



Simplifying System Integration™

73M2901CE

Demo Board User Manual

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1 Introduction

The Teridian Semiconductor Corporation 73M2901CE Demo Board is a platform for evaluating the 73M2901CE single-chip modem ICs. It incorporates the 73M2901CE integrated circuit, and it has been designed to operate with a PC using the serial COM1 or COM2 RS-232 level ports and standard communications software packages such as HyperTerminal.

This document describes the two available demo board configurations, the 73M2901CE-EVM-600 and the 73M2901CE-EVM-WW.

The 73M2901CE EVM-600 is a board fitted with 600 Ω resistive termination and is suitable for use in USA and Japan. This board has been designed to comply with U.S. Part 68, USA, and AS/ACIF S002:2001.

The 73M2901CE EVM-WW has selectable terminations, which makes it suitable for use in many different countries worldwide. The board has been designed to comply with FCC Part 68, ETSI TS 203, JATE and AS/ACIF S002:2001.

1.1 Getting Started

Figure 1 shows the basic connections of the Demo Board.

- Use the supplied motherboard and 5 V power supply.
- The motherboard includes a 3.3 V regulator to power the 73M2901CE Demo Board.
- The motherboard also includes RS-232 level shifters and DCE connector to connect the demo board to a PC or other terminal device.
- Use a standard PC terminal emulation program to communicate with the 73M2901CE Demo Board. See the *73M2901CE AT Command User Guide* for a complete list of commands.
- Type "AT" on the terminal at any speed from 1200 bps to 9.6 Kbps to verify communications with the modem are working correctly. The 73M2901CE modem will return "OK" if communication is properly established.
- Connect the RJ-11 connector to a telephone network emulator or private branch exchange (BPX). The demo board, although meeting all the required telecom standards, is not a certified device. Therefore the 73M2901CE Demo Board should not be connected to the outside telephone network.

It is not possible to connect two 73M2901CE demo boards back-to-back to test their operation. A DC loop current is needed to activate the network-side circuitry. A simple current-mirror current-source circuit can be used to provide the required DC loop current. A simple circuit is shown in Figure 13. This circuit supplies two independent sources, one for each modem. The loop current provided is approximately 20 mA to each modem. This circuit does not provide network impairments, call progress signals, or attenuation, which are also typically used for modem testing.

1.2 Recommended Operating Conditions and Absolute Maximum Ratings

Table 1: Recommended Operating Conditions

Parameter	Conditions	Rating
Supply Voltage V_{DD}	At the demo board power pins	2.7 to 3.6 VDC
Supply Voltage V_{PC}	At the mother board power connector	4.75 to 5.5 VDC
Ambient Operating Temperature	Without condensation or icing	-40 °C to +85 °C
Input Voltage for Digital Inputs		0 V to $V_{DD} + 0.3$ V

Table 2: Absolute Maximum Ratings

Parameter	Rating
Supply Voltage V_{DD}	-0.5 to 4.0 VDC
Supply Voltage V_{PC}	-0.5 to 6.0 VDC
Input Voltage for Digital Inputs	-0.3 to ($V_{DD}+0.5$) VDC
Storage Temperature	-60 to 150 °C
Pin Voltage	-0.3 to 5.5 V VDC
ESD Tolerance – Other pins	+/- 2kV

Operation outside these rating limits may cause permanent damage to the device.

1.3 Basic Connections

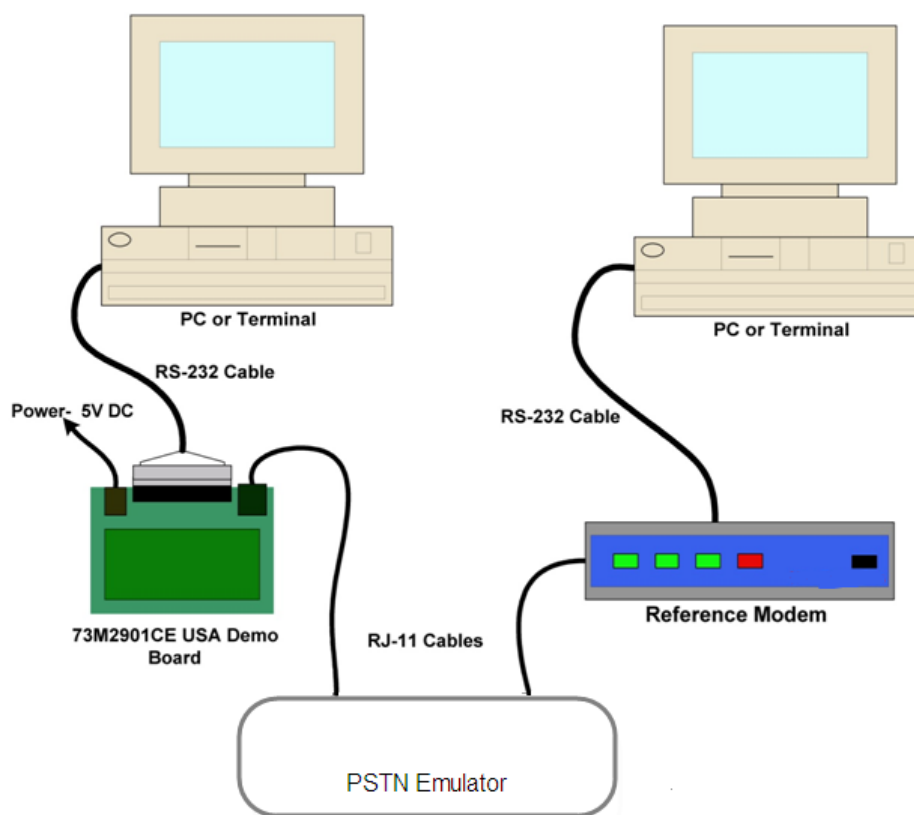


Figure 1: T73M2901CE Demo Board Basic Connections

2 Design Considerations

Keep OSCIN and OSCOUT signals as short as possible and locate the crystal near the pins. Use an 11.0592 MHz parallel mode crystal only. Do not use ground planes under the oscillator circuit since this will increase the parasitic capacitance on the pins. The values of C2 and C3 depend on the load capacitance rating of the crystal that is used, not the 73M2901CE. This load capacitance will typically be between 15 pF and 27 pF, but usually 18 or 22 pF. Parallel resonant crystals are tuned with a specific capacitive load and will be within their specifications when this load is used. This rating is the capacitance measured between the crystal pins including all parasitic capacitances. It is not the values of the capacitors used. The selection of these capacitors can vary with the layout of the PCB, so do not assume the values used with the 73M2901CE demo board are correct for all designs.

System noise is the most likely cause of poor Caller ID and low-level receive performance. The lowest amplitude signals that the modem will need to receive are on the order of 5 mV rms. The Caller ID receive levels are also very low due to the requirement to have a high (60 k Ω) AC input impedance while on hook. Having a 20 dB gain boost during Caller ID reception compensates for this, but if there is excessive noise, it will also be amplified. Keeping the analog and digital grounds separate helps control the amount of noise that gets to the receiver input. Dramatic improvements in low-level performance can be gained by proper layout.

Keep the VCC trace as short as possible. Make the power trace a minimum of 0.5 mm thick. The analog and digital power and ground should be kept separate for best low receive level performance. Route the power to the digital pins and bypass capacitors on one net and the analog power and VBG bypass pins on another net with inductors separating the two. If power planes are used, separate the power and ground planes so there are separate analog and digital planes for the 73M2901CE.

Keep 0.1 μ F and 3.3 μ F bypass capacitors close to VPD power pins of the device and take other end to the digital ground.

Keep 0.1 μ F and 10 μ F bypass capacitors close to VPA power pin of the device and directly connect the other end to analog ground.

Keep all analog signaling away from any high-speed digital circuitry and traces that may be on the board.

Observe the separation of the network and modem side circuitry. Maintain at least ¼ inch (6 mm) separation between the two. Do not run power planes under the network side circuitry and maintain the same spacing for the planes from the network. Use only UL, CSA, or TUV approved components that cross the isolation barrier or for network protection to assure compliant performance for the DAA.

