RDCLPU USERS MANUAL

20KA LIGHTNING PROTECTION UNIT
OPTIMIZED FOR ISOLATED RS-232, RS-422, RS-485 DATA COMMUNICATIONS LINES

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1. INTRODUCTION

Everyone's talking these days - even lowly temperature probes and relays can be purchased with RS-485 communications capability. Yet all this talking has a serious downside - every device you integrate adds one more potential source/sink for surge damage and/or ground loops. RobustDC is the technological leader in isolated RS-232, RS-422, and RS-485 devices targeted at industry - devices which eliminate problems due to induced surges and ground loops. But what about the large common mode surges caused by lightning discharges? The voltages involved can arc across isolation barriers. The answer is RobustDC's two-part lightning-proof solution. We combine industrial-quality galvanic/optical isolation with a heavy-duty (20kA) impulse surge diversion. For more information, please see RobustDC's application notes AN018 (Surge Management) & AN031 (Lightning-Proof RS-485).

1.1. Product Overview

figure 1.1: rdcLPU face plate

Everyone's talking these days - even lowly temperature probes and relays can be purchased with RS-485 For robust operation, the rdcLPU combined with any of RobustDC's optically/galvanically isolated products (such as the rdc485ic or rdc485ir3) creates the ultimate in wire-based data comm robustness. It combines high-energy, heavy-duty lightning surge management with full galvanic isolation. The rdcLPU provides the following unique combination of features:

- One unit of rdcLPU fully protects one isolated RS-485 2-wire circuit (with signal reference ground) or one isolated RS-232 3-wire. Two units of rdcLPU are required for RS-422 or RS-485 4-wire.

- Lightning protection of up to 6kV and 20kA (8/20µs wave form).
- Fine over-voltage protection of +/-15vdc - suitable for RS-232, RS-422, and RS-485.
- Self-resetting 250mA current limiting on both data wires and the ground wire.
- Large 2.5mm² capacity screw terminals simplify field wiring.
- Combined with RobustDC's rdc485ic or rdc485ir3, eliminates the need to run the 3rd ground wire between remote sites without compromising ground isolation.

2. FUNCTIONAL DESCRIPTION

The rdcLPU uses a 3 stage design to manage both large and small surges.

2.1. Course Lightning Protection Stage

Figure 2.1 shows the actual scope output of the rdcLPU in a test with an IEC801.5 (6kV/3kA in a 8/20µs) impulse surge wave. Both waves shown are voltage inputs to the field side of the rdcLPU - this requires a bit of explanation. Suppose I give you a closed container and ask you to pressurize it to 100 psi with a 100psi air supply - can you do it? Of course. Now suppose I give you the same container with a 20psi self-resetting relief valve. Will you be able to pressurize it to 100psi with a 100psi supply? Of course NOT. Once the relief valve open at 20psi, the pressure in the container will be higher than 20psi but less than 100psi.

