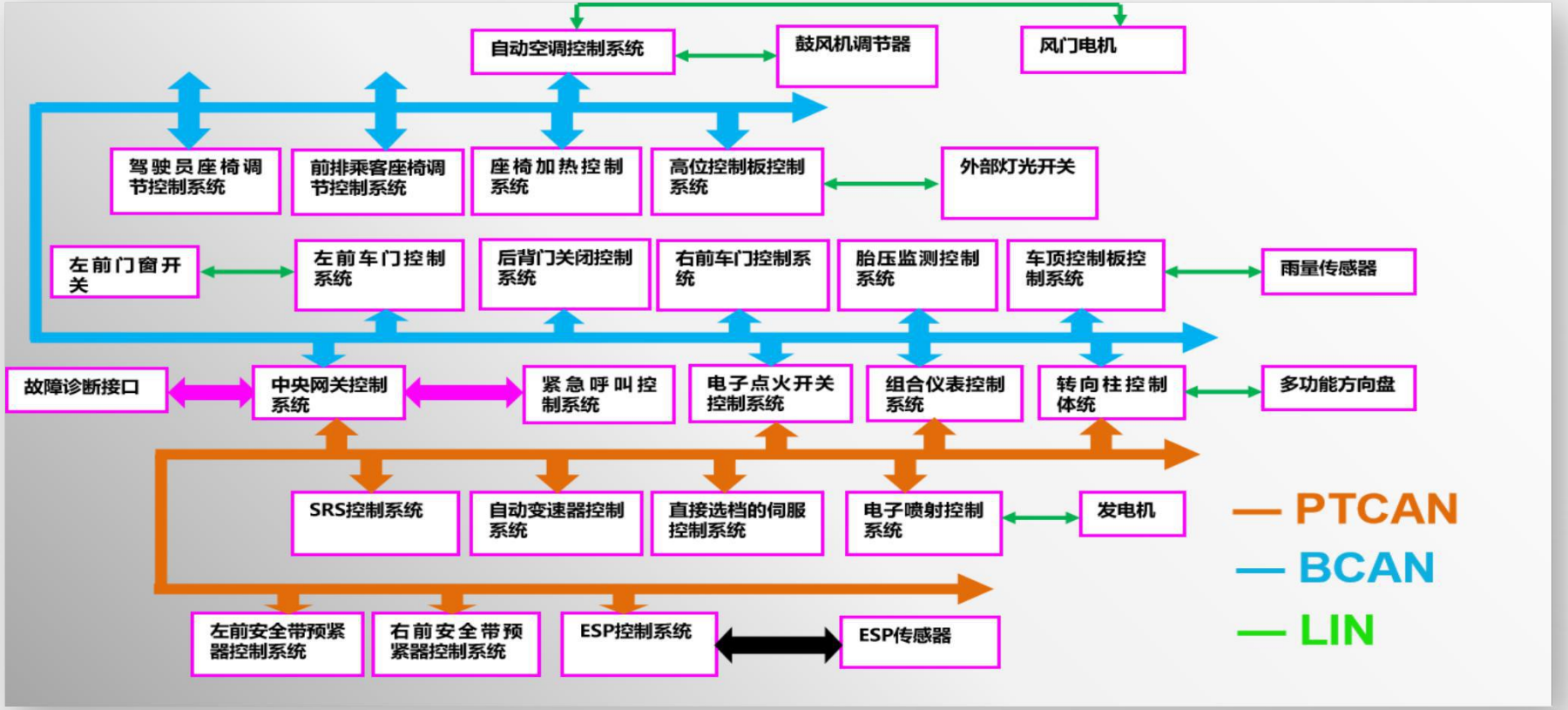

1. 只有少数的节点
2. 每个节点单独接线
3. 每个节点都独立连接到中央控制器或仪表显示上
4. 节点通过开关或继电器进行控制

# 车辆节点ECU的变化

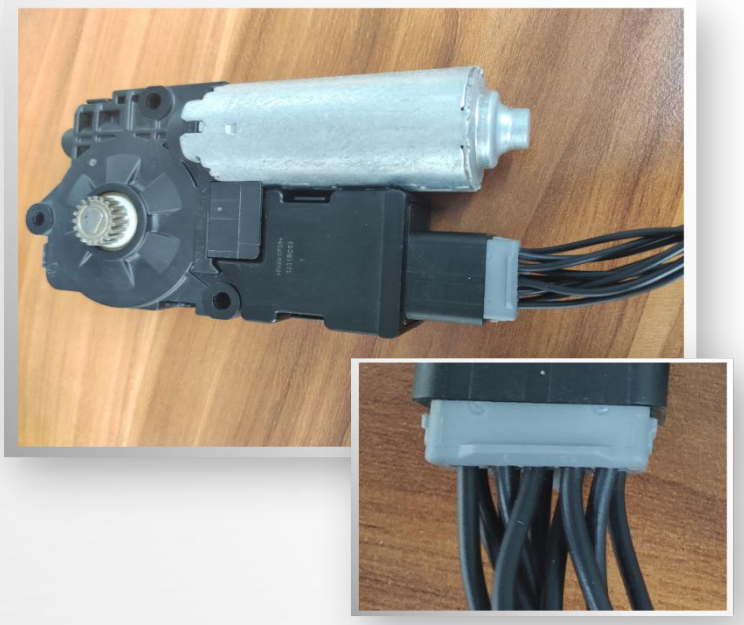



1. 节点数量增加
2. 节点智能化，集成化
3. 线束中含有供电及信号线束
4. 中央控制器通过总线进行单个或多个节点同时控制

# 车辆节点ECU的变化

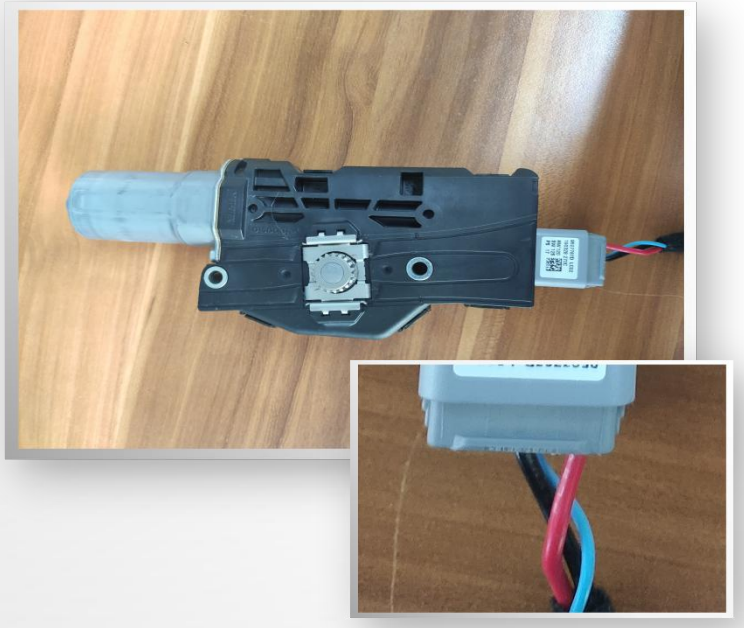

自动空调控制系统
鼓风机调节器
风门电机
驾驶员座椅调节控制系统
前排乘客座椅调节控制系统
座椅加热控制系统
高位控制板控制系统
外部灯光开关
左前门窗开关
左前车门控制系统
后背门关闭控制系统
右前车门控制系统
胎压监测控制系统
车顶控制板控制系统
雨量传感器
故障诊断接口
中央网关控制系统
紧急呼叫控制系统
电子点火开关控制系统
组合仪表控制系统
转向柱控制体统
多功能方向盘
SRS控制系统
自动变速器控制系统
直接选档的伺服控制系统
电子喷射控制系统
发电机
左前安全带预紧器控制系统
右前安全带预紧器控制系统