The transformer used for coupling will have an influence on the values of the components in the DAA circuitry. The winding resistance, inductances and other characteristics of the transformer affect the values of the impedance matching components. Make sure you have the transformer manufacturer's recommended circuit values when using other transformers. The values can be determined through simulations, but may still require some adjustment to optimize the design.

3 73M2901CE EVM-600 Demo Board

During the past several years, there have been significant changes to the way telecommunications device certification is handled. Previously you were required to take your new product to an authorized certification laboratory to have certification testing performed. The United States has fundamentally changed their approval procedures for telephone equipment. They have introduced the concept of SDoC (Self-Declaration of Conformity), implying that formal approval of a TCB (Telecommunication Certification Body) is not further necessary. The definition of the technical requirements has been delegated to industry. There is a choice of conformity testing but, in general, the manufacturer or his authorized representative must maintain technical documentation that includes a declaration of conformity and shows how compliance is achieved. It is still a requirement to meet all the same technical requirements for electrical compatibility with the network (TIA/EIA/IS-968 (Part 68)), electrical safety (UL-60950 power cross) and EMI (Part 15 radiated emissions). Unless you are equipped to perform the tests to verify the operation of your product, it is still prudent to use a third party testing laboratory to assure compliance with applicable regulations. The ACTA (Administrative Council for Terminal Attachments) is the body that now administers the telecom terminal equipment. The FCC is no longer involved in any aspect of the process. The ACTA is a privatized organization and administers all aspects of the telecom equipment. See <http://www.part68.org> for information on the ACTA.

The 73M2901CE Demo Board is designed to meet all the applicable certification regulations defined in those regulations. The 73M2901CE EVM-600 Demo Board design is intended for use in countries that use a 600 Ω resistive termination. Although designed to meet the ACTA defined specifications, the 73M2901CE EVM-600 demo board is not a certified device, and it is therefore not intended for use on the PSTN network. It should only be used in a laboratory environment with network simulation equipment.

The network input protection is now standard worldwide, so finding components that that meet UL-60950 Power Cross requirements are not too difficult. Input current limiting and over-voltage protection are both universally required or advised. Self-resetting PPTC fuses are now available that not only protect the product but eliminate the need to replace parts if they are tripped. These protection devices tend to be some of the more expensive components in the design, but to scrimp on these in the initial design can cause problems latter when fixing the problem is more expensive.

3.1 Using the 73M2901CE EVM-600 Demo Board

The schematic in Figure 2 shows the design for the 73M2901CE EVM-600 Demo Board. The design uses a “wet transformer” that uses the transformer as the DC load on the line. The advantage to using this topology is that the BOM cost can be lower compared to a “dry transformer” which passes the DC current through an external circuit that simulates an inductor. A dry transformer can be made much smaller, so if small size is important, a dry transformer is preferred.

Table 3 shows the termination impedances for 600 Ω resistive as well as ETSI TS 203 and Australian complex impedances. With these three terminations, worldwide terminations impedance requirements can be met. Other demo boards are available to support these other terminations. The 73M2901CE EVM-600 Demo Board uses a wet transformer design that has a 600 Ω resistive termination.

Table 3: Termination Impedance Network Values

Termination	Terminator Component Values
600 Ohm	600 Ω
ETSI TS 203 complex	750 Ω 150nF + 270 Ω
Australia	820 Ω 120nF + 220 Ω

3.2 73M2901CE EVM-600 Hardware Design

This section includes schematic drawings, PCB layouts and bill of materials for the 73M2901CE 600Ω Demo Board.

3.2.1 73M 2901CE EVM-600 Schematic Diagrams

Figure 2 and Figure 3 provide the schematics for the 73M2901CE EVM-600 Demo Board and Motherboard.

