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Design House – Philips Application Support

TDA5051A
Application Note

An insulated coupling network using the Newport 76250 Transformer

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Summary

Application diagrams of this note have been tested with care but are not guaranteed for any particular purpose.

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1 – Introduction

This application note describes a simple insulated coupling network, built with a standard signal transformer, the Newport 76250, and a few discrete components.

It provides a low cost and efficient solution compared to the use of a Toko T1002 transformer, which is no longer in production and which does not meet new requirements of insulation voltage with the mains.
It does not need any tuning (no tuning screw) and is best suited for mass production.

This network could be used in a wide range of power line signaling applications:
- Domestic appliances requiring an insulation with the mains
- Industrial applications with 120dBuV output voltage range
- Signaling on dedicated AC or DC power lines
- Tele-metering systems
- Etc.

However, special cares must be taken if this kind of network is intended to be used with an external output amplifier at a higher output voltage (more than 1Vrms =120dBuV).

Because of the small size of the transformer's magnetic core, saturation problems may occur, featuring a bad harmonic distortion…
In such a case, larger signal transformers must be used, like pulse transformers for SCR's driving (see Shaffner or Timonta devices for instance).

2- Main features of the coupling network:

The basic function of a coupling network is to feature an efficient high-pass behavior in order to damp the 230V AC (or 120V AC) 50Hz (60Hz) signal of the mains, without attenuating the incoming HF signal.

A typical 230V AC power line can be compared to a 50Hz sine wave signal generator, delivering 167dBuVrms at the modem input !
Since the modem sensitivity is about 80dBuV, it is mandatory to provide an attenuation of 167-80=87dBuV of the 50Hz (60Hz) sine wave component.
But the coupling network is not only a high-pass filter: as explained in the Data Sheet, the digital filter of the RX section needs an anti- aliasing filter to operate properly.
For these reasons, the complete behavior of the coupling network is in fact a band pass filter, featuring a center frequency equal to the chosen carrier frequency (Fc).

In transmission mode, the band-pass behavior is used to eliminate the unexpected harmonics of the digitized carrier and the aliasing components around the sampling frequency (Fosc/2+Fc, Fosc/2-Fc) (see Philips Application note for more details).

The following table shows the mains features of the described coupling network.

Parameter	Value	Unit
Center frequency = Carrier frequency (Fc)	115	KHz
Insulation voltage between primary and secondary	1500	Vrms
RECEPTION MODE		
Typical input impedance at Fc	35	Ohms
-3dB Bandwidth	100	KHz
50Hz attenuation	> 90	dB
Anti-aliasing around Fosc/2	> 50	dB
Input sensitivity with TDA5051A	78	dBuVrms
TRANSMISSION MODE		
Typical output impedance, including TDA5051A stage	6..7	Ohms
Output voltage on a CISPR16 load	120	dBuVrms

3 – Electric diagram of the coupling network

The complete application diagram is shown on page 6.

A- Mains section

A fast fuse F1 of 630mA max. is used to protect the mains in case of a short circuit on the board, but also in case of overvoltage across the Metal Oxide Varistor E1 (rated for 230V operation).
A large value resistor R0 discharge the high voltage capacitor C1 when the coupling network is disconnected from the power line.

B- Coupling Network:

It consists of two LC networks and the Newport 76250 signal transformer.
Because of the high inductance value of the 76250 windings (2mH), the tuning is only provided by the L and C values of the external networks L1-C1 and L2//C2.

The capacitor C1 (47nF) **MUST BE** a X2 type, rated for 230V AC operation. The inductor L1 is chosen to provide a low serial resistance (lower than 1 Ohm).

The resistor R1 (100 Ohms - optional) is used to damp the transient response of the L2-C2 network, during power-up or in heavy pulse noise conditions on the power line.