ESP控制系统
ESP传感器
PTCAN
BCAN
LIN

# 传统天窗电机



1. 电机接口PIN脚众多
2. 天窗打开、关闭、起翘、速度等通过模拟开关量单独控制

# 总线天窗电机



1. PIN脚只有电源、地及总线信号线束
2. 电机打开、关闭、起翘、速度等均可通过总线信号进行控制
3. 电机状态通过总线实时反馈
4. 总线数据共享，可与其他节点进行交互，如与遮阳帘联动

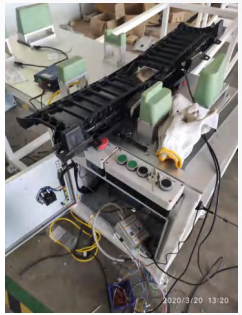
PART 02

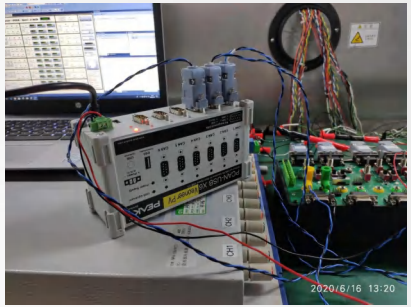
# CANLIN总线设备的测试

# CANLIN总线设备的测试

汽车零部件测试内容：

- 环境可靠性测试
- 电学性能测试
- 功能测试
- EMC测试
- 材料测试等





# CANLIN总线设备的测试

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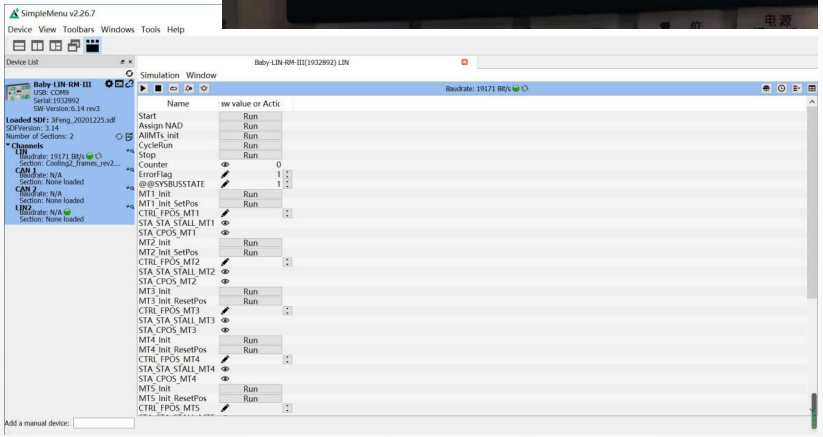
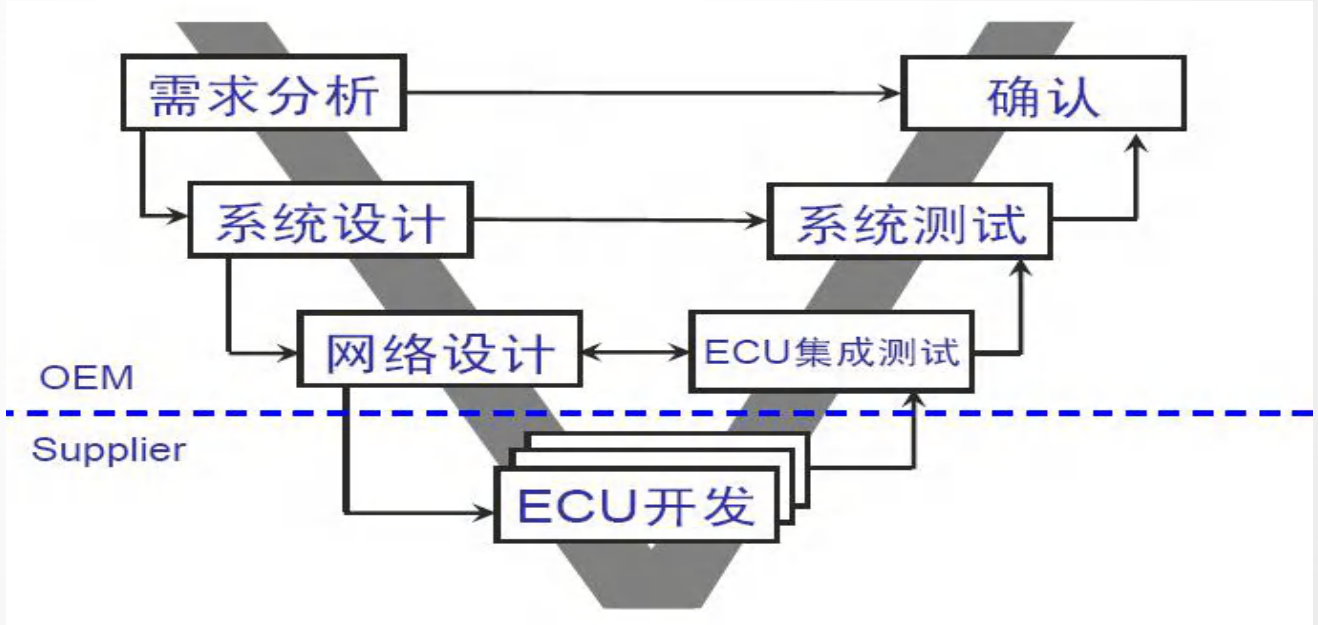
## 和通信相关的测试内容：

