

Application Note - XRT73L04 4-Channel DS3/E3/STS-1 LIU IC Power Conditioning Requirements

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1.0 OVERVIEW

XRT73L04 is a 4-Channel DS3/E3/STS-1 Transceiver (Line Interface Unit) that is designed for use in multi-standard Networking and Transmission Systems.

The XRT73L04 device is a mixed signal device that supports the transmission and reception of data at the DS3, E3 and STS-1 rates. Hence, this chip handles both digital input and output signals (which switch at very fast rate and generate a lot of electrical and radio frequency noise). Additionally, this chip also consists of four independent sensitive analog receivers. As a consequence, the user must be careful in how to handle the VDD and GND pins, in order to ensure good performance of the XRT73L04 device.

In particular, the user's PCB layout and handling of the VDD and GND signals must accomplish the following:

1. It must provide good isolation between the Transmit and Receive signals.
2. It must provide good isolation between Analog and Digital signals.
3. It must provide good isolation between each of the four (4) Channels within the LIU IC
4. It must provide good isolation between signals from other components on the board.

In many networking or transmission systems the source of power is a DC-DC converter, which uses a switching converter to transform a -48VDC input to a +3.3VDC output. The switching converter typically uses a switching frequency from 20KHz to 1MHz and the 3.3VDC power normally carries a significant amount of 'ripple' noise at this switching frequency. This ripple noise can adversely affect performance of analog circuits in the mixed signal devices (XRT73L04 and similar).

This application note presents some guidelines on how to layout and filter the VDD and GND signals that are fed to the XRT73L04 device.

2.0 XRT73L04 'GND' PINS

Tie all XRT73L04 'GND' pins (pin numbers 6, 15, 18, 19, 22, 31, 49, 50, 56, 62, 63, 81, 89, 92, 100, 109, 112, 118, 124, 129 and 132) to the system ground plane. In case there are separate analog and digital ground planes are available, tie all 'GND' pins to the

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analog ground. Do not insert any impedance (an inductor or ferrite bead) between analog and digital ground pins of XRT73L04.

3.0 XRT73L04 'POWER' PINS

The XRT73L04 device has 17 power supply pins. Pins 78, 86, 95, and 103 are the receive analog section power supply pins. Pins 4, 10, 13, 24, 27, 33, 47 and 134 are the transmit analog section power supply pins. Finally, pins 51, 58, 122 and 128 are digital power supplies. The receive analog power supply pins (pins 78, 86, 95 and 103) are the most critical as they power the four (4) clock recovery phase-lock-loops and therefore power to these pins should be as clean as possible.

It is also desirable to keep the transmit power supply noise isolated from the receive power supply. Further, it is also desirable to keep the individual channels (within a given XRT73L04 device) isolated from each other. Finally, if multiple XRT73L04 devices are used in a system it is further desirable to keep their power isolated (from each other) in order to minimize cross-talk.

The attached schematic (Figure 1) illustrates Exar's recommendations on how to connect the Analog and Digital VDD pins (of a single XRT73L04 device) to a 3.3V Power Supply. Exar's approach recommends the use of two-stage LC filtering.

3.1 STAGE 1 – A LARGE LC FILTER (consisting of L1 and C1)

This particular LC filter consists of a 15uH inductor and a 33uF capacitor. The purpose of this LC filter is to eliminate much of the "DC-to-DC Converter-induced" low frequency ripple, within the 3.3V power supply line, prior to being routed to any of the VDD pins of the XRT73L04 device.

NOTES ABOUT THIS LC FILTER:

1. This LC filter should be placed close to the output of the DC-to-DC Converter.
2. Only one such LC filter is needed, per board (even in multi-channel applications). However, multi-channel designs may have to use multiple instantiations of this LC filter due to large voltage drops across the inductor (due to the increased amount of current draw of multiple XRT73L04 devices and the dc resistance of the inductor), or because of the maximum operating current limit of this inductor as well.
3. This LC filter may not be necessary if the 3.3V Power Supply is already filtered elsewhere in the system.

