

PCB Thermal

2000年1月27~28日
EDA TechnoFair 2000
アンソフトジャパン株式会社



Thermal/Mechanical Simulation: EDA/CAD Tools とのインテグレーション

インターフェース

AutoCAD DXF
Cadence Allegro
Flomerics
Fluent
Gerber
Incases (old ComputerVision)
Intercept Encore PCB (old Xynetix)
Mentor Graphics BoardStation
Mentor Graphics MCMStation
PADS
PCAD
Protel
Tango Pro
VeriBest
図研リダック Cadstar
図研リダック Visula
図研 CR3000/CR5000

抽出データ

物理的形状
ネットリスト
機械データ
製造データ
テストデータ

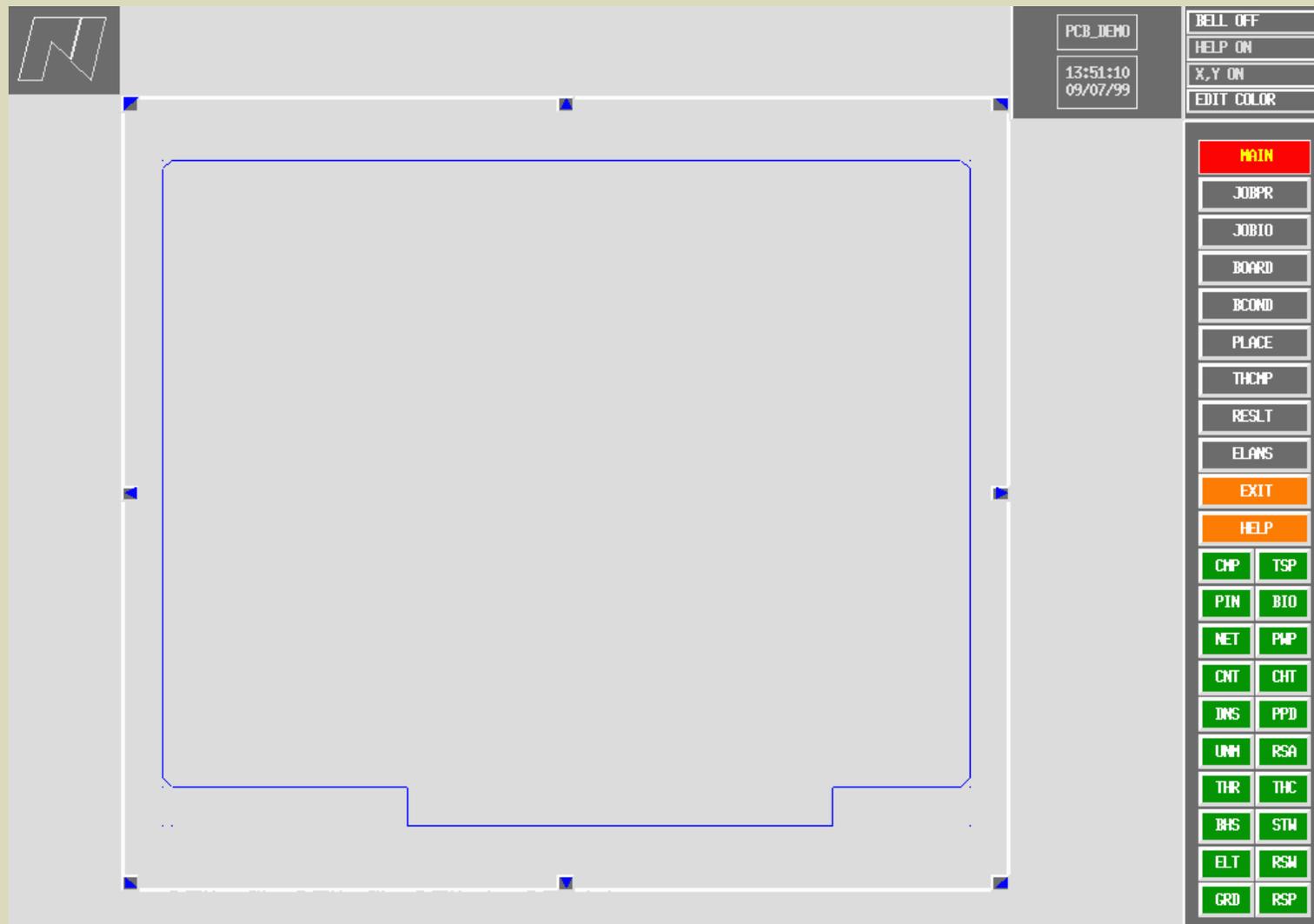
PCB Explorer/PCB Thermal

は下記を含みます:

- PCB Place: 会話型・自動部品配置
- プリポスト・プロセッサ (thermal, vibration plus, and solder simulation software)
- PCB Thermal: 部品・PCBのための熱解析ツール

