Isolation with imc CRONOSflex

Individual channel-wise and block isolation
Characterizing “isolation”:
Individual vs. block isolation

UNI-4: most flexible (individually isolated main amps)
UNI2-8: competing with isolated bridge amps
ISO2-8: optional sensor supply
HRENC, ICPU-8: benefit from ground loop suppression

Review of Specs (TD)
Summary
Isolation
What does isolation refer to?

Galvanic isolation
• High impedance (GΩ range)
• Can be checked with handheld multimeter instrument

Block isolation
• Isolation of entire functional blocks
• Across multiple channels
• Especially: isolation with respect to: Case / CHASSIS / GND / Power supply

Individual channel-wise isolation
• Channels mutually isolated

Decoupled channels
• Nonreactive, independently configurable, decoupled in events of error or output short circuit, etc.

Overvoltage protection
• Overvoltage on measurement inputs
• Differential mode (instead of common mode)
• Not to be confused with “Isolation voltage”
• Not to be confused with Common mode noise rejection ratio (CMRR, IMR)
Isolation UNI-4
CRFX/UNI-4 module components and levels of isolation

imc CRONOSflex UNI-4

- Channel 1
  - Sensor supply
  - Bridge circuits

- Channel 4
  - Sensor supply
  - Bridge circuits

- EtherCAT
  - System bus
  - Galvanically-isolated Standard network

- System
  - Signal processing
  - TEDS, CJC

- Power SUPPLY
  - Galvanically-isolated, PoE wide input range 10-50V DC

- CHASSIS (case, housing)

Individual galvanical isolation
Functional block isolation
No isolation between components
differential overvoltage

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Main amplifier

- **Individual galvanic isolation** - for voltage and thermocouple mode
- When used in bridge mode: “neutralized” - block isolation of sensor supply and bridge circuitry applies!

Sensor supply and bridge mode

- **TD specs: declared as “Block isolation”**
- Functional block isolation to CHASSIS (case) for entire 4-channel circuitry as a unit including bridge circuits (half/quarter bridge, shunt calibration etc.)
- Sensor / bridge supply with decoupled and individual settings (2.5V..15V) - but no individual isolation!

System functions

- Functional block isolation to CHASSIS (case)
- Hidden internal functionalities
- TC cold junction compensation, TEDS interface, signal processing

Power supply

- Isolated power supply of module, wide range DC input, PoE capabilities
- Avoiding ground loops in wide area distributed setups

EtherCAT

- CRFX system bus, inherently isolated standard network technology
- Secure signal integrity and ground loops in wide area distributed setups
Isolation for CRFX-UNI-4

In detail: main voltage amplifier

• Functions
  o Main signal path for voltage and thermocouple mode
  o Individual galvanic isolation
  o Fully isolated design with individual ADCs and isolated data couplers

• Rating
  o Explicitly suited for high common mode levels: 60V rated / 300V tested
  o Moderate 60 V rating – mainly for reasons of formal certification issues (human safety)

• Applications
  o Thermocouples mounted with galvanic connection to elevated voltage levels
  o Differential 20 mA current via external shunt plug (ACC/DSUB-I2): fully isolated!
  o Once bridge mode is involved and/or extended input circuitry options used: refer to: block isolation of sensor supply and bridge circuitry
Isolation with CRFX-UNI-4
In detail: sensor supply and bridge mode

• Hardware design
  o Sensor supply and all extended bridge circuitry: common internal supply and reference
  o No individual isolation channel-by-channel
    But: common and global block isolation to CHASSIS (case) for entire 4-channel circuitry
• Bridge supply “-VB1” .. “-VB4” interconnected to same potential, but isolated from
  o CHASSIS, case
  o Protective earth, PE, wall adapter GND
  o External machinery, metal structures and installations
• “Isolation” vs. “Decoupling”:
  o Sensor / bridge supply allow channel-wise individual settings (2.5V..15V)
  o Completely decoupled in case of failure / short circuit
• Block isolation applies to all extended input options:
  o Half/quarter bridge
  o Shunt calibration
  o Single ended voltage mode
  o Single ended 20 mA current input (internal shunt, return path to internal GND)
  o RTD / PT100 with block isolated reference current sources
## Isolation with CRFX-UNI-4