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COMPONENT SELECTION FOR L1 AND C1

The XRT73L04 device draws about 470mA of current. We recommend that the user select a High Current Inductor, that has a small enough DC resistance such that the voltage drop across the inductor will not exceed 50mV. Therefore, the user should select a 15uH Inductor that has a DC resistance of less than 0.106Ω.

An example of an acceptable inductor for L1 is the 4922-15L from API-Delevan. This particular inductor has a maximum dc resistance of 0.089Ω, and has a maximum current rating of 2.11A. Contact information for API-Delevan is presented in Appendix A, at the end of this Applications Note.

The capacitor, C1, should be a 33uF 10V Tantalum capacitor, which is supplied by various manufacturers. Digikey PCT2336CT-ND or equivalent would be acceptable.

3.2 STAGE 2 – SMALLER LC FILTERING FOR RECEIVE AND TRANSMIT ANALOG VDD PINS

After the Power Supply signal passes through the large LC filter (consisting of L1 and C1), it should then be routed to nine different points, in parallel (in order to support each of the four channels).

- Directly to the Digital VDD pins of the XRT73L04 device.
- To an LC filter (consisting of L2 and C2), prior to being routed to the Receive Analog VDD pin of Channel 0 (pin 78).
- To an LC filter (consisting of L3 and C3), prior to being routed to the Transmit Analog VDD pins of Channel 0 (pins 33 and 47).

- To an LC filter (consisting of L4 and C4), prior to being routed to the Receive Analog VDD pin of Channel 1 (pin 86).
- To an LC filter (consisting of L5 and C5), prior to being routed to the Transmit Analog VDD pins of Channel 1 (pins 24 and 27).

- To an LC filter (consisting of L6 and C6), prior to being routed to the Receive Analog VDD pin of Channel 2 (pin 103).
- To an LC filter (consisting of L7 and C7), prior to being routed to the Transmit Analog VDD pins of Channel 2 (pins 4 and 134).

- To an LC filter (consisting of L8 and C8), prior to being routed to the Receive Analog VDD pin of Channel 3 (pin 95).

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- To an LC filter (consisting of L9 and C9), prior to being routed to the Transmit Analog VDD pins of Channel 3 (pins 13 and 10).

The purpose of this LC filter is three-fold:

1. To provide some isolation and filtering between the Digital VDD line and the Analog VDD lines.
2. To provide some isolation (and reduce cross-talk) between the Transmit and Receive Analog VDD lines.
3. To provide some isolation (and reduce cross-talk) between each of the four channels within the XRT73L04 device.

NOTE: In contrast to the LC filter (consisting of Inductor L1 and Capacitor C1), these LC filters must not be shared with other Channels or LIU Devices.

COMPONENT SELECTION FOR L2 – L9 AND C2 – C9

As mentioned above, each of the LC filter (consisting of Inductors L2 through L9 and capacitors C2 through C9) are used to filter and isolate the power supply line, going to each of the Receive Analog VDD pins and the Transmit Analog VDD pins. Each of these inductors should be of value 6.8uH, and each of these capacitors should be of value 2.2uF.

The current consumption (via each of the Power Supply pins, of the XRT73L04 device) is presented below in Table 1.



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Table 1, The Current Consumption via each of the XRT73L04 Power Supply Pins

Pin Number	Description	Amount of Current
Measurements for Channel 0		
33	Transmit Analog VDD – Channel 0	49.5mA
47	Transmit Analog VDD – Channel 0	4.22mA
58	Receive Digital VDD – Channel 0	16.1mA
78	Receive Analog VDD – Channel 0	48.6mA
Total Current Consumption – Channel 0		118.42mA
Measurements for Channel 1		
24	Transmit Analog VDD – Channel 1	51.2mA
27	Transmit Analog VDD – Channel 1	6.7mA
51	Receive Digital VDD – Channel 1	16.15mA
86	Receive Analog VDD – Channel 1	49.2mA
Total Current Consumption – Channel 1		123.25mA
Measurements for Channel 2		
4	Transmit Analog VDD – Channel 2	42.7mA
134	Transmit Analog VDD – Channel 2	4.5mA
122	Receive Digital VDD – Channel 2	16.28mA
103	Receive Analog VDD – Channel 2	48.3mA
Total Current Consumption – Channel 2		111.78mA
Measurements for Channel 3		
13	Transmit Analog VDD – Channel 3	43.1mA
10	Transmit Analog VDD – Channel 3	4.15mA
128	Receive Digital VDD – Channel 3	16.11mA
95	Receive Analog VDD – Channel 3	49.7mA
Total Current Consumption – Channel 3		110.06mA
130	EXVDD	2.77mA
Total Current Consumption – XRT73L04 Device		466.28mA

