CML Microcircuits

COMMUNICATION SEMICONDUCTORS

Application Note

CMX868 and CMX869 MODEM With Opto-Isolated DAA

AN/Telecom/Litelink/3 July 2004

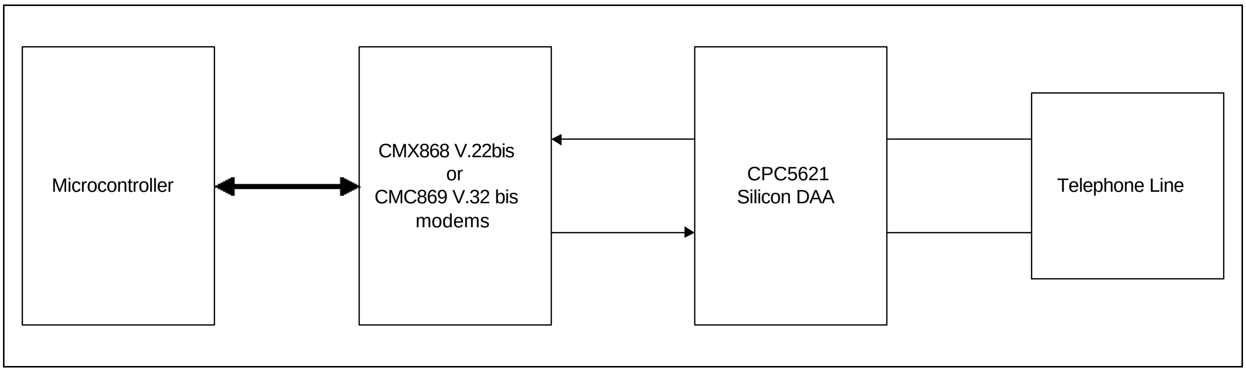
1 Introduction

This application note describes how the Clare CPC5621 optical DAA can be used to interface the CMX868 V.22bis and CMX869 V.32bis modem chips to the telephone line. The primary benefit of the Clare LightLink DAA is that it requires very little board area and has a very low profile. This can be important in applications where there are tight space constraints.

Alternate designs based on low cost "wet" transformer DAAs are presented in other CML application notes. In general, these transformer DAAs offer comparable V.22bis only performance at slightly lower cost. The main disadvantages of the wet transformer designs are the comparatively large size of the transformer, the inability to meet the return loss requirements in certain countries such as Australia, New Zealand, and Brazil and poor performance at V.32bis. For this reason, a design based on the Clare DAA has been developed to provide designers with an alternative option for both the CMX868 and CMX869.

Note: This application note can also be used with other modems in the CML range, please contact CML Technical Support for details.

The two circuits shown in this application note can be populated in two basic configurations, each of which must be further configured for operation with a 3.3 or 5 volt supply:
A "General Purpose" configuration that can be used in any country except Australia.
A "TBR 21" configuration that fully complies with the former European specification TBR 21. This configuration does not cover as many countries as the general-purpose configuration, but some manufacturers still prefer to comply with TBR 21 for their European products, including Australia.



2 Contents

3 The Clare 5621 Litelink DAA

The Litelink DAA uses optical isolators to couple analogue signals across an isolation barrier. Aside from the optical barrier inside the Litelink package, the only other components that bridge the isolation barrier are two high voltage capacitors that couple the “snoop” circuit to the phone line. The snoop circuit is used for on-hook detection of both ringing and caller ID (CLIP) signals.

In combination with some external discrete components, the Litelink implements a complete DAA function that includes ring detection, switch hook, DC termination, AC termination, hybrid function, and on-hook receive for caller ID (CLIP).

Control of the Litelink DAA uses just two digital lines. The /OH control line is used to place the DAA in either the on-hook or off-hook state. This input connects directly to the RDRVN output of the CMX868. The second control line is the /CID input. When the /CID input is high, the snoop circuit is used to detect ringing. When the /CID input is low, the output of the snoop circuit is directed to the analogue receive path, so that caller ID (CLIP) signals can be detected in the on-hook state. The state of the /CID input must be controlled by the host processor.

A detailed data sheet for the CPC5621 is available at the Clare web site. Particular importance for Litelink users is the application note AN-146, “Guidelines for Effective Litelink Designs.”

