

PSQ 6000: Advanced Quality Assurance in Spot Welding

PSQ 电阻点焊接质量保证系统

博世力士乐（中国）有限公司

PSQ 6000: Advanced Quality Assurance in Spot Welding

- Requirements to Welding Control
电阻焊接的需要
- New Regulators: 新的调整方式
 - Ultrasonic Regulator USR
超声波反馈系统
 - Voltage-Current Regulator UIR
恒功率反馈系统
- PSQ6000: Components, Benefits
PSQ6000: 组成, 好处
- Function of UI Regulator, Software BQR
恒功率反馈系统的软件功能

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- **Requirements to Welding Control**电阻焊接的需要
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Requirements from Car Body Shop

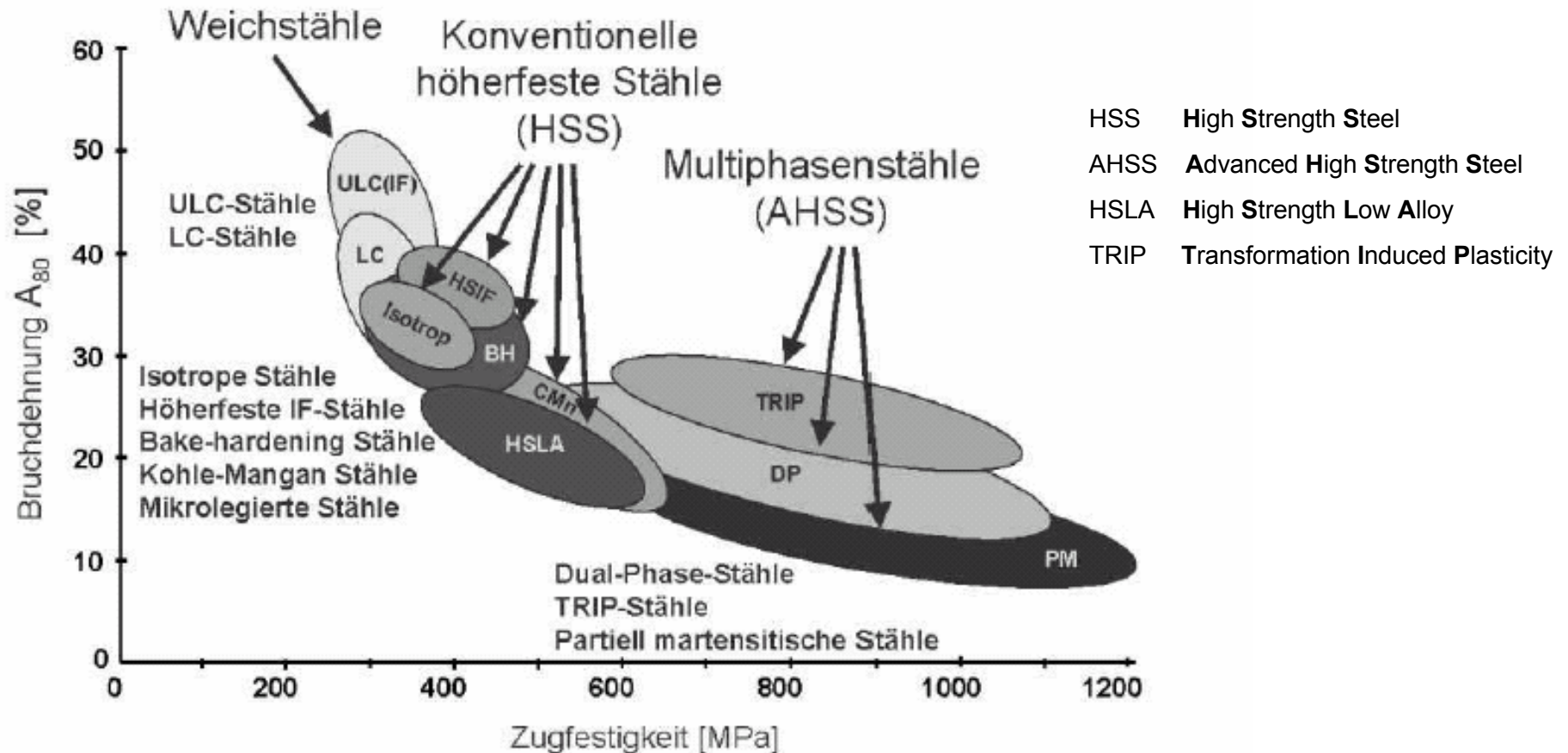
- Better crash **stability**
碰撞的稳定性要求



- Reduction of **weight**
减少车身的质量



Requirements from Car Body Shop: Utilization of New Steel Material 新材料的使用



aus: Tagungsband SLV-Tagung 2004 „Treffpunkt Widerstandsschweißen“, S.139

Referat: Optimierung der Gebrauchseigenschaften von punktgeschweißten Verbindungen an höherfesten Multiphasenstählen

Requirements from Car Body Shop: Process Control 过程控制

Higher demand to current regulator due to:更高的电流精度调整要求

- Utilization of **high-strength steel** 使用高强度钢板
 - Smaller tolerance band for weld parameters 公差带更小
 - Fitting problems due to higher rigidity of material 装配不好
 - Bad testability 检测难度大
 - Higher wear of electrode tips and gun 更大的电极磨损
- Requirement of **easier setup** of the line 需要更容易的安装
 - Adaptive regulator 自适应调整
- **Quality of material varies**, due to global purchasing 材料成分有差异
- Utilization of **new coatings** 使用新的涂层

Technological Trends 汽车工程的趋势

- **Complex construction** of car body 车身结构复杂性大大增加
 - Utilization of high-strength steel 使用高强度钢板
 - More complicated welding guns, no standards.
结构复杂的非标准焊钳的使用
- Emphasis on **weld proces** (till now automation of welding equipment)
 - Cope with high-strength steel 怎样焊接高强度钢
 - Assurance of weld quality 怎样确保焊接质量
 - Utilization of servoguns 使用伺服焊枪
 - Evaluation of welding parameters and optimization as service
需要优化焊接参数
- Partly substitution of resistance welding by **other joining technologies**