For inductors L2 through L9, the user should select as large a value as the selected size (0805, 1210 or 1812 etc.) will allow while keeping the DC resistance of each inductor to less than 2 ohms. The goal is to keep the power supply voltage (at the VDD pins of the XRT73L04 device) above 3.135 volts.

An example of an acceptable inductor would be the 1210-682J or the S1210-682K (each of size 1210) from API-Delevan. The 1210-682J inductor is spec'd to have a maximum dc resistance of 1.8ohms. Additionally, the 1210-682J inductor has a maximum current

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rating of 321mA. The S1210-682K inductor is spec'd to have a maximum dc resistance of 1.5ohms. Further, the S1210-682K has a maximum current rating of 372mA.

3.3 THE ZENER DIODE

It is **strongly recommended** that a 3.6V 400mW Zener Diode be connected from the +3.3V supply to power GND to suppress power supply transients in case of excessive charge injection into the Ground plane. These transients can occur while connecting the remote terminal or test equipment to the board via coaxial cable. Such transients can expose integrated circuit devices to momentary 'reverse' polarity or excessive (7V to 10V) power supply voltages. Most voltage regulators are too slow to respond to such transient conditions.

NOTE: This zener diode is also useful for suppressing peak overshoots and ringing (in the power supply line) following a rapid ramp in the power supply voltage, due to events such as "hot-swapping", etc.

An example of an acceptable 3.6V zener diode would be the 1N5914, which is available from various suppliers.



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3.4 DECOUPLING CAPACITORS

We strongly recommend that the user provide de-coupling capacitors for each VDD pin of the XRT73L04 device (Analog as well as Digital). The placement and routing of these decoupling capacitors must be such to minimize the trace length (and in-turn, inductance) between the capacitor and the corresponding VDD pin, and the capacitor and the corresponding via (which connects to the GND plane).

Miscellaneous Notes

The component values shown for capacitors and inductors are to be used as guidelines only. Use following guidelines for selecting components:

For decoupling capacitors use X7R for ceramic non-polar capacitors, solid-tantalum for polar capacitors. Avoid Z5U and electrolytic capacitors.

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4.0 THE BNC CONNECTOR SHIELD

As a general rule, we highly recommend that the customer either AC or DC couple the BNC connector shield to Frame or Chassis Ground. In the schematic design, we recommend that the customer AC couple the BNC connectors (on both the Transmit and Receive Sides) to Frame GND. Further, we also recommend that the customer also design in a Jumper, which permits installation personnel to DC couple the BNC connector shield to Frame GND, when set.

Component selection for the for the Capacitor (used to AC couple the BNC Connector Shield to GND)

The characteristics of a capacitor, to be used in this role are as follows.