4 Circuit Description

The attached schematics and bill of materials show how the CMX868 and CMX869 both interface to the CPC5621. Note that the bill of materials shows a General Purpose configuration and a TBR 21 configuration. For each configuration there are two components (R79 and R80) that have different values depending on whether the supply voltage to the CMX868/869 is 3.3 volts or 5 volts.

It should be noted that the circuits shown would not meet the regulatory requirements in certain countries for the pulse dialling waveform. However, in the few cases where this occurs, the country in question has either 100% or close to 100% DTMF dialling compatibility throughout their network. In these countries the modem will have to be restricted to DTMF dialling.

4.1 General Purpose Configuration

The General Purpose configuration can be used in any country except Australia. It has excellent return loss with respect to 600 ohms, a DC V-I characteristic that is less than 6 volts at 20mA, and a fuse that helps it to pass the over-voltage safety requirements for North America. In general, this would be the recommended circuit for any country except Australia, unless there are good reasons to do otherwise.

4.2 TBR 21 Configuration

The TBR 21 specification for Europe was withdrawn by the RTTE directive in April, 2000, and was not replaced with a comparable standard. Under the RTTE directive, the only regulatory requirements that now apply to a DAA are those for safety and EMC.

Some manufacturers are uneasy with this comparative lack of regulation, and have continued to self-impose TBR 21 compliance on their designs. In the attached design, the TBR 21 configuration differs from the General Purpose configurations in only three respects:

Loop current is limited to less than 60mA (As per clause 4.7.1 of TBR 21).
The AC impedance matches the reference impedance in TBR 21, instead of 600 ohms. As it turns out, the 600ohm impedance of the General Purpose configuration also meets the requirement in TBR 21, but the compliance margin is greater with the TBR 21 configuration.
The fuse shown in the circuit is not mandatory for compliance with TBR 21, and can be omitted if desired.

The 60mA current limiter was included in TBR 21 at the request of France, due to a unique situation that occurred only in France. France had some older central offices that relied on the terminal equipment to limit the loop current to less than 60mA. According to France Telecom, the last of this older equipment was scheduled to be removed from service by October 2002. In view of this, the current limiting function should no longer be required in new designs.

The TBR 21 configuration has better matching than the General Purpose configuration to the AC reference impedance defined in TBR 21. However, there is likely to be no significant performance difference between the two versions of the CMX868/869 circuit. One beneficial side effect of the TBR 21 configuration is that its AC impedance meets the impedance requirement for Australia, while the AC impedance of the General Purpose configuration does not.

It should be noted that the 60mA current limiter in the TBR 21 configuration can be removed by simply using the 8.2ohm value for R16 as shown in the General Purpose configuration. No other parameters are affected by this change, so the 8.2ohm value should be used if the only goal is compliance for Australia.

In summary, there are few benefits of using the TBR 21 configuration in a new design. The 60mA current limiter is no longer needed, and in fact generates unnecessary heating in the DAA when installed. The modified AC impedance is not likely to result in a noticeable difference in performance, but it is useful for meeting the AC impedance requirement in Australia. Lastly, the fuse that is typically required for North America can be omitted if the target market does not include North America.

4.3 Transmit Level

The CMX868 and CMX869 have a programmable attenuator in the transmit path that can be used to attenuate the transmit signal by up to 10.5dB. In the attached circuits, the transmit path gain of the Litelink DAA has been set so that the modem transmit level on tip/ring is -6dB when the attenuator in the CMX868/869 is set to 0dB attenuation.

As a result, the available range of transmit levels is -6dB to -16.5dB, based on the setting of the CMX868/869 transmit attenuator. For most countries, the maximum allowable transmit level is about -10 dBm, so a typical setting for the transmit attenuator in the CMX868/869 would be -4.5dB. Some countries may require a different setting for the attenuator.

Note that the same transmit attenuator is used to set the level of DTMF tones. With the transmit attenuator set to -4.5dB, the levels of the high group and low group in the DTMF tone pair with be -6.5dBm and -8.5dBm, respectively. This will be suitable for most countries, however some countries require slightly lower DTMF levels.

