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## EPT SPICE Modeling Kit

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**ON Semiconductor**

Formerly a Division of Motorola

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### APPLICATION NOTE

#### Objective

The objective of this kit is to provide customers with enough schematic and SPICE parameter information to perform system level interconnect modeling with the ON Semiconductor ECLinPS Plus™ Translator EPT family. The EPT devices MC100EPT2xD are single or dual supply 1 or 2 Bit translators between the TTL and ECL/PECL worlds. Single supply devices translate between TTL and PECL, dual supply devices translate to or from negative supplied ECL. All devices are designed as 100K compatible 100EPT2x.

The kit contains representative schematics and model files for the I/O circuits used by the EPT20 and EPT22 devices. The package model should be placed on all external inputs, outputs and supply pins.

#### Input and Output Schematics

The TTL-PECL Translator function uses circuit schematics LVTTL01 and LVTTL02 for references diagrams to the SPICE netlists.

All inputs and outputs of the ELT family are protected by ESD protection circuitry. The ESD circuit, IN\_ESD, is used for TTL Input and OUT\_ESD for PECL outputs.

If the user would like to just simulate the output behavior of an TTL output the TTL\_OUT circuit can be stimulated with internal signals.

To all external pins the package model, LINES, needs to be added. If users want to reduce simulation time and just simulate 1 channel or only the output of a circuit, they need to take care of the correct power supply management. The channels share power supply pins. Dynamic ICC current will add up at power pins. When a simulation is performed with only one channel, the package models of the power pins

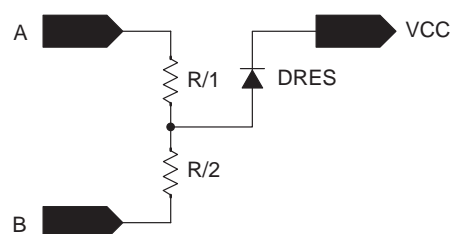
need to be adjusted. The parasitic capacitance and inductance should be adjusted accordingly.

#### Modeling

The bias driver schematics for VCS and V1 generation are not included in this kit, as they are unnecessary for interconnection simulation. In addition their use would result in a relatively large in simulation time. Alternatively the internal reference voltages should be driven with ideal constant voltage sources.

Parameter	Typical Level	Worst Case
VCS	VEE+1.3V	±50mV
V1	VEE+2.1V	±50mV

This model kit is intended for simulations within the specified power supply range. If supply voltages drop below minimum specification, VCS and V1 can no longer be assumed to be constant. Thus, this model kit can not be used for power up or power down simulations. The 10K ohm resistor should NOT be simulated as simple SPICE resistor because it is fabricated by a diffusion step in wafer processing and there is an associated parasitic. The following subcircuit should be used to enhance the performance of the simulation.



**Figure 1. Resistor Model**

```
.SUBCKT RESK A B VCC params: R=10000
* Assumes Sheet Rho=5000HM, Resistor Width=10U, and Cap in Farads.
Ra A 1 {R/2} TC=900U
Rb 1 B {R/2} TC=900U
D1 1 VCC DRES
.MODEL DRES D
+ (IS=3.7E-16
+ CJO=0.265E-16*R+29E-16)
.ENDS RESK
```

The nodes in the model files and the schematics are:

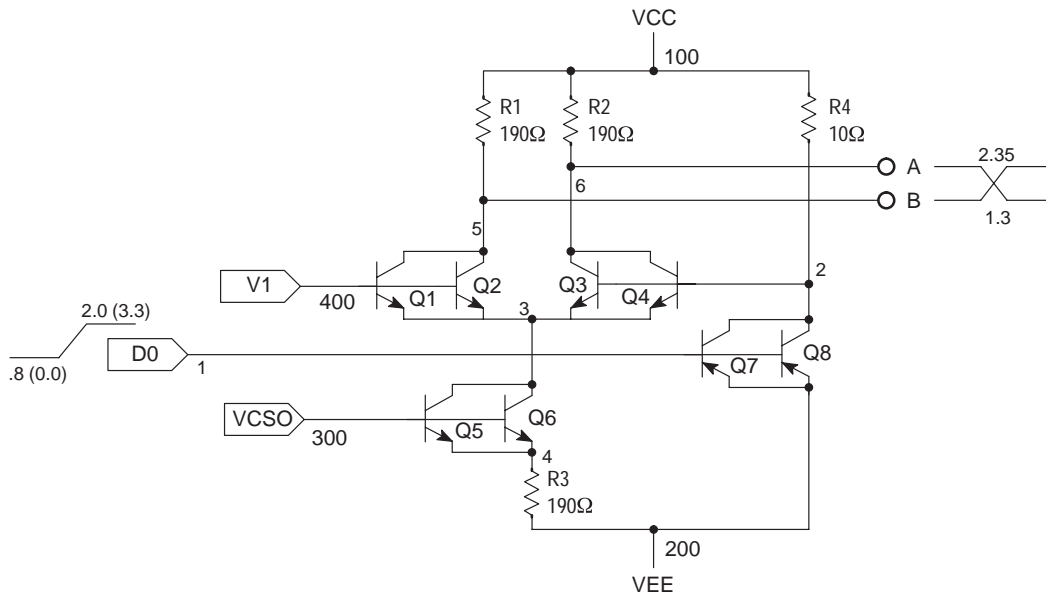
Name Node Description

VCC	100	3.3V High rail power supply
VEE	200	0.0V Lowest Rail Power supply
VCS	300	1.24 Current Source Base Voltage (VEE+1.3V)V
V1	400	2.1 Internal TTL Transfer Reference Supply
VTT	500	1.3V External termination sink supply (VCC—2V)
VIN	51	PULSE (.8 to 2.0, tr/tf 5NS, PW 20NS, PER 50NS)

Temperature coefficients are annotated (\* TC=).

For typical load ECL and PECL outputs should be terminated 50ohm to VTT=VCC—2V. TTL outputs are loaded with 20pF to GROUND and 500OHM to GROUND.

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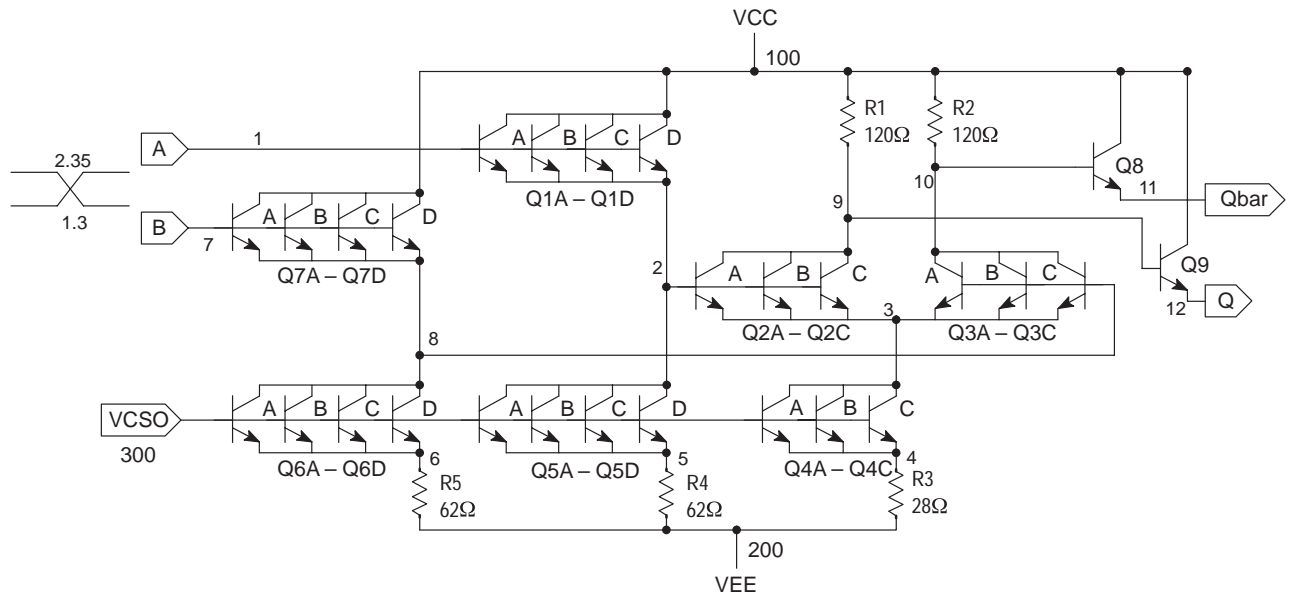