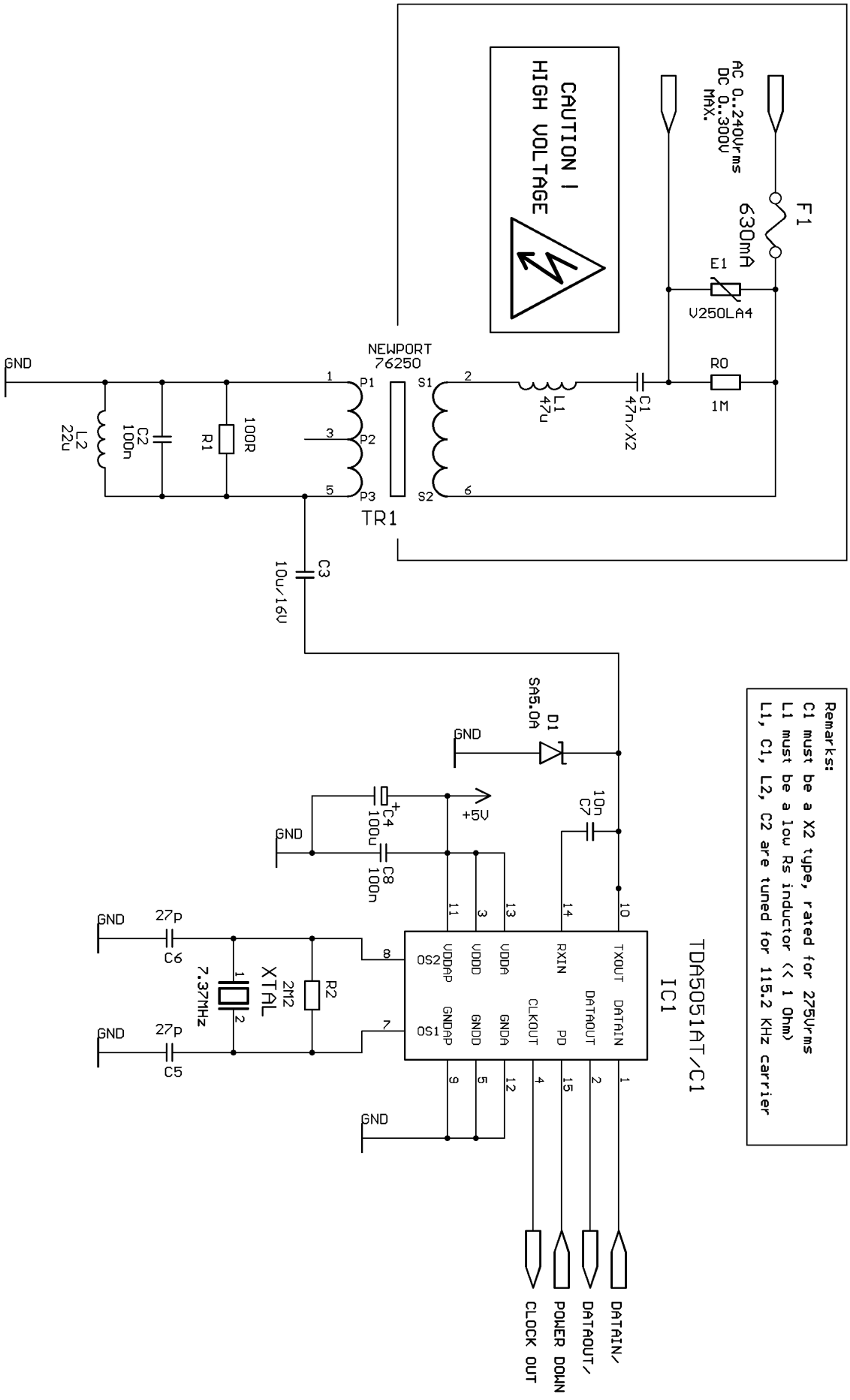
It is possible to use SMD components for L1, C2 and L2. But in such a case, *the designer will have to check the maximum peak current within inductors and the peak voltage across the capacitor C2 during power up.*

These components values have been chosen for a 115KHz carrier frequency.