4.4 Receive Gain

The receive gain has been set up so that the carrier detect threshold of the CMX868 and CMX869 corresponds to a level of -43 dBm on tip/ring.

4.5 Caller ID (CLIP)

In most countries, Caller ID information, also known as calling line identity presentation (CLIP), is transmitted from the central office during the silent interval between the first and second ring bursts. With this type of protocol, it is easy for the host processor to assert a low on the /CID pin of the Litelink during the first silent interval.

When the Litelink is in the on-hook state, a logic low on /CID directs the received signal on tip/ring to the RX+ pin of the Litelink, so it is presented to the modem's normal receive path. When the Litelink is in the on-hook state and the /CID input is held high, the output of the ring detector is presented on the /RING pin of the Litelink, allowing the CMX868 and CMX869 to detect ringing.

Caller ID signal detection is more complicated for the UK, because the caller information is transmitted prior to the first ring burst. The signal that indicates the information is about to be transmitted from the central office is a polarity reversal followed by a dual frequency "tone alert signal" (TAS).

A polarity reversal will appear as a single pulse on the ring detect bit. In response to the first pulse on the ring detect bit, the host processor must pull /CID low and look for the TAS signal on tip/ring. If TAS is detected, the caller ID detection process continues. If TAS is not detected, the /CID pin is pulled high and the host processor resumes monitoring for a valid ringing signal. Some careful attention is required in the software design to make sure that the host processor software adequately detects both caller ID and incoming ringing.

It should be noted that the attached circuits do not implement the "wetting pulse" and the special AC termination called for in the UK specification, but many manufacturers have found that these features are not necessary for good caller ID detection.

Japan is another country where caller ID information is sent prior to the start of normal ringing. The signal that information is about to be sent is a polarity reversal followed by a special ringing cadence. Thus, the /CID pin can be held high to allow the ring detector to look for the polarity reversal and/or the special ringing cadence. Once this indication is detected, the actual reception of caller ID signals is performed in the off-hook state. Thus, the /CID pin does not need to be pulled low at any time to detect caller ID in Japan.

5 Safety Compliance

The internal safety isolation provided by the Litelink DAA is classified as "supplementary insulation for a working voltage of 250 volts" according to IEC 60950 and its international derivatives. This is sufficient for worldwide applications.

The only other components that bridge the isolation barrier are the two capacitors C7 and C8 in the snoop circuit. For most applications, the only requirements that apply to these capacitors are that they must withstand 1500 VRMS, and must have a physical separation between their leads of at least 1.6 mm. There are many vendors who offer such parts in both through hole and surface mount versions.

In some of the Nordic countries such as Norway and Sweden, C7 and C8 must be special safety rated capacitors with a classification of "Y2" or higher. Such capacitors are readily available in through hole versions. A few manufacturers, such as Murata Erie, make Y2 capacitors in surface mount.

Fuse F1 is generally required to meet the "M1" over-voltage test in UL/CSA 60950 for North America, although if certain restrictions are met the fuse can be omitted. The fuse is not required outside of North America. Note that the specified fuse is specially rated to tolerate lightning surges on the phone line, so substitutions should not be made without careful consideration of both the over-voltage tests and lightning immunity.

6 EMC Compliance

Most countries place restrictions on the amount of high frequency noise that is transmitted on to the phone line. The Litelink itself is not a source of noise, but noise can be coupled into it via the power supply or by magnetic coupling from a nearby DC/DC converter. Such external sources should be avoided to the extent possible.

In Europe, EN 55024 requires that modem operation be relatively unaffected by radio frequency interference that is either radiated from other sources or applied conductively on the phone line. Some other countries have begun to adopt similar immunity requirements.

These immunity requirements can be very difficult to meet, so the attached schematic includes filtering components FB2, FB3, L1, C22, and C24. The extent to which these components are needed will depend on the application and on the rest of the system design. Typically, not all of these components will be required.

FB2 and FB3 are inexpensive ferrite beads, so these should be the first thing added if testing indicates that filtering is needed. Capacitors C22 and C24 can be extremely helpful if the system has a good chassis ground, but they are of limited use in systems that lack such a ground. The common mode choke L1 can provide useful filtering regardless of whether the system has a chassis ground. Note that since capacitors C22 and C24 typically bridge the safety isolation barrier, they must meet the applicable safety requirements described previously in the section on safety.