- 功能测试
- 耐久测试
- EOL（End of Line）等



# 如何组织对一个节点进行测试?

1. 需求
2. 通信协议
3. 环境搭建
4. 测试实施
5. 确认



# CANLIN总线设备的测试

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Database CAN/DBC

LIN Description File/LDF

| Result | No. | Signal Description | Signal Name | Transmitter | Message ID | Factor | Offset | Minimum | Maximum | Unit | Value Description | Receiver: BCM | Receiver: inRoof | Receiver: RLS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | send system power mode to power window | SystemPowerMod | BCM | 0x10 | 1 | 0 | 0 | 3 | / | 0: OFF<br>1: ACC<br>2: ON<br>3: Crank | | x | |
| | 2 | Vehicle Speed, gateway signal from CAN | VehicleSpeed | BCM | 0x10 | 0.0563 | 0 | 0 | 300 | km/h | 0x0~0x14D5: valid value<br>0x14D6~0x1FFE: Reserved<br>0x1FFF: Invalid | | x | |
| | 10 | close sunroof command | CloseSunroofCmd | BCM | 0x10 | 1 | 0 | 0 | 1 | / | 0: No Request<br>1: Request Close<br>2: Not Availiable<br>3: Reserved | | x | |
| | 54 | Check error happen Reporting to the Network | SunroofErrorSts | SunRoof | 0x13 | 1 | 0 | 0 | 1 | / | 0: No Error<br>1:Error Present | x | | |
| | 55 | Report sunroof position | SunRoofPosition | SunRoof | 0x13 | 1 | 0 | 0 | 7 | / | 0: fully up<br>1: tilt stop<br>2: ATS in tilt area<br>3: fully close<br>4: ATS in slide area<br>5: slide stop<br>6: fully open<br>7: Degrade Mode | x | | |
| | 56 | report Relay status | RelayFault | SunRoof | 0x13 | 1 | 0 | 0 | 1 | / | 0: No Error<br>1: Error Present | x | | |
| | 57 | report Hall sensor status | HallSensorFault | SunRoof | 0x13 | 1 | 0 | 0 | 1 | / | 0: No Error<br>1: Error Present | x | | |
| | 58 | report over temperature | ThermalProtection | SunRoof | 0x13 | 1 | 0 | 0 | 1 | / | 0: No Error<br>1: Error Present | x | | |

LIN1 Signals-BCM | Frame_List | Schedule Table

# CANLIN总线设备的测试

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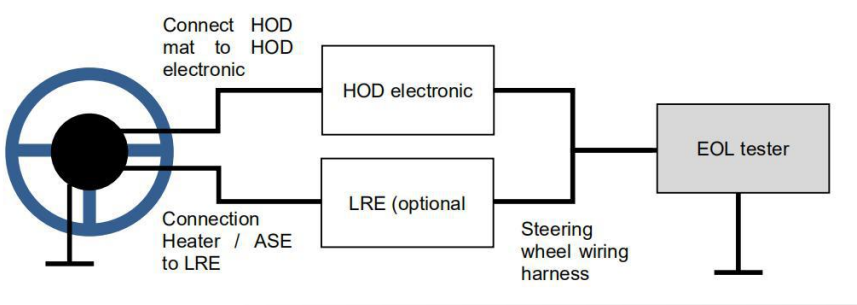

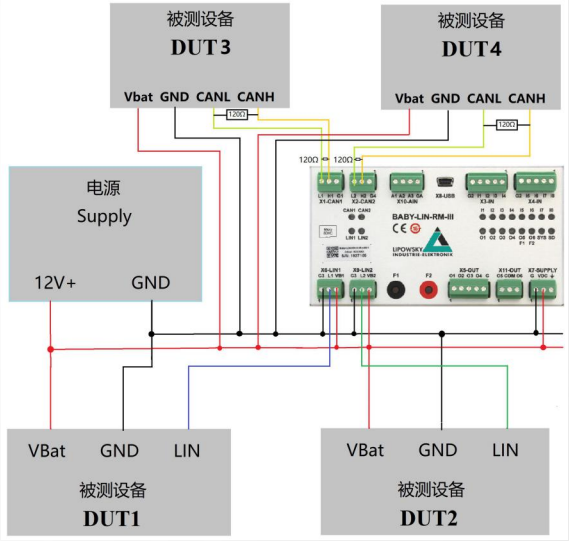

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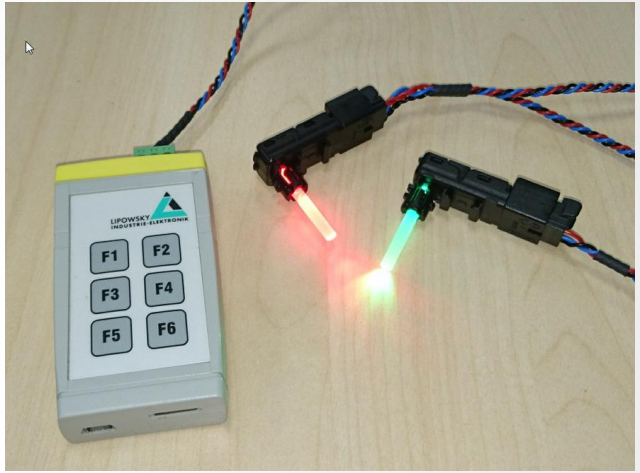