PCB Place

PCB 外形寸法: インポートor マニュアル入力



PCB Place

部品配置: EDA CADよりインポート, 電気・熱の制約条件による自動配置, 会話型配置

The screenshot displays the ANSYS PCB Place software interface. The main workspace shows a detailed PCB layout with numerous components and their interconnections. Components are labeled with IDs such as U18, U59, U19, U55, U56, U57, U58, U52, U54, U53, U54, U64, U61, U57, U36, U63, U38, RP8, U49, U46, U41, U39, U40, U45, U37, U62, U47, U48, U44, U65, U42, U51, U43, U35, Y1, U69, U15, U13, U32, U16, U10, U12, U50, U27, U35, U11, U17, U14, U28, U3, U30, U29, U31, U5, U9, U8, U6, U7, U25, U20, U34, U70, U71, U4, U2, and J1. The components are interconnected with a dense network of magenta lines representing electrical connections. The interface includes a top menu bar with options like BELL OFF, HELP ON, X,Y ON, and EDIT COLOR. A central toolbar contains buttons for PLACE, INFLC, PLCPAR, ADJCHP, RSAREA, PLCPAD, PREPLC, AUTPLC, MANPLC, EXIT, and HELP. A bottom toolbar contains buttons for CMP, TSP, PIN, BIO, NET, PMP, CNT, CHT, DNS, PPD, UNH, RSA, THR, THC, DNS, STM, ELT, RSM, GRD, and RSP. The bottom left corner features the ANSOFT logo.

PCB Place

部品配置情報



PCB_DEMO
14:48:42
09/07/99

BELL OFF
HELP ON
X,Y ON
EDIT COLOR

PLACE
INPLC

Search String F-Search B-Search Save Text Exit

```
***** COMPONENT PLACEMENT *****  
  
TY = COMPONENT TYPE  
IC: INTEGRATED CIRCUIT    CP: CAPACITOR    RY: RELAY  
TS: TRANSISTOR            CL: COILS        TR: TRANSFORMER  
RS: RESISTOR              DI: DIODE        HM: HOLEHOLE  
CN: STRAIGHT IN CONNECTOR SM: SWITCH         FL: FILTERS  
CT: RIGHT ANGLE CONNECTOR XT: CRYSTAL       MC: MISCELLANEOUS  
  
SH = OUTLINE SHAPE (C: CIRCLE S: SQUARE R: RECTANGLE O: OTHER)  
RF = COUNTER-CLOCKWISE ROTATIONAL FREEDOM (DEGREES)  
    0: FREE    1: 0 & 180    2: 90 & 270    3: NO ROTATION  
    4: 90     5: 180     6: 270  
BS = BOARD SIDE (F: FRONT B: BACK)  
PP = PREPLACEMENT (F: FIXED M: MOVABLE N: NOT PREPLACED)  
ORN= ORIENTATION  
ADJ= NUMBER OF PRE-ASSIGNED ADJACENT COMPONENTS  
  
U-NAME  PART NAME      TY SH RF BS PP ORN ADJ OP-PMR  X & Y LOCATION(in)
```

U-NAME	PART NAME	TY	SH	RF	BS	PP	ORN	ADJ	OP-PMR	X & Y LOCATION(in)
C1	CAPACITOR-470PF	MC	R	0	B	N	270	0		1,9090 0,5685
C2	CAPACITOR-0.01UF	MC	R	0	B	N	180	0		5,7025 0,9750
J1	ECON-1	CT	R	0	F	N	0	0		3,4000 0,1500
R1	RESISTOR-4.7K	MC	R	0	B	N	270	0		0,9500 2,9000
R2	RESISTOR-4.7K	MC	R	0	B	N	180	0		1,6500 3,9750
R3	RESISTOR-4.7K	MC	R	0	B	N	180	0		1,3000 1,4250
R4	RESISTOR-4.7K	MC	R	0	B	N	180	0		0,4000 1,4250
RP1	SIPRES-4.7K	IC	R	0	F	N	90	0	0,2500	4,3000 2,2750
RP2	SIPRES-4.7K	IC	R	0	F	N	90	0	0,2500	2,5500 2,2750
RP3	SIPRES-4.7K	IC	R	0	F	N	90	0	0,2500	1,3500 1,8250
RP4	SIPRES-4.7K	IC	R	0	F	N	90	0	0,2500	1,3500 2,0750
RP5	SIPRES-1K	IC	R	0	F	N	90	0	0,2500	4,2500 0,9750
RP6	SIPRES-1K	IC	R	0	F	N	90	0	0,2500	2,5000 0,9750



PCB Place

イニシャル・レイアウトの後、マニュアル配置

PCB_DEMO
14:47:19
09/07/99

BELL OFF
HELP ON
X,Y ON
EDIT COLOR

H-ALIGN CENTER
H-ALIGN PIN #1
H-ALIGN TOP
H-ALIGN BOTTOM
V-ALIGN CENTER
V-ALIGN PIN #1
V-ALIGN LEFT
V-ALIGN RIGHT
ON-GRID PLACEMENT ALIGNMENT
MOVE OR ROTATE SINGLE COMPONENT
MOVE OR ROTATE GROUP OF COMPONENTS
ROTATE W/O MOVE GROUP OF COMPONENTS

PLACE
ABORT