To help with immunity to common mode lightning surges, the total resistance in each leg of the snoop circuit path has been split up into three physical resistors. The reason for this is to prevent arcing across the surface of the resistors during surge events.

Lastly, note that the amount of lightning surge current that L1 has to handle is greatly reduced by placing it to the left of E1, as shown in the schematic. Some designers like to place common mode chokes right up against the phone line jack. This is feasible with some common mode chokes such as the Coilcraft TTTRF2000, but most common mode chokes have difficulty handling lightning and/or over-voltage tests when not protected by E1.

7 Layout Guidelines

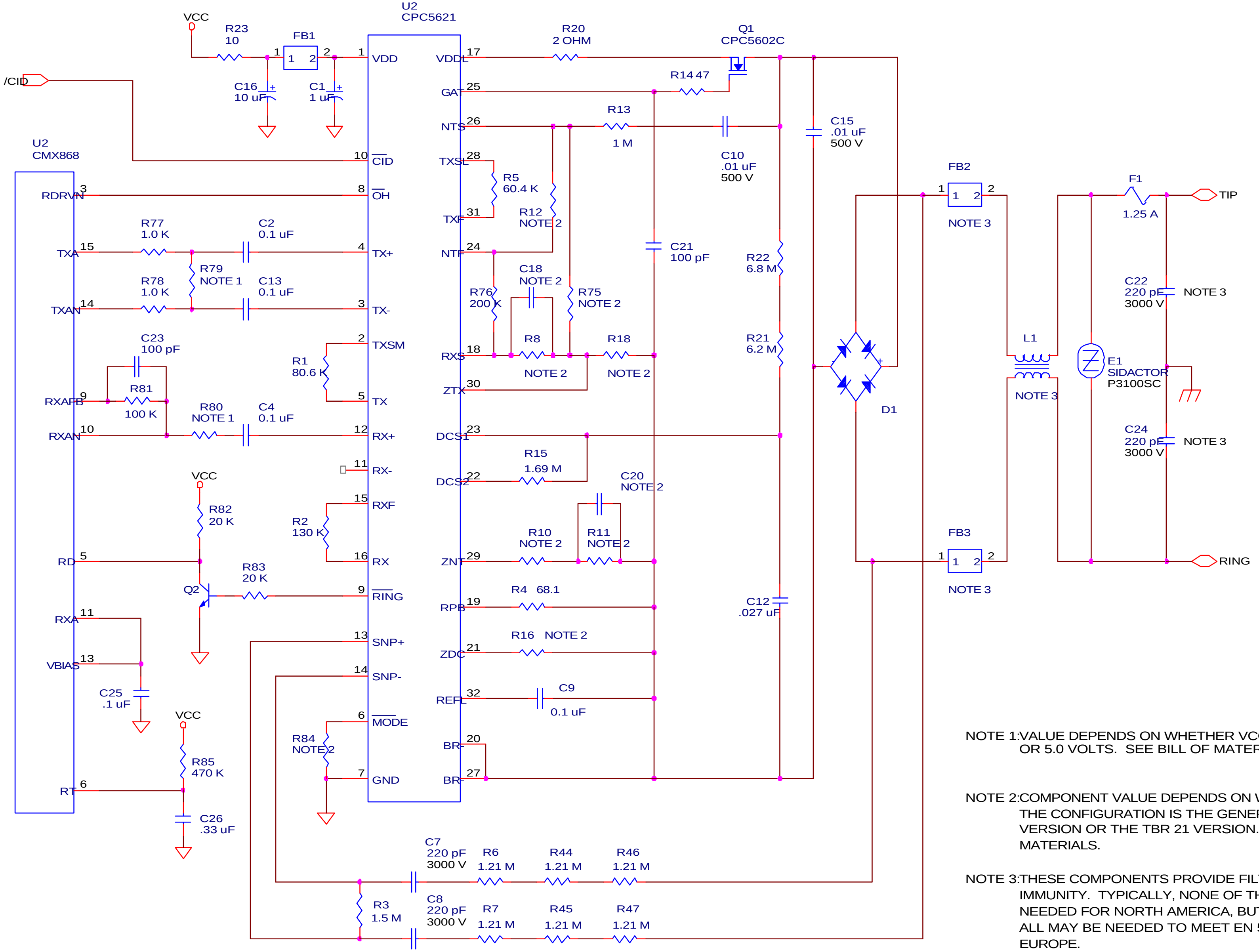
The layout guidelines in Clare application note AN-146 should be followed carefully.