**Figure 2. LVTTTL–LVPECL Translator  
EPT20/22  
LVPECL output**

For LVTTTL01, the following transistors are used:

Q1	TRANA
Q2	TRANA
Q3	TRANA
Q4	TRANA
Q5	TRANA
Q6	TRANA
Q7	TRANE
Q8	TRANE

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**Figure 3. LVTTTL-LVPECL Translator  
EPT20/22  
LVPECL output**

For LVTTTL02 the following transistors are used:

Q1A-D	TRANA
Q2A-C	TRANB
Q3A-C	TRANB
Q4A-C	TRANB
Q5A-D	TRANA
Q6A-D	TRANA
Q7A-D	TRANA
Q8	TRANB
Q9	TRANB

```
.TRAN 0.2NS 120NS
XLVTTTL01 100 200 300 400 1 5 6 LVTTTL01
XLVTTTL02 100 200 300 5 6 11 12 LVTTTL02
XINESD 100 200 51 1 IN_ESD
XOUTESD 100 200 11 OUT_ESD
XOUTESDB 100 200 12 OUT_ESD
XQBTERM 500 12 RTERM
XQTERM 500 11 RTERM
```

```
.SUBCKT LVTTTL01 100 200 300 400 1 5 6
Q1 5 400 3 200 TRANA
Q2 5 400 3 200 TRANA
Q3 6 2 3 200 TRANA
Q4 6 2 3 200 TRANA
Q5 3 300 4 200 TRANA
Q6 3 300 4 200 TRANA
Q7 2 1 200 200 TLS
Q8 2 1 200 200 TLS
R1 100 5 190
* TC=0.26M, 0.9U
R2 100 6 190
```

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```
* TC=0.26M, 0.9U
R3  4    200 190
* TC=0.26M, 0.9U
R4 100  2    10000
* TC=0.26M, 0.9U
.ENDS LVTTTL01
```

```
.SUBCKT LVTTTL02 100 200 300 1 7 11 12
Q1A 100  1  2  200 TRANA
Q1B 100  1  2  200 TRANA
Q1C 100  1  2  200 TRANA
Q1D 100  1  2  200 TRANA
Q2A  9  2  3  200 TRANB
Q2B  9  2  3  200 TRANC
Q2C  9  2  3  200 TRANC
Q3A 10  8  3  200 TRANB
Q3B 10  8  3  200 TRANC
Q3C 10  8  3  200 TRANC
Q4A  3 300  4  200 TRANB
Q4B  3 300  4  200 TRANB
Q4C  3 300  4  200 TRANB
Q5A  2 300  5  200 TRANA
Q5B  2 300  5  200 TRANA
Q5C  2 300  5  200 TRANA
Q5D  2 300  5  200 TRANA
Q6A  8 300  6  200 TRANA
Q6B  8 300  6  200 TRANA
Q6C  8 300  6  200 TRANA
Q6D  8 300  6  200 TRANA
Q7A 100  7  8  200 TRANA
Q7B 100  7  8  200 TRANA
Q7C 100  7  8  200 TRANA
Q7D 100  7  8  200 TRANA
Q8  100 10 11  200 TRAND
Q9  100  9 12  200 TRAND
R1  100  9 120
* TC=0.26M, 0.9U
R2  100 10 120
* TC=0.26M, 0.9U
R3  4    200 28
* TC=0.26M, 0.9U
R4  5    200 62
* TC=0.26M, 0.9U
R5  6    200 62
* TC=0.26M, 0.9U
.ENDS LVTTTL02
```

```
* INPUT ESD 51 = in, 61 out
.SUBCKT IN_ESD 100 200 51 61
D1  51    100    ES14X19M
D2  51    100    ES14X19M
D3  51    100    ES14X19M
D4  200    51    ES14X19M
D5  200    51    ES14X19S
D6  200    51    ES14X19M
D7  200    51    ES14X19S
D8  200    51    ES14X19M
D9  200    51    ES14X19S
RB1  51  61 1000
* TC=0.26M, 0.9U
.ENDS IN_ESD
```

## AND8014/D

```
* OUTPUT ESD
.SUBCKT OUT_ESD 100 200 81
D1      81      100      ES14X19M
D2      81      100      ES14X19M
D3      200     81       ES14X19M
D4      200     81       ES14X19S
D5      200     81       ES14X19M
D6      200     81       ES14X19S
.ENDS OUT_ESD