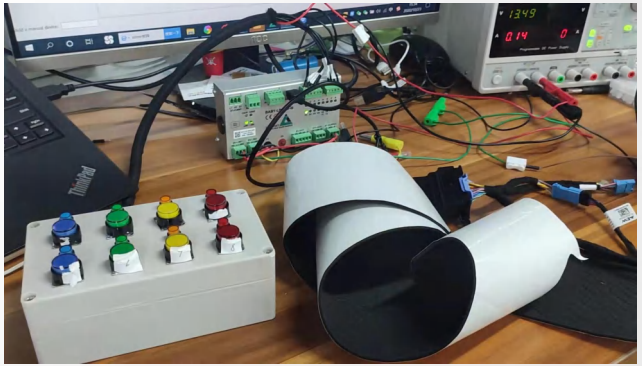

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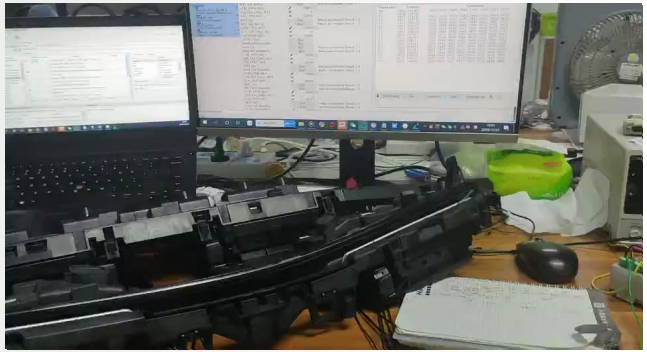

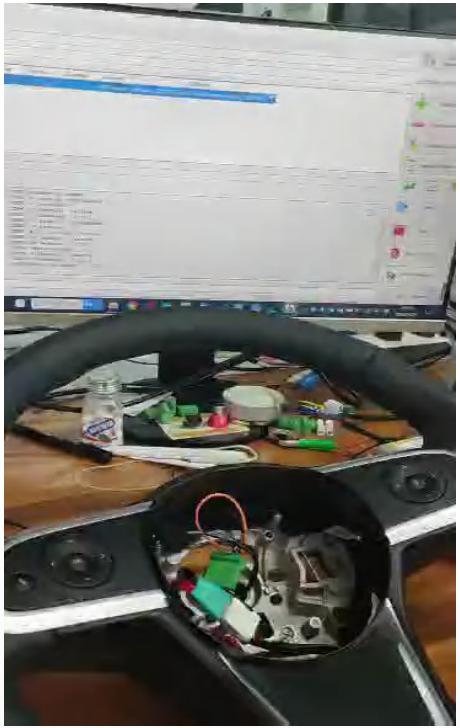

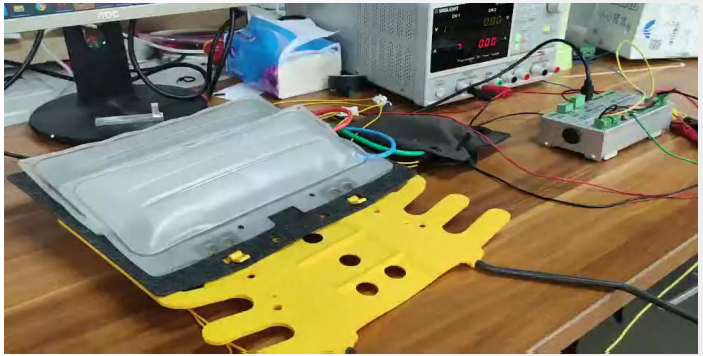

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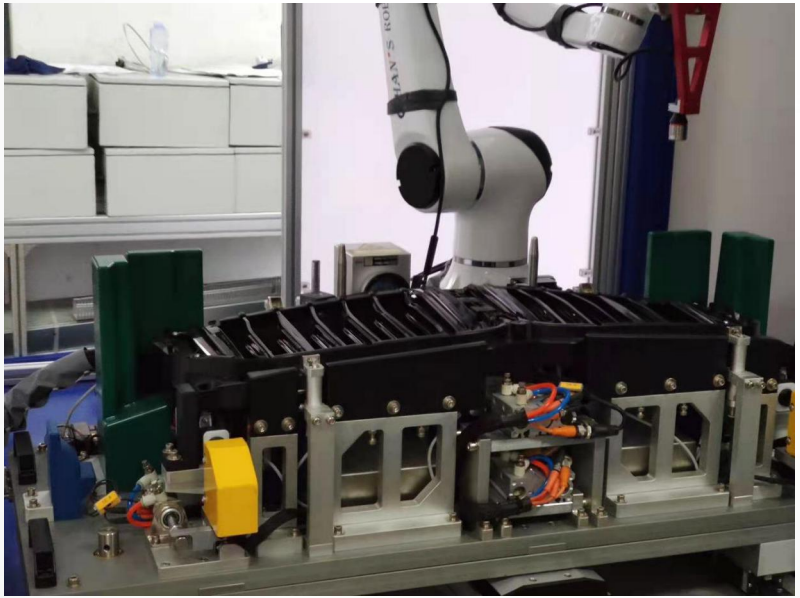
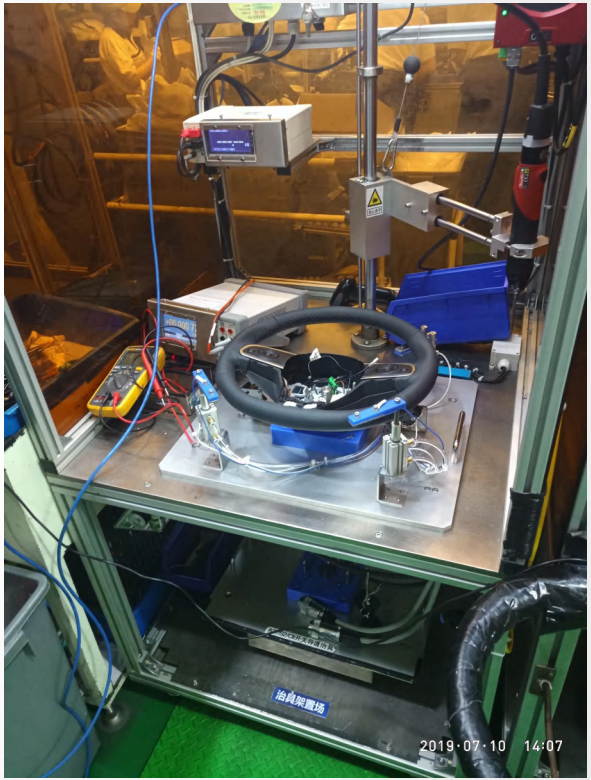