8 Summary

The CMX868 and CMX869 modem chips can be easily interfaced to the Clare CPC5621 optical DAA to implement a complete modem function in a very small form factor. The resulting designs are sufficiently flexible to meet worldwide regulatory requirements with only two hardware configurations.

Acknowledgements

Randolph Telecom Inc. – http://www.randolph-telecom.com
Clare Inc. – http://www.clare.com



NOTE 1:VALUE DEPENDS ON WHETHER VCC IS 3.3 VOLTS OR 5.0 VOLTS. SEE BILL OF MATERIALS.

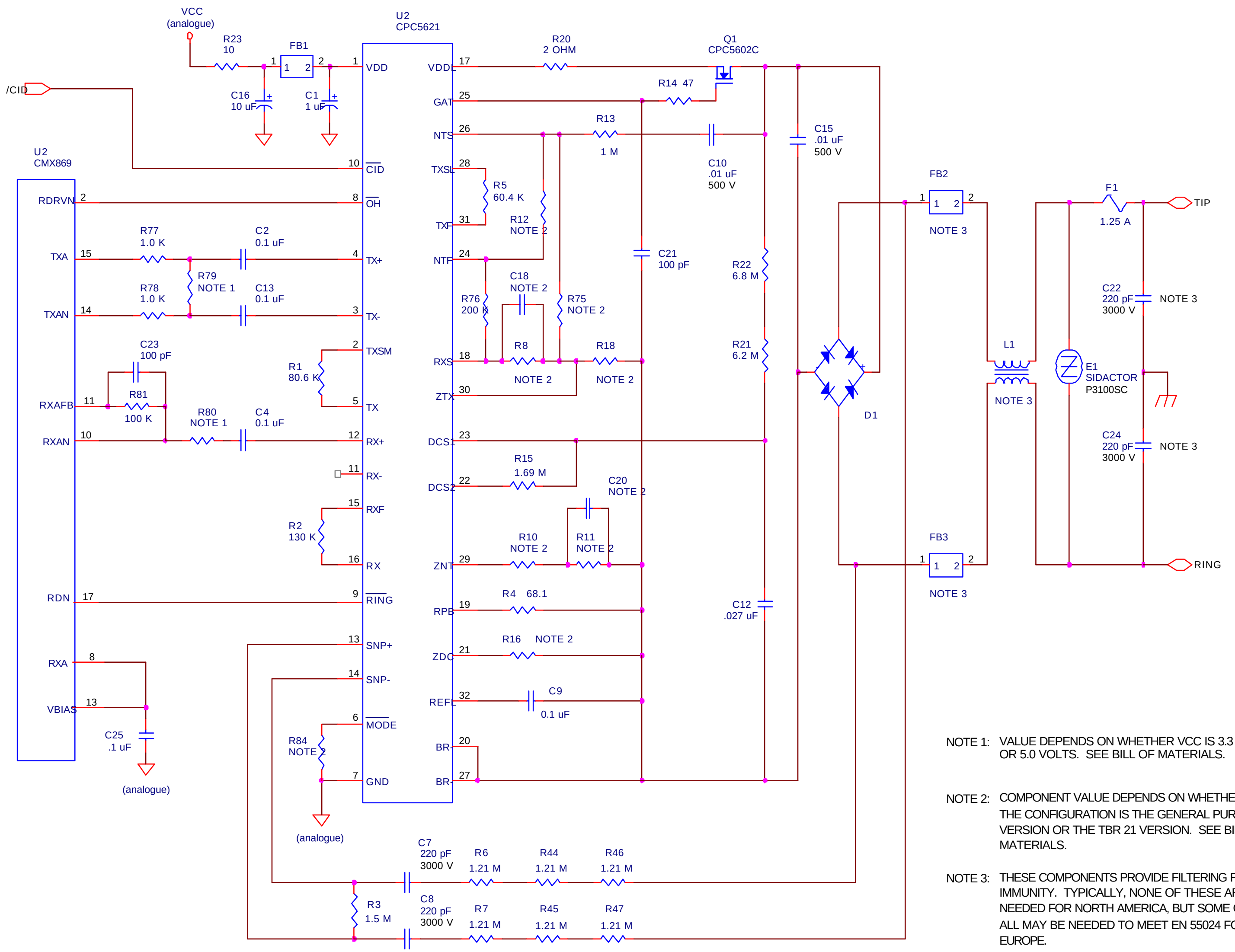
NOTE 2:COMPONENT VALUE DEPENDS ON WHETHER THE CONFIGURATION IS THE GENERAL PURPOSE VERSION OR THE TBR 21 VERSION. SEE BILL OF MATERIALS.