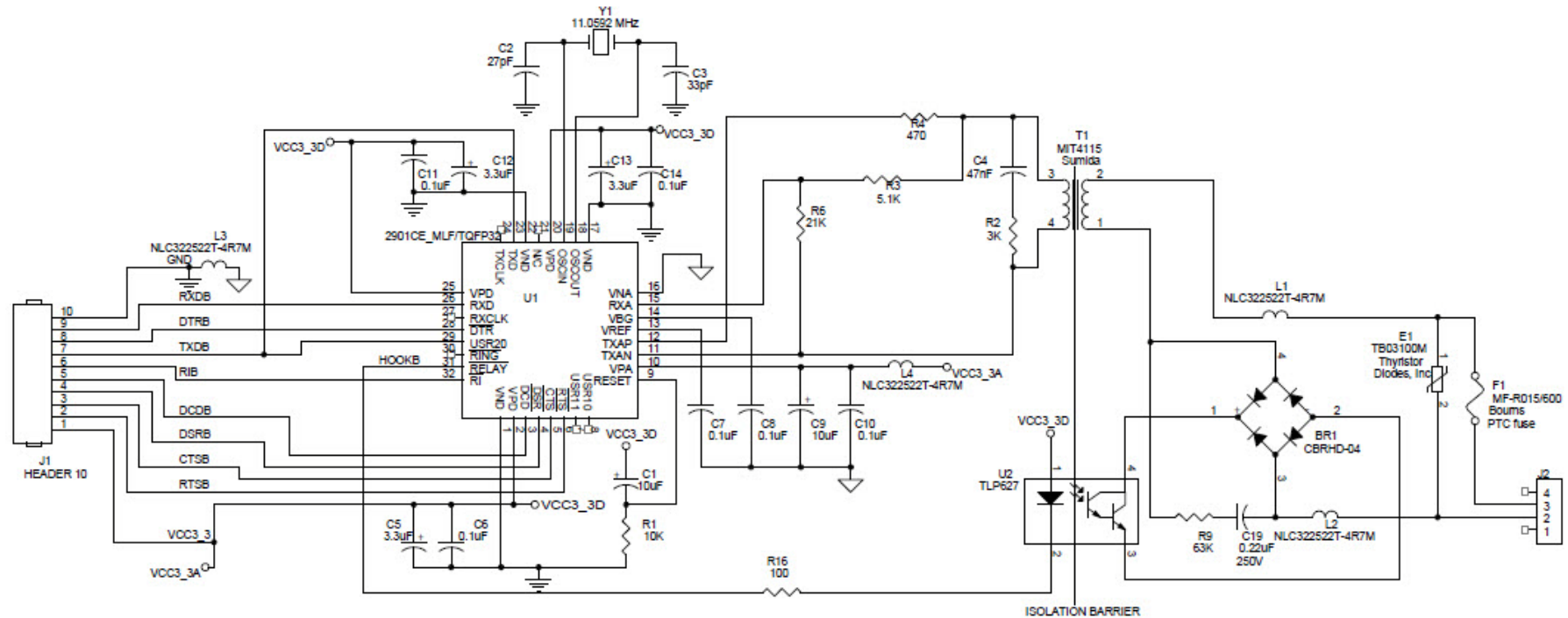


Figure 2: 73M2901CE EVM-600 Demo Board Schematic

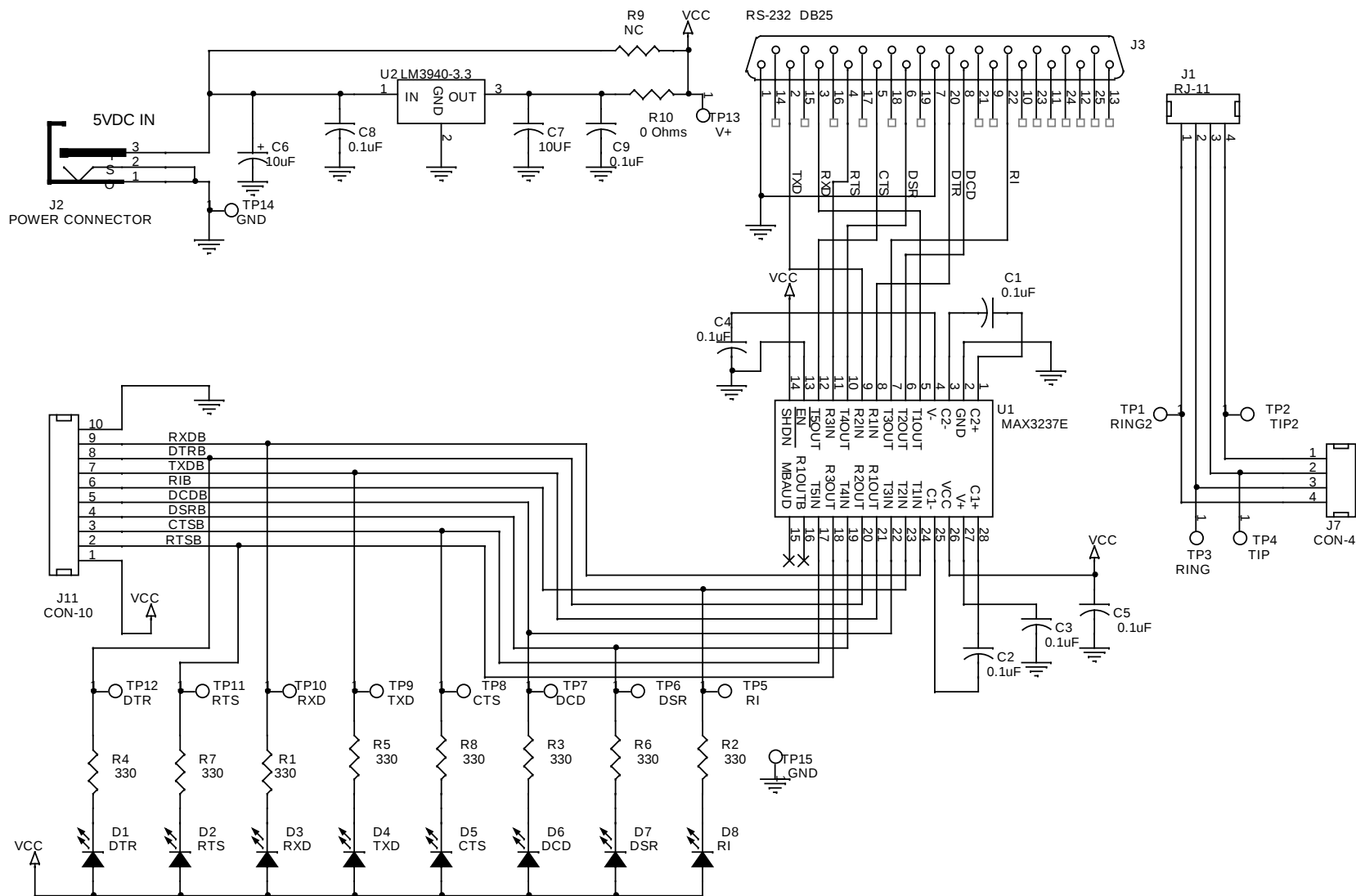


Figure 3: 73M2901CE EVM-600 Motherboard Schematic

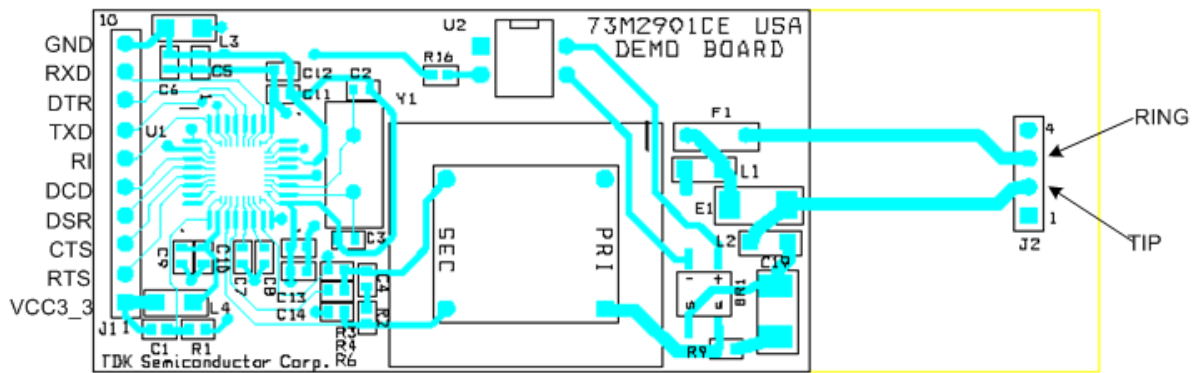


Figure 4: 73M2901CE EVM-600 Demo Board Pin Connections

3.2.2 73M2901CE EVM-600 Demo Board Pin Description

Table 4: 73M2901CE EVM-600 Demo Board Description: Digital Interface

Name	Pin #	Description
VCC	J1-1	3.3V power source for the demo board.
RTS	J1-2	<u>R</u> esult <u>T</u> o <u>S</u> end – Low true input. Used for RTS/CTS flow control and V.23 transmission control. Controlled by the Kn command.
CTS	J1-3	<u>C</u> lear <u>T</u> o <u>S</u> end – Low true output. Used for RTS/CTS flow control and to indicate carrier is being sent in V.23 mode. Controlled by the Kn command.
DSR	J1-4	<u>D</u> ata <u>S</u> et <u>R</u> eady – Low true output. Indicates the modem is present and ready for use.
DCD	J1-5	Data Carrier Detect – Low true output. Indicates a carrier is being received. Controlled by the Cn command.
RI	J1-6	<u>R</u> ing – Low true output. Indicates a valid ring signal is being received. Goes low for the duration the “ring” result code is being sent on RXD.
TXD	J1-7	<u>T</u> ransmit <u>D</u> igital Input. Pin used as the digital data input for commands and data transmission.
DTR	J1-8	Data Terminal Ready – Low true Input. Pin used by the terminal to control certain actions of the modem, such as return to command mode, terminate call, V.23 turnaround, reset, and power down.
RXD	J1-9	<u>R</u> ecieve <u>D</u> igital Output. Pin used as the digital data output for echoing commands and for data reception.
GND	J1-10	Demo board ground.

Table 5: 73M2901CE EVM-600 Demo Board: Telephone Network Interface

Name	Pin #	Description
TIP 2	J2-1	No Connection
TIP	J2-2	Polarity independent connection to the telephone network.
RING	J2-3	Polarity independent connection to the telephone network.
RING2	J2-4	No Connection

Table 6: 73M2901CE EVM-600 Demo Board: DB-25 RS-232 Level Serial Interface

Name	DB-25pin	Description
TXD	2	<u>T</u> ransmit <u>D</u> igital Inverted Input. Pin used as the digital data input for commands and data transmission.
RXD	3	<u>R</u> ecieve <u>D</u> igital Inverted Output. Pin used as the digital data output for echoing commands and for data reception.
RTS	4	<u>R</u> equest <u>T</u> o <u>S</u> end – High true input. Used for RTS/CTS flow control and V.23 transmission control. Controlled by the Kn command.
CTS	5	<u>C</u> lear <u>T</u> o <u>S</u> end – High true output. Used for RTS/CTS flow control and to indicate carrier is being sent in V.23 mode. Controlled by the Kn command.
DSR	6	<u>D</u> ata <u>S</u> et <u>R</u> eady – High true output. Indicates the modem is present and ready for use.
DCD	8	<u>D</u> ata <u>C</u> arrier <u>D</u> etect – High true output. Indicates a carrier is being received. Controlled by the Cn command.
DTR	20	<u>D</u> ata <u>T</u> erminal <u>R</u> eady – High true Input. Pin used by the terminal to control certain actions of the modem, such as return to command mode, terminate call, V.23 turnaround, reset, and power down.
RI	22	<u>R</u> Ing – High true output. Indicates a valid ring signal is being received. Goes low for the duration the “ring” result code is being sent on RXD.