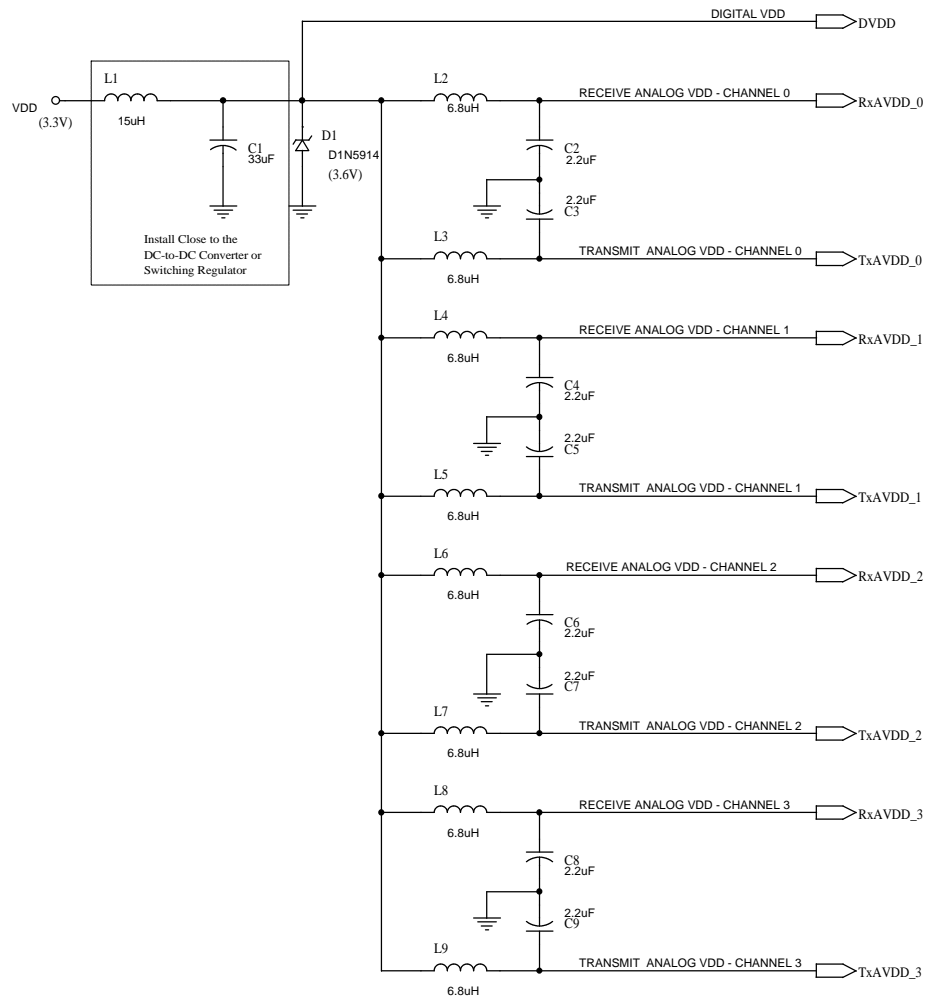
- This capacitor must be rated for high voltages.
- This capacitor must impose minimum AC impedance to Frame GND.

Therefore, the optimum choice for such a capacitor would be a capacitor that has a very high voltage rating and very large capacitance. The best capacitor that we could find that has both of these characteristics is a 1000pF capacitor that has a working voltage of 2000V.