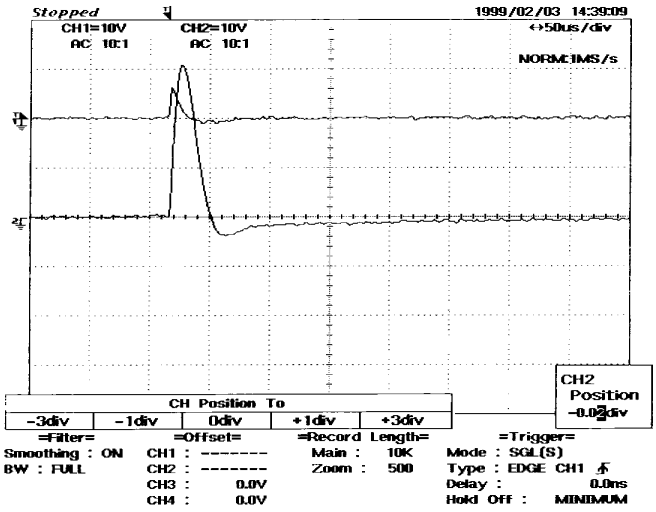

figure 2.1 - IEC 801.5 wave form test results

A properly installed, industrial lightning protection device functions much like a relief valve. The test device prepares a 6000v potential which can be discharged at a short current flow of 3000 Amp (per IEC 801.5). If the test leads remain open, you could actually measure 6000 voltages - but the leads connect to the "load" of the rdcLPU. When the test device attempts to (in effect) charge the data terminal of the rdcLPU to 6000 volts with reference to the ground lead, the **course lightning protection** ("voltage relief valve") within starts to conduct ("opens"). When the rdcLPU's industrial quality ceramic gas discharge tube conducts at low resistance, the test device's wire leads became the "R" in the V = I * R equation. The upper-wave form (CH1) shows that the rdcLPU "leaks" the surge to ground well enough that even though 6000 volts was applied, only a voltage of 800-900 volt can exist at the field terminals of the rdcLPU.

Prof. Nr.	Rep. Nr.	Form	Pol.	Up	Angle		Nr. of Surges	Surge Nr. Tot.	Surge Nr. Prof.	Measured Up	Measured Ip	EUT	Time
1	1	Surge LZ	+	6000	S	0	1	1	1	837	3374	Ok	02:24:56
2	1	Surge LZ	-	6000	S	0	1	2	1	783	3396	Ok	02:25:06

figure 2.2 - IEC 801.5 wave form values

So the rdcLPU effectively guarantees that the 2500 volt isolation barrier within of RobustDC's isolated RS -232, RS-422, and RS-485 devices is never exceeded. In figure 2.2 "Up" shows the voltage at the field terminals and "Ip" shows the current flow through the rdcLPU during discharge.

2.2. Self-Resetting Current Limiter Stage

The next stage is the critical addition of impedance to boost the effectiveness of the course lightning protection. The rdcLPU's PTC thermisters not only accomplish this, but provide a measure of self-resetting protection against continuous overloads due to field wiring mistakes. The rdcLPU limits the current through all 3 terminals to less than 250mA.

2.3. Fine Over-Voltage/Transient Voltage Protection Stage

The final stage of the rdcLPU is the fine over-voltage protection. While the rdcLPU's course protection stage prevents any over-voltage from breaching the 2500v isolation barrier, the fine protection stage keeps the final voltage to with the ±25v range required by the EIA standards for RS-232, RS-422, and RS-485.

2.4. Comparing the rdcLPU to Competing Devices

Comparing surge management devices is difficult. There is an abundance of acronyms and alternative technologies to confuse the average engineer. One alternative is varistor or MOV technologies, which are often used in lower-cost solutions because a single MOV component can do 80% of what the multi-stage rdcLPU does. But the MOV cannot manage the large 20kA surges like the rdcLPU, plus the MOV is damaged during each surge and becomes less effective over time. Another even lower-cost alternative is the use of only transient surge diode. This is common in the $20 department-store variety surge devices. But they have such a low surge energy limit that they cannot honestly be considered lightning protection at all. Surge diodes generally are rated to handle between 400 to 1500 watts of surge energy. Compare this with the 6kV/20kA design of the rdcLPU which can easily handle surges over 20,000,000 watts.