.SUBCKT RTERM 500 91
R1 91 500 50
.ENDS

.END

.MODEL TRANA NPN (IS=8.12E-18 BF=192 NF=1 VAF=75.6 IKF=1.49E-02
+ ISE=9.14E-17 NE=2 BR=15.8 VAR=2.76 IKR=2.2E-03 ISC=2.62E-16
+ NC=1.578 RB=327 IRB=4.8E-05 RBM=0.001 RE=10 RC=15 CJE=2.0E-14
+ VJE=.8867 MJE=.2868 TF=9.02E-12 ITF=7.6E-03 XTF=2.8 VTF=3.4 PTF=41.56 TR=1NS
+ CJC=5.6E-15 VJC=.6324 MJC=.3006 XCJC=.3 CJS=4.8E-15 VJS=.4193 MJS=.2563
+ EG=1.119 XTI=3.999 XTB=0.8826 FC=0.9)

.MODEL TRANC NPN (IS=1.36E-17 BF=180 NF=1 VAF=87.6 IKF=2.19E-02
+ ISE=6.65E-16 NE=2 BR=16.9 VAR=2.76 IKR=1.5E-03 ISC=1.11E-16
+ NC=1.578 RB=136 IRB=3.24E-05 RBM=0.001 RE=6 RC=8 CJE=1.02E-13
+ VJE=.8867 MJE=.2868 TF=9.02E-12 ITF=1.27E-02 XTF=2.8 VTF=3.4 PTF=41.56 TR=1NS
+ CJC=10.3E-15 VJC=.6324 MJC=.3006 XCJC=.3 CJS=9.94E-15 VJS=.4193 MJS=.2563
+ EG=1.119 XTI=3.999 XTB=0.8826 FC=0.9)

.MODEL TRAND NPN (IS=6.55E-17 BF=103 NF=1 VAF=90 IKF=2.91E-01
+ ISE=8.85E-15 NE=2 BR=15.7 NR=1 VAR=3.82 IKR=2.01E-02 ISC=1.48E-15
+ NC=2 RB=10.5 IRB=4.39E-04 RBM=0.29 RE=0.351 RC=9 CJE=3.5E-13
+ VJE=.8167 MJE=.1973 TF=8.99E-12 ITF=1.3E-01 XTF=5.67 VTF=1.86 PTF=41.43 TR=6.405E-10
+ CJC=1.4E-13 VJC=.6401 MJC=.2674 XCJC=1 CJS=9.3E-14 VJS=.5002 MJS=.1706
+ EG=1.135 XTI=4.177 XTB=0.6322 FC=0.961)

.MODEL TRANB NPN (IS=2.71E-17 BF=172 NF=1 VAF=71.4 IKF=4.38E-02
+ ISE=1.33E-15 NE=2 BR=17.9 VAR=2.76 IKR=3.0E-03 ISC=2.22E-16
+ NC=1.578 RB=67 IRB=6.47E-05 RBM=0.001 RE=3 RC=4 CJE=5.09E-14
+ VJE=.8867 MJE=.2868 TF=9.02E-12 ITF=2.53E-02 XTF=2.8 VTF=3.4 PTF=41.56 TR=1NS
+ CJC=20.6E-15 VJC=.6324 MJC=.3006 XCJC=.3 CJS=1.7E-14 VJS=.4193 MJS=.2563
+ EG=1.119 XTI=3.999 XTB=0.8826 FC=0.9)

.MODEL TRANEPNP (IS=1.65e-17 BF=210 NF=1 VAF=7.5 IKF=6.51e-05
+ ISE=7.75e-17 NE=1.813 BR=210 VAR=5.68 IKR=6.51e-05 ISC=7.75e-17
+ NC=1.813 RB=349 IRB=1.77e-07 RBM=53 RE=119 RC=158 CJE=7.04e-15
+ VJE=0.6578 MJE=0.149 TF=6.33e-10 ITF=2.2e-08 XTF=2.8 VTF=1.4
+ PTF=41.56 TR=1e-9 CJC=7.04e-15 VJC=0.8034 MJC=0.1773 XCJC=.3
+ CJS=4.79e-15 VJS=.4193 MJS=0.0902
+ EG=1.158 XTI=2.015 XTB=0.1208 FC=0.9)