C- MODEM section:

The TXOUT pin of the TDA5051A is directly connected to a transient suppressor D1, as mentioned in the DATA SHEET. The capacitor C3 provides the decoupling of the DC voltage present at TXOUT. The RXIN pin is connected to TXOUT by means of C7…

In this application diagram, the on-chip oscillator is used, and needs the external components XTAL, R2, C5 and C6 to operate properly. A wide range of crystals or ceramic resonators can be connected to the TDA5051 without changing the values of these components.

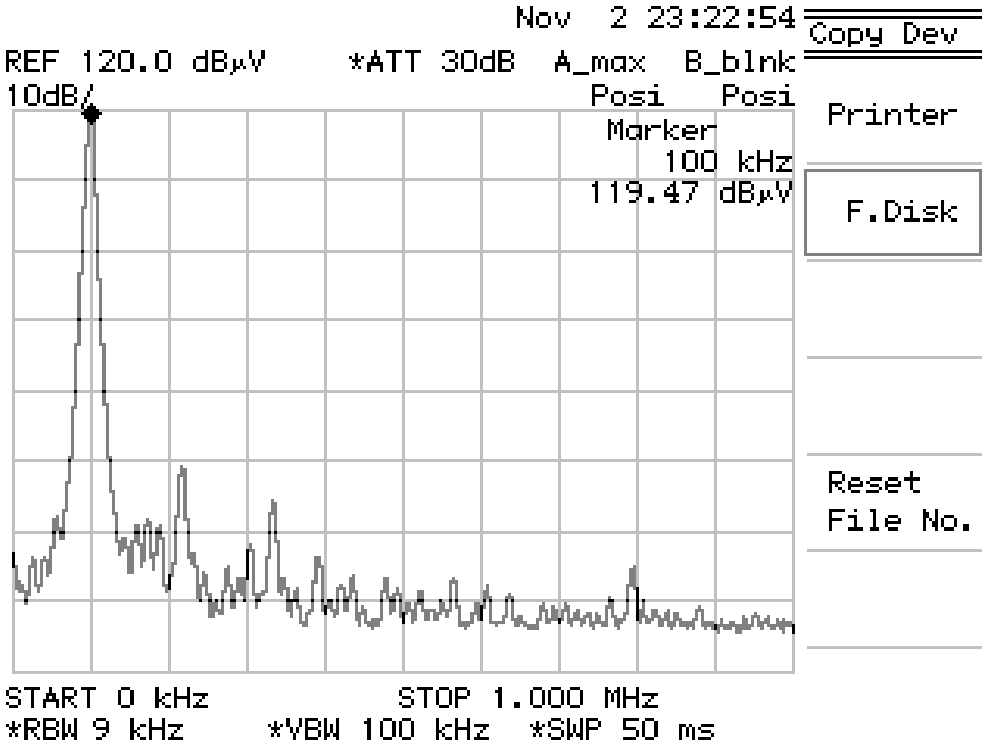

CAUTION !
HIGH VOLTAGE
AC 0..240Vrms
DC 0..300V
MAX.
F1
630mA
E1
V250LA4
R0
1M
C1
47n/X2
L1
47u
NEWPORT
76250
P1
P2
P3
S1
S2
TR1
GND
L2
22u
C2
100n
R1
100R
C3
10u/16V
D1
SA5.0A
+5V
C4
100u
C8
100n
C7
10n
27p
C6
C5
7.37MHz
XTAL
2M2
R2
TDA5051AT/C1
IC1
TXOUT
DATAIN
DATAOUT
RXIN
PD
CLKOUT
VDDA
VDDD
VDDAP
GNDA
GNDD
GNDAP
OS2
OS1
DATAIN/
DATAOUT/
POWER DOWN
CLOCK OUT
Remarks:
C1 must be a X2 type, rated for 275Vrms
L1 must be a low Rs inductor (< 1 Ohm)
L1, C1, L2, C2 are tuned for 115.2 KHz carrier