SOME ACCEPTABLE CAPACITORS for AC Coupling the BNC Connector to Frame GND

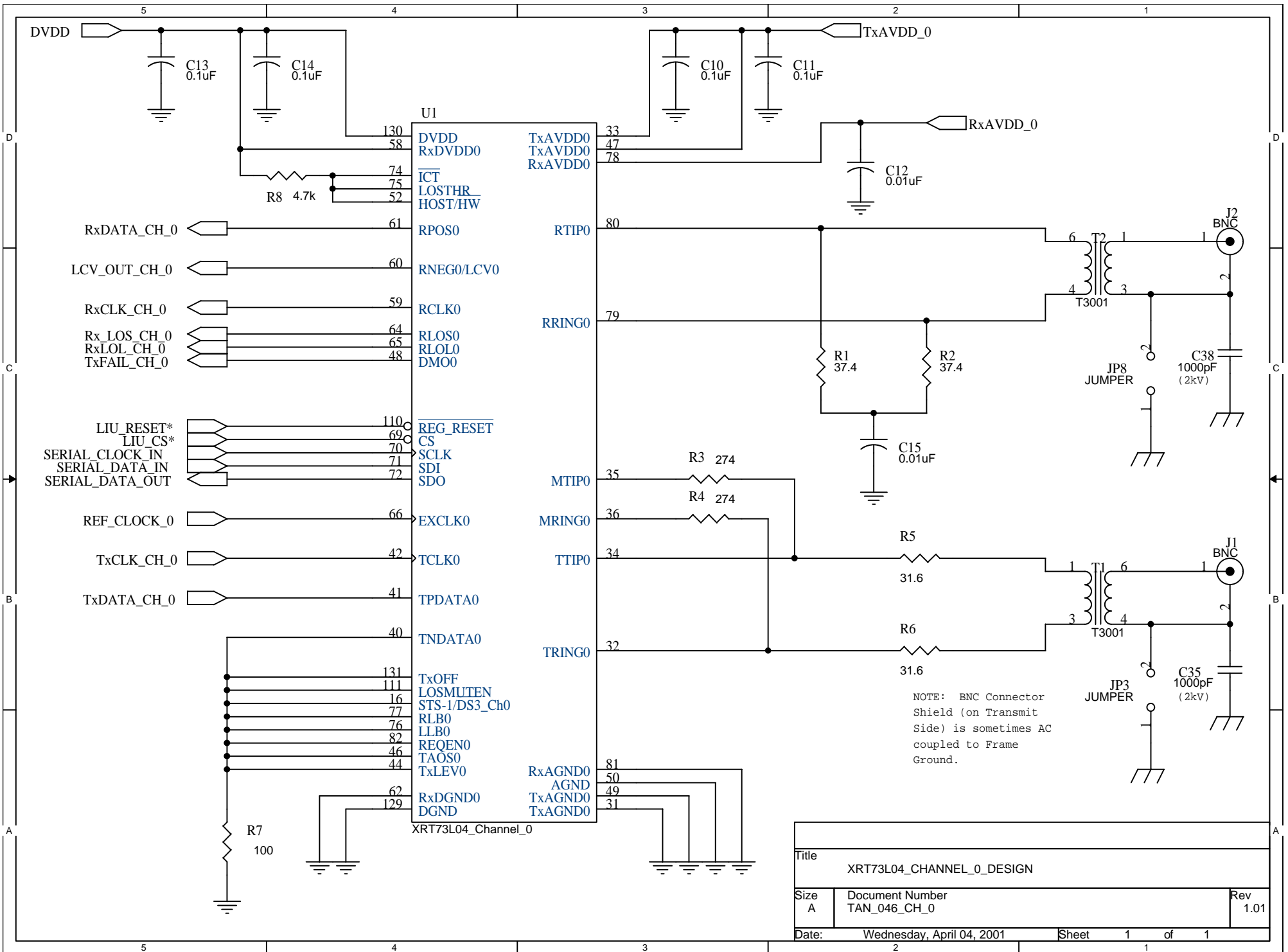
Any of the following capacitors are suitable for this applicable. In all cases, these are Ceramic, X7R, 1000pF, 2kV, 10% capacitors which come in a 1812 case size.

Manufacturer	Part Number
AVX	1812GC102KA11A
AVX	1812GC102KAT2A
CALCHIP	CHV1812N2K0102KXT
JARO	CC1812XR102JN202ER
JARO	CC1812XR102KN202ER
MURATA	GRM43-2X7R102K2KVAL
JOHANSON	202S43W102KV4E