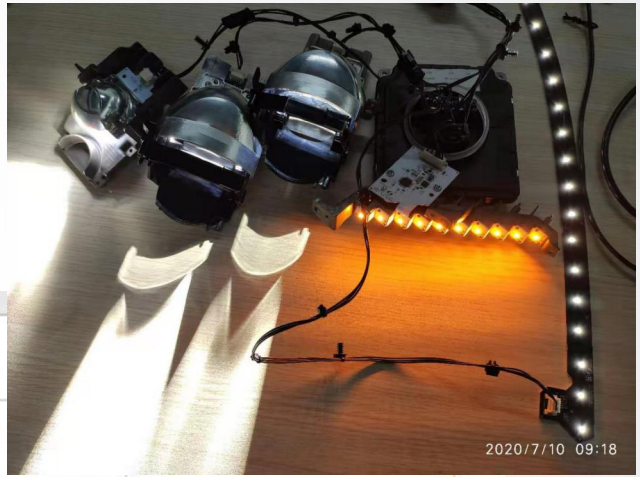


PART 03

# 测试案例分析

# 1.某车型大灯LCU

## 客户需求

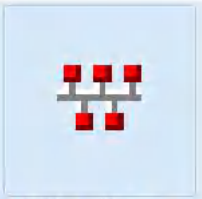



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 两种循环模式 | 1、｛（5xAB+5xBC）+30分钟的OFF状态｝x200 | | | | | | | |
| | 2、｛（2xAB+2xBC）+30分钟的OFF状态｝x200 | | | | | | | |
| 阶段 | AB | | BC | | | | | 备注 |
| 时间 | 50分钟 | 10分钟 | 20分钟 | 10分钟 | 15分钟 | 10分钟 | 5分钟 | |
| 功能 | 日行灯 | 转向灯 | 位置灯 | 转向灯 | 位置灯 | 位置灯 | 位置灯 | 循环开始前和结束时，要解锁和闭锁一次 |
| | | | 近光灯 | 位置灯 | 近光灯 | 近光灯 | 近光灯 | |
| | | | | 近光灯 | | 远光灯 | | |

