

基于TMR技术的无磁芯电流检测方案

TMR-based magnetic-core-less design for current detection

EVCP2021工业报告仅限于内部文件，注意保密勿外传！

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- 传统电流传感器的局限
- 无磁芯的TMR电流传感器
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 - ▣ 铜排电流检测方案

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希磁科技公司概况

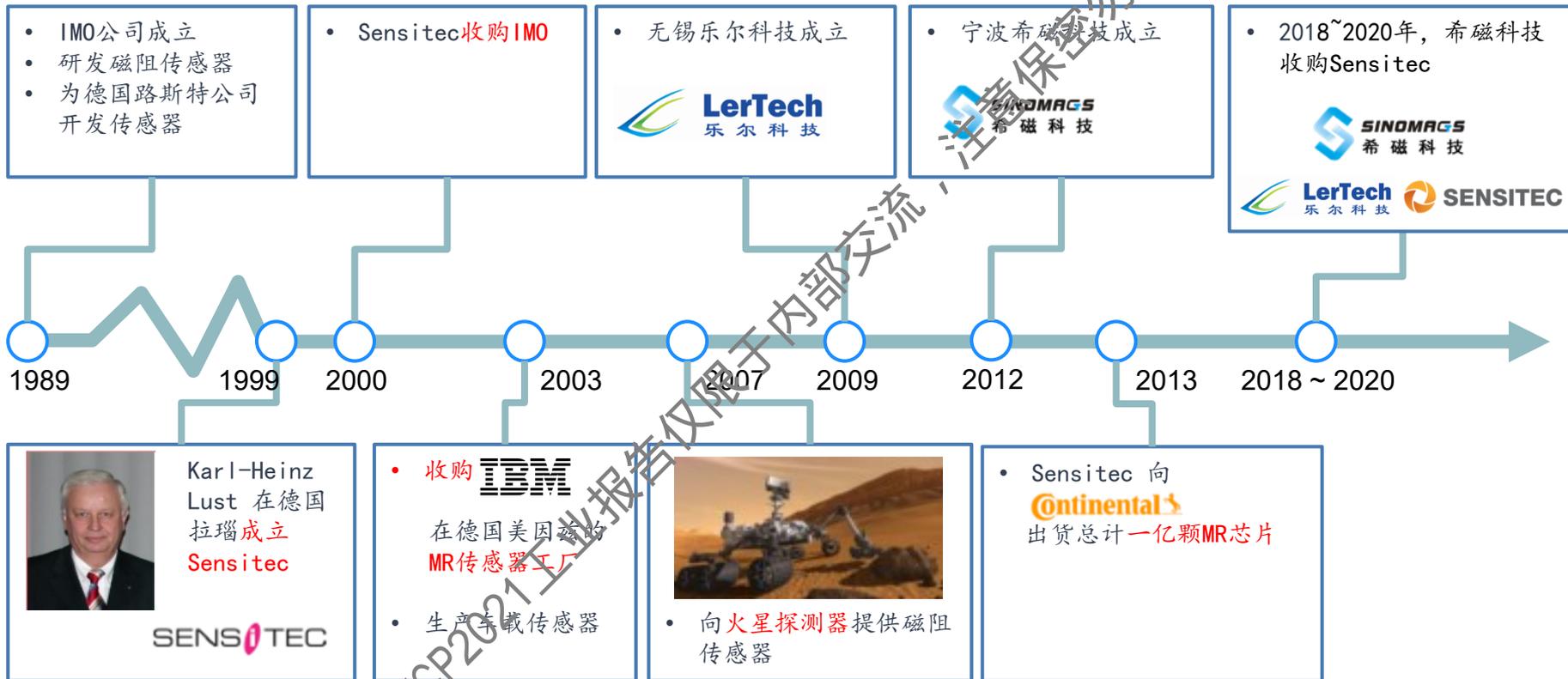
员工
500人



磁性传感器芯片
~ 2 亿颗/年

地点	功能	人数	描述
无锡 	R&D Center 特殊传感器	120 人	<ol style="list-style-type: none"> 1. WAFER → CHIP → MODULE → SYSTEM的研发 2. 货币检伪磁性传感器生产
宁波 	电流传感器 RD & 生产	220 人	电流传感器的研发 & 生产
德国 	RD & 生产 xMR 生产线	150 人	<ol style="list-style-type: none"> 1. WAFER → CHIP → MODULE → SYSTEM的研发 2. 磁性传感器的生产

希磁科技公司里程

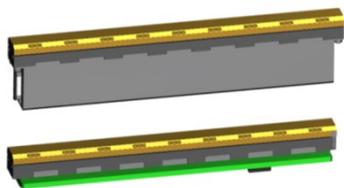


希磁科技产品家族

典型行业



典型产品



角度、位移



AA FreePitch®
Sensors (SO8)



AFF Field
Sensors (LGA)



GLM Tooth
Sensor
Modules



GA 3D-Field
Sensors (Chip)

电流检测



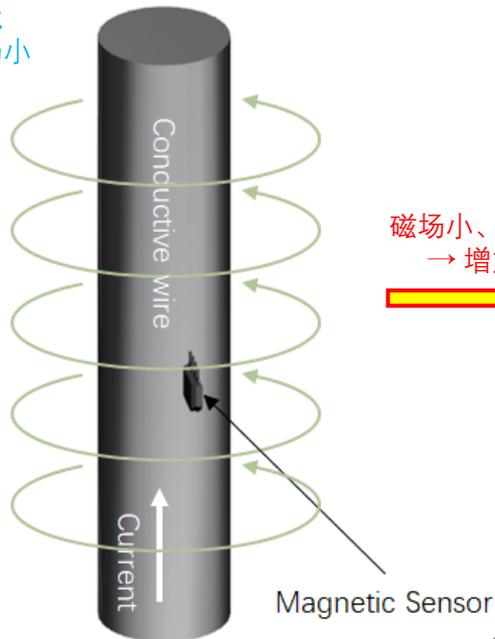
典型客户



电流传感器原理：磁感应芯片 → 开环 → 闭环

外磁干扰
耦合磁场小

体积小
频响高

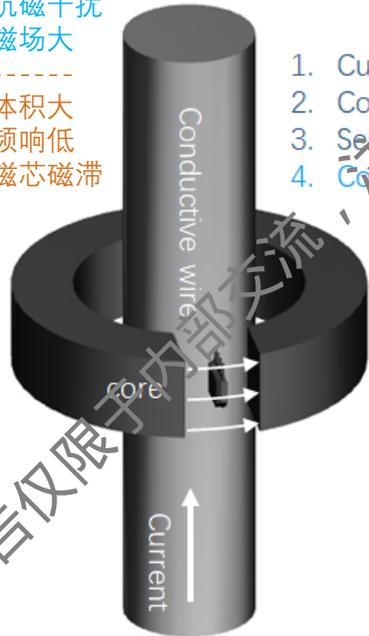


Current detection
by Magnetic Sensor

磁场小、外场干扰
→ 增加磁芯

抗磁干扰
磁场大

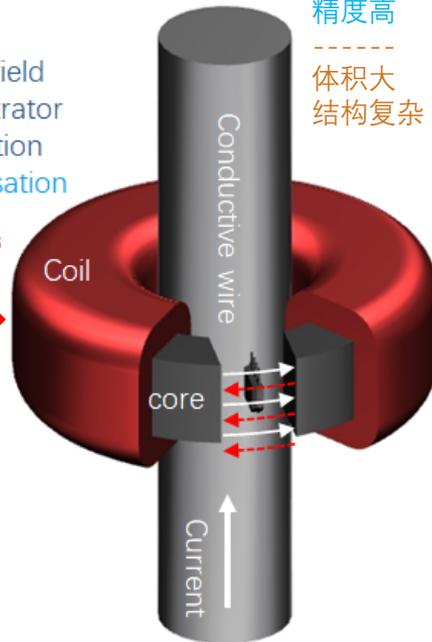
体积大
频响低
磁芯磁滞



Open-loop Current Sensor
with magnetic core

频响、温漂、磁滞
→ 增加反馈线圈

1. Current Magnetic field
2. Core Field Concentrator
3. Sensor Field Detection
4. Coil Field Compensation



Close-loop Current Sensor
with magnetic core
& feedback coil

精度高

体积大
结构复杂

电流检测用磁感应器件技术

磁通门：1920年代

1. 电荷在外磁场中运动
2. 电荷的运动产生电压

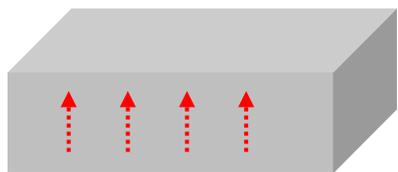
1. 磁性薄膜中电荷流动（电流）
2. 薄膜中磁矩与电流有夹角
3. 该夹角可被外磁场改变
4. 电阻与该夹角直接相关