3. PLANNING & DESIGN

3.1. Fully Isolated RS-485 Interfaces

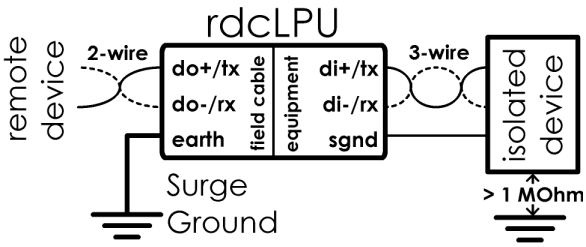

figure 3.1 - Wiring for Isolated RS-485

This is the target application for the rdcLPU - part of an optimized, "lightning proof" solution with the isolated rdc485ic or rdc485ir3. ***An isolated RS-485 interface has 3 signals available (such as D+, D-, and SG) and the resistance between all 3 and the frame-chassis or power supply ground is greater than 1 meg-ohm.*** Examples of fully isolated RS-485 interfaces are rdc485ic (isolated RS-232 to RS-485 converter) and rdc485ir3 (isolated RS-485 repeater). 3-wire panel-grade cable is required between your fully isolated RS-485 device and the rdcLPU. 2-wire (1-pair) field-grade cable can be used between the rdcLPU and your remote device. See RobustDC's application notes AN018 (Surge Management) & AN031 (Lightning-Proof RS-485) for other design details you must consider. Of special note - the third wire (the signal ground) between the isolated device and the rdcLPU is critical for long-term survival of the interface. It will "work fine" without this third wire ... until the first large surge comes in!

3.2. Non-isolated RS-485 (not optimal)

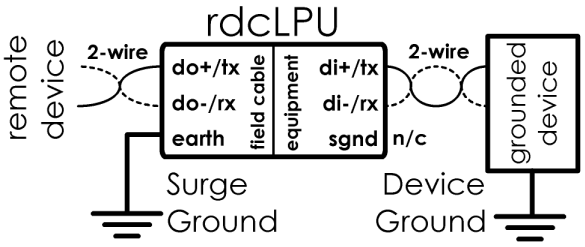

figure 3.2 - Wiring for Non-isolated RS-485

Although optimized for isolated interfaces, the rdcLPU can be used with non-isolated interfaces. However, a non-isolated interface can never be though of as "lightning proof". ***A non-isolated RS-485 interface has 2 or 3 signals available and the resistance between ANY of the signals and the frame-chassis or power supply ground is less than 1 meg-ohm.*** Examples of non-isolated RS-485 interfaces are most low-cost RS-232 to RS-485 converters and most commercial RS-485 field devices. A 2-wire (1-pair) cable is used through-out. See RobustDC's application notes AN018 (Surge Management) for other design details you must consider. Of special note - during large lightning surges you may have ground loop problems between your surge ground & panel ground through your device. Therefore extra care must be taken to implement a fool-proof grounding system. While fully isolated interfaces are very forgiving of minor ground design flaws, ***non-isolated interfaces are very unforgiving such flaws!***

3.3. Fully Isolated RS-422 Interfaces

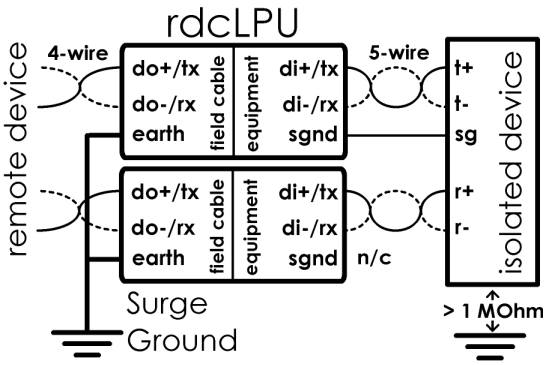

figure 3.3 - Wiring for Isolated RS-422

A pair of rdcLPU effectively "lightning proof" a fully isolated RS-422 interface. ***An isolated RS-422 interface has 5 signals available (such as T+, T-, R+, R-, and SG) and the resistance between all 5 signals and the frame-chassis or power supply ground is greater than 1 meg-ohm.*** Examples of fully isolated RS-422 interfaces are rdc422ic (isolated RS-232 to RS-422 converter) or rdc422ir (isolated RS-422 repeater). 5-wire panel-grade cable is required between your fully isolated RS-422 device and 2 rdcLPU. 4-wire (2-pair) field-grade cable can be used between the rdcLPU and your remote device. See RobustDC's application notes AN018 (Surge Management) & AN031 (Lightning-Proof RS-485) for other design details you must consider. Of special note - the 5th wire (the signal ground) between the isolated device and the rdcLPU is critical for long-term survival of the interface. It will "work fine" without this 5th wire ... until the first large surge comes in!