3.2.3 73M2901CE-EVM-600 Demo Board Bill of Materials

Table 7: 73M2901CE EVM-600 Demo Board Bill of Materials

Quant	Reference	Part	PCB Footprint	DigiKey #	Manufacturer #	Manufacturer
1	BR1	HD04	miniDIP	HD04DITR-ND	HD04	Diodes, Inc.
2	C1,C9	10 μ F	0805	PCC2182CT-ND		Panasonic
1	C2	27pF	0805	PCC270ACVCT-ND		Panasonic
1	C3	33pF	0805	PCC330ACVCT-ND		Panasonic
1	C4	47nF	0805	PCC1808CT-ND		Panasonic
3	C5,C12,C13	3.3 μ F	0805	PCC1841CT-ND		
6	C6,C7,C8, C10,C11,C14	0.1 μ F	0805	PCC1762CT-ND		Panasonic
1	C19	0.22 μ F	1812		CR1812X7R224ZWT	UTC
1	E1	Bidirectional Thyristor	SMB		TISP4350T3BJR, TB03100M	Bourns, Diodes, Inc
1	F1	MF-R015/600	200mil T.H.			Bourns, Raychem
1	J1	HEADER 10		100 mil, 10 position		
1	J2	HEADER 4		100 mil, 4 position		
4	L1,L2,L3,L4	NLC322522T-4R7M	1206			TDK
1	R1	10K	0805	311-10KHCT-ND		Phicomp
1	R2	20K		311-20KHCT-ND		Phicomp
1	R3	5.1K	0805	311-5.1KHCT-ND		Phicomp
1	R4	470	0805			Phicomp
1	R6	21K	0805	311-21KHCT-ND		Phicomp
1	R9	63K	0805	311-63KHCT-ND		Phicomp
1	R16	100	0805	311-100HCT-ND		Phicomp
1	T1	MIT4115			MIT4115	Sumida
1	U1	2901CE_MLF/TQFP32	0805			Teridian Semi.
1	U2	TLP627	0805	TLP627TP1CT-ND		Toshiba
1	Y1	11.0592 MHz	200 mil T.H.	CTX409-ND		

3.2.4 73M2901CE-EVM-600 Demo Board PCB Layout

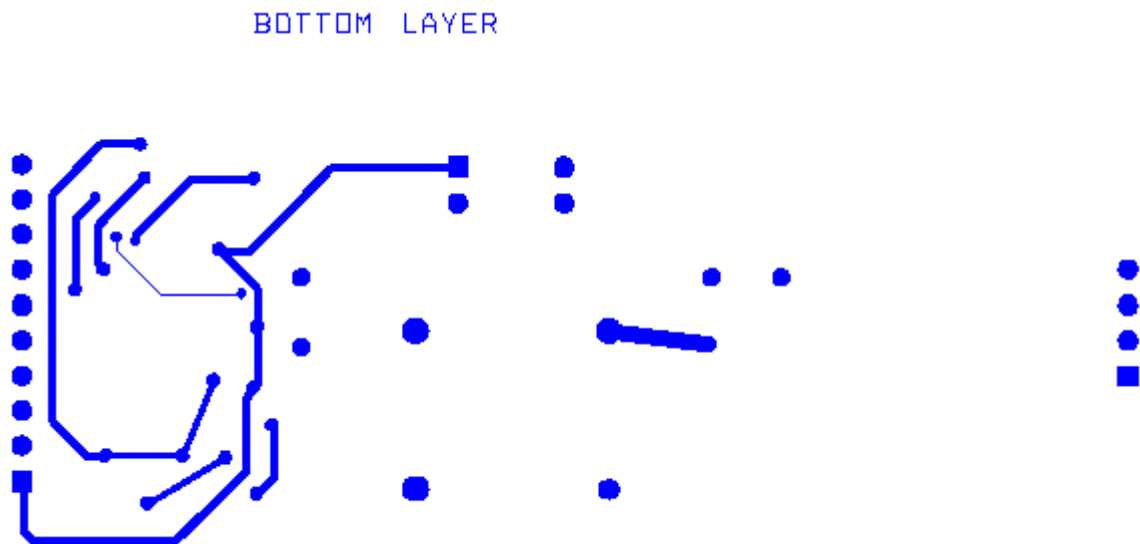


Figure 5: 73M2901CE EVM-600 Demo Board: Bottom Layer

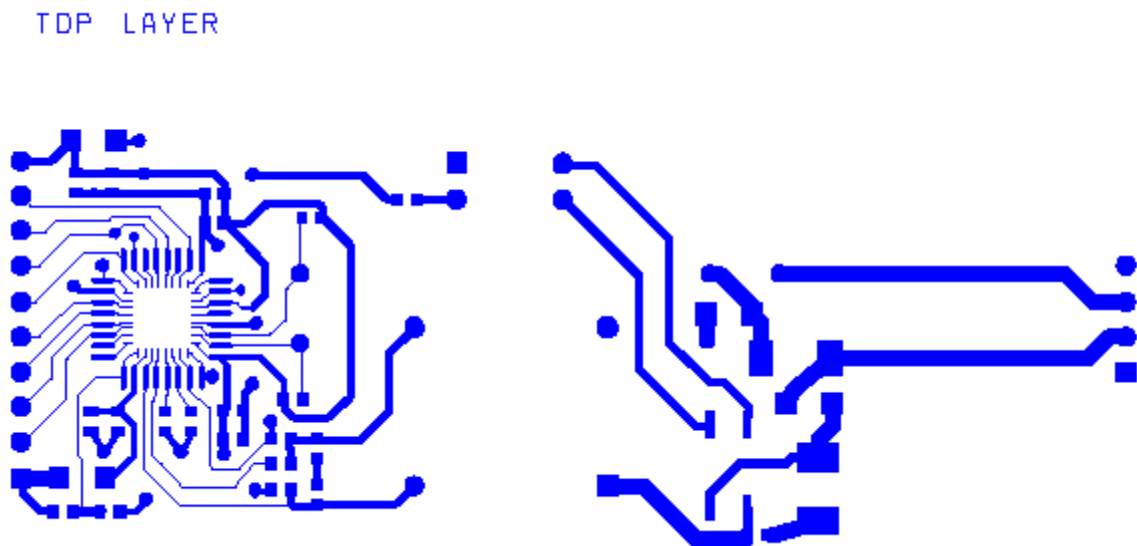


Figure 6: 73M2901CE EVM-600 Demo Board: Top Layer

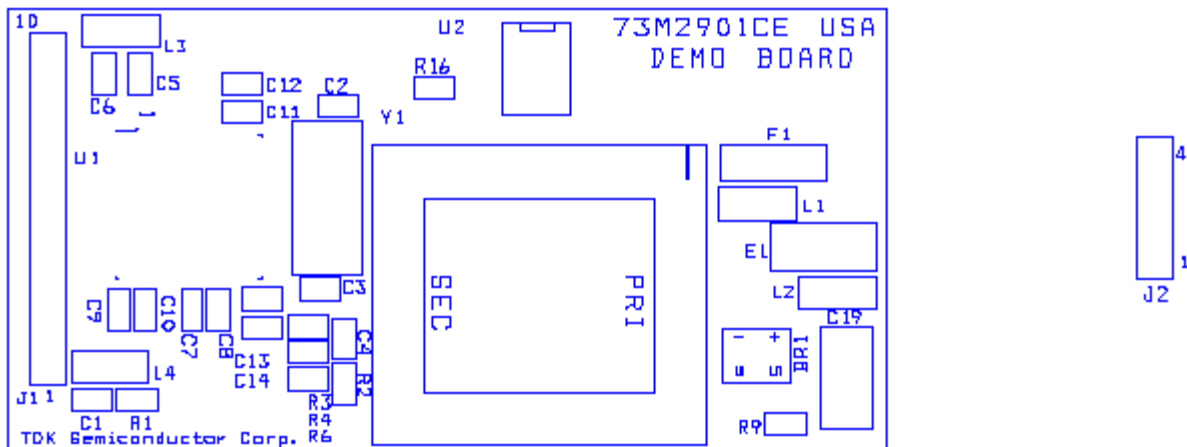


Figure 7: 73M2901CE EVM-600 Demo Board: Top Silk Screen

4 73M2901CE EVM-WW Demo Board

It is possible to design a modem that can be used in virtually any country without the need to fit different hardware for different countries' standards. One of the more significant differences between countries is the line impedance match that is required. This termination can be a concern since poorly matched impedances will affect the network by increasing the reflections and crosstalk. Therefore, there are different terminations required in different countries to match the equipment impedance to the local network's characteristics. Worldwide countries use three basic network models (see Table 8 and Table 9). In the U.S and North America, a 600 Ω resistive termination is used. Many other counties also use this termination. In most of Europe, the primary termination is a complex AC impedance commonly called "ETSI TS 203". This is also used in other countries outside of Europe. The third network model is for Australia and New Zealand. There are other concerns such as transmit levels, ring frequencies and levels, call progress tone frequencies and cadence, and network protection. The first four of these are all programmable through the 73M2901CE S-registers. The last can be taken care of by designing for the most stringent specifications. Keep in mind that the overall cost of components will tend to be higher since components with higher ratings will cost more. If Australia and New Zealand are on your list of target countries, then design your protection for them.