# 案例分析1.某车型大灯LCU

## 通讯协议

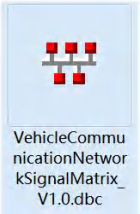
| ECU | Msg Name | Msg ID(hex) | Msg Send Type | Msg Cycle Time (ms) | Msg Length(bytes) | Signal Information 信号信息 | | | | | | | | | | | | | | | | 配置 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Signal Name | Signal Description | Signal Length | Start Byte Position | Start Bit Position | Resolution | Offset | Range 范围 | | Signal Unit | Signal Value Description (dec) | Initial Value (hex) | Invalid value | Remark | Process method | Source | Source signal name | HOJR | C1STD | C1STD+OCT | | |
| 控制器名称/简写 | 报文名称 | 报文ID | 报文发送类型 | 报文周期 | 报文长度 | 信号名称 | 信号描述 | 信号长度 | 起始字节位置 | 起始位位置 | 精度 | 偏移量 | Min-Max(hex)最小值—最大值（十六进制值） | Min-Max(phys)最小值—最大值（物理值） | 信号单位 | 信号值描述 | 初始值(hex) | 无效值(hex) | 备注 | 处理方式 | 源节点 | 源信号 | 出厂信息标签 | E2 | E1 | E2 | E3 |
| BCM | | 0 | 周期事件 | 40 | | | | | | | | | | | | | | | 未使用位定义Byte0填充 | | | | Rx | √ | √ | √ | √ |
| | | | | | | BCM_RightLight | 右转向灯命信号 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | — | 0: 关<br>1: 开 | 0x0 | — | | | | | Rx | √ | √ | √ | √ |
| | | | | | | BCM_PositionLamp | 位置灯状态 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | — | 0: 关<br>1: 开 | 0x0 | — | | | | | Rx | √ | √ | √ | √ |
| | | | | | | BCM_HighBeamStatus | 远光灯状态 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | — | 0: 关<br>1: 开 | 0x0 | — | | | | | Rx | √ | √ | √ | √ |
| | | | | | | BCM_LowBeamStatus | 近光灯状态 | | 1 | | 1 | 0 | 0x0-0x1 | 0~1 | — | 0: 关<br>1: 开 | 0x0 | — | | | | | Rx | √ | √ | √ | √ |
| | | | | | | Right_TailLamp_Water_Control | 右转向流水 | | 7 | | 1 | 0 | 0x0-0x1 | 0~1 | — | 0: 流水<br>1: 常亮 | 0x0 | — | | | | | Rx | | | | √ |
| BCM | | | 周期事件 | 100 | | | | | | | | | | | | | | | 未使用位定义Byte0填充 | | | | Rx | √ | √ | √ | √ |
| | | | | | | BCM_IgnitionSt | 点火开关信号 | | 0 | | 1 | 0 | 0x0-0x3 | 0~3 | — | 0: OFF<br>1: ACC<br>2: ON<br>3: START | 0x0 | — | | | | | Rx | √ | √ | √ | √ |
| | | | | | | BCM_RightDayTimeRunningLampStatus | 右侧日行灯输出状态 | | 7 | | 1 | 0 | 0x0-0x3 | 0~3 | — | 0: OFF<br>1: ON<br>2: 错误<br>3: 无效 | 0x0 | — | | | | | Rx | √ | √ | √ | √ |
| BCM | | | 周期 | 100 | | | | | | | | | | | | | | | 未使用位定义Byte0填充 | | | | Rx | √ | √ | √ | √ |
| | | | | | | BCM_BattVolt | 蓄电池电压 | | 1 | | 0.05 | 0 | 0x000-0x230 | 0~28 | V | | 最近的一个有（last value） | 0x3FF | BCM接螺栓，用模拟蓄电池供电压，拆除后发现数Max，干扰被放掉 | | | | Rx | √ | √ | √ | √ |
| BCM | | | 周期事件 | 25 | | | | | | | | | | | | | | | 未使用位定义Byte0填充 | | | | Rx | √ | √ | √ | √ |
| | | | | | | BCM_GreetingPattern1 | 迎宾模式1 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | — | 0: 禁止<br>1: 使能 | 0x0 | — | | | | | Rx | | | | √ |
| | | | | | | BCM_GreetingPattern2 | 迎宾模式2 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | — | 0: 禁止<br>1: 使能 | 0x0 | — | | | | | Rx | | | | √ |
| | | | | | | BCM_LowBeamStatusBackup | 近光灯状态备份 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | — | 0: 关<br>1: 开 | 0x0 | — | | | | | Rx | | | | √ |
| ELME | | | 周期事件 | 500 | | | | | | | | | | | | | | | 未使用位定义Byte0填充 | | | | Tx | | | | √ |
| | | | | | | BCMR_RTTurnLightFault16 | 右侧转向灯故障 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:无故障<br>1:故障 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RTPositionLightFault16 | 右前位置灯/日行灯故障 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:无故障<br>1:故障 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RightLowBeamFault16 | 右近光灯1故障 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:无故障<br>1:故障 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RightLowBeam2Fault16 | 右近光灯2故障 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:无故障<br>1:故障 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RightHighBeamFault16 | 右远光灯故障 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:无故障<br>1:故障 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RTECU16 | 右前灯控制器状态 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:无故障<br>1:故障 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RightLowBeam216Feedback | 右近光灯1状态反馈 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:关<br>1:开 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RightLowBeam216Feedback | 右近光灯2状态反馈 | | 0 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:关<br>1:开 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RightHighBeamOFFFeedback | 右远光灯状态反馈 | | 1 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:关<br>1:开 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RTPositionLight16Feedback | 右前位置灯状态反馈 | | 1 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:关<br>1:开 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RTTurnLight16Feedback | 右侧转向灯状态反馈 | | 1 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:关<br>1:开 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RightDRL16Feedback | 右日行灯状态反馈 | | 1 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:关<br>1:开 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_UnlockFeedback | BCM解锁动作完成反馈 | | 1 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:未完成<br>1:完成 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_LockFeedback | BCM闭锁动作完成反馈 | | 1 | | 1 | 0 | 0x0-0x1 | 0~1 | | 0:未完成<br>1:完成 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RTLL_LRFailure | 右侧日行灯/前位灯故障 | | 1 | 1 | 1 | 0 | 0x0-0x1 | 0~1 | | 0:无故障<br>1:故障 | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RTLL_Voltage1 | 右侧日行灯前位灯电压 | | 3 | | 0.1 | 0 | 0x00-0x19 | 0~25.5 | V | | 0x0 | — | | | | | Tx | | | | √ |
| | | | | | | BCMR_RTLL_Voltage2 | 右侧日行灯前位灯电压 | | 3 | | 0.1 | 0 | 0x00-0x19 | 0~25.5 | V | | 0x0 | — | | 最小值0x | EMS | | Rx | √ | √ | √ | √ |

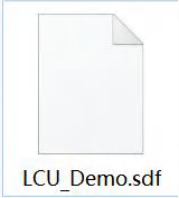


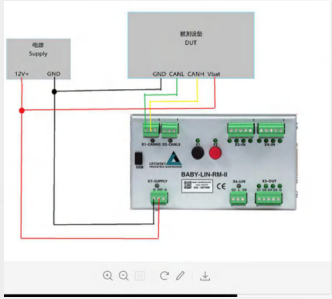
VehicleCommunicationNetworkSignalMatrix_V1.0.dbc