NOTE 3:THESE COMPONENTS PROVIDE FILTERING FOR RF IMMUNITY. TYPICALLY, NONE OF THESE ARE NEEDED FOR NORTH AMERICA, BUT SOME OR ALL MAY BE NEEDED TO MEET EN 55024 FOR EUROPE.

CMX868 MODEM WITH CPC5621 LITELINK DAA

CMX868 DAA Bill Of Materials

Ref. Des.	Vendor	General Purpose Component Description	TBR 21 Design Component Description
C1	Generic	1 µF, 16 V, 20%, tantalum	1 uF, 16 V, 20%, tantalum
C2,C4,C9,C13,C25	Generic	0.1 µF, 16 V, 20%, ceramic Z5U	0.1 uF, 16 V, 20%, ceramic Z5U
C7,C8,C22,C24	Generic	220 pF, 3000 V, 5%, ceramic NPO	220 pF, 3000 V, 5%, ceramic NPO
C10,C15	Generic	0.01 µF, 500 V, 10%, ceramic X7R	0.01 uF, 500 V, 10%, ceramic X7R
C12	Generic	0.027 µF, 16 V, 10%, ceramic X7R	0.027 uF, 16 V, 10%, ceramic X7R
C16	Generic	10 µF, 16 V, 20%, tantalum	10 uF, 16 V, 20%, tantalum
C18	Generic	15 pF, 16 V, 10%, ceramic NPO	Omit
C20	Generic	Omit	0.68 uF, 16 V, 10%, ceramic X7R
C21,C23	Generic	100 pF, 16 V, 10%, ceramic NPO	100 pF, 16 V, 10%, ceramic NPO
C26	Generic	0.33 µF, 16 V, 20%, ceramic X7R	0.33 uF, 16 V, 20%, ceramic X7R
R1	Generic	80.6 K, 1%, 1/16 W	80.6 K, 1%, 1/16 W
R2	Generic	130 K, 1%, 1/16 W	130 K, 1%, 1/16 W
R3	Generic	1.5 M, 1%, 1/16 W	1.5 M, 1%, 1/16 W
R4	Generic	68.1 ohm, 1%, 1/16 W	68.1 ohm, 1%, 1/16 W
R5	Generic	60.4 K, 1%, 1/16 W	60.4 K, 1%, 1/16 W
R6,R7,R44, R45,R46,R47	Generic	1.21 M, 1%, 1/8 W	1.21 M, 1%, 1/8 W
R8	Generic	221 K, 1%, 1/16 W	200 K, 1%, 1/16 W
R10	Generic	301 ohm, 1%, 1/16 W	59 ohm, 1%, 1/16 W
R11	Generic	0 ohm	169 ohm, 1%, 1/16 W
R12	Generic	499 K, 1%, 1/16 W	221 K, 1%, 1/16 W
R13	Generic	1 M, 1%, 1/16 W	1 M, 1%, 1/16 W
R14	Generic	47 ohm, 5%, 1/16 W	47 ohm, 5%, 1/16 W
R15	Generic	1.69 M, 1%, 1/16 W	1.69 M, 1%, 1/16 W
R16	Generic	8.2 ohm, 1%, 1/16 W	22.1 ohm, 1%, 1/16 W
R18	Generic	3.32 K, 1%, 1/16 W	10 K, 1%, 1/16 W
R20	Generic	2 ohm, 5%, 1/16 W	2 ohm, 5%, 1/16 W
R21	Generic	6.2 M, 1%, 1/16 W	6.2 M, 1%, 1/16 W
R22	Generic	6.8 M, 1%, 1/16 W	6.8 M, 1%, 1/16 W
R23	Generic	10 ohm, 5%, 1/16 W	10 ohm, 5%, 1/16 W
R75	Generic	261 K, 1%, 1/16 W	110 K, 1%, 1/16 W
R76	Generic	200 K, 1%, 1/16 W	200 K, 1%, 1/16 W
R77,R78	Generic	1.0 K, 1%, 1/16 W	1.0 K, 1%, 1/16 W
R79 (5 volt)	Generic	1.47 K, 1%, 1/16 W	1.47 K, 1%, 1/16 W
R79 (3.3 volt)	Generic	3.57 K, 1%, 1/16 W	3.57 K, 1%, 1/16 W
R80 (5 volt)	Generic	56.2 K, 1%, 1/16 W	56.2 K, 1%, 1/16 W
R80 (3.3 volt)	Generic	84.5 K, 1%, 1/16 W	84.5 K, 1%, 1/16 W
R81	Generic	100 K, 1%, 1/16 W	100 K, 1%, 1/16 W
R82,R83	Generic	20 K, 5%, 1/16 W	20 K, 5%, 1/16 W
R84	Generic	Omit	0 ohm
R85	Generic	470 K, 1%, 1/16 W	470 K, 1%, 1/16 W
FB1,FB2,FB3	TDK	Ferrite bead, MMZ2012Y202B	Ferrite bead, MMZ2012Y202B
D1	Shindengen	Diode bridge, 600 volt, SIZB60	Diode bridge, 600 volt, SIZB60
E1	Teccor	Sidactor, 310V, P3100SC	Sidactor, 310V, P3100SC
F1	Bussmann	Fuse, C515-1.25, through hole	N/A
F1 (Alternate)	Teccor	Fuse, F1250T, surface mount	N/A
L1	Pulse Eng.	Common mode choke, PE-68624	Common mode choke, PE-68624
L1 (Alternate)	Coilcraft	Common mode choke, TTTRF2000	Common mode choke, TTTRF2000
Q1	Clare	FET, CPC5602	FET, CPC5602
Q2	On Semi	Generic NPN, such as MMBT3904LT1	Generic NPN, such as MMBT3904LT1
U1	CML	Modem chip, CMX868	Modem chip, CMX868
U2	Clare	Optical DAA, CPC5621	Optical DAA, CPC5621