Australia and New Zealand have higher isolation voltage requirements than other countries (3750VDC) and require that the transformer be encapsulated. Any other devices that cross the isolation barrier, such as opto-couplers, must also meet this requirement. They also have somewhat larger creepage and clearance requirements to match their isolation requirements. The network input protection is now standard, so finding components that that meet worldwide requirements are not too difficult. Input current limiting and over-voltage protection are both universally required or advised. It is possible to pass PTT testing in some cases without current limiting, but you put the integrity and survivability of your product at jeopardy by not using it. Self-resetting PPTC fuses are now available that not only protect the product but eliminate the need to replace parts if they are tripped.

4.1 Using the 73M2901CE0-EVM-WW Demo Board

The schematic in Figure 8 shows how to change the termination using the USR pins of the 73M2901CE to control the AC termination network. The user pins control the analog switches that determine the termination impedance. The user pins may have some other defined purposes if certain S register settings are used.

Table 8: S-register Settings for Worldwide Modem Design

Termination	Initialization String
WW DAA 600 Ω	ATS102-3S104-1S95-128S110-64S101+1S101-2S103-1
WW DAA CTR21	ATS102-3S104-1S95-128S110-64S101-1S101+2S103-1
WW DAA Australia	ATS102-3S104-1S95-128S110-64S101-1S101-2S103+1

An example of this is the USR11 pin. If the continuous Caller ID mode is selected by setting the MSB of S95, the USR11 pin will toggle during the Caller ID time. If you are using S95 in this mode, you should set the modem termination just before going off hook to assure that you are configured with the correct termination. Table 8 shows the initialization strings needed for the 73M2901CE Worldwide Demo Board. If you choose to rearrange the USR controls in your design, the string settings will of course need to be changed.

Table 9: Termination Impedance Network Values

Termination	Component Values
600 Ohm	600 Ω
ETSI TS 203	750 Ω 150nF + 270 Ω
Australia	820 Ω 120nF + 220 Ω

Table 10: Worldwide Country AC Impedance Requirements

Country	AC Impedance	Country	AC Impedance	Country	AC Impedance
Argentina	600	Hong Kong	600	Oman	600
Australia	Aust.	Hungary	600	Pakistan	600
Austria	Aust.	Iceland	ETSI TS 203	Peru	600
Bahrain	ETSI TS 203	India	Aust.	Philippines	600
Belgium	ETSI TS 203	Indonesia	600	Poland	600
Brazil	600	Ireland	ETSI TS 203	Portugal	ETSI TS 203
Bulgaria	Aust.	Israel	ETSI TS 203	Romania	600
Canada	600	Italy	ETSI TS 203	Russia	600
Chile	600	Japan	600	Saudi	600
China	600	Jordan	600	Singapore	600
Columbia	600	Kazakhstan	600	Slovakia	Aust.
Croatia	ETSI TS 203	Kuwait	600	Slovenia	ETSI TS 203
CTR/TBR 21	ETSI TS 203	Latvia	ETSI TS 203	S. Africa	ETSI TS 203
Cyprus	ETSI TS 203	Lebanon	ETSI TS 203	S. Korea	600
Czech Rep.	ETSI TS 203	Luxembourg	ETSI TS 203	Spain	ETSI TS 203
Denmark	ETSI TS 203	Macao	600	Sweden	ETSI TS 203
Ecuador	600	Malaysia	600	Switzerland	ETSI TS 203
Egypt	600	Malta	ETSI TS 203	Syria	600
El Salvador	600	Mexico	600	Taiwan	600
Finland	ETSI TS 203	Morocco	ETSI TS 203	Thailand	600
France	ETSI TS 203	Netherlands	ETSI TS 203	UAE	600
Germany	Aust.	New Zealand	Aust.	UK	ETSI TS 203
Greece	ETSI TS 203	Nigeria	ETSI TS 203	USA	600
Guam	600	Norway	ETSI TS 203	Yemen	600

4.2 73M2901CE EVM-WW Hardware Design

This section includes schematic drawings, PCB layouts and bill of materials for the 73M2901CE-WW Demo Board.

4.2.1 73M 2901CE EVM-WW Schematic Diagrams

Figure 8 and Figure 9 illustrate the schematics for the 73M2901CE EVM-WW Demo Board and Motherboard.

-EMIT4033 is required for Australia only; the non-encapsulated MIT4033 can be used for designs not requiring Australian operation.