# 案例分析1.某车型大灯LCU

## 环境搭建



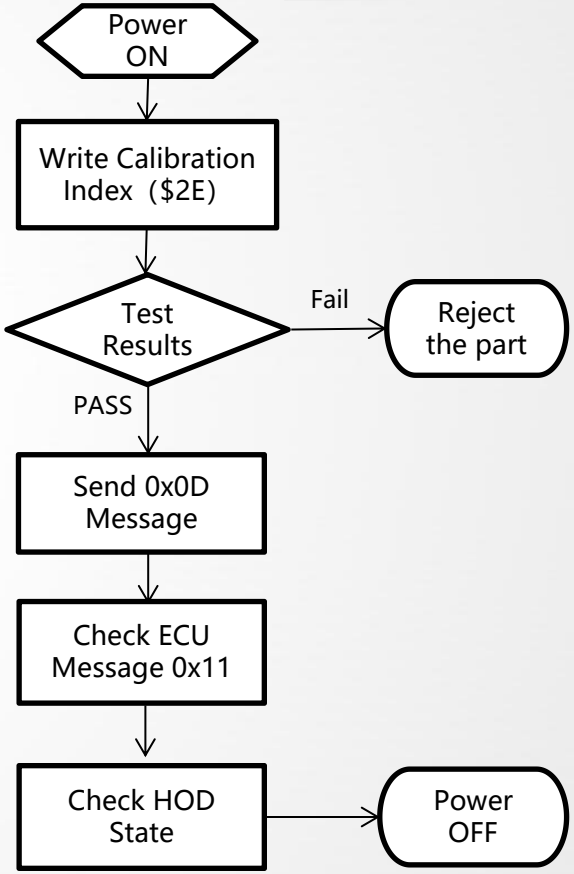
# 案例分析1.某车型大灯LCU

## 测试实施

# 2.某车型方向盘HOD EOL

## EOL Test Flow

1. Power on.
2. Write calibration index into ECU by Service ID 2Eh.(Detailed information see following page.)
3. Send ID 0x0D with 4 bytes data to HOD ECU.(detailed information see following page.)
4. Wait 2500ms.
5. Send ID 0x11to HOD ECU at empty steering wheel state.(detailed information see following page.)
6. Check if **no error** and hands on state is **Hands off**.
7. Send ID 0x11 to HOD ECU at activation tool state.
8. Check if **no error** and hands on state is **Hands on**.
9. Power off.



# 案例分析2.某车型方向盘HOD EOL

```
// version 9.0.0
   0.000162 Li SleepModeEvent 0 starting up in wake mode
607761  17875.608281  17875.608802  17875.609323  17875.609844  17875.610365  1787
19883.007455 Li 3c              Tx     8 30 06 2e [illegible] ff ff  checksum = fa
19883.057370 Li 3d              Rx     8 30 03 7f 2e 78 ff ff ff  checksum = a6
19883.107408 Li 3d              Rx     8 30 03 7f 2e 78 ff ff ff  checksum = a6
19883.157422 Li 3d              Rx     8 30 03 6e [illegible] ff ff ff  checksum = be
19884.866981 Li d               Tx     4 7e 61 fe 00              checksum = 14
19884.893927 Li d               Tx     4 7e 61 fe 00              checksum = 14
19886.923037 Li 11              Rx     8 97 00 2e 38 3e 00 00 00  checksum = b2
```

Calibration parameter 1 or 2

Positive response of write calibration.

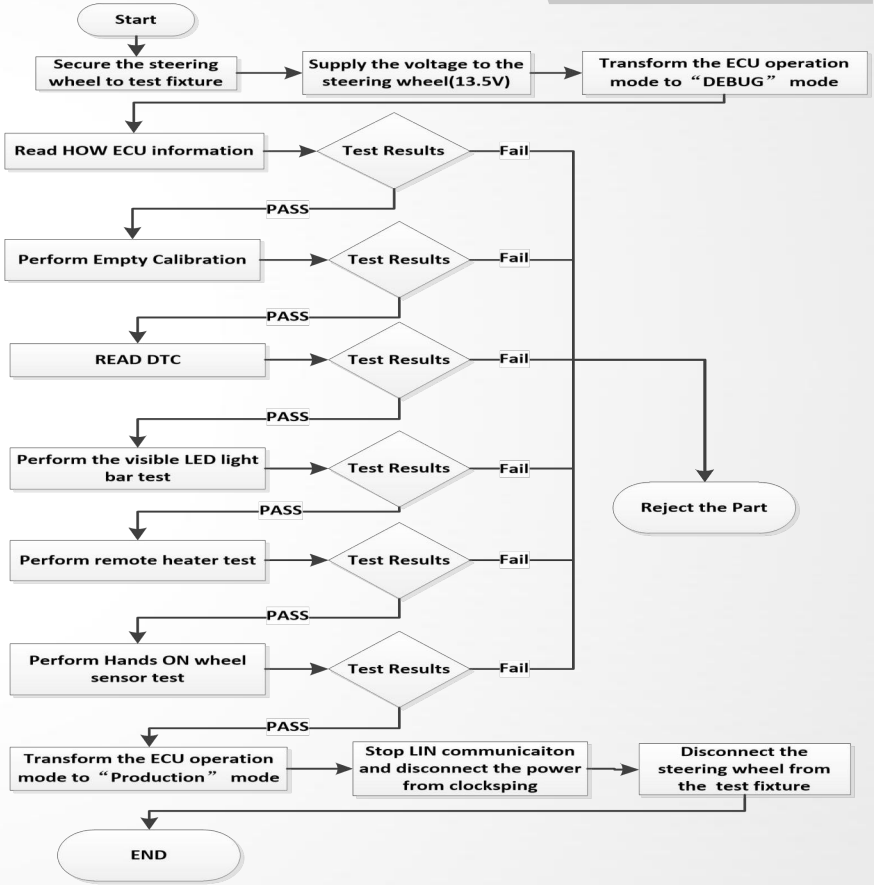
Standard message: 0x0D Just to make sure the lowest bit in second byte is 1.