1. 电子有两个自旋态，自旋态被磁矩定义
2. 磁性材料的磁矩，可定义电子自旋态
3. 两个导电磁层材料做电极，两个电极之间做 nm 级绝缘层，形成“结”
4. 不同自旋态的电子可选择性流过该绝缘层
5. 外磁场改变磁性材料的磁矩方向，从而定义电子的自旋态，从而对应“结”的不同阻值

响应：1 μ s；分辨： $\sim 10^{-2}$ Gs

响应： \sim ns；分辨： $\sim 10^{-4}$ Gs

灵敏度方向



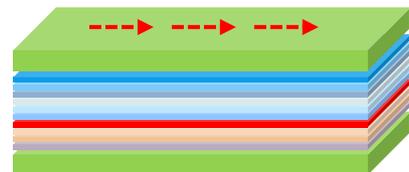
HALL



AMR



GMR



TMR

1960

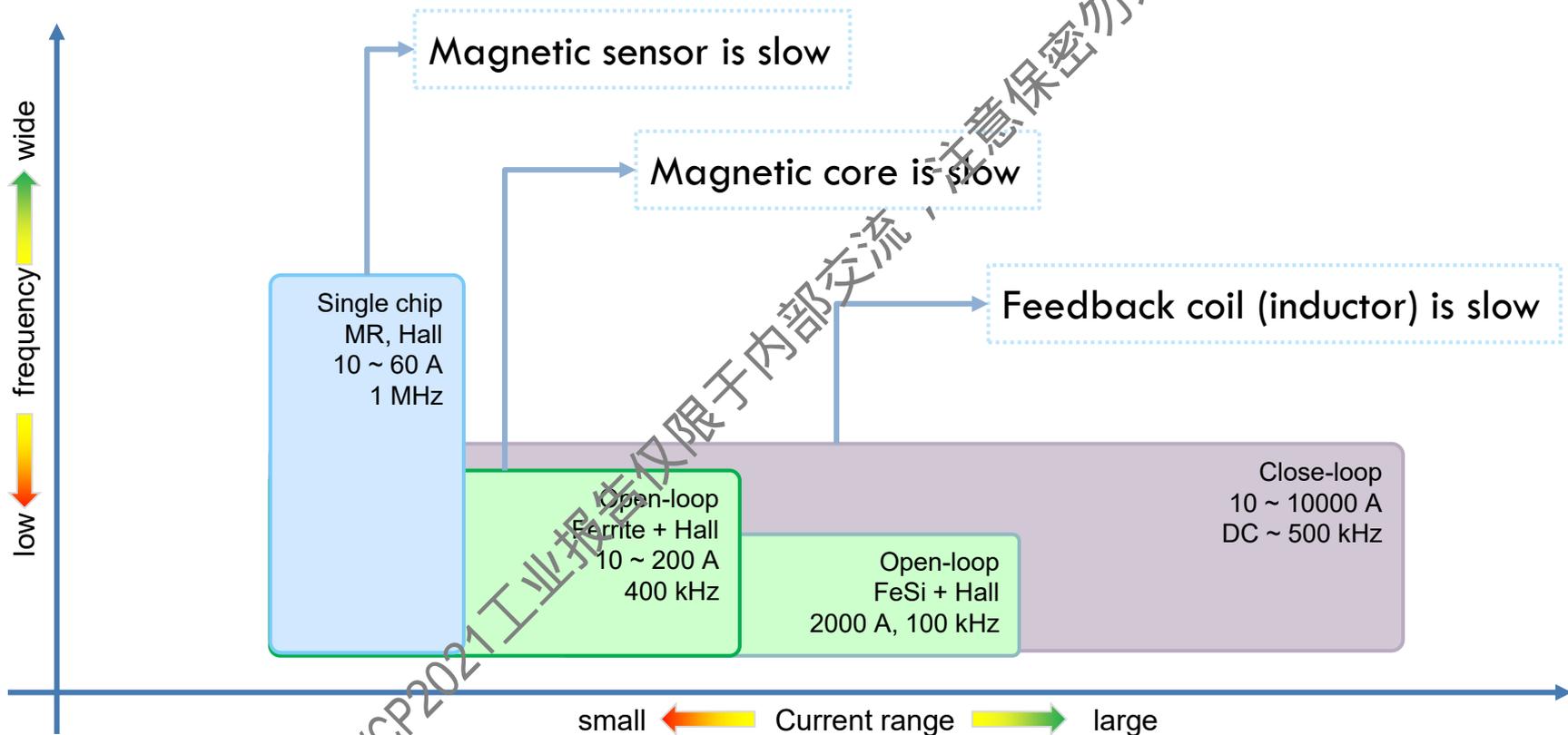
1980

1990

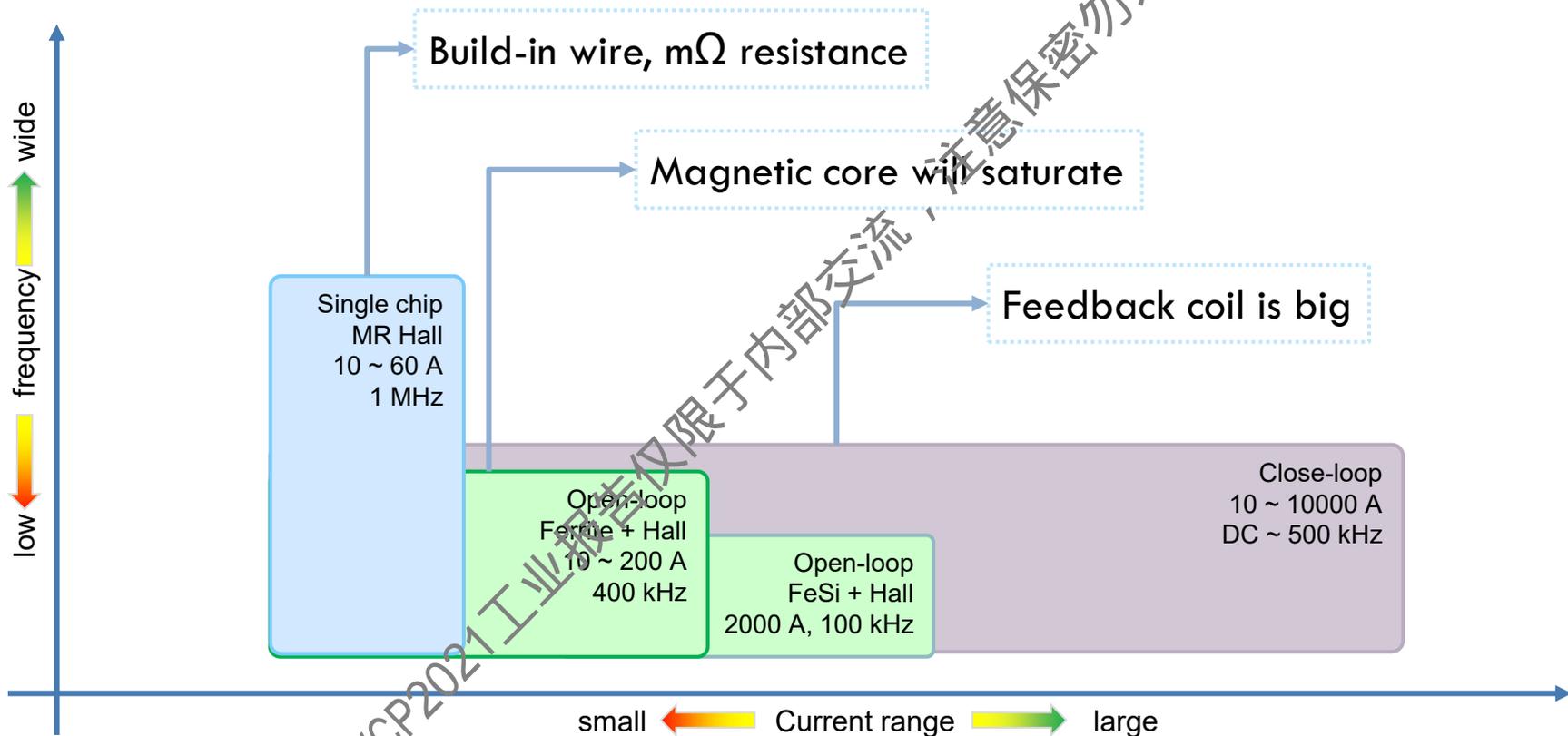
2000

2010

电流传感器传统方案：频率带宽限制

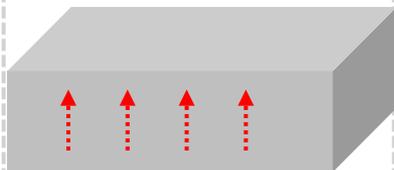


电流传感器传统方案：电流量程限制



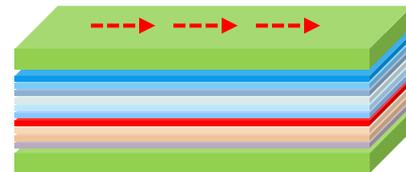
无磁芯的TMR电流检测方案：量程 & 频响

Hall



Fast response time, big current range

TMR



频响

$\sim \mu\text{s}$

DC ~ MHz

Upgrade the frequency performance

$\sim \text{ns}$

DC ~ GHz

分辨率

10 mGs

Mag. Core:

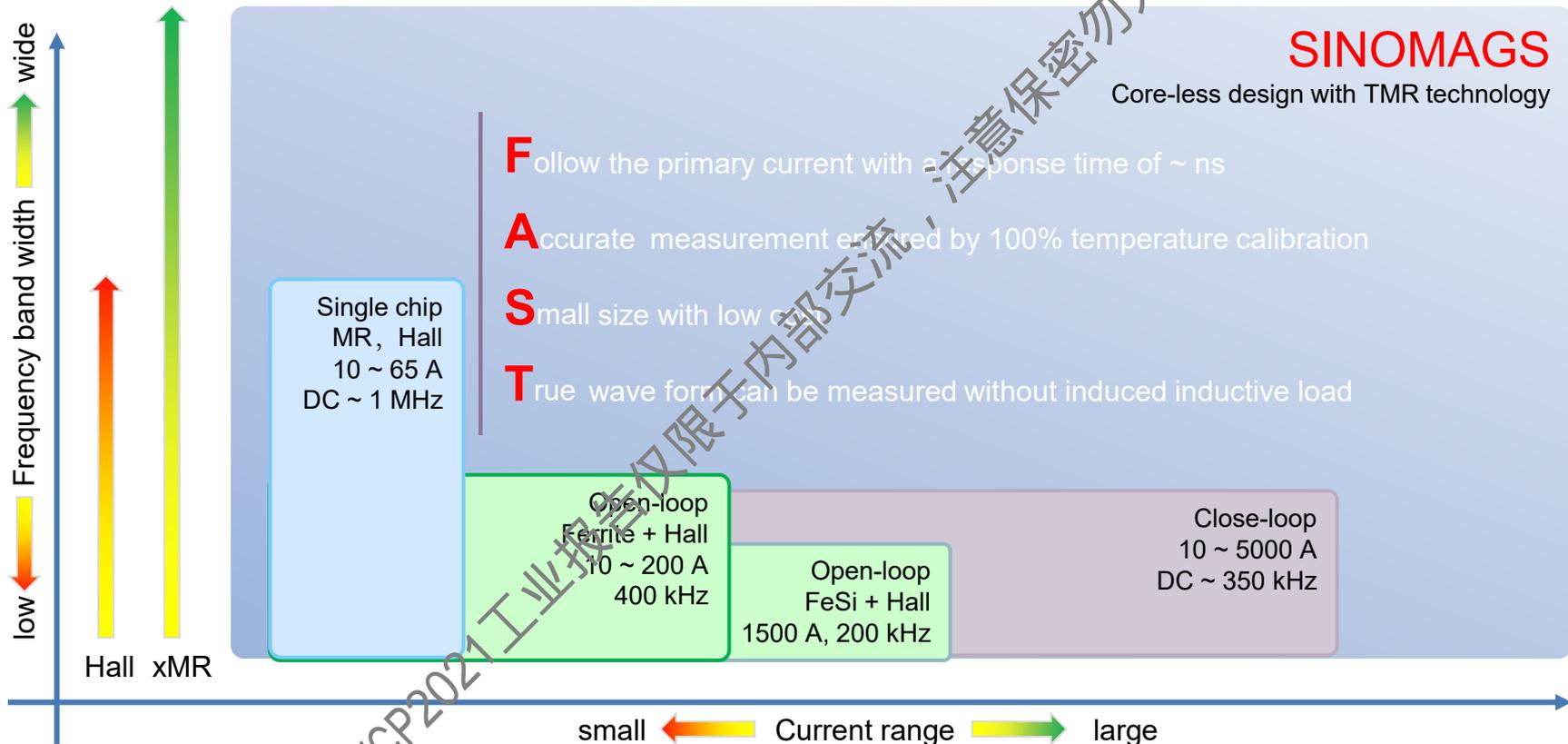
Remove the limitation of core

0.1 mGs

Core-less

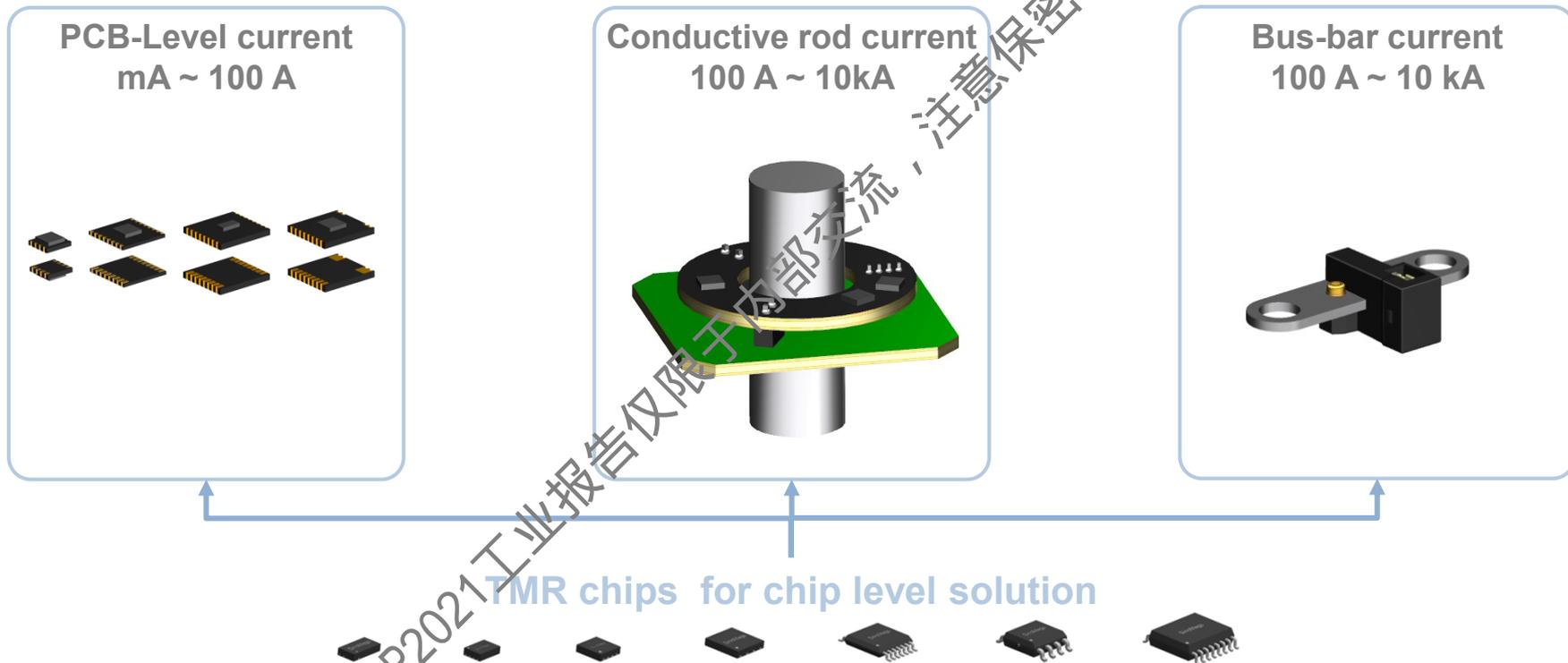
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无磁芯的TMR电流传感器