New Regulators: Requirements 新的调整模式

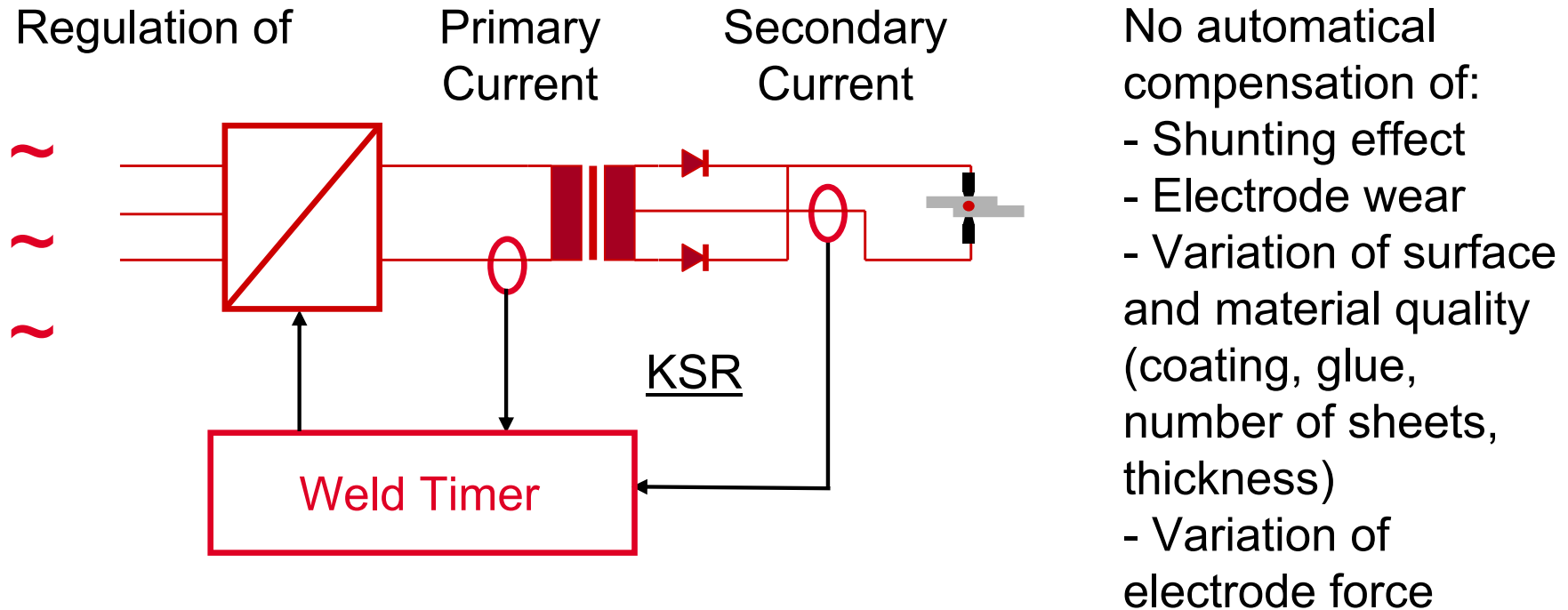
- **Extended operation range** for more stable process
扩展焊接参数范围
- **Simpler operation** (less parameters, integration in BOS6000)
操作简单
- **Cope with new steel materials** that are used in the car body shop
适合新材料的需求
- **Cope with disturbances**
适合各种扰动影响
- **Supervise** the weld quality by parameters
监控焊接质量
- New regulators must be **retrofitted** in inverters PSI 6000
可以对PSI6000进行升级

PSQ 6000: 高级点焊质量监控系统

- Requirements to Welding Control
- **New Regulators:**
新的调整模式
 - Ultrasonic Regulator USR超声波调整
 - Voltage-Current Regulator UIR恒功率调整
- PSQ6000: Components, Benefits
- Function of UI Regulator, Software BQR

从前都是恒流控制: Constant Current Regulation

从前:都是对机器回路的闭环, 从没有对焊点质量进行闭环

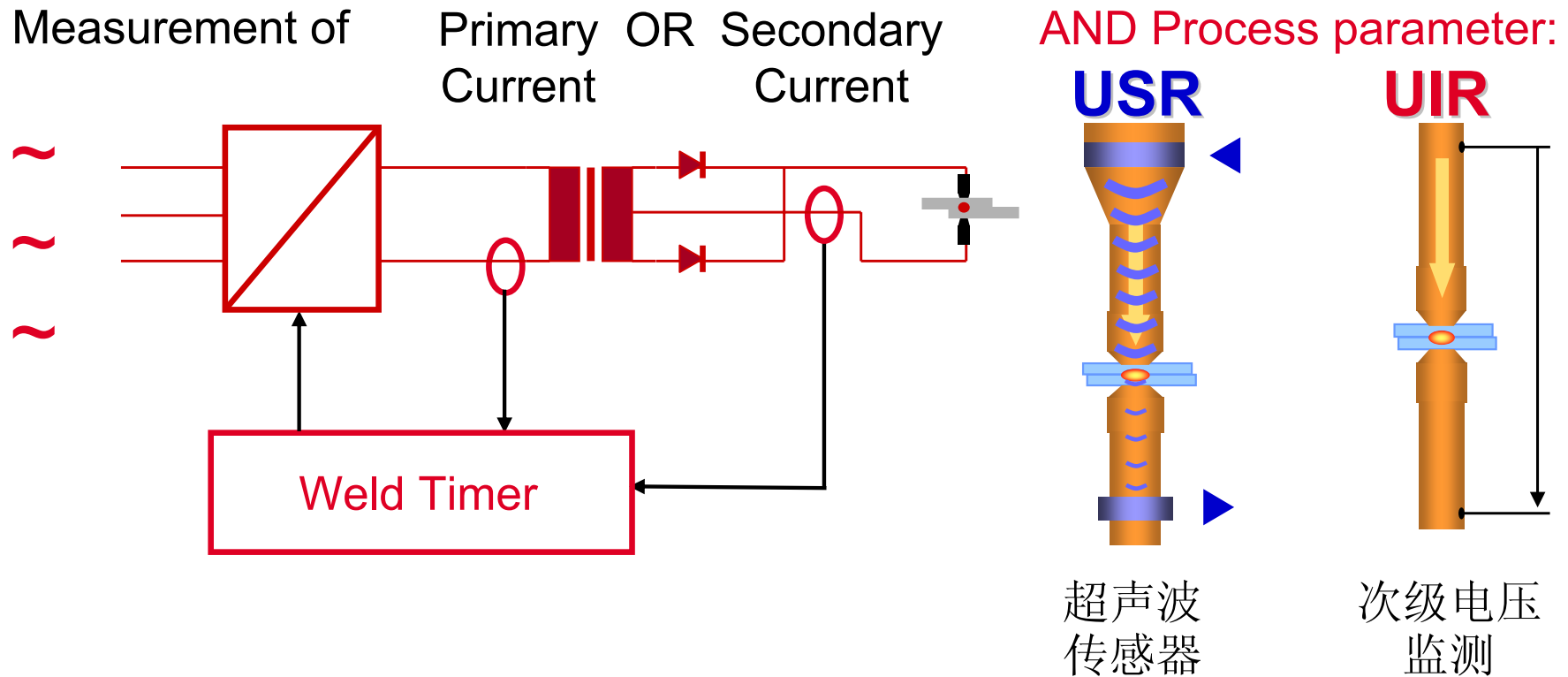


=> **Little information** about the **welding process** 可怜的焊接质量信息

=> Only regulation and monitoring of **energy input** in the welding circuit

现在: US超声波 和 UI 恒功率调整

现在:可以对焊点进行闭环监控, 并对焊接的各种扰动因素进行补偿



=> **Comprehensive information** about the **welding process**

=> Supervision of process parameter, **disturbances are compensated**

PSQ 6000: 高级点焊监控系统

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 - Ultrasonic Regulator USR
 - Voltage-Current Regulator UIR
- **PSQ6000: 组成和好处**
- Function of UI Regulator, Software BQR