Standard message : 0x11

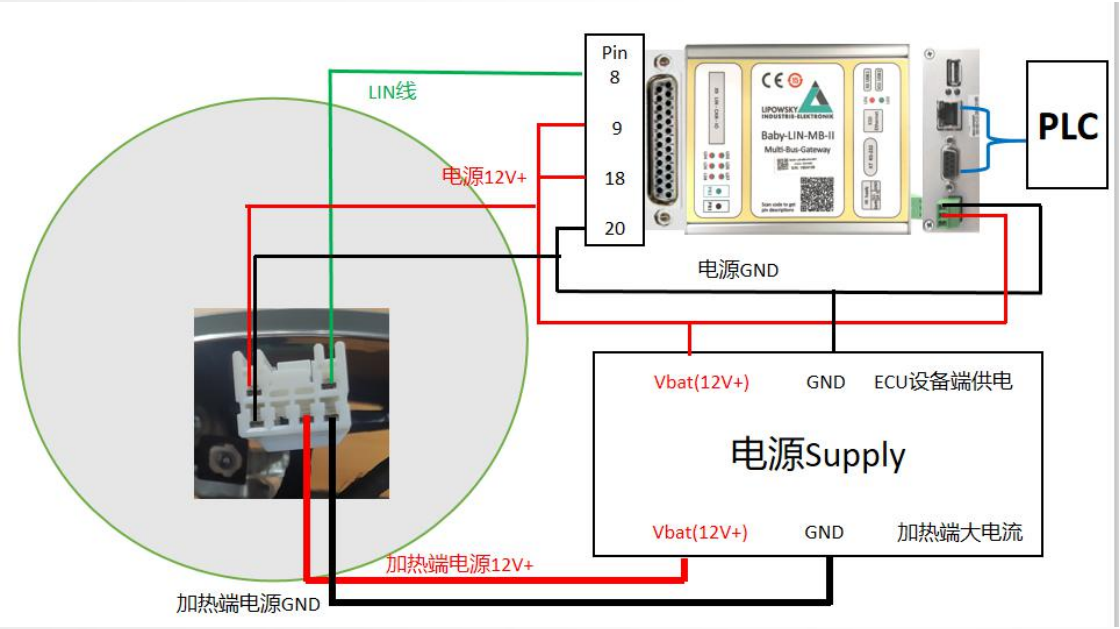
# 案例分析3.某车型方向盘EOL

## 3.某车型方向盘EOL

EOL 流程框图



# 案例分析3.某车型方向盘EOL



# 案例分析3.某车型方向盘EOL

SDF Version 3

1-LIN: [redacted]

- Verify Mode
- Debug Develop Mode
- Develop Mode
- Delay Verify
- Clear DTC
- Data Sequence
- ECU Serial Number
- Bootloader Part Number
- Software Part Number
- Read-Only Config Part Nu...
- Read-Write Calibration Pa...
- HOW Software Traceabilit...
- Read DTCs LSB
- Read DTCs MSB
- Active Faults
- History Faults
- Empty Calibration
- IQ Error
- IQ Request
- Get Value I
- Get Value Q
- Read IQ
- LEDs OFF
- Red ON
- Green ON
- Blue ON
- Yellow ON
- Offset Calibration

Macro number 5

Name Data Sequence

Parameter count 0

Comment

| | Label | Condition | Command | Comment |
|---|---|---|---|---|
| 0 | | | Select schedule BCM_Schedule_1 with mode "Cyclic" | |
| 1 | | | Set signal "Data Sequence" to value 0 | |
| 2 | | | Delay 20ms | |
| 3 | read data | | Execute service Read ECU Parameters of protocol DiagEOL | |
| 4 | | | Delay 20ms | |
| 5 | | If Signal Data Sequence = 15 | Exit | |
| 6 | | | Add 1 to signal "Data Sequence" | |
| 7 | | | Jump to "read data" | |

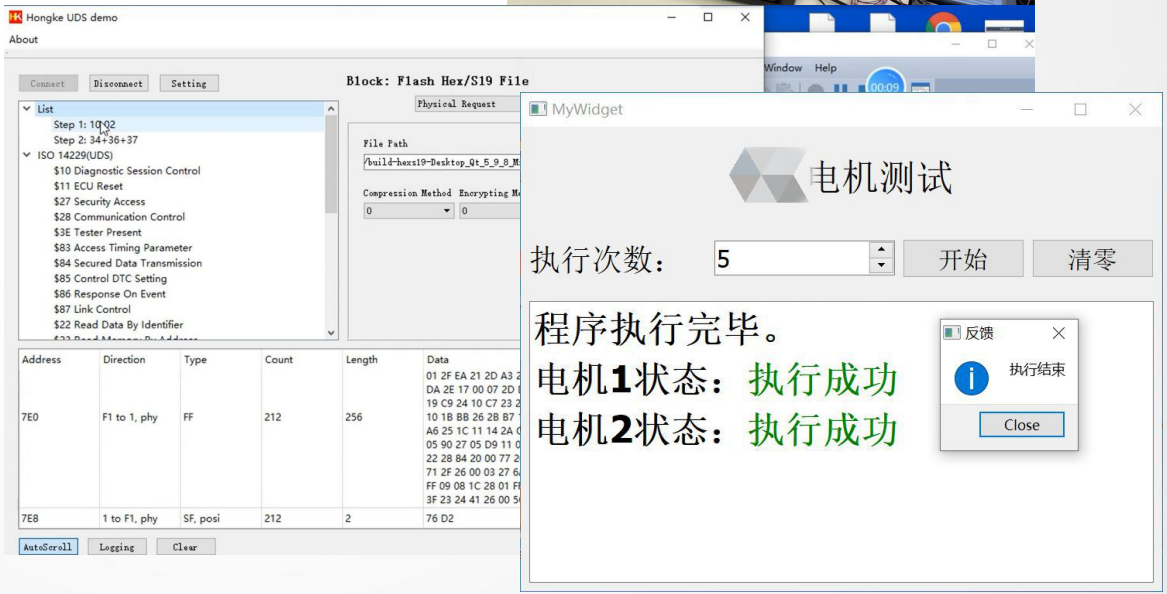
Add Remove Duplicate toggle disable flag Copy Elements Paste Elements

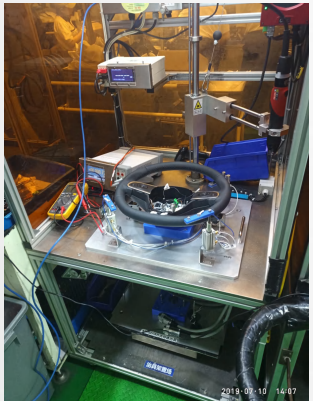
# 案例分析

HongKe 虹科

## 虹科能为您提供哪些通信测试服务？

1. 设备功能、耐久、EOL等测试
2. CANLIN设备一致性测试
3. 上位机定制开发服务
4. 配合设备供应商定制产线



# 谢谢观看

- 何志阳
- 广州虹科 车辆网络事业部