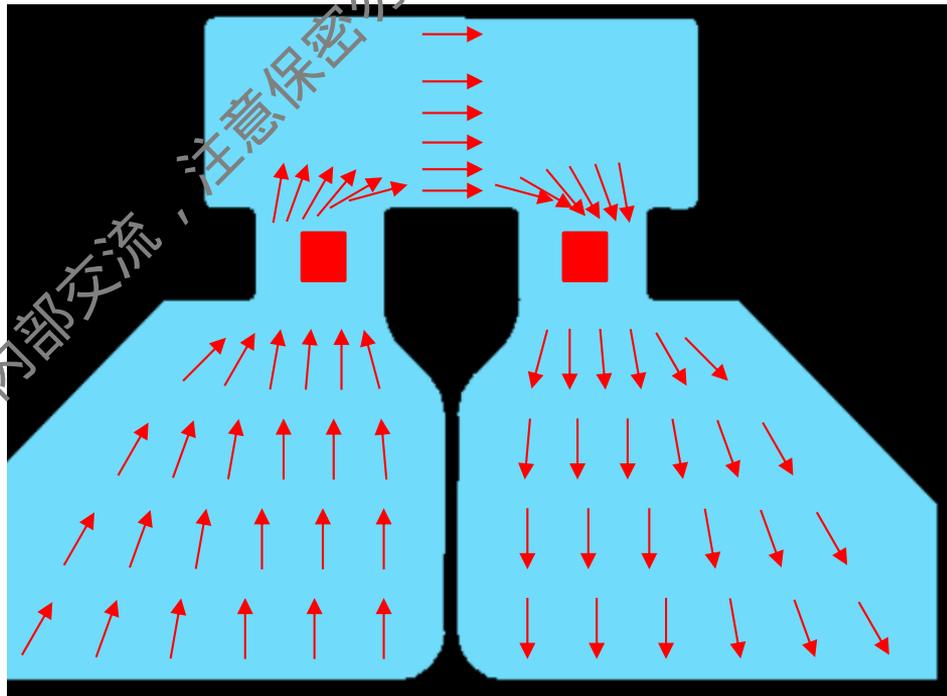
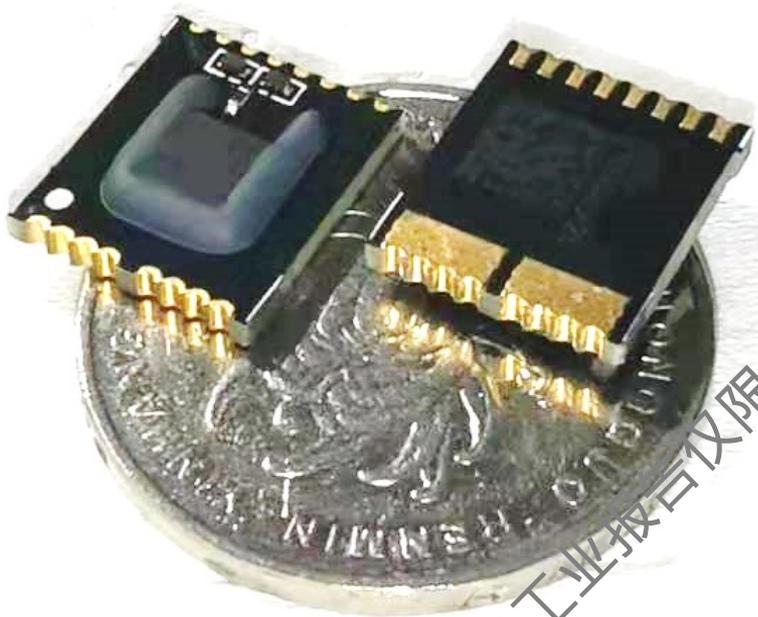
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几种工作方式



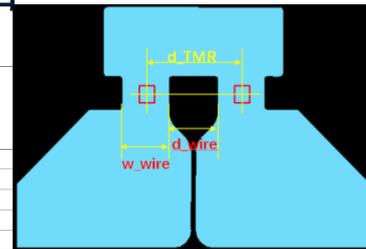
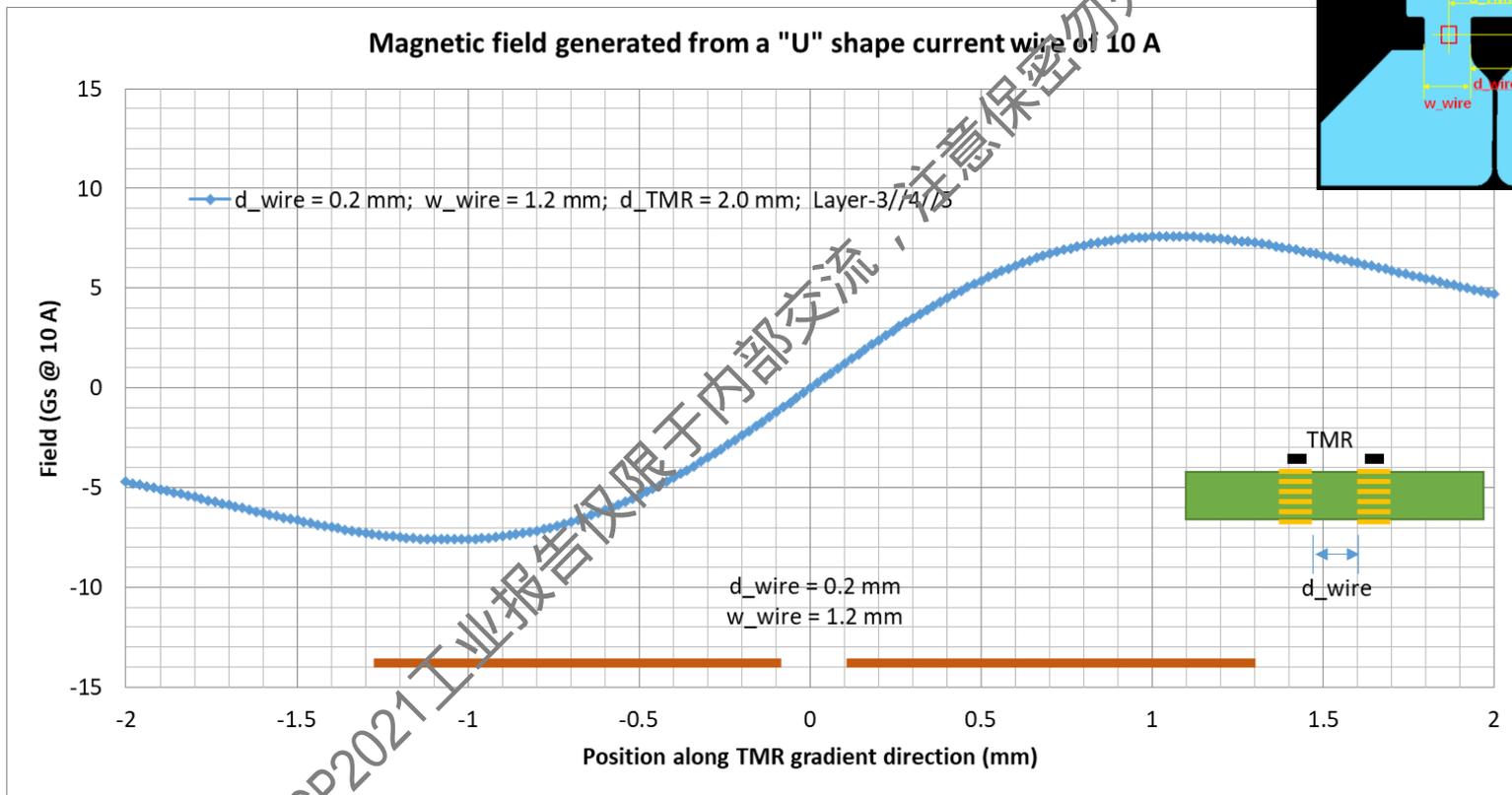
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PCB电流检测方案：STK-616产品系列