.MODEL TLS LPNP (IS=1.65e-17 BF=210 NF=1 VAF=7.5 IKF=6.51e-05
+ ISE=7.75e-17 NE=1.813 BR=210.1 NR=1 VAR=5.68 IKR=2.61e-04 ISC=7.75e-17
+ NC=1.813 RB=349 IRB=1.8e-07 RBM=53 RE=119 RC=158 CJE=7.0e-15
+ VJE=.6578 MJE=.149 TF=6.33e-10 ITF=2.2e-08 XTF=.5356 VTF=.2365 PTF=0 TR=6.33e-10
+ CJC=7.0e-15 VJC=.8034 MJC=.1773 XCJC=1 CJS=4.8e-15 VJS=.5 MJS=.09022
+ EG=1.158 XTI=2.015 XTB=0.1208 FC=0.9)
```

## AND8014/D

.MODEL ES14X19M D (IS=1.55E-14 CJO=160FF RS=12 VJ=.58 M=.25 BV=9)

.MODEL ES14X19S D (IS=1.55E-14 CJO=29FF VJ=.624 M=.571)  
.END

\* PACKAGE: 8SOIC  
\* SPICE SUBCIRCUIT FILE OF COUPLED TRANSMISSION LINES  
\* CREATED FRI APR 25 16:47:54 1997  
\* BY PMG VERSION 3.6.2  
\*

\* TRANSMISSION LINE MODEL

* CONDUCTOR	PIN
* 1	1
* 2	2
* 3	3
* 4	4
* 5	5
* 6	6
* 7	7
* 8	8

\* NUMBER OF LUMPS: 1  
\* FASTEST APPLICABLE EDGE RATE: 0.076 NS  
\* CONNECT CHIP SIDE TO N\*\*I AND BOARD SIDE TO N\*\*O  
\*

.SUBCKT LINES N01I N01O N02I N02O N03I N03O N04I N04O  
+ N05I N05O N06I N06O N07I N07O N08I N08O

L01WB	N01I	N01M	1.367E-09
L01	N01M	N01O	7.794E-10
C01	N01M	0	2.445E-13
L02WB	N02I	N02M	1.287E-09
L02	N02M	N02O	5.473E-10
C02	N02M	0	1.888E-13
L03WB	N03I	N03M	1.287E-09
L03	N03M	N03O	5.473E-10
C03	N03M	0	1.901E-13
L04WB	N04I	N04M	1.367E-09
L04	N04M	N04O	7.723E-10
C04	N04M	0	2.443E-13
L05WB	N05I	N05M	1.367E-09
L05	N05M	N05O	7.710E-10
C05	N05M	0	2.478E-13
L06WB	N06I	N06M	1.287E-09
L06	N06M	N06O	5.489E-10
C06	N06M	0	1.916E-13
L07WB	N07I	N07M	1.287E-09
L07	N07M	N07O	5.495E-10
C07	N07M	0	1.930E-13
L08WB	N08I	N08M	1.367E-09
L08	N08M	N08O	7.786E-10
C08	N08M	0	2.451E-13
K0102	L01	L02	0.1687
K0102WB	L01WB	L02WB	0.3400
C0102	N01O	N02O	3.674E-14
K0103	L01	L03	0.0702
K0103WB	L01WB	L03WB	0.1847
K0203	L02	L03	0.1822
K0203WB	L02WB	L03WB	0.3505
C0203	N02O	N03O	3.521E-14
K0204	L02	L04	0.0682
K0204WB	L02WB	L04WB	0.1847


## AND8014/D

K0304	L03	L04	0.1694
K0304WB	L03WB	L04WB	0.3400
C0304	N03O	N04O	3.675E-14
K0305WB	L03WB	L05WB	0.1847
K0405WB	L04WB	L05WB	0.3455
K0406WB	L04WB	L06WB	0.1847
K0506	L05	L06	0.1697
K0506WB	L05WB	L06WB	0.3400
C0506	N05O	N06O	3.720E-14
K0507	L05	L07	0.0682
K0507WB	L05WB	L07WB	0.1847
K0607	L06	L07	0.1824
K0607WB	L06WB	L07WB	0.3505
C0607	N06O	N07O	3.570E-14
K0608	L06	L08	0.0702
K0608WB	L06WB	L08WB	0.1847
K0708	L07	L08	0.1691
K0708WB	L07WB	L08WB	0.3400
C0708	N07O	N08O	3.632E-14

.ENDS LINES



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