PSQ 6000: 扩展电路板 **USR** 和 **UIR**

Plug-in Control Board XQR

USR超声波

Measure

Supervision

Control

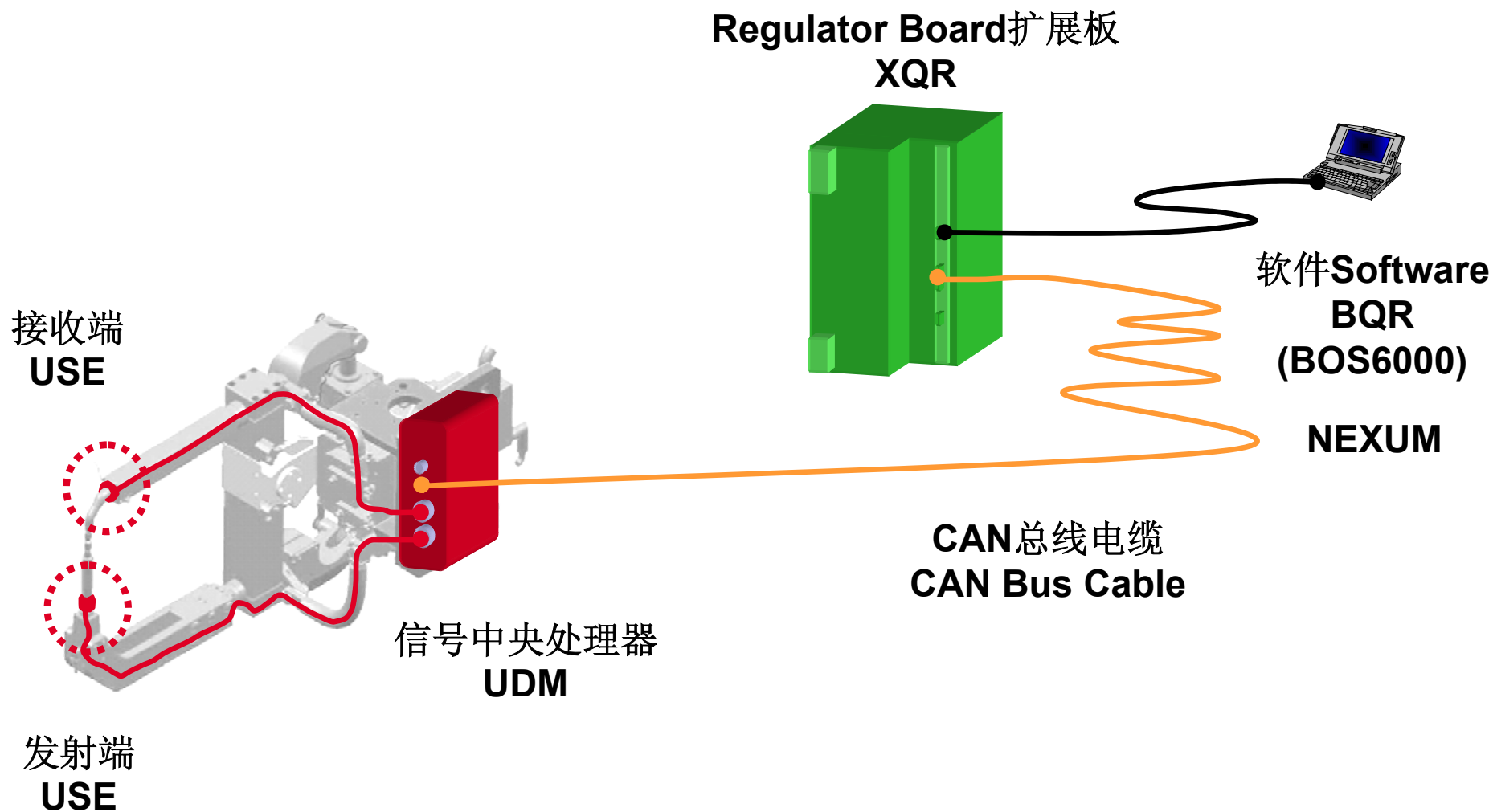
UIR恒功率

Measure

Supervision

Control

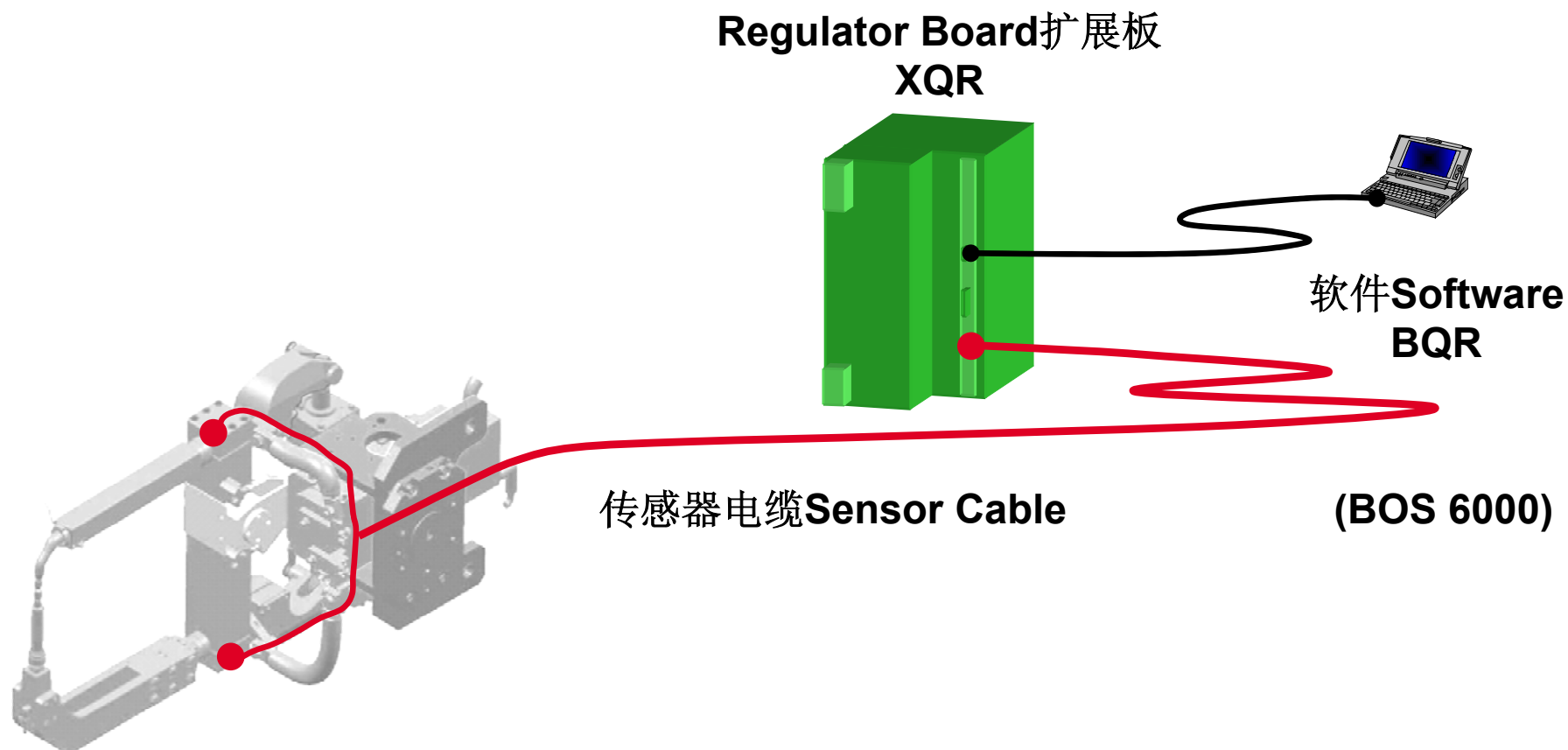
PSQ 6000: USR超声波组成



USR: 超声波的优点

- **Independent** parameter for spot growth独立监控焊核成长:
ultrasonic transmission
- **Direct comparision between** 焊接工艺过程中独立补偿实际焊核
与要求焊核的变化
commanded and actual value **during the welding process**
- Disturbances are compensated **automatically**自动补偿扰动
- Assurance of **constant** spot diameter确保焊接的直径
- **Online documentation** of measured values在线储存测量数值

PSQ 6000: UIR恒功率的组成



UIR: 恒功率的好处

- **No separate sensors required**
不要专门的焊接传感器
- **Simple setting and operation**
简单的安装和设置
- **Variation of current and weld time during the welding process**
焊接工艺中可以自动变化焊接时间和电流
- **Disturbances are compensated automatically**
自动补偿焊接扰动因素
- **Online documentation of measured curves**
在线可以测量曲线

PSQ 6000焊点质量监控系统的概念

USR

- ➔ Valuation spot diameter
- ➔ Control of spot diameter
- ➔ Documentation weld quality
- ➔ Analysis by PC (external)