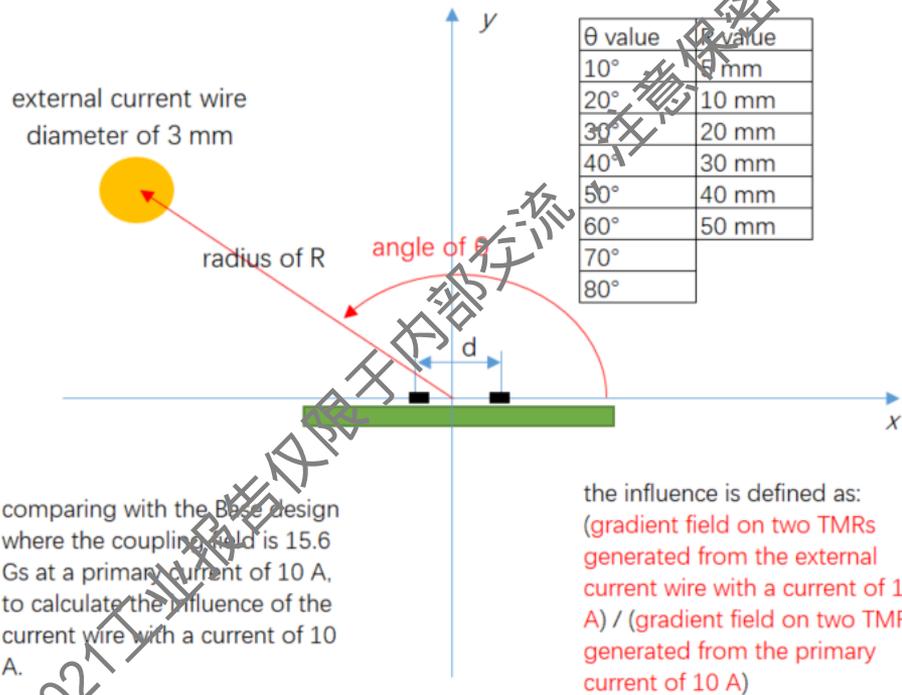


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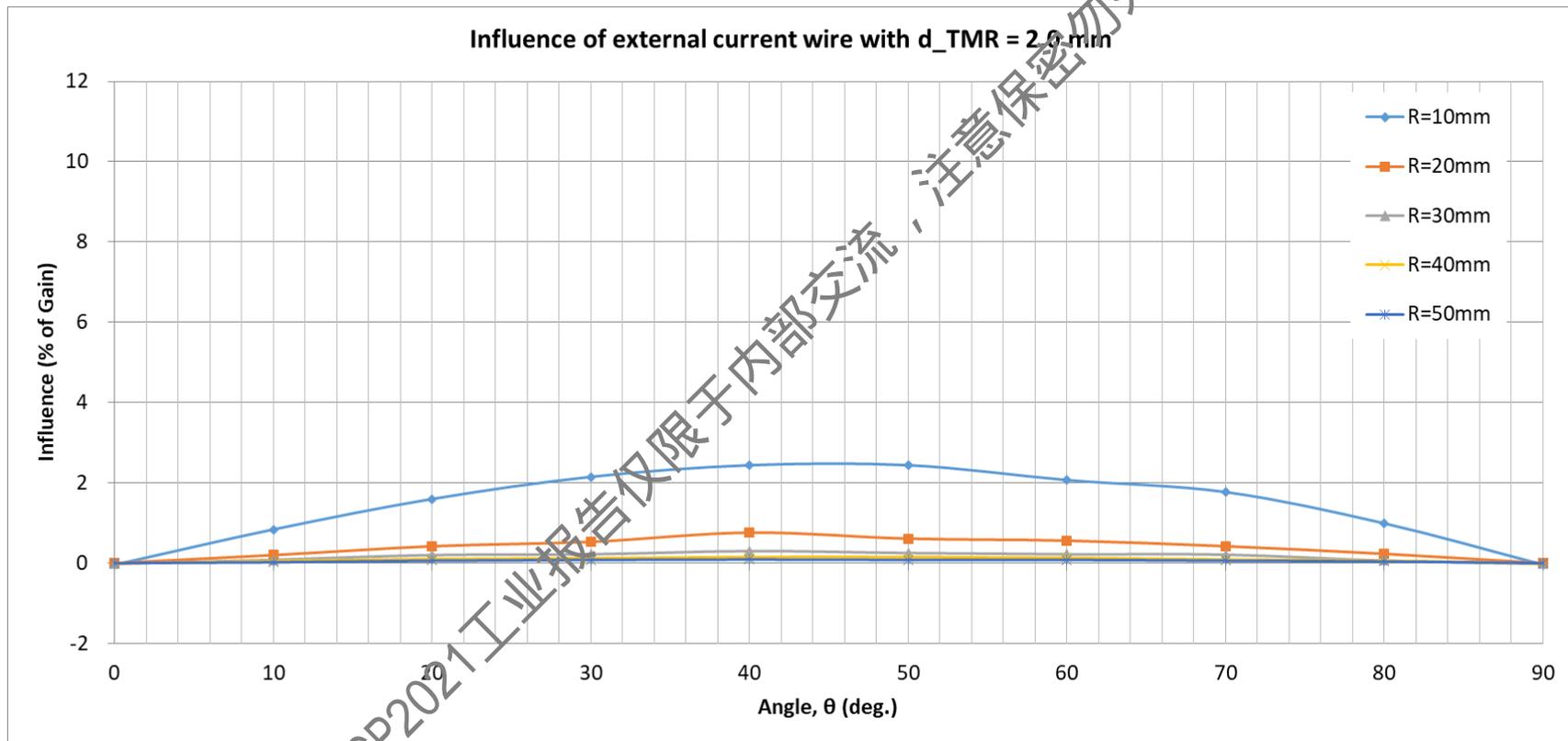
PCB电流检测方案：电流-磁场耦合



PCB电流检测方案：外部导线干扰描述

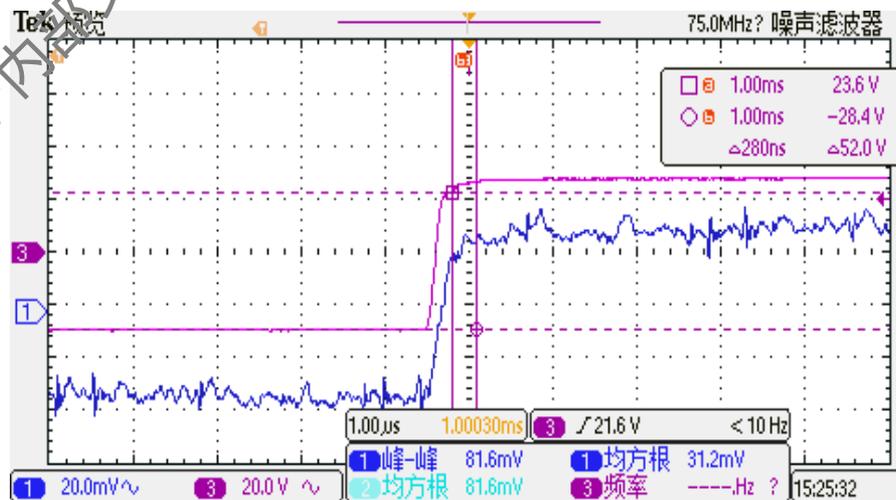
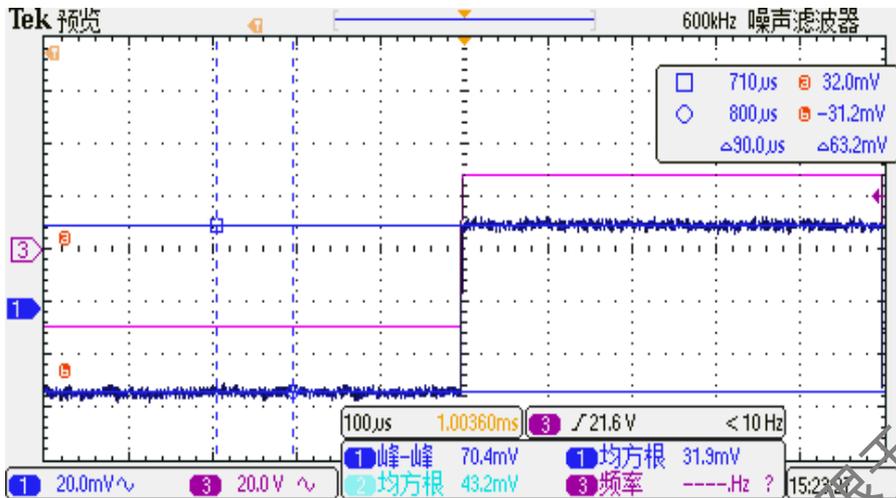


PCB电流检测方案：外部导线干扰情况



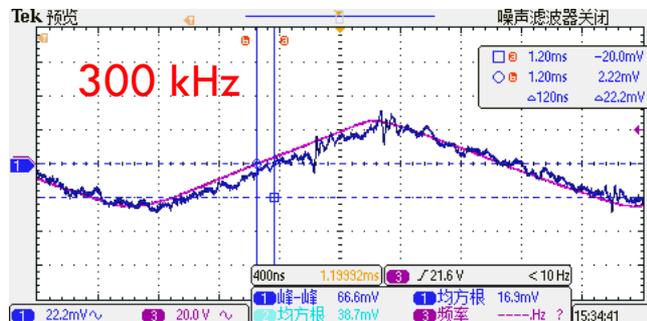
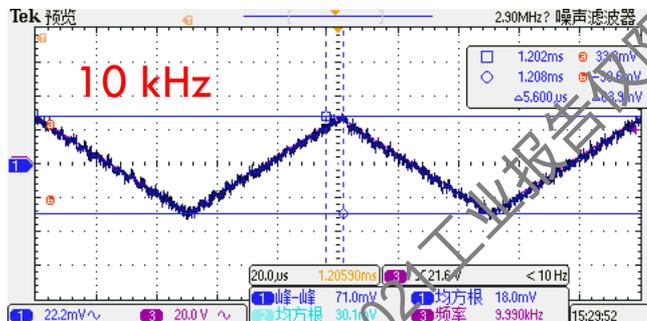
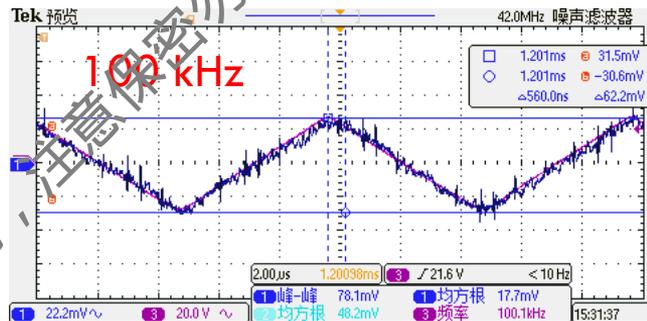
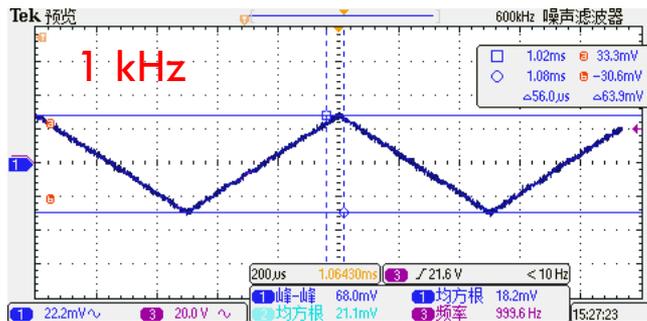
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PCB电流检测方案：阶跃响应 ~ 300 ns