3.4. Non-isolated RS-422 (not optimal)

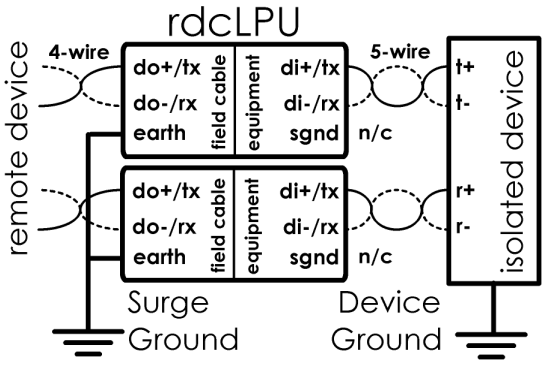

figure 3.4 - Wiring for Non-isolated RS-422

Although optimized for isolated interfaces, the rdcLPU can also be used with non-isolated interfaces. However, a non-isolated interface can never be though of as "lightning proof". ***A non-isolated RS-422 interface has 4 or 5 signals available and the resistance between ANY of the signals and the frame-chassis or power supply ground is less than 1 meg-ohm.*** Examples of non-isolated RS-422 interfaces are most low-cost RS-232 to RS-422 converters and most commercial RS-422 field devices. 4-wire (2-pair) cable is used through-out. See RobustDC's application notes AN018 (Surge Management) for other design details you must consider. Of special note - during large lightning surges you may have ground loop problems between your surge ground & panel ground through your device. Therefore extra care must be taken to implement a fool-proof grounding system. While fully isolated interfaces are very forgiving of minor ground design flaws, ***non-isolated interfaces are very unforgiving!***

3.5. Fully Isolated RS-232 Interfaces

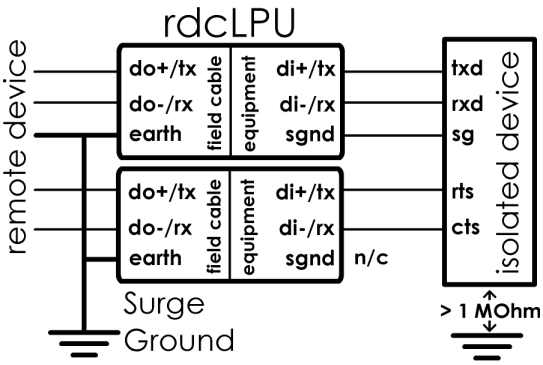

figure 3.5 - Wiring for Isolated RS-232

One or more rdcLPU can be used with a fully isolated RS-232 interface - such as the rdc232ir3 or rdc232ir9. ***An isolated RS-232 interface has a resistance between the signal ground and the frame-chassis or power supply ground of greater than 1 meg-ohm.*** Examples of fully isolated RS-232 interfaces are rdc232ir3 (isolated RS-232 three-wire repeater) or rdc232ir9 (isolated RS-232 nine-wire repeater). See RobustDC's application notes AN018 (Surge Management) for other design details you must consider. Of special note - the field signal ground wire leaving the rdcLPU is directly connected to the surge earth, therefore you must use a 2nd set of rdcLPU at the remote end to separate the remote signal ground from the surge ground. ***In general, RS-232 is a poor choice for use when lightning is a concern - RS-485 or RS-422 are better choices.*** RS-232 is very susceptible to both noise interference and grounding problems.

3.6. Non-isolated RS-232 (not recommended)

The rdcLPu is not recommended for use with non-isolated RS-232 interfaces. Either isolate the RS-232 or convert to RS-485 or RS-422.

4. INSTALLATION - DEVICE LAYOUT WITHIN THE PANEL

Even the best industrial lightning protection devices like ***the rdcLPU will be completely ineffective if not installed properly***. Follow the guidelines below carefully. A key requirement for effective lightning protection is space - you cannot squeeze everything into the panel and retain effective surge protection.