- + Signal processor UDM
- + Ultrasonic sensors USE
 - Visualisation of the melting process
 - Ultrasonic adaptive controller

+ Regulator Board XQR

PSI 6000

- Constant current regulation
- Supervision of current and force

UIR

- ➔ Good / Bad Validation 判别好/坏焊点
- ➔ Analysis by PC (external) 可以用外部电脑进行分析

+ Voltage tap

- Visualisation of U-, I-, R-curves
- U/I-controller

PSQ 6000: 保证每一个焊接点的质量

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- PSQ6000: Components, Benefits
- **Function of UI Regulator, Software BQR恒功率的功能和软件**

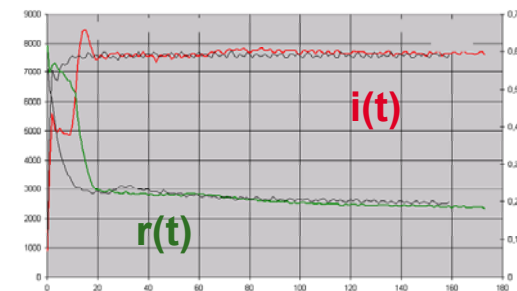
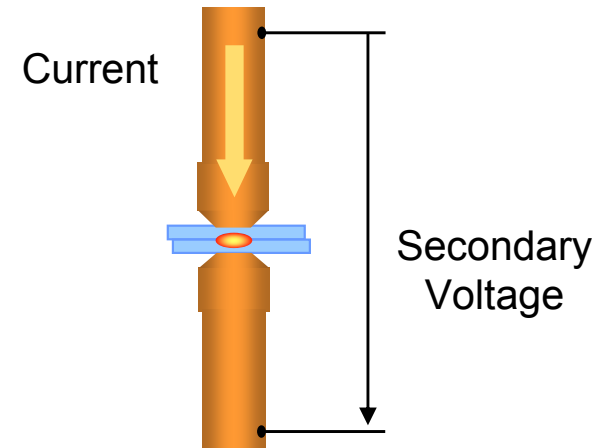
Function of UI Regulator 恒功率的功能

■ 需要的焊接参数:

- 1.) 初级电流 或 次级 电流
和
- 2.) **Voltage** drop on electrodes 次级电压
= Secondary voltage at gun arms

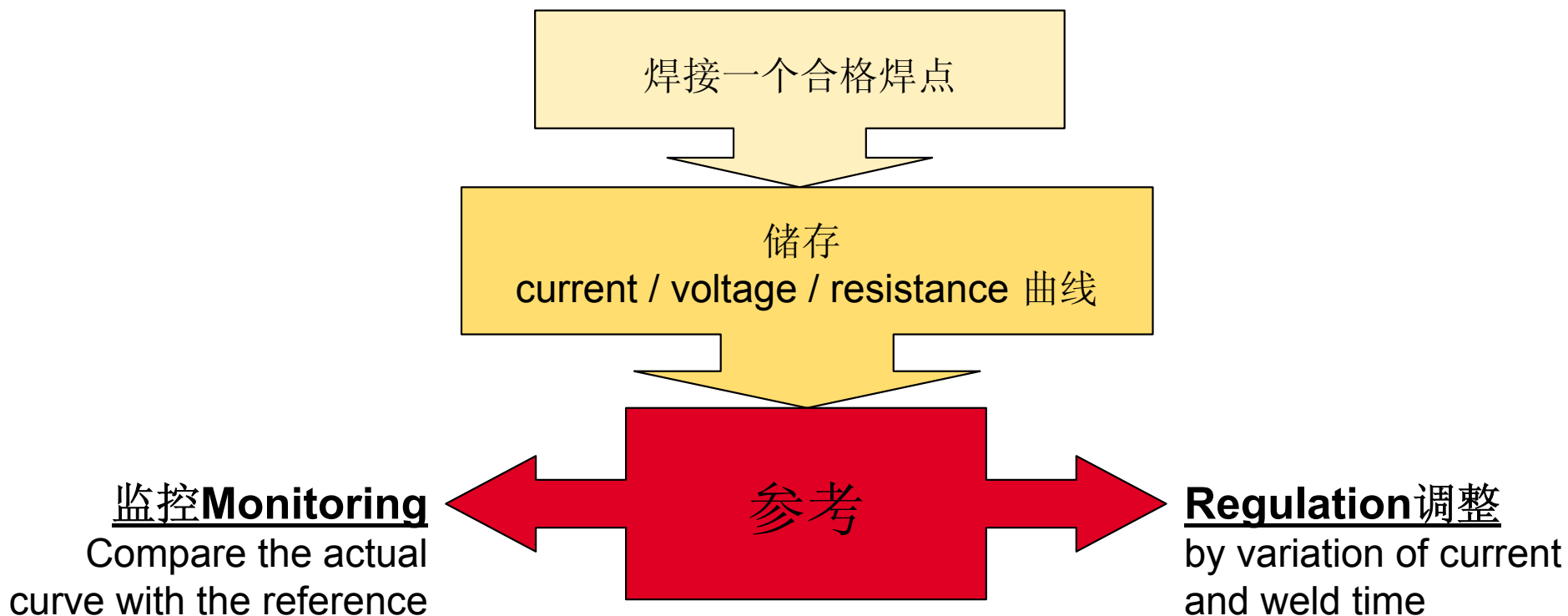
=> Dynamical **resistance** during weld
is calculated from process parameters
current and voltage. 动态电阻测量