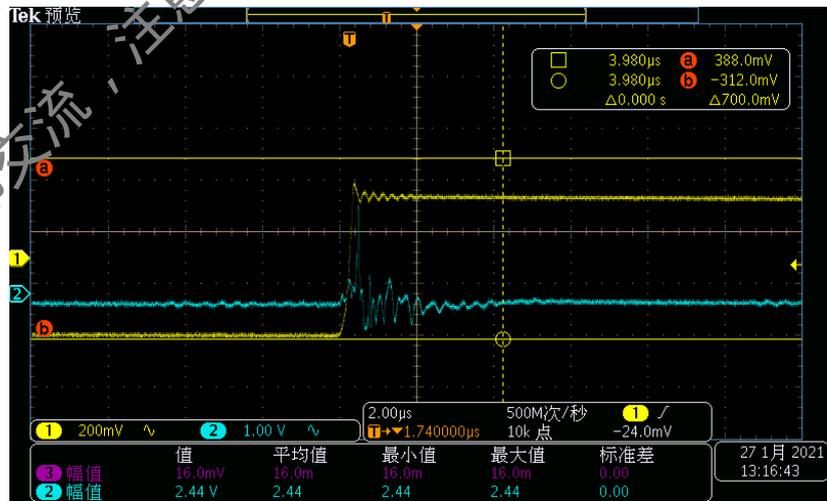
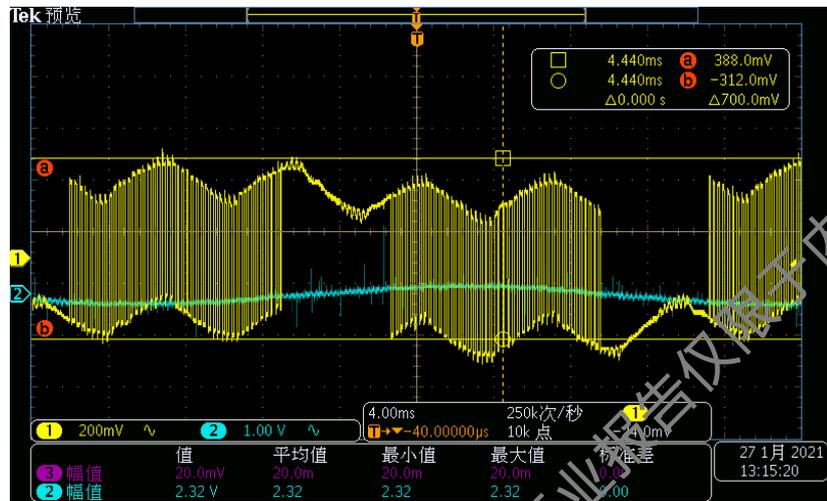
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PCB电流检测方案：三角波延时 ≈ 120 ns



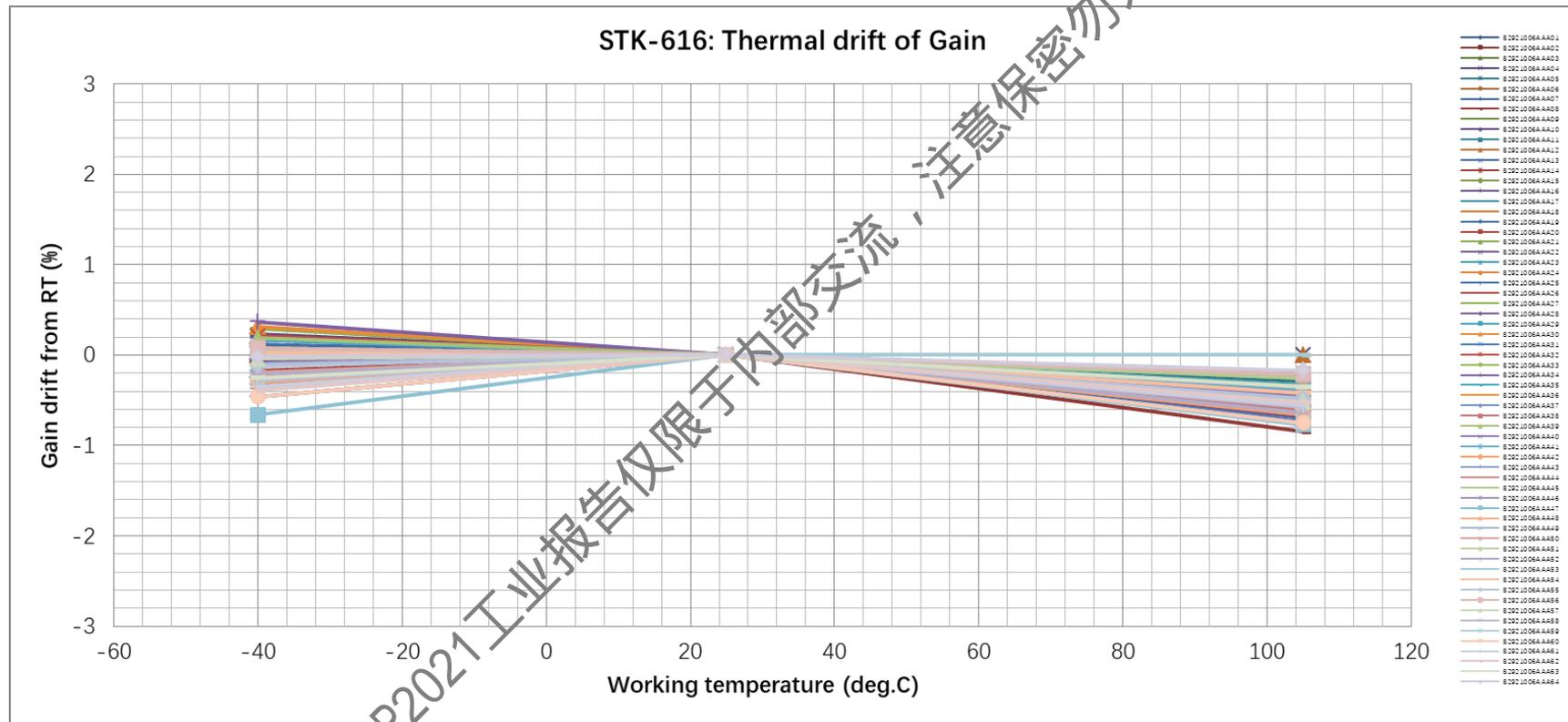
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PCB电流检测方案：dV/dt测试