4.1. Effective Panel Layout

Figure 4.1 shows the recommended panel layout. For effective surge protection you must layout your panel and route your cables properly! Notice the minimum separations listed. These exist because:

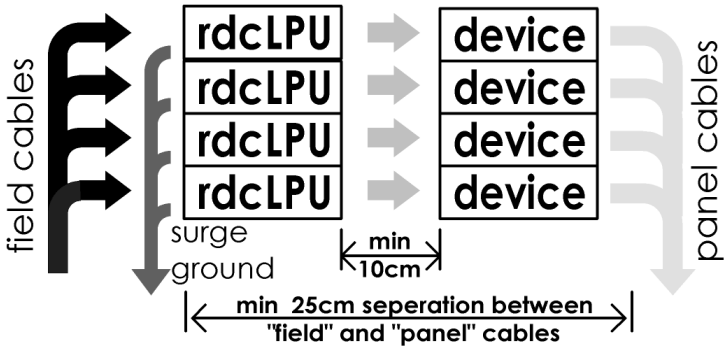

figure 4.1 - RECOMMENDED Panel Layout

- Without adequate separation, surges in the field cables will induce surges in the panel cables - bypassing the rdcLPU.

- The cable lengths provide both "voltage drop" and "impedance", integral to the effectiveness of the lightning protection system.

4.2. Bad Panel layout - NOT RECOMMENDED

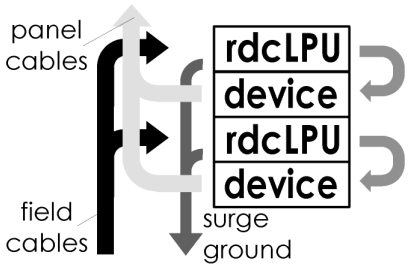

figure 4.2 - BAD LAYOUT!

Figure 4.2 shows bad panel layout common in small panels. Notice how the surge device and data communication devices are mixed. The field cables ("dirty") and panel cables ("clean") are also intermixed. Large surges entering this panel are guaranteed to induce smaller surges in the "clean" panel cables, effectively bypassing the surge protection system and causing damage to other panel equipment. While RobustDC's recommended minimum separations are debatable and perhaps too conservative, you will never suffer for following them!

5. TECHNICAL SPECIFICATION

5.1. Surge Management

5.1.1. **Nominal Operating Voltage**..... ± 15vdc (suitable for RS-232, RS-422, RS-485)

5.1.2. **Nominal Operating Current**..... less than 250mA (max spec for RS-485)

5.1.3. **Series Resistance**..... 6.5 ohms (at 25 °C with minimum current)

5.1.4. **Impulse Discharge Current**..... 20kA (wave form 8/20µs like IEC 801.5)

5.1.5. **Course Protection Method**..... Ceramic Gas Discharge Tube

5.1.6. **Fine Protection Method**..... High-Speed Transient Suppressor Diode

5.1.7. **Current Limiting**..... Positive-Temperature-Coefficient Thermistor

5.1.8. **Capacitance Effect**..... Approximately 4000pF per wire due

5.1.9. **Supported Speeds**..... 300 to 115kbps

5.2. Mechanical / Environmental

5.2.1. **Ambient operating temperature**..... -40°C to +65°C

5.2.2. **Ambient storage temperature**..... -40°C to +100°C

5.2.3. **Relative Humidity**..... 10 to 95% RH, non condensing

5.2.4. **Case Material**..... Fungus/termite resistant, self-extinguishing to UL.

5.2.1. **Weight**, 60g.

5.2.2. **Terminal Capacity**
2.5mm strand (12 AWG)
4.0mm solid (12 AWG).

5.2.3. **Mounting Rail**
DIN EN 50022 (35mm "symetrical")
DIN EN 50025 (32mm "asymetrical")
Note: it fits best on the DIN 50022 style rail.