Data sheet: Modes - individually isolated vs. “non isolated” with block isolation

### Measurement modes DSUB

<table>
<thead>
<tr>
<th>Isolated measurement modes:</th>
<th>ACC/DSUB(M)-UNI2 for all modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual galvanical isolation</td>
<td>voltage measurement (differential)</td>
</tr>
<tr>
<td></td>
<td>current measurement</td>
</tr>
<tr>
<td></td>
<td>thermocouple</td>
</tr>
<tr>
<td>Functional block isolation</td>
<td>with Shunt-plug (ACC/DSUB(M)-I2)</td>
</tr>
<tr>
<td>No isolation between channels</td>
<td>voltage measurement (single-end)</td>
</tr>
<tr>
<td></td>
<td>current measurement</td>
</tr>
<tr>
<td></td>
<td>bridge-sensor</td>
</tr>
<tr>
<td></td>
<td>strain gauges</td>
</tr>
<tr>
<td></td>
<td>PT100/PT1000</td>
</tr>
<tr>
<td></td>
<td>(3- and 4-wire connection)</td>
</tr>
<tr>
<td></td>
<td>current fed sensors</td>
</tr>
<tr>
<td></td>
<td>(IEPE/ICP)</td>
</tr>
<tr>
<td></td>
<td>with internal Shunt</td>
</tr>
<tr>
<td></td>
<td>ACC/DSUB-ICP2,</td>
</tr>
<tr>
<td></td>
<td>ACC/DSUB-ICP-BNC</td>
</tr>
</tbody>
</table>
# Isolation with CRFX-UNI-4

TD: Definition of “individually-isolated” vs. “non-isolated” with block isolation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation of voltage channels</td>
<td>channel-wise galvanically-isolated</td>
<td>voltage channels isolated against each other and against system ground (housing, CHASSIS, PE), as well as against common reference and all bridge excitation voltages &quot;-VB&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isolation with IEPE/ICP plug: depends on plug type</td>
</tr>
<tr>
<td>Individual galvanical isolation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge excitation voltage isolation</td>
<td>not channel-wise isolated</td>
<td>isolated against additional electronics (all sensor power supplies, bridge and input wiring, TEDS, etc.) with common reference ground “-VB”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Block-isolated against system ground (housing, CHASSIS, PE)</td>
</tr>
<tr>
<td>Functional block isolation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No isolation between channels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max common mode voltage isolated mode</td>
<td>±60 V</td>
<td>against internal reference ground “-VB”, against system ground (housing, CHASSIS, PE)</td>
</tr>
<tr>
<td>tested</td>
<td>300 V (10 sec.)</td>
<td></td>
</tr>
<tr>
<td>Max common mode voltage non-isolated mode</td>
<td>±10 V</td>
<td>against internal reference ground “-VB”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Also for “non-isolated” mode, there is an additional global block-isolation of the entire internal measurement electronics from the housing (CHASSIS, PE)</td>
</tr>
</tbody>
</table>
### Block isolation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block isolation</td>
<td>60 V</td>
<td>all internal electronics isolated from the housing (CHASSIS, PE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exception: additional individual isolated voltage channels</td>
</tr>
<tr>
<td>Isolation impedance</td>
<td>500 kΩ</td>
<td></td>
</tr>
<tr>
<td>Internal reference ground</td>
<td>-VB, GND, TEDS_GND</td>
<td></td>
</tr>
<tr>
<td>External reference ground</td>
<td>CHASSIS, metal housing</td>
<td>internal electronics as an entity, galvanically isolated from housing</td>
</tr>
</tbody>
</table>

**Note**

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.
# Isolation with CRFX-UNI-4

**TD: Protection against differential overvoltage**

| Overvoltage protection (inputs +IN, -IN) | ± 100 V  
ESD 2 kV  
transient protection:  
avtomotive load dump  
ISO 7636, test impulse 6 | differential input voltage (continuous)  
human body model  
test pulse 6 with max. -250 V  
R_i=30 Ω, t_d=300 μs, t_b<60 μs |
**Isolation with CRFX-UNI-4**