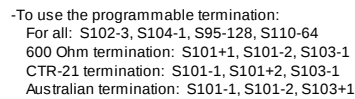


Figure 8: 73M2901CE Worldwide Demo Board: Daughter Board Schematic

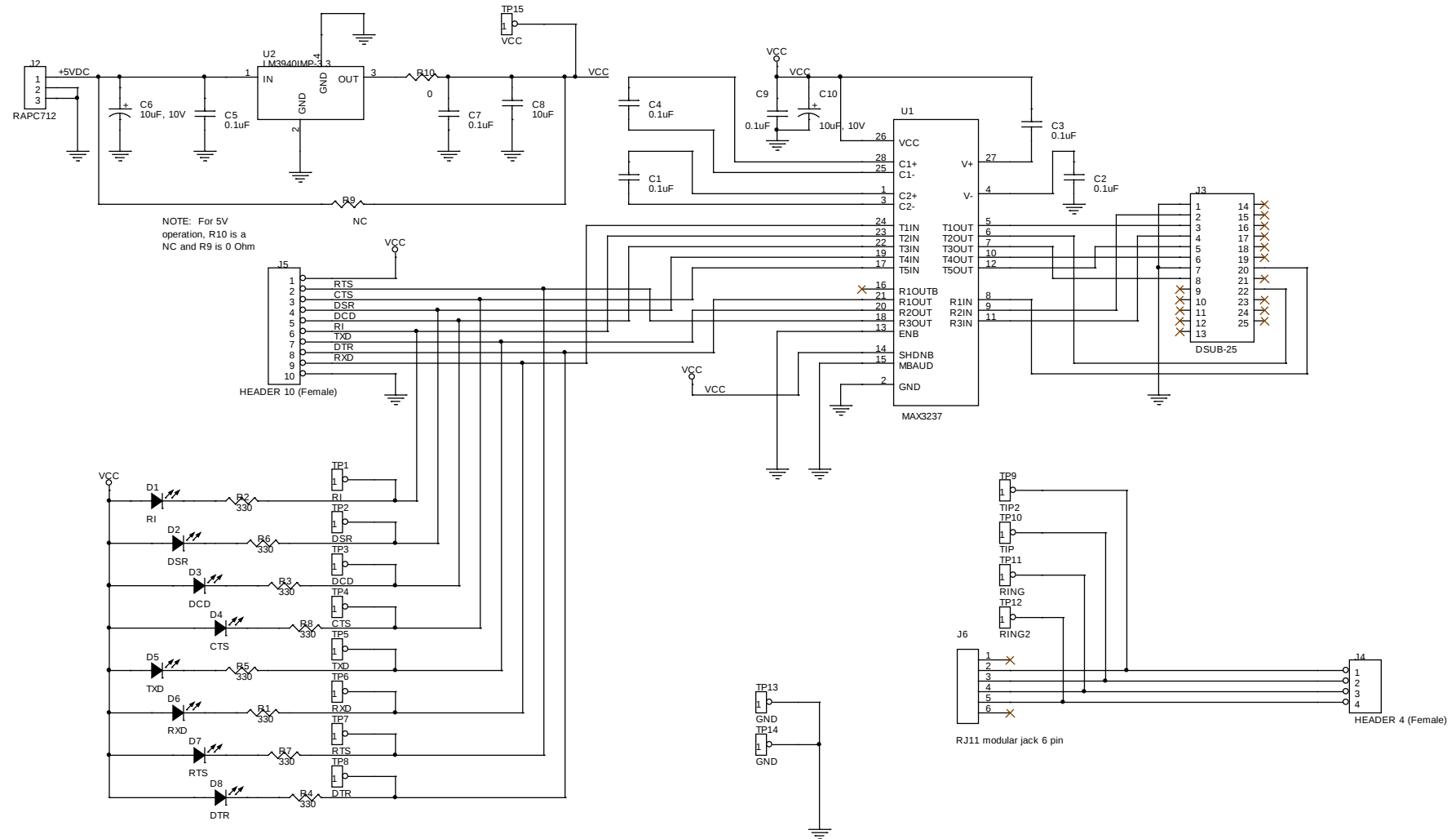


Figure 9: 73M2901CE Worldwide Demo Board: Motherboard Schematic

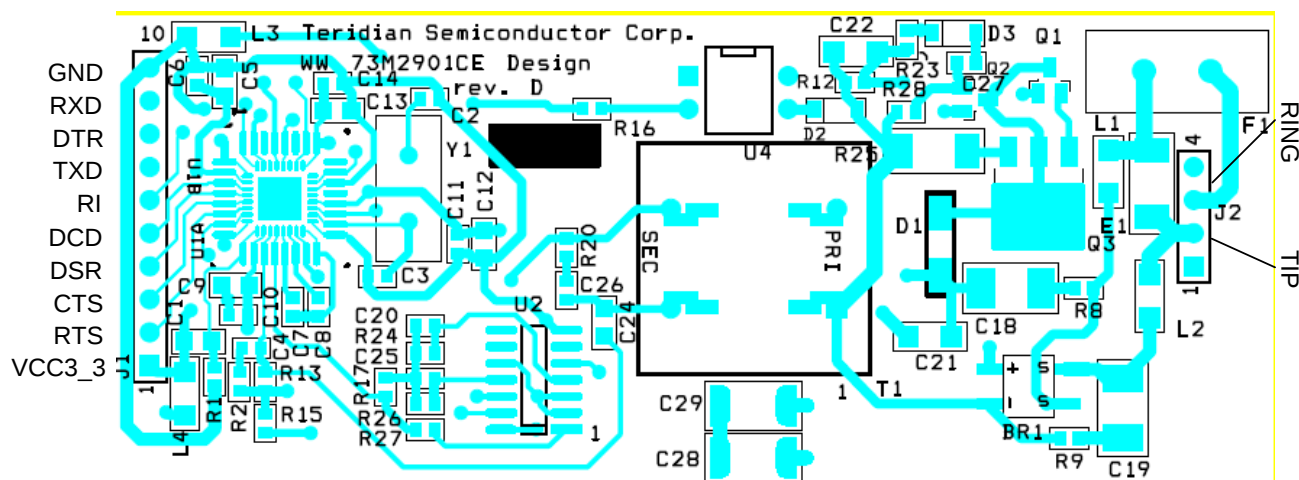


Figure 10: 73M2901CE Worldwide Daughter Board Pin Connections

4.2.2 73M2901CE EVM-WW Demo Board Pin Description

Table 11: 73M2901CE Worldwide Demo Board: Digital Interface

Name	Pin #	Description
VCC	J1-1	3.3 V power source for the demo board.
RTS	J1-2	<u>R</u> equ st <u>T</u> o <u>S</u> end – Low true input. Used for RTS/CTS flow control and V.23 transmission control. Controlled by the Kn command.
CTS	J1-3	<u>C</u> lear <u>T</u> o <u>S</u> end – Low true output. Used for RTS/CTS flow control and to indicate carrier is being sent in V.23 mode. Controlled by the Kn command.
DSR	J1-4	<u>D</u> ata <u>S</u> et <u>R</u> eady – Low true output. Indicates the modem is present and ready for use.
DCD	J1-5	Data Carrier Detect – Low true output. Indicates a carrier is being received. Controlled by the Cn command.
RI	J1-6	<u>R</u> ing – Low true output. Indicates a valid ring signal is being received. Goes low for the duration the “ring” result code is being sent on RXD.
TXD	J1-7	<u>T</u> ransmit <u>D</u> igital Input. Pin used as the digital data input for commands and data transmission.
DTR	J1-8	Data Terminal Ready – Low true Input. Pin used by the terminal to control certain actions of the modem, such as return to command mode, terminate call, V.23 turnaround, reset, and power down.
RXD	J1-9	<u>R</u> ecieve <u>D</u> igital Output. Pin used as the digital data output for echoing commands and for data reception.
GND	J1-10	Demo board ground.

Table 12: 73M2901CE Worldwide Demo Board: Telephone Network Interface

Name	Pin #	Description
TIP 2	J2-1	No Connection
TIP	J2-2	Polarity independent connection to the telephone network.
RING	J2-3	Polarity independent connection to the telephone network.
RING2	J2-4	No Connection

Table 13: 73M2901CE Worldwide Demo Board: DB-25 RS-232 Level Serial Interface

Name	DB-25pin	Description
TXD	2	<u>T</u> ransmit <u>D</u> igital Inverted Input. Pin used as the digital data input for commands and data transmission.
RXD	3	<u>R</u> ecieve <u>D</u> igital Inverted Output. Pin used as the digital data output for echoing commands and for data reception.
RTS	4	<u>R</u> equest <u>T</u> o <u>S</u> end – High true input. Used for RTS/CTS flow control and V.23 transmission control. Controlled by the Kn command.
CTS	5	<u>C</u> lear <u>T</u> o <u>S</u> end – High true output. Used for RTS/CTS flow control and to indicate carrier is being sent in V.23 mode. Controlled by the Kn command.
DSR	6	<u>D</u> ata <u>S</u> et <u>R</u> eady – High true output. Indicates the modem is present and ready for use.
DCD	8	<u>D</u> ata <u>C</u> arrier <u>D</u> etect – High true output. Indicates a carrier is being received. Controlled by the Cn command.
DTR	20	<u>D</u> ata <u>T</u> erminal <u>R</u> eady – High true Input. Pin used by the terminal to control certain actions of the modem, such as return to command mode, terminate call, V.23 turnaround, reset, and power down.
RI	22	<u>R</u> ing – High true output. Indicates a valid ring signal is being received. Goes low for the duration the “ring” result code is being sent on RXD.