=> **Energy** balance of weld spot
is calculated. 每个焊点的能量平衡

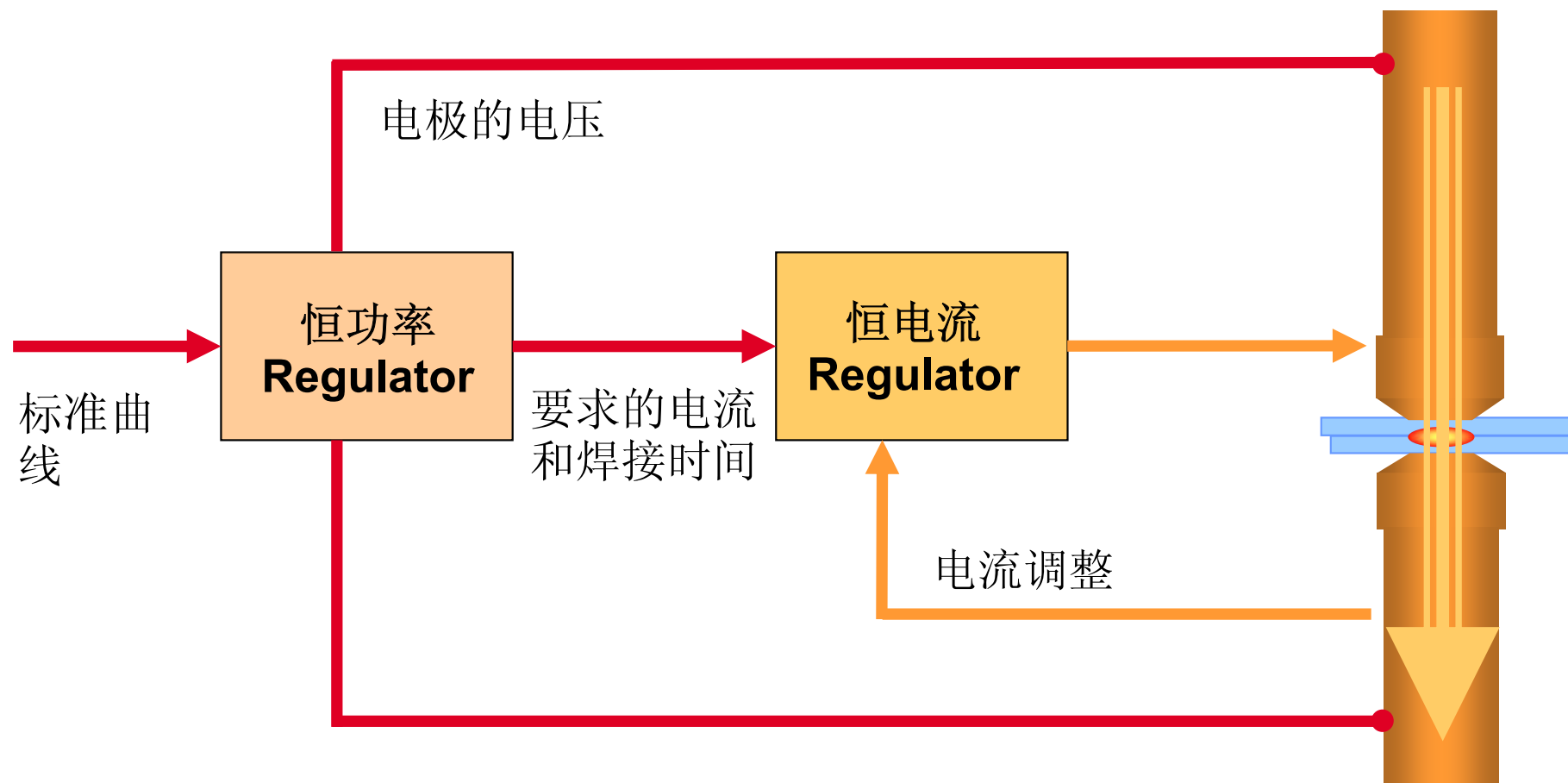


Current / Resistance
Curves

恒功率的工艺过程



恒功率的原理



恒功率的调整模式

■ Regulation Features used:

1.) Energy Balance 能量平衡 :

When the variation of weld time is activated, the regulator secures the actual spot to be welded with at least the energy of the reference spot:

$$E_{act} \geq E_{ref}$$

2.) Spatter Compensation 飞溅补偿:

Spatters are detected. The loss of liquid material will be compensated by **extending the weld time.**

3.) Compensation of Disturbances 扰动因素补偿:

The deviation of process parameters from the reference, caused by disturbances, is detected. Disturbances will be compensated by **variation of current and weld time.**

The value of variation depends on the type of disturbance.

恒功率的调整模式

4.) Operation in the Contact Phase:

At the start of the weld contact problems can occur, due to e.g.:

- polluted tip surface
- bad fitting of parts
- polluted sheet surface
- glue between the sheets

The UI regulator detects the delayed begin of the weld, caused by contact problems and **compensates it by extending the weld time**.

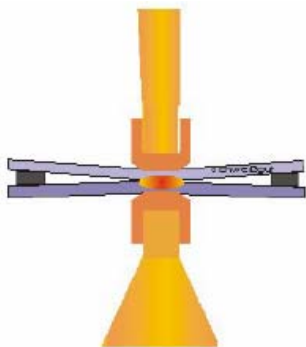
■ Summary:

The UI Regulator is **active during the whole weld**.

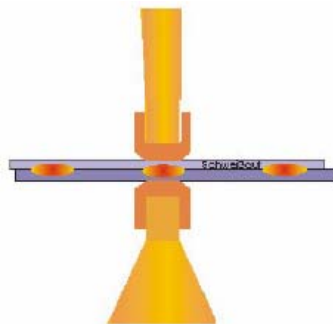
The process parameters are monitored from the begin to the end of the weld time.

The dynamical curves are **analyzed continuously** and in case of deviations, appropriate actions will be taken.