Data sheet: Power supply and EtherCAT system bus

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### Power supply of the module

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input supply voltage</td>
<td>10 V to 50 V DC</td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td>10 W</td>
<td>10 V to 50 V DC</td>
</tr>
<tr>
<td>Isolation</td>
<td>60 V</td>
<td>nominal isolation specification of the supply input</td>
</tr>
<tr>
<td>Power-over EtherCAT (PoE)</td>
<td>42 V to 50 V DC</td>
<td>supply via EtherCAT network cable</td>
</tr>
</tbody>
</table>

---

### Terminal connections of the module

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>EtherCAT connection</td>
<td>2x RJ45</td>
<td>system bus for distributed imc CRONOSflex components</td>
</tr>
<tr>
<td>Input supply plug (female)</td>
<td>LEMO.EGE.1B.302</td>
<td>multicoded 2 notches for optional individually power supply</td>
</tr>
<tr>
<td>Module connector</td>
<td>2x 20 pin</td>
<td>direct connection of modules (click) supply and system bus</td>
</tr>
</tbody>
</table>
Isolation with UNI2-8
UNI-8 module for CRFX: components and levels of isolation

Main amplifier
• **No individual** galvanic *isolation* (unlike UNI-4)
• Functional block isolation for complete input – including sensor supply

Sensor supply and bridge mode
• **TD specs: declared as “Block isolation”**
• Functional block isolation to CHASSIS (case) for entire 8-channel circuitry of analog front end
• **No individual settings** for sensor / bridge supply (2.5V..24V) – common global choice!

System functions
• Functional block isolation for TC cold junction compensation, TEDS interface, signal processing
• Hidden internal functionalities: uniform concept for most CRFX amplifiers

Power supply
• Isolated power supply of module, wide range DC input, PoE capabilities
• Uniform concept for all CRFX amplifiers: suited for distributed topologies
• Avoiding ground loops in wide area distributed setups

EtherCAT
• CRFX system bus, inherently isolated standard network technology
• Uniform concept for all CRFX amplifiers: suited for distributed topologies
• Secure signal integrity and ground loops in wide area distributed setups
Isolation with CRFX-UNI-8

*New* TDs: explicitly specifying block isolation

### Block isolation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block isolation</td>
<td>60 V</td>
<td>all internal electronics isolated from the housing (CHASSIS, PE)</td>
</tr>
<tr>
<td>Isolation impedance</td>
<td>500 kΩ</td>
<td></td>
</tr>
<tr>
<td>Internal reference ground</td>
<td>-VB, GND, TEDS_GND</td>
<td>internal electronics as an entity, galvanically isolated from housing</td>
</tr>
<tr>
<td>External reference ground</td>
<td>CHASSIS, metal housing</td>
<td></td>
</tr>
</tbody>
</table>

**Note**

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

*Devices or modules purchased before ca. 2012 do not feature block isolation.*
# Isolation with CRFX-UNI-8

*New* TDs: global sensor supply and front-end as a common block

## Sensor supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration options</td>
<td>5 selectable settings</td>
<td>The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V</td>
</tr>
<tr>
<td>Output voltage</td>
<td>Voltage (+1 V) 580 mA</td>
<td>Current 580 mA Power 0.6 W Set jointly for all eight channels optional, special order: +12 V or +15 V can be replaced by +2.5 V preferred selection with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V</td>
</tr>
<tr>
<td></td>
<td>(+2.5 V) 580 mA</td>
<td>+1.5 W</td>
</tr>
<tr>
<td></td>
<td>+5.0 V 580 mA</td>
<td>+2.9 W</td>
</tr>
<tr>
<td></td>
<td>+10 V 300 mA</td>
<td>+3.0 W</td>
</tr>
<tr>
<td></td>
<td>+12 V 250 mA</td>
<td>+3.0 W</td>
</tr>
<tr>
<td></td>
<td>+15 V 200 mA</td>
<td>+3.0 W</td>
</tr>
<tr>
<td></td>
<td>+24 V 120 mA</td>
<td>+2.9 W optional, special order: +15 V can be replaced by ±15 V</td>
</tr>
<tr>
<td></td>
<td>(±15 V) 190 mA</td>
<td>+3.0 W</td>
</tr>
<tr>
<td>Block isolation</td>
<td>60 V</td>
<td>Isolation of the entire global sensor supply (for all 8 channels, reference ground: &quot;-VB&quot;) as well as the internal electronics from housing (CHASSIS, PE)</td>
</tr>
</tbody>
</table>
Isolation ISO2-8
CRFX/ISO2-8 module components and levels of isolation