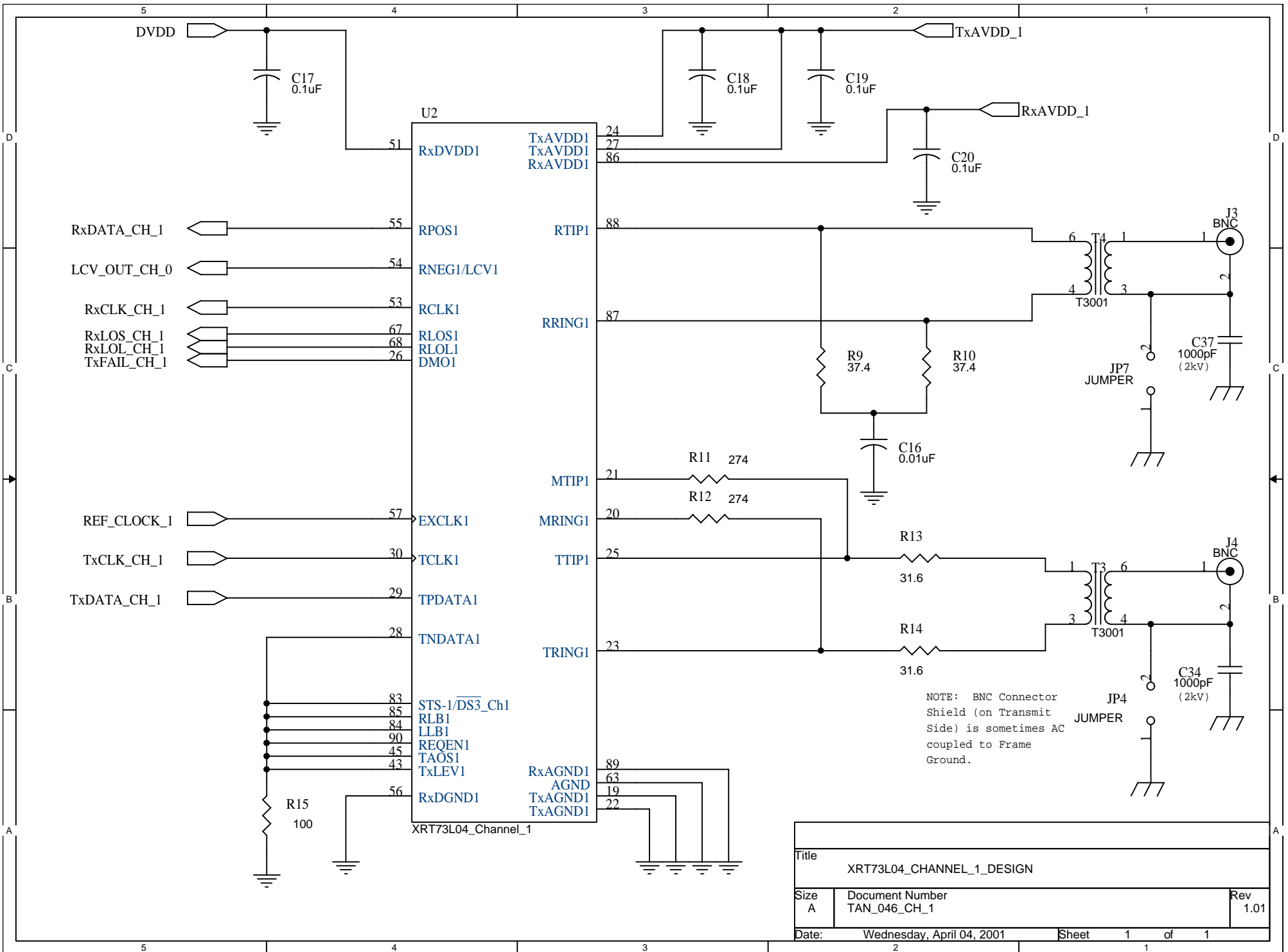


Install Close to the DC-to-DC Converter or Switching Regulator

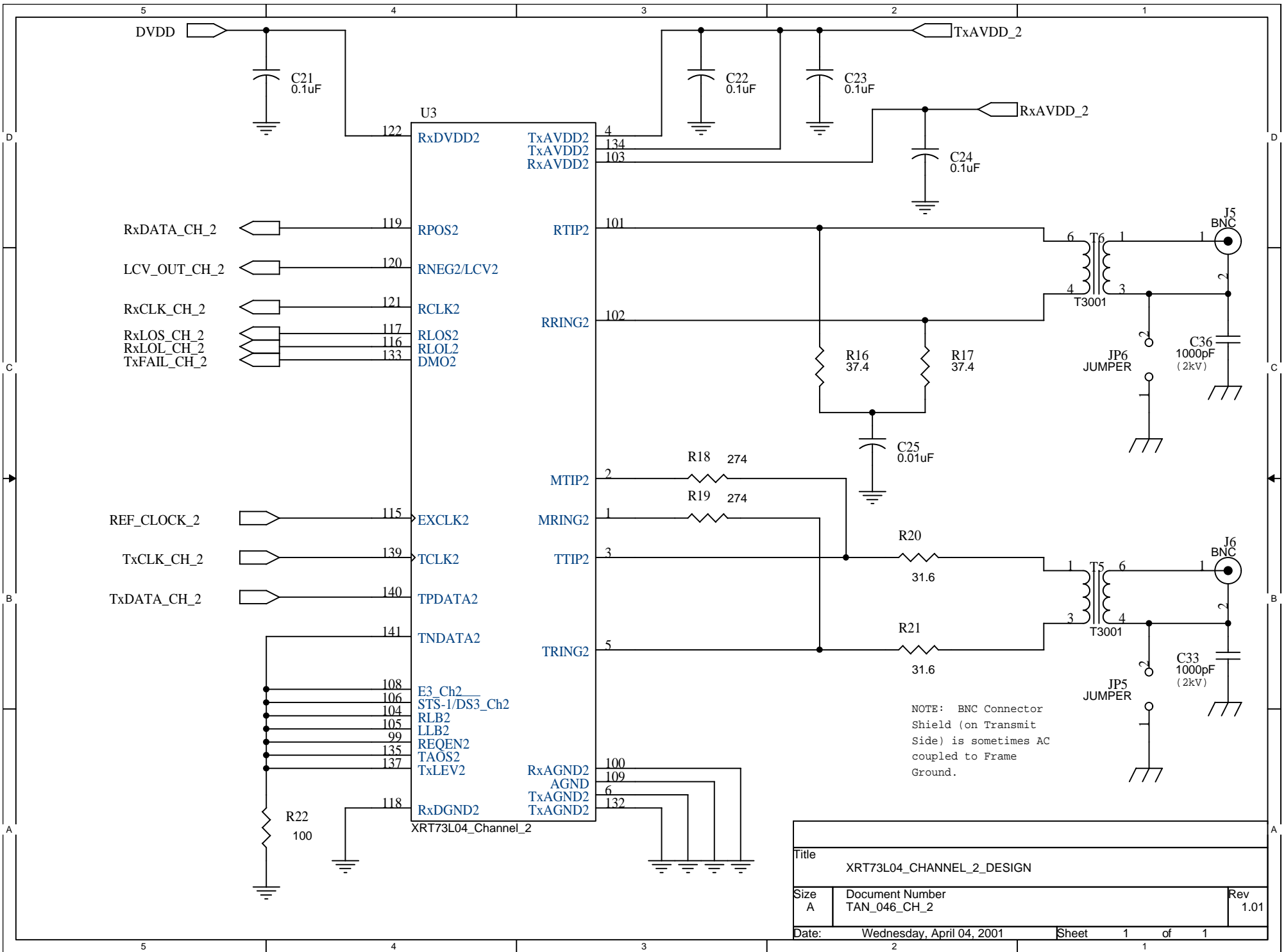
Title		
Power_Conditioning_Circuit		
Size	Document Number	Rev
B	POWER_CON_SCH	1.01
Date:	Wednesday, April 04, 2001	Sheet 1 of 1



Title		
XRT73L04_CHANNEL_0_DESIGN		
Size	Document Number	Rev
A	TAN_046_CH_0	1.01
Date:	Wednesday, April 04, 2001	Sheet 1 of 1