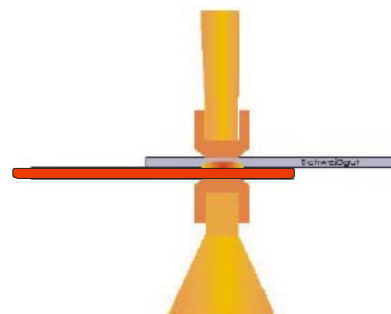
UIR: 恒功率补偿的扰动



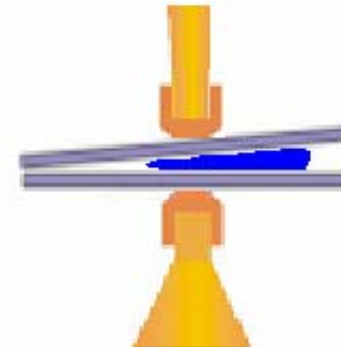
板间装配不好



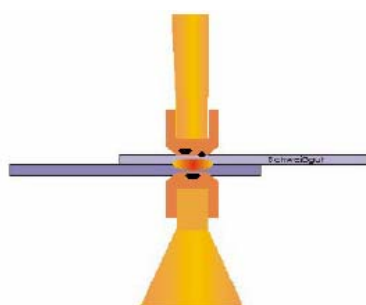
焊点之间的分流



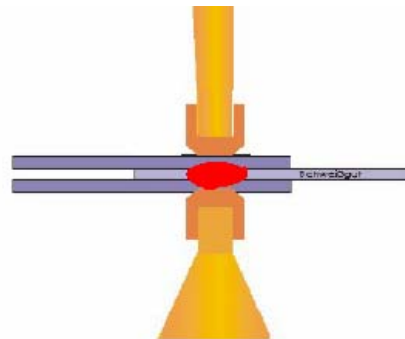
不同的涂层



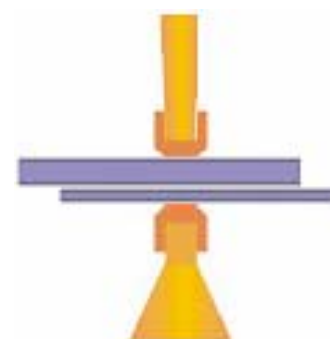
胶水



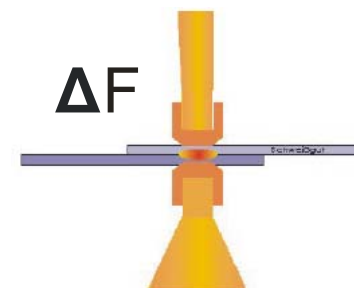
电极磨损



多层板焊接



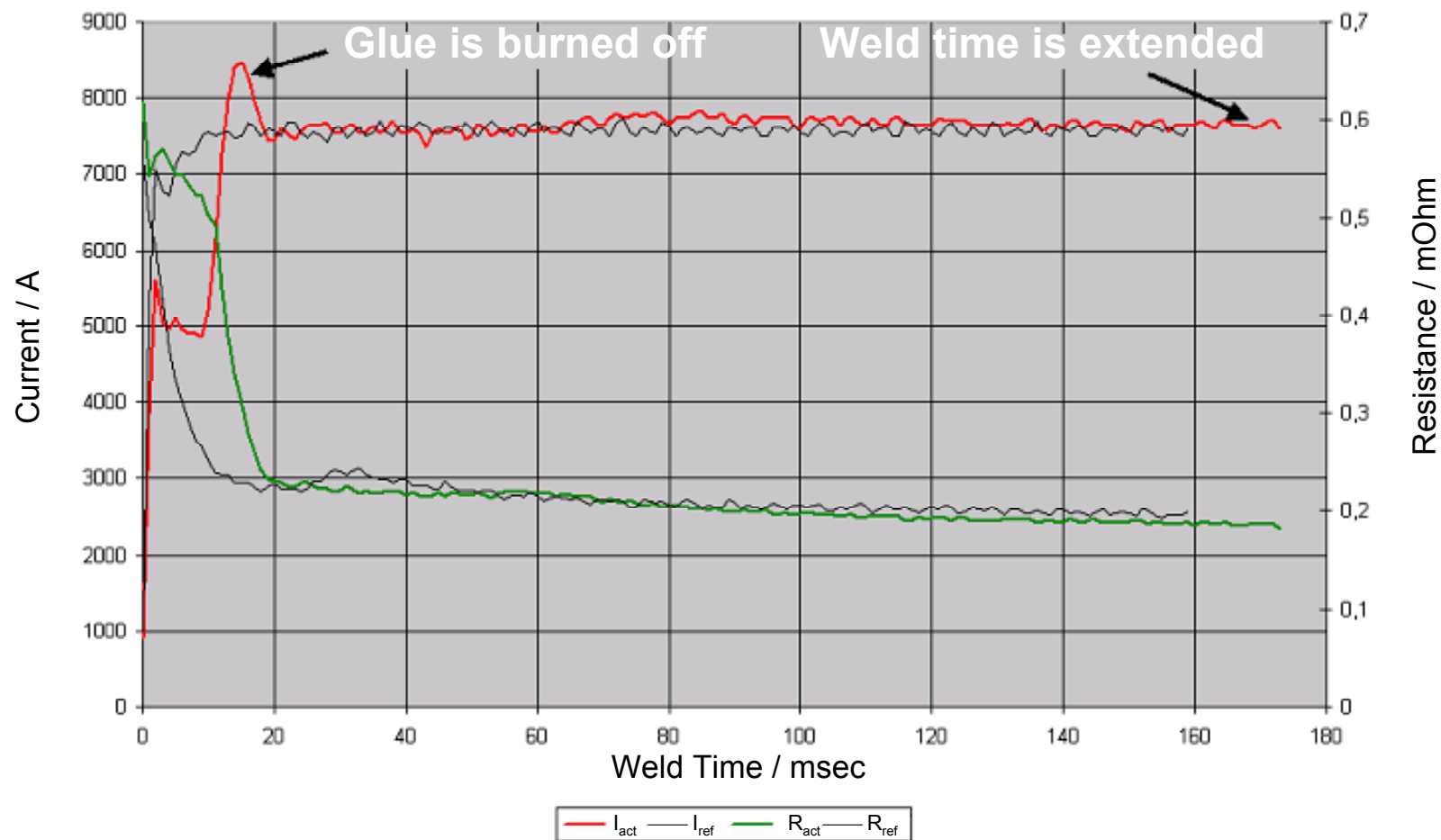
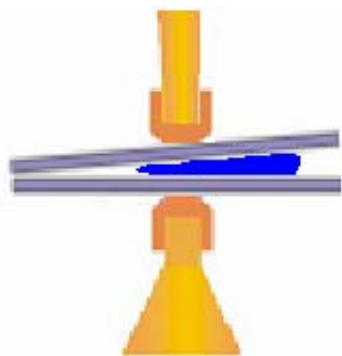
不同的板厚焊接



不同的压力变化

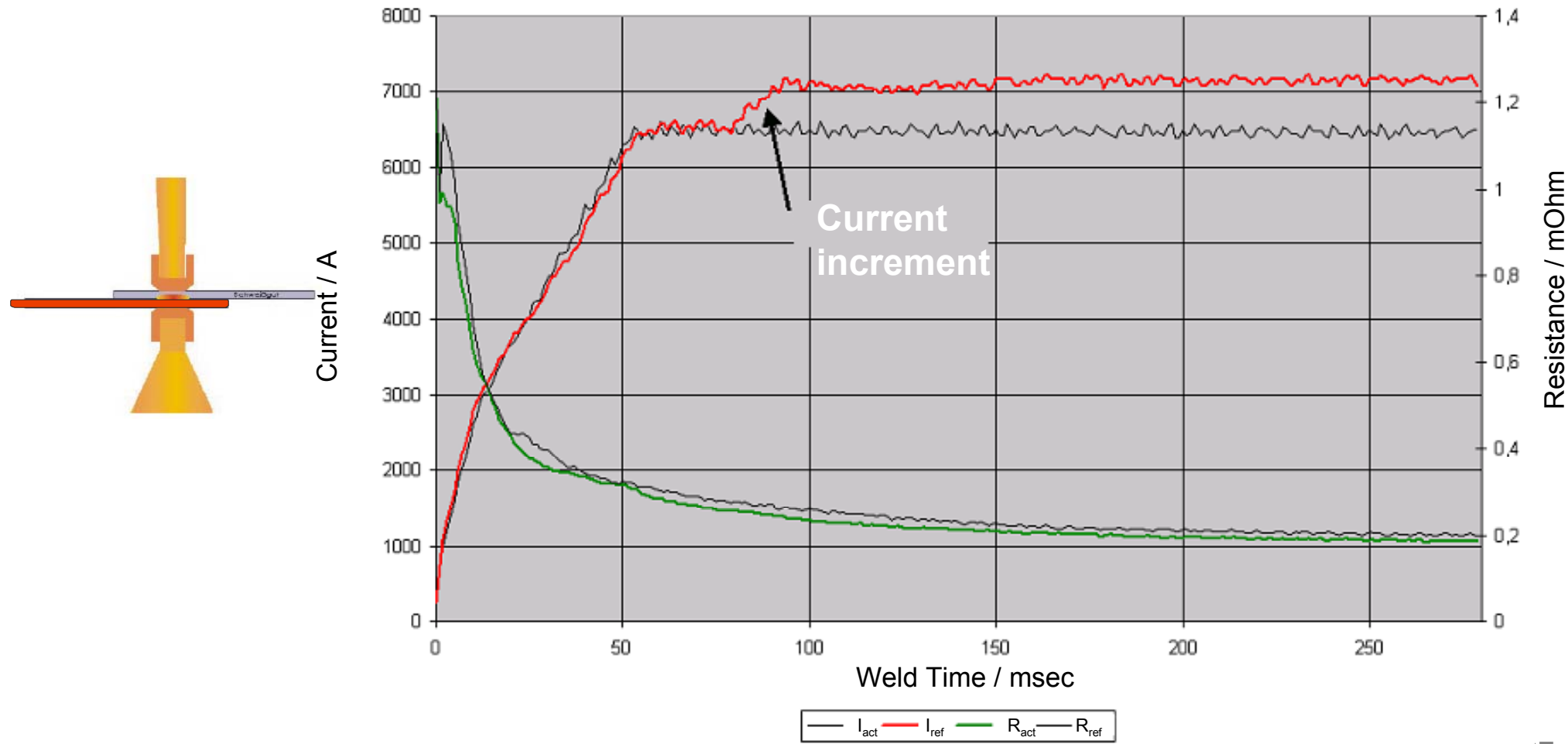
恒功率补偿例1: 板间有胶水

Example 1: Glue between the sheets; Test A (160msec; 7,8kA; 2,5kN)