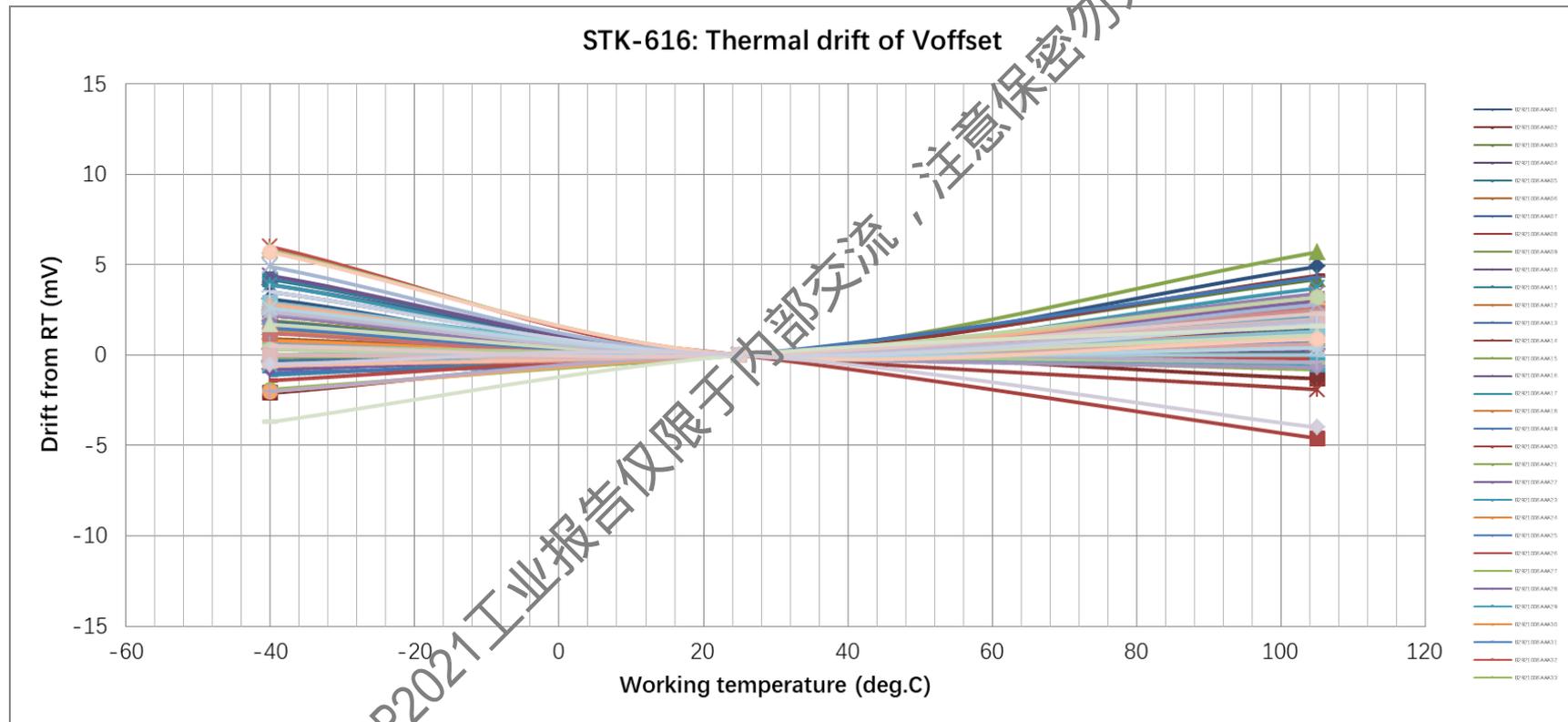
黄色为变频驱动器两相间电压
蓝色为STK-616产品输出

PCB电流检测方案：增益温漂



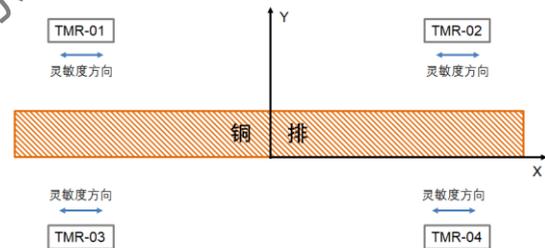
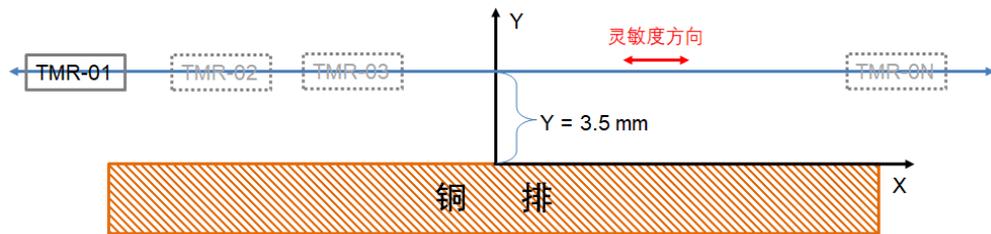
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PCB电流检测方案：Offset温漂

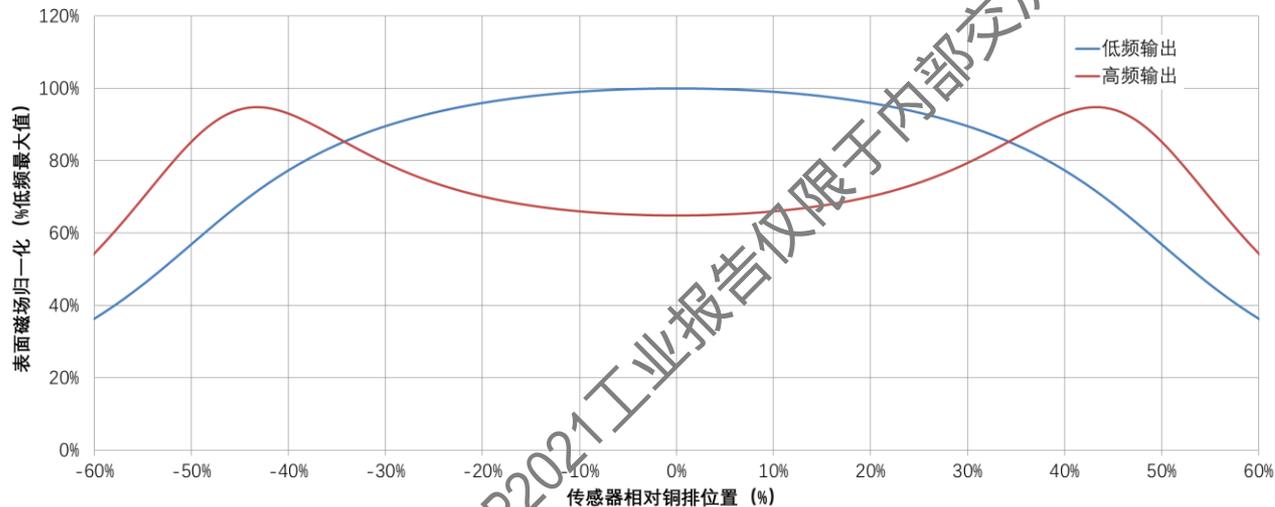


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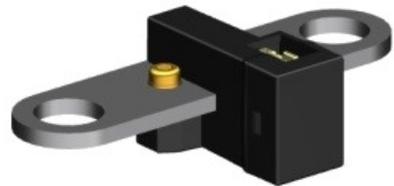
铜排电流检测方案



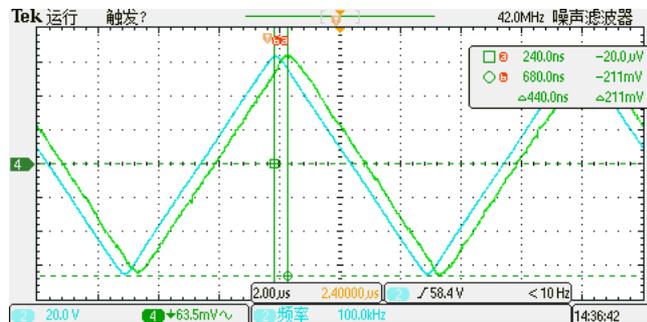
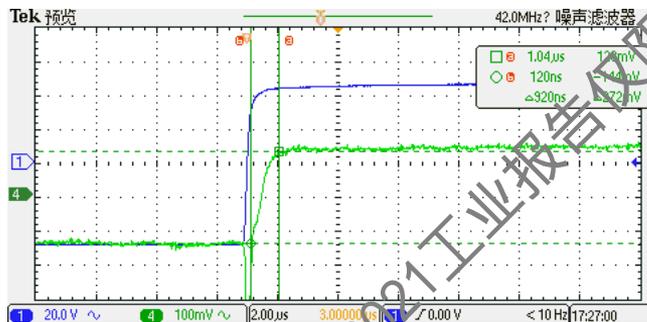
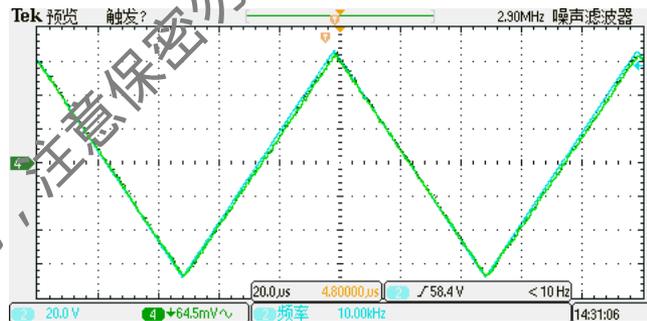
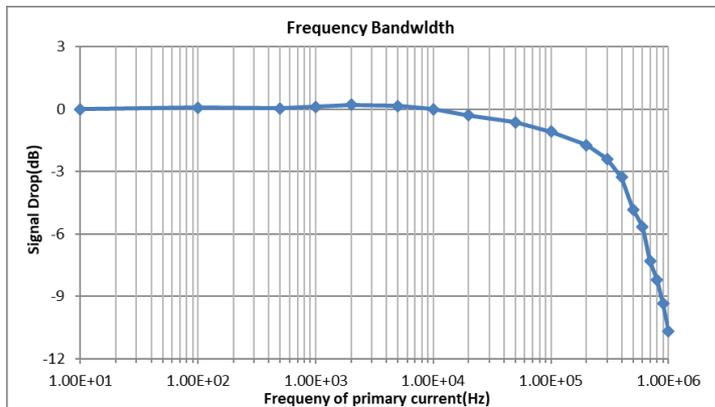
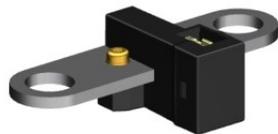
铜排表面磁场与铜排电流频率的关系