Optional global Sensor supply

Individual galvanical isolation

Galvanically-isolated, PoE wide input range 10-50V DC

Functional block isolation

No isolation between components

differential overvoltage
Isolation with ISO2-8
ISO2-8 module for CRFX: components and levels of isolation

- Functions
  - Full individual galvanic isolation for voltage and thermocouple mode
  - Thermocouples mounted with galvanic connection to elevated voltage levels
  - Differential 20 mA current via external shunt plug (ACC/DSUB-I4): fully isolated!
  - RTD / PT100 with block isolated reference current sources, only
    → no major restriction: Unlike TC, any RTD will always be mounted isolated to substrate (2/4 wires)

- Rating
  - Explicitly suited for high common mode levels: 60V rated / 300V tested
  - Moderate 60 V rating – mainly for reasons of formal certification issues (human safety)

- Optional sensor supply
  - TD specs: declared as "Block isolation"
  - Block isolation to CHASSIS (case) for entire sensor supply unit!
  - Global sensor supply: no individual settings, common global choice!
  - Common pin on DSUB-15: used by 4 channels per plug
Block isolation

- Common global isolation of analog front end and system functions
- For all current CRFX amplifiers (since 2012) – **even the non-isolated** types (UNI2-8, DCB2-8, LV3-8, BR2-4, HRENC-4)!
- Initially (before 2012), block isolation was NOT activated
- TD specs had not been updated after 2012: **still formally declared as “non-isolated”**
- Because:
  - Not entirely independent, yet sufficient for ground loop suppression
  - Requires careful attention and understanding
  - Not fully “fire and forget”
  - Aiming to avoid confusion
  - Historical evolution of product development

- Now (2014): **block isolation fully supported**! **fully documented detailed specs (TD)**
Isolation with imc CRONOSflex (CRFX)

Summary and conclusion for UNI-4 and UNI2-8

Degree of isolation

1. Individual galvanical isolation
2. Functional block isolation
3. No isolation between components

**UNI-4 vs. UNI2-8 and CRFX block isolation**

- UNI-4 has *individually-isolated* voltage channels
- Also isolated against the supply unit as a whole
- This is an additional degree of flexibility compared to UNI2-8
- Sensor supply and *bridge circuits* are *NOT individually* isolated
- This *neutralizes individual isolation in the case of bridge mode (1) vs. (4)*

- CRFX features “*block isolation*” of the entire front end as an additional benefit, extending beyond the properties of CRC, C-SERIES, SPARTAN
- This is not quite as comprehensive as (6) – but often *well sufficient*!
Isolation with imc CRONOSflex (CRFX)

Overview

Degree of isolation
- Individual galvanical isolation
- Functional block isolation
- No isolation between components

imc CRONOSflex UNI-4
- Channel 1
- Sensor supply
- Bridge circuits
- Main Amp
- Power SUPPLY
  - galvanically isolated, PoE
  - wide input range 10-50V DC

imc CRONOSflex UNI-8
- Channel 1
- Sensor supply
- Bridge circuits
- Main Amp
- Power SUPPLY
  - galvanically isolated, PoE
  - wide input range 10-50V DC

imc CRONOSflex ISO2-8
- Channel 1
- Optional global
- Sensor supply
- Amp
- Power SUPPLY
  - galvanically isolated, PoE
  - wide input range 10-50V DC

imc CRONOSflex LV3-8, BR2-4, IPCU2-8, HREN-4
- Analog front end
- Channel 1
- Sensor supply
- Amp
- Power SUPPLY
  - 20-50V DC, PoE

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Thank you for your attention.

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