4.2.3 73M2901CE EVM-WW Demo Board Bill of Materials

Table 14: 73M2901CE Worldwide Demo Board Bill of Materials

Quant	Reference	Part	DigiKey #	Manufacturer P/N	Manufacturer
1	BR1	HD04	HD04DICT-ND	HD04-T	Diodes, Inc.
2	C1,C9	10 μ F	587-1295-1-ND	EMK212BJ106KG-T	Taiyo
1	C2	27pF	PCC270ACVCT-ND	ECJ-1VC1H270J	Panasonic
1	C3	33pF	PCC330ACVCT-ND	ECJ-1VC1H330J	Panasonic
0	R2,C4	NC			
4	C5,C12,C13,C24	3.3 μ F Cer.	PCC2288CT-ND	ECJ-2FB1A335K	Panasonic
2	C21,C22	3.3 μ F, 25V	399-3140-1-ND	C1206C335K3PACTU	Kemet
6	C6,C7,C8,C10,C11,C14	0.1 μ F	445-1314-1-ND	C1608X7R1H104K	TDK
1	C15	220pf, 250V (min.)	445-2338-1-ND	C3216COG2J221J	TDK
2	C18,C19	0.22 μ F, 200V	490-3544-1-ND	GRM43DR72E224KW01L	Murata
1	C20	0.15 μ F (150nF)	PCC1748CT-ND	ECJ-1VB1A154K	Panasonic
1	C25	0.12 μ F (120nF)	PCC1906CT-ND	ECJ-1VB1A124K	Panasonic
1	C26	0.082 μ F (82nF)	PCC2280CT-ND	ECJ-1VB1E823K	Panasonic
1	C27	0.047 μ F	PCC1758CT-ND	ECJ-1VB1C473K	Panasonic
2	C28, C29	220pF, 3kV	445-2380-1-ND	C4532COG3F221K	TDK
1	D1	Rectifier, 1A, 400V	RS1G-FDICT-ND	RS1G-13-F	Diodes, Inc.
2	D2	18V Zener Diode	MMSZ5248BT1GOSCT-ND	MMSZ5248BT1G	ON
1	D3	2.4V Zener Diode	BZT52C2V4-FDICT-ND	BZT52C2V4-7-F	Diodes, Inc.
1	E1	Thyristor, 270V 250A	P3100SBLRPCT-ND	P3100SBLRP, TISP4350T3BJR	Tecor Elect., Bourns
1	F1	PPTC Fuse, 150mA, 600V	TRF600-150-ND	TRF600-150, MF-R0150/600	Rachem, Bourns
1	J1	HEADER 10	S1011E-36-ND	PBC36SAAN	Sullins
1	J2	HEADER 3	S1011E-36-ND	PBC36SAAN	Sullins
4	L1,L2,L3,L4	NLV32T-4R7J-PF	445-1521-1-ND	NLV32T-4R7J-PF	TDK
2	Q1,Q2	MMBTA06	MMBTA06LT1GOSCT-ND	MMBTA06LT1G	ON
1	Q3	BCP-56	BCP56T1GOSCT-ND	BCP56T1G	ON
1	R1	10K	P10.0KHCT-ND	ERJ-3EKF1002V	Panasonic
2	R8,R9	30K	P30KGCT-ND	ERJ-3GEYJ623V	Panasonic
1	R12	62K	P62KGCT-ND	ERJ-3GEYJ303V	Panasonic
1	R13	21K	P21.0KHCT-ND	ERJ-3EKF2102V	Panasonic
1	R15	5.1K	P5.1KGCT-ND	ERJ-3GEYJ512V	Panasonic
2	R16,R17	100	P100HCT-ND	ERJ-3EKF1000V	Panasonic
1	R20	20K	P20KGCT-ND	ERJ-3GEYJ203V	Panasonic
1	R23	33K	P33KGCT-ND	ERJ-3GEYJ333V	Panasonic
1	R24	750	P750GCT-ND	ERJ-3GEYJ751V	Panasonic
1	R25	18	P18ECT-ND	ERJ-8GEYJ180V	Panasonic
1	R26	820	P820GCT-ND	ERJ-3GEYJ821V	Panasonic
1	R27	422	P422HCT-ND	ERJ-3EKF4220V	Panasonic
1	R28	47K	P47KGCT-ND	ERJ-3GEYJ473V	Panasonic
1	T1	See Table 15*			See Table 15*
1	U1	2901CE_QFN/TQFP32			Teridian
1	U2	74LVC4066D-T	74LVC4066D-T-ND		NXP
1	U4	TLP627(F,T)	TL627F-ND	TLP627(F,T) or SD400	TOSHIBA
1	Y1	11.0592 MHz	CTX409-ND	ATS111	CTS

* Equivalent parts are available from Datatronics, Sumida, Umec, and Allied.

4.2.4 Recommended Components Used in the Demo Boards

Several components are required in all modem designs that significantly affect the total BOM cost. The following parts and suppliers have proven to supply reliable and cost effective components.

Table 15: Transformers and Suppliers Tested and Used with the 73M2901CE

Manufacturer	“Wet” Transformers (DC Current OK)	“Dry” Transformers (No DC Current)
Allied	AEE-208D1	AEE-207D1, AEP-322D1
Datatronics	LM72019	PT79281
Etal	None currently available	P1200
Sumida	MIT4115V	MIT4033L, T50101
Würth-Midcom	671-8001, 671-8005	671-8236-MU-LF1
Umec	None currently available	UTB01542

The transformers listed in Table 15 are used in the 73M2901CE Demo Boards. The transformers listed as “wet” are suitable in applications that pass the DC current through the transformer windings. These transformers are physically larger than the “dry” types in order to prevent saturation with DC current, and generally have lower return loss performance. These are used in the EVM-600 type designs. The “dry” transformers require a separate DC holding circuit or gyrator (Q1-Q3 and associated circuitry in Figure 8) to provide a DC load to the network. This circuit is also used for pulse dialing (when required), and must present a high AC impedance to the line so that AC audio performance is not compromised. These transformers are used on the 73M2901CE EVM-WW Demo Boards.

The Tip/Ring inductors on the demo board are 4.7 μ H and are used to control EMI that might be coupled out to the line. Inductors that are intended for EMI control applications are sometimes rated for a particular impedance at some frequency, e.g., 2 k Ω at 100 MHz. Since the telephone connections also carry DC current, these inductors must also work with the DC current that may be present. All inductors in the Tip/Ring path must be rated to operate with a minimum of 200 mA so that performance is not overly degraded at high frequencies by core saturation. Inductance also tends to go down with temperature, so this must also be factored into the component selection. The actual EMI frequencies and levels that must be controlled are not always the same since EMI generated in any part of the design can end up being radiated from the telephone connection, so some characterization of the emissions is needed to determine the best fit for the frequencies that are present. The parts we use have good characteristics for the board when used alone, but may not work in every application that is encountered. Inductors can have a wide range of impedance versus frequency depending on the materials that are used, so there cannot be “one size fits all” solution for every application. Be sure the inductors are not located between the Tip and Ring connection and the over voltage/over current protection in the design. You do not want to have the surge current and voltage across these devices! Table 16 contains some inductors that might be used in your application.

Table 16: EMI Inductors for the Tip/Ring Signal Path

Manufacturer	Part Number	Value, μ H or Z @ Freq.	Rated Current
Allied	MC20A-4R7M-RC	4.7 μ H	220 mA
Laird (Steward)	HZ0805C202R-00	2 k Ω @ 100MHz	300 mA
TDK	NLV32T-4R7J-PF	4.7 μ H	220 mA

There are high voltage capacitors connected to Tip and Ring to earth ground that also aid in limiting EMI to the outside connections. These must have the same voltage ratings as the isolation required for the design (i.e., normally the transformer isolation voltage rating). There is also a capacitor across the Tip/Ring path that acts as a shunt to EMI energy coming from the DAA. The voltage rating of this part only needs to be high enough to tolerate voltages up to the TVS clamp voltage (see the over voltage protection section that follows).

If TVS devices are also provided on the Tip and Ring lines to earth ground, the voltage rating for the Tip/Ring capacitors only needs to be able to withstand the maximum TVS clamping voltage. These and the TVS devices must be removed during the isolation voltage certification tests to prevent triggering the TVS devices or damaging the capacitors.

Over voltage and current protection are required for a reliable design that will survive the real-world conditions that are encountered in the field. Nearly all certifying bodies have specifications for the severe conditions that can occur due to lightning, static discharge, and even voltage cross to power mains. In some cases these minimums are not adequate to survive some common fault conditions or ignore other conditions that would seem to be less severe, but actually can present more stress to the design, so many equipment providers will have even higher level or additional requirements not specified by the certifying bodies.

For example, the minimum isolation voltage required for the telecom transformers is 2 kV, but lightning strikes near power and telephone lines often far exceed these levels. For these reasons, some customers require 6kV or more isolation. Protection from the telephone network connection is usually provided to prevent over voltage and over current conditions from causing the product to fail. The PTC (Positive Temperature Coefficient) fuse (F1) and thyristor Transient Voltage Suppressor or TVS (E1) provide this protection on our demo boards. The devices we chose are parts that meet the minimums required for UL 60950 and EN-60950, which have the most stringent requirements of the commonly used standards. The 73M2901 designs are fully functional after the surge and power cross testing has been performed, even though this is not a requirement to pass, (the requirement for off hook is that it not catch fire). The following tables show the recommended components to meet various certification requirements. The PTC fuses listed are through-hole mounted, but surface mount is also available for most types. There are also different initial “ON” resistance versions that primarily affect the cost; the lower the initial resistance, the higher the cost.

There are also single fault telecom fuses that are designed to be used in these applications, but they must be replaced if they are triggered. The cost of these is about the same or more compared to the PTC types, so there is little advantage to using them in most cases.