Component list

IDENT	DESIGNATION	MANUFACT	PACKAGE	TYPE	ORDER CODE
F1	630mA Fast Fuse				
E1	Metal Oxide Varistor 250V AC			V250LA4	
TR1	Signal Transformer	Newport			76250
IC1	TDA5051AT/C1	Philips			
D1	Unidirectional Transil diode	GI			SA5.0A
L1	47uH low Rs	Newport	Radial		22R473
L2	22uH standard				
R0	1M 1/2W	Philips		PR02	
R1	100R (optional)				
R2	2M2				
C1	47nF 275 V AC			**X2**	
C2	100nF 63V			CERAMIC	
C3	10uF 16V Non polarized	Nitai	Radial		
C4	100uF/10V			Electrolytic	
C5	27pF 25V			CERAMIC	
C6	27pF 25V			CERAMIC	
C7	10nF/25V			CERAMIC	
C8	100nF 25V			CERAMIC	
XTAL	7.37MHz Ceramic Reson.	Murata			

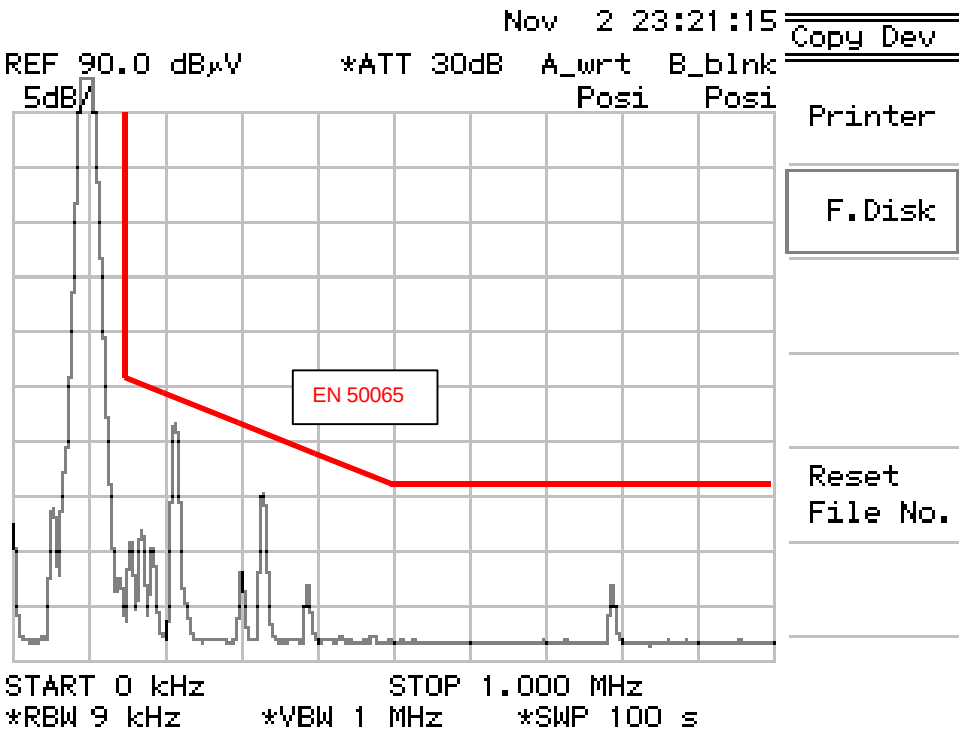
4 – Carrier spectrum

4-1 Carrier spectrum on a 50 Ohms load



This plot has been recorded in the following conditions:
- External linear +5V power supply
- Start frequency 0KHz - Stop 1MHz - Resolution Bandwidth 9KHz - **Peak Hold**
- Scale: 10dB/div
- Coupling network: Newport 76250 with Ls=47uH Cs=47nF Lp=22uH Cp=100nF
- The reference level (top) is 120 dBuV

4-2 Carrier spectrum on a CISPR16 load



This plot has been recorded in the following conditions:
- External linear +5V power supply
- Start frequency 0KHz - Stop 1MHz - **Resolution Bandwidth 9KHz**
- **Quasi-peak detector mode, sweep time=100s**
- Coupling network: Newport 76250 with Ls=47uH Cs=47nF Lp=22uH Cp=100nF

The spectrum is below the EN50065-1 Quasi-Peak limits.