STK-GB/W

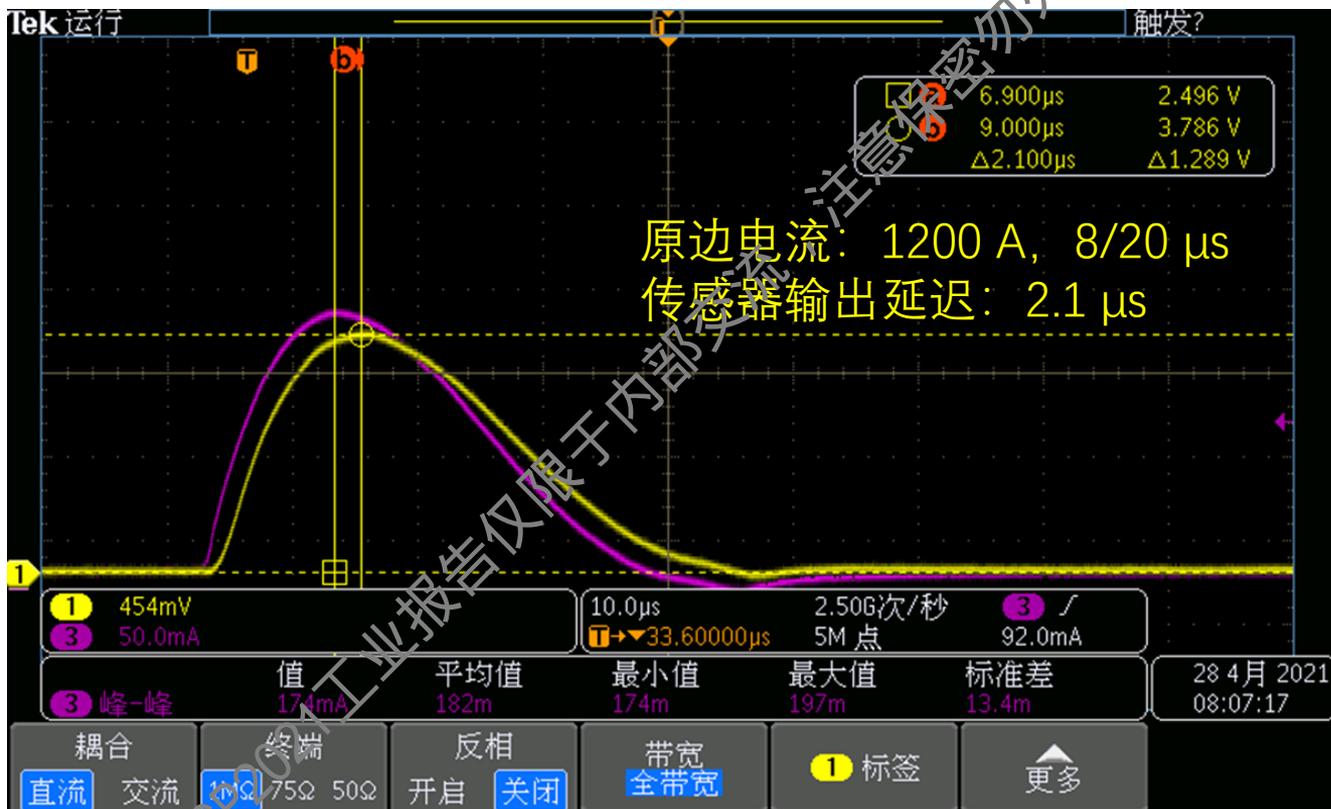


铜排电流检测：频率特性！

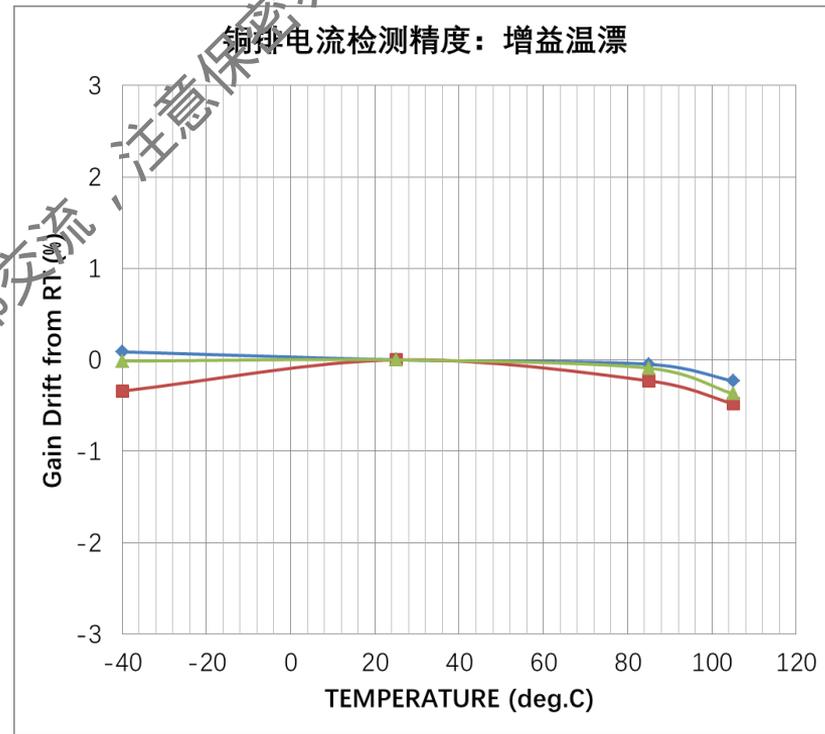
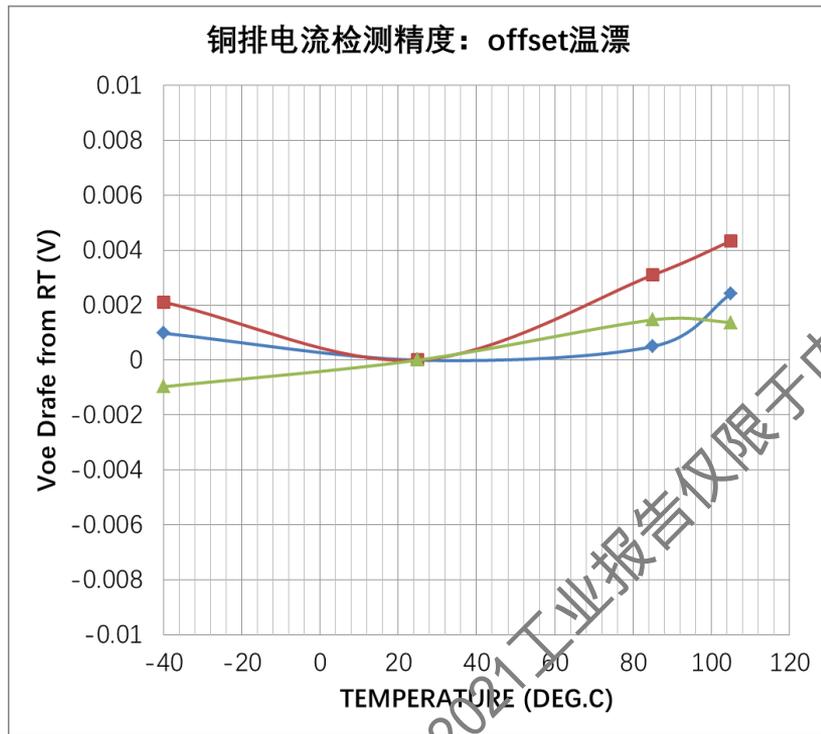
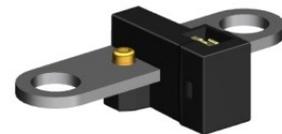


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铜排电流检测：1200 A电流脉冲测试



铜排电流检测：精度温漂



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THANK YOU

Please contact us: jianmin.bai@sinomags.com

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