Table 17: Recommended PTC Fuses for CPE Applications

Manufacturer	Part Number	Voltage/Current Rating	Specification
Bourns	MF-R015/600	600V, 150mA	TIA-968-A, UL60950
	MF-RX012/250	250V, 120mA	ITU-T K.20/21/45
Thinking Electronic Ind. Co.	KRT6000015xxx	600V, 150mA	TIA-968-A, UL60950
	KRT2500012xxx	250V, 120mA	ITU-T K.20/21/45
Tyco (Raychem)	TRF600-150	600V, 150mA	TIA-968-A, UL60950
	TRF250-120x	250V, 120mA	ITU-T K.20/21/45

The TVS is important because large voltages can damage the DAA if the DAA transistor switches' voltage ratings are exceeded. The TVS works in conjunction with the PTC fuse by going into a low impedance state when the TVS are triggered, which then causes the fuse to go to a high impedance until the fault condition is cleared. This prevents the TVS from having to dissipate large amounts of energy if there is a persistent high voltage fault. The TVS will also be triggered for short duration surges, but this will usually not trigger the fuse since it may take seconds for the fuse to go to the high impedance mode, depending on the current through it. In any case, these components work as a “team” to protect the DAA circuitry.

Table 18: Recommended TVS Over Voltage Protectors

Manufacturer	Part Number	Voltage/Current Rating	Specification
Bourns	TISP4395T3BJR	275V/100A (10/560μS)	TIA-968-A, UL60950 ITU-T K.20/21/45
Diodes, Inc	TB3100H	275V/100A (10/560μS)	TIA-968-A, UL60950 ITU-T K.20/21/45
Littlefuse (SIDACTor)	P3100EB	275V/100A (10/560μS)	TIA-968-A, UL60950 ITU-T K.20/21/45
Tyco SiBar	TVB275NSC	275V/100A (10/560μS)	TIA-968-A, UL60950 ITU-T K.20/21/45

It is not a requirement to function after the safety testing has been performed as long as there is not a hazardous condition afterwards. If this is not a primary concern, it is possible to pass these tests with less expensive protection solutions. This usually involves supplying a heavier gauge telephone cord and TVS that replace the ones above. It also requires mounting in a fire enclosure to contain any resultant fire and damage. This is a choice that the designer (and buyer) must make when deciding on the end product's requirements.

The recommendations listed should not be construed as the final word on components that can be used with Teridian's products. Other sources exist that we have not had experience with that could also be used in applications with our modem and FXO devices. The customer is encouraged to investigate other sources of parts that are not listed here.

4.2.5 73M2901CE EVM-WW Demo Board PCB Layout

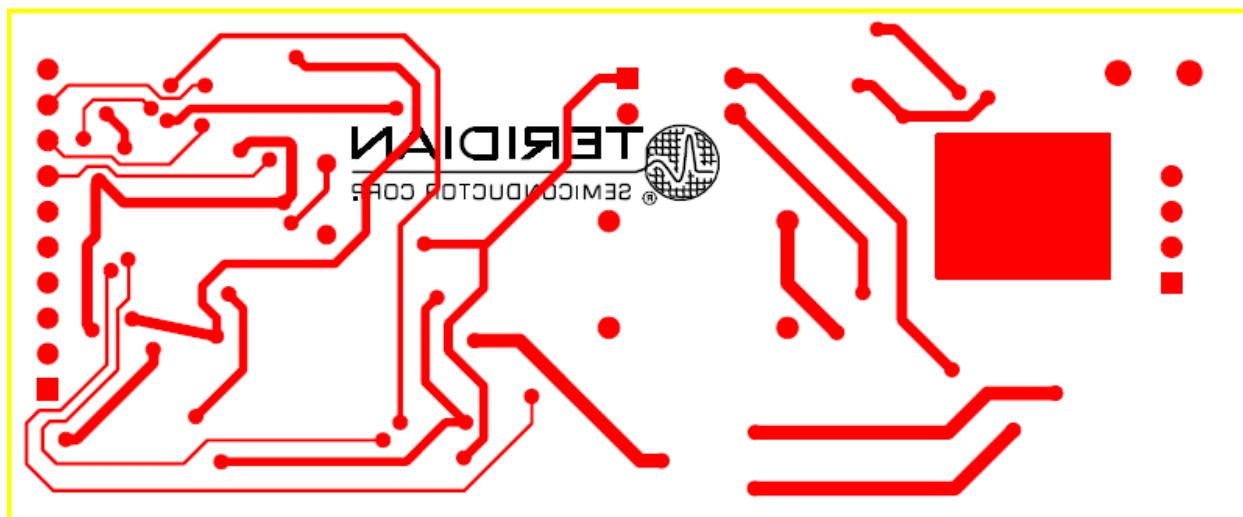


Figure 11: 73M2901CE Worldwide Demo Board: Bottom

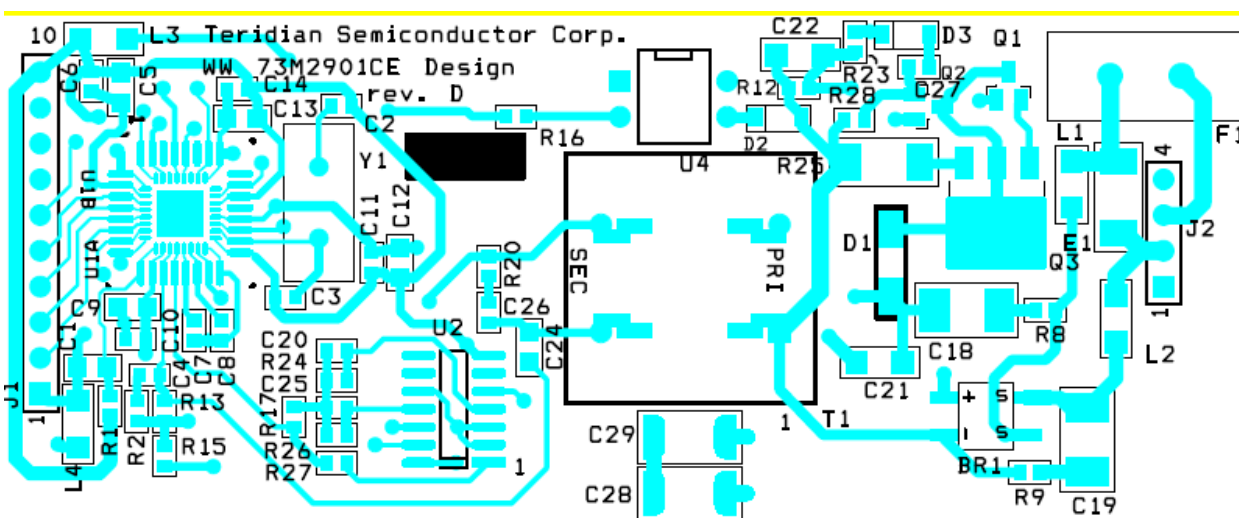


Figure 12: 73M2901CE Worldwide Demo Board: Top Layer and Silk Screen

Revision History

Revision	Date	Description
1.0	11/12/2008	Created from a merge of the USA (version 1.2) and Worldwide (version 2.1) DBUM documents. Modified to use new corporate format and assign a Document Number. Section on the AT Command has been moved to its own document (UM_2801CE_027).
1.1	2/19/2009	In Table 8, corrected the entries for WW DAA CTR21 and WW DAA Australia.
1.2	8/7/2009	Replaced the Daughter Board schematic in Figure 8.
1.3	10/1/2009	Fixed the corrupted schematics in Figure 2 and Figure 8.
1.4	1/15/2010	Replaced the schematic in Figure 9 with a new schematic. Removed Section 5 (the 73M2901CE/CL differences were moved to the <i>73M2901CE Data Sheet</i>) and subsequent sections were renumbered.
1.5	3/17/2010	Updated the schematic in Figure 8. Replaced the layouts in Figure 10, Figure 11 and Figure 12. Updated the Bill of Materials in Table 14. Updated the first part of Section 4.1. Added Section 4.2.4, Recommended Components Used in the Demo Boards.