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CMX869 DAA Bill Of Materials

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C1	Generic	1 µF, 16 V, 20%, tantalum	1 uF, 16 V, 20%, tantalum
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R79 (3.3 volt)	Generic	3.57 K, 1%, 1/16 W	3.57 K, 1%, 1/16 W
R80 (5 volt)	Generic	56.2 K, 1%, 1/16 W	56.2 K, 1%, 1/16 W
R80 (3.3 volt)	Generic	84.5 K, 1%, 1/16 W	84.5 K, 1%, 1/16 W
R81	Generic	100 K, 1%, 1/16 W	100 K, 1%, 1/16 W
R84	Generic	Omit	0 ohm
FB1,FB2,FB3	TDK	Ferrite bead, MMZ2012Y202B	Ferrite bead, MMZ2012Y202B
D1	Shindengen	Diode bridge, 600 volt, SIZB60	Diode bridge, 600 volt, SIZB60
E1	Teccor	Sidactor, 310V, P3100SC	Sidactor, 310V, P3100SC
F1	Bussmann	Fuse, C515-1.25, through hole	N/A
F1 (Alternate)	Teccor	Fuse, F1250T, surface mount	N/A
L1	Pulse Eng.	Common mode choke, PE-68624	Common mode choke, PE-68624
L1 (Alternate)	Coilcraft	Common mode choke, TTTRF2000	Common mode choke, TTTRF2000
Q1	Clare	FET, CPC5602	FET, CPC5602
U1	CML	Modem chip, CMX869	Modem chip, CMX869
U2	Clare	Optical DAA, CPC5621	Optical DAA, CPC5621

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For a full data sheet listing see: http://www.cmlmicro.com/products/datasheets/download.htm

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