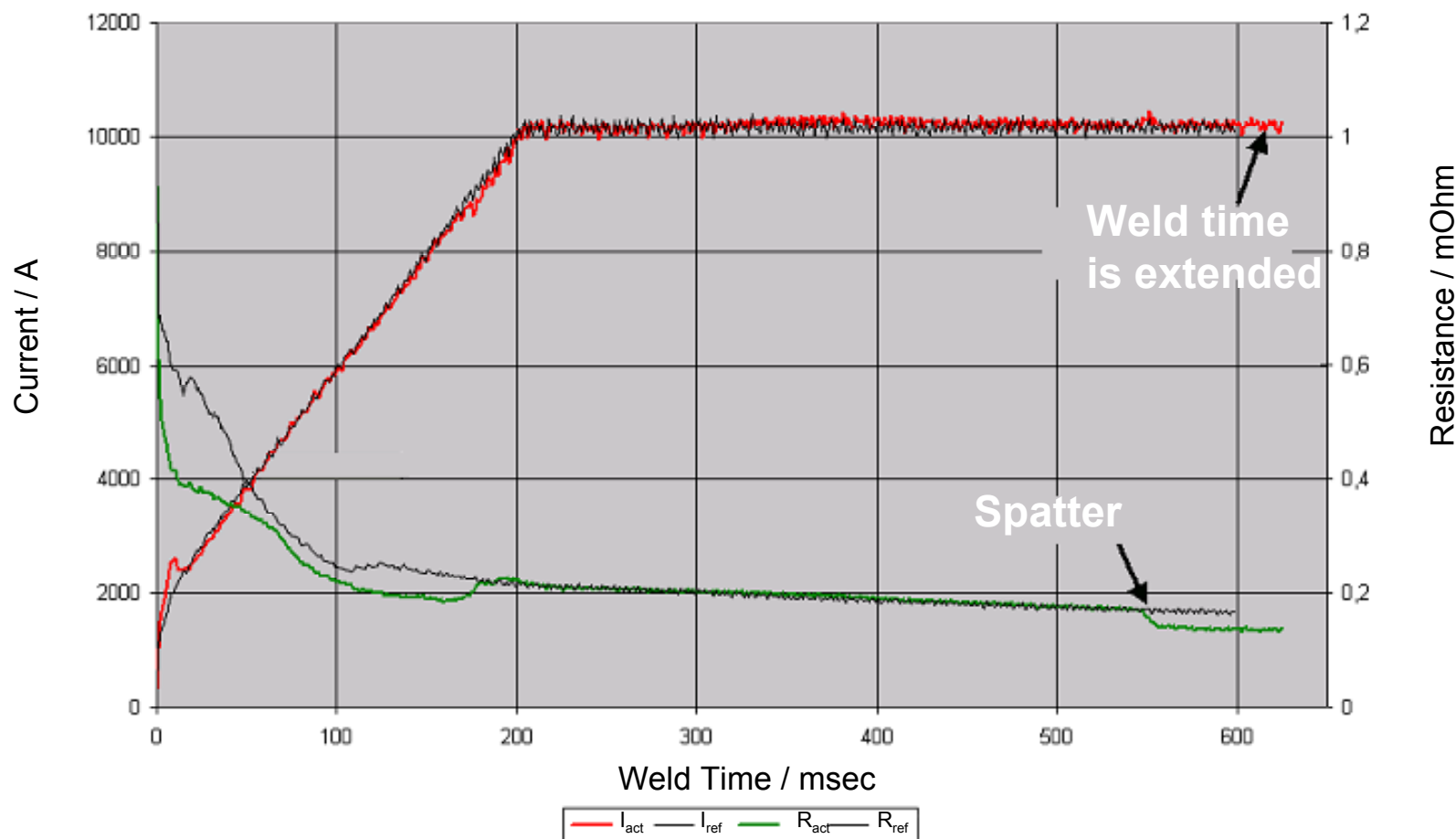
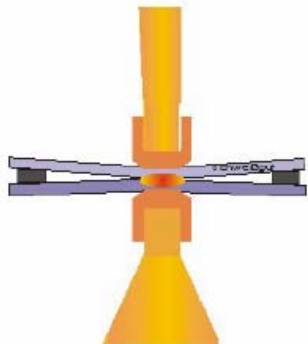
恒功率补偿控制例2: 涂层的变化

Example 2: Different coating; Test E ((50)280msec; (2,0)6,5kA; 3kN)
(2nd sheet DC04elo. zinc-coated instead of TRIP700)