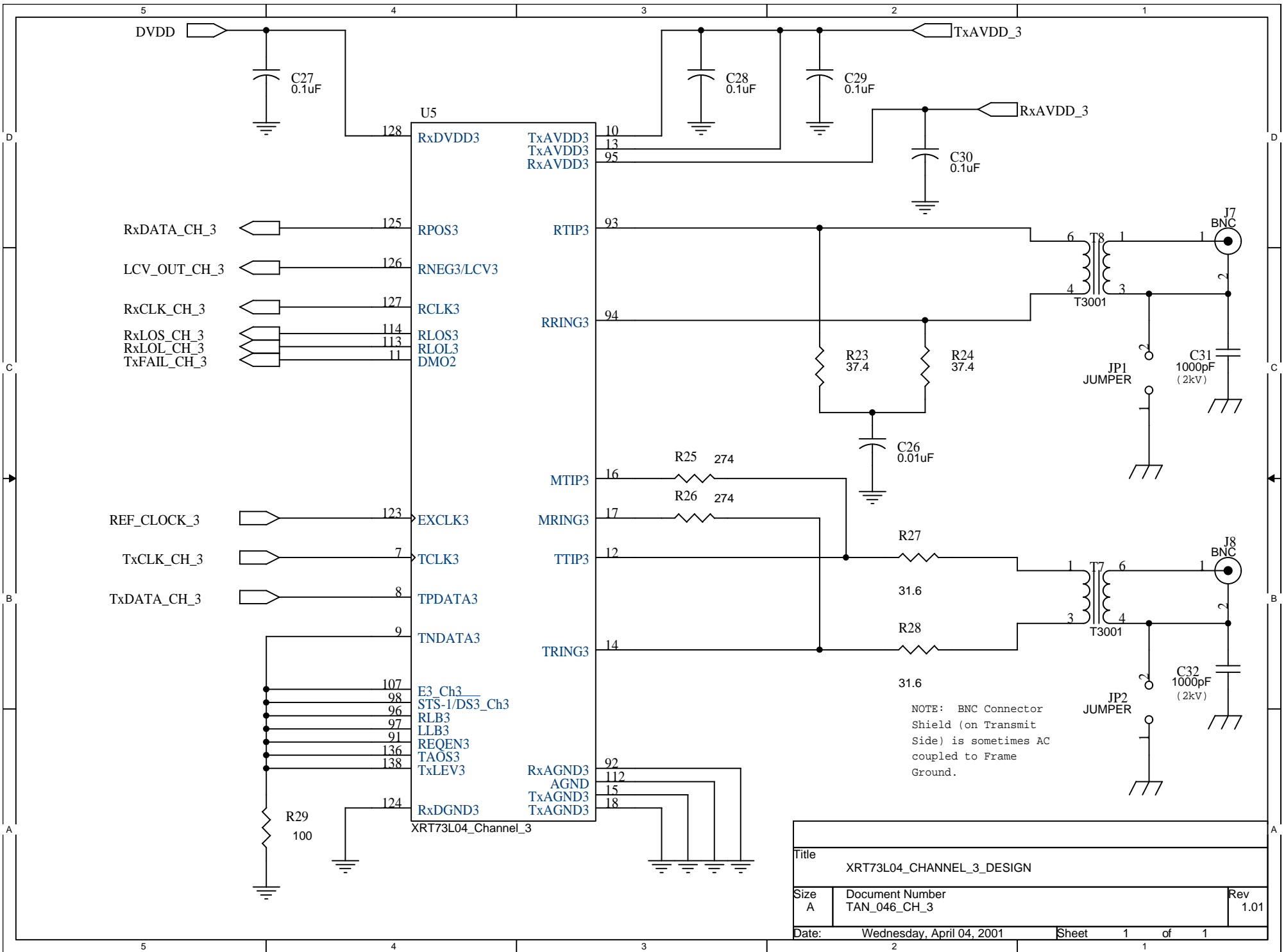


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XRT73L04_CHANNEL_1_DESIGN		
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A	TAN_046_CH_1	1.01
Date:	Wednesday, April 04, 2001	Sheet 1 of 1



NOTE: BNC Connector Shield (on Transmit Side) is sometimes AC coupled to Frame Ground.

Title		
XRT73L04_CHANNEL_2_DESIGN		
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A	TAN_046_CH_2	1.01
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APPENDIX A

CONTACT INFORMATION FOR API-DELEVAN:

Corporate Office

API Delevan
270 Quaker Road
East Aurora, NY 14052
Phone: 716-652-3600
FAX: 716-652-4814

email: apisales@delevan.com

website: www.delevan.com

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APPENDIX B – REVISION CHANGE HISTORY**CHANGES FROM REVISION 1.00 TO 1.01**

1. Modified Schematic Design to include Jumpers JP5, JP6, JP7 and JP8.
2. Changed Capacitors C31, C32, C33, C34, C35, C36, C37 and C38 to 1000pF (2kV) capacitors.

CHANGES FROM REVISION 1.01 TO 1.02

1. Included recommendations on handling the BNC Connector shield (Section 4.0)

CHANGES FROM REVISION 1.02 TO 1.03

1. Included a list of acceptable part numbers for capacitors that can be used to AC couple the BNC Connector shield to Frame GND (Section 4.0).