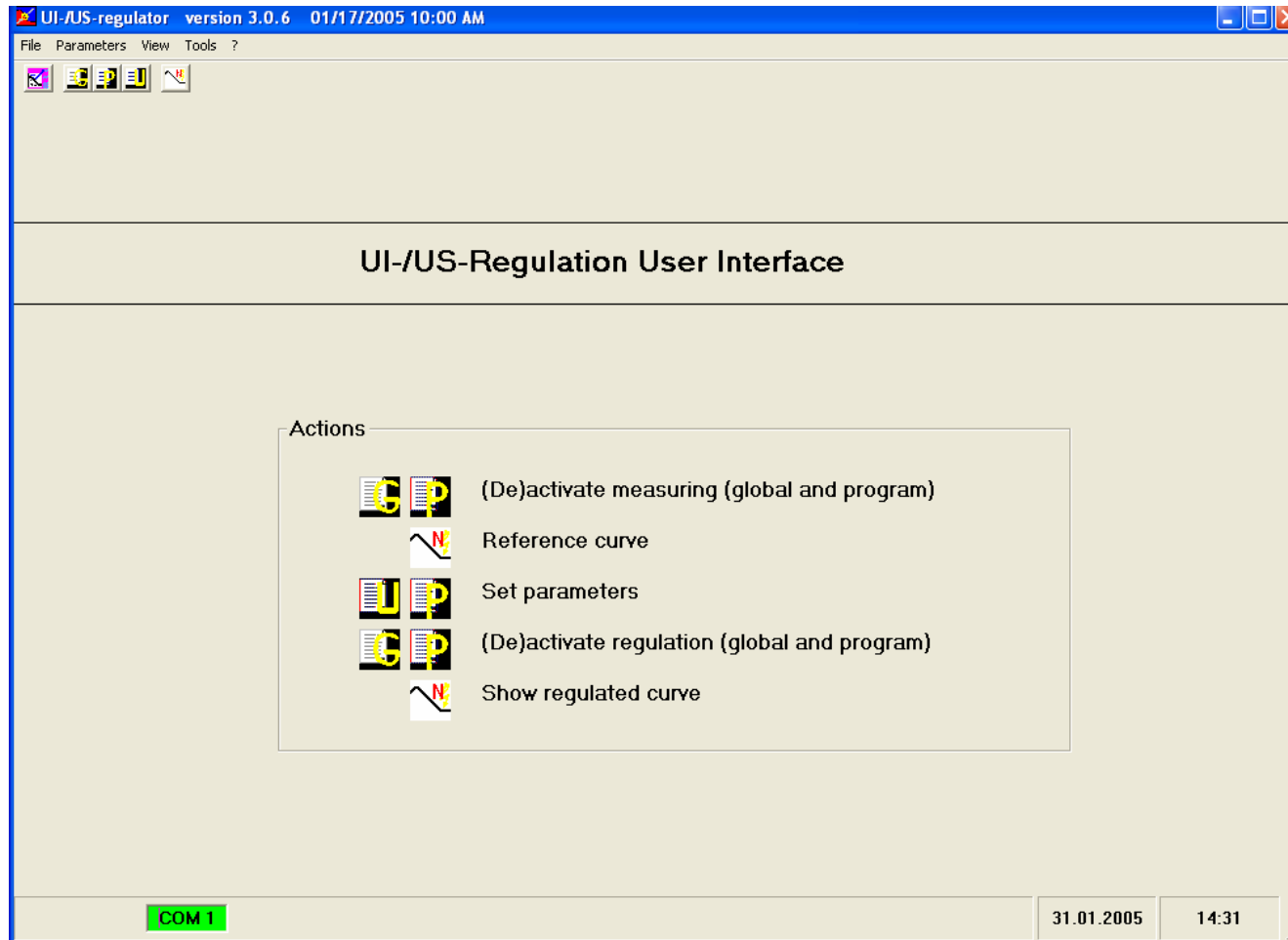


恒功率补偿例3：装配质量差导致飞溅

**Example 3: Bad fitting of sheets with spatter; Test B (200/600msec; 2/10,2kA; 5,2kN)
(2nd spot on test strip)**

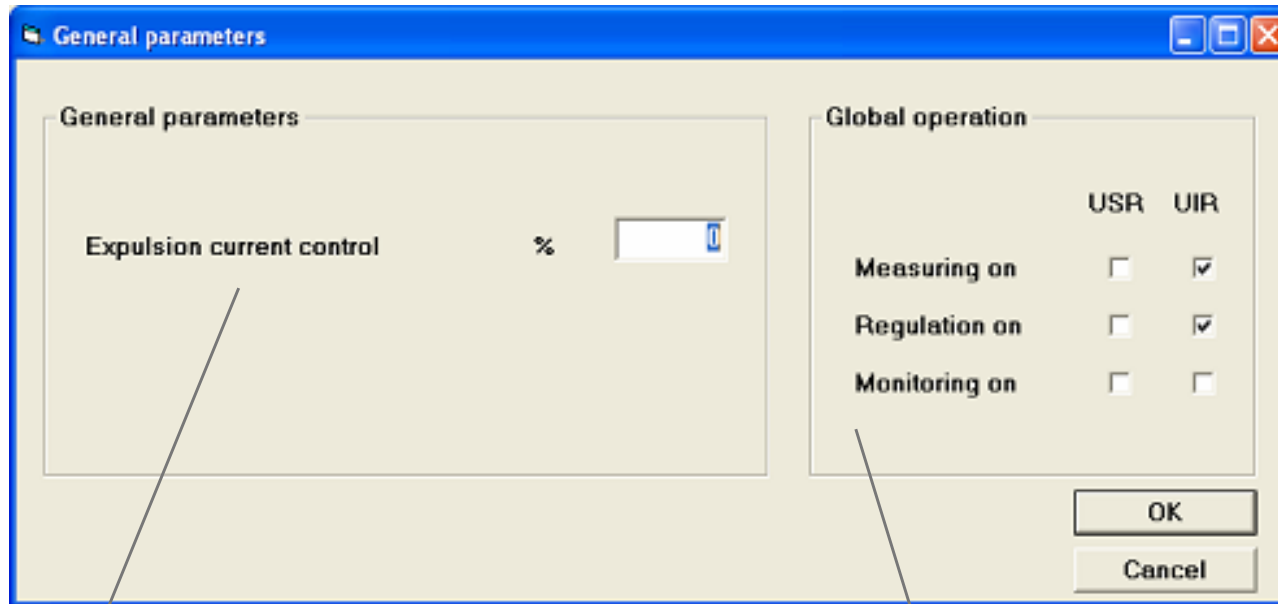


用户接口 BQR for PSQ 6000



Single software for
UIR and USR

用户接口 BQR: General Parameters



Reaction of the regulator
in case of spatter:
+/- % current

Activation of measurement,
regulation and monitoring
for USR ands UIR



Settings for
all electrodes
and programs

用户接口 BQR: Program Parameters

Program parameters (measuring and regulation parameters)

File

Measuring parameters

Measuring on ☐ USR ☐ UIR ☒

UI regulation active

Program number
Select program 1

Regulation parameters

Regulation on ☐ USR ☐ UIR ☒

Max. PWM raise % 50

Max. PWM reduction % 25

UIR Parameter
Welding time prolongation on ☒

Values
Expulsion counter 0

OK
Cancel

Measurement

Regulation



Settings for
single programs

Limits of current variation + / - %

with / without prolongation of weld time

用户接口 BQR: UIR Parameters

Program parameters (measuring and controller parameters)

File

Program number

Select program 1

Prolongation of welding time

maximum 200 %

Period II

Beginning of regulation 40 ms

OK

Cancel

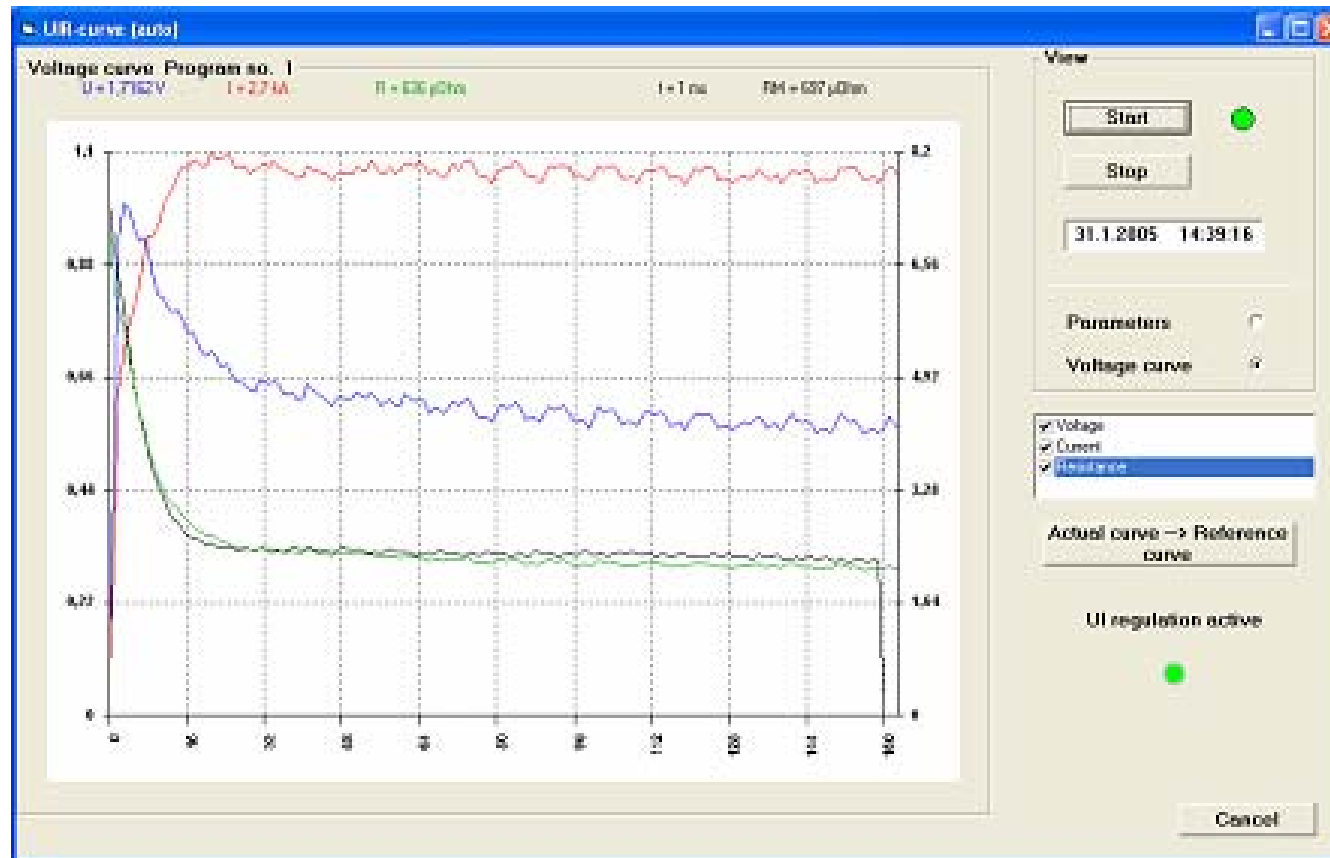


Settings for
single programs

Max. prolongation
of weld time

Start of
regulation
(will be calculated
automatically)

用户接口 BQR: UIR Curves



总结：PSQ 6000的优点

- **Comprehensive system** of quality assurance
全面的质量保证系统
- Provides an **analysis** of the spot weld process
全面提供焊点的全面分析
- Allows an **optimization** of the welding parameters
全面优化焊接工艺
- Provides **quality assurance** in operation
提供实际焊接的质量保证
- Regulator board **can be retrofitted** in all PSI 6000 controls
可以在PSI 6000 焊接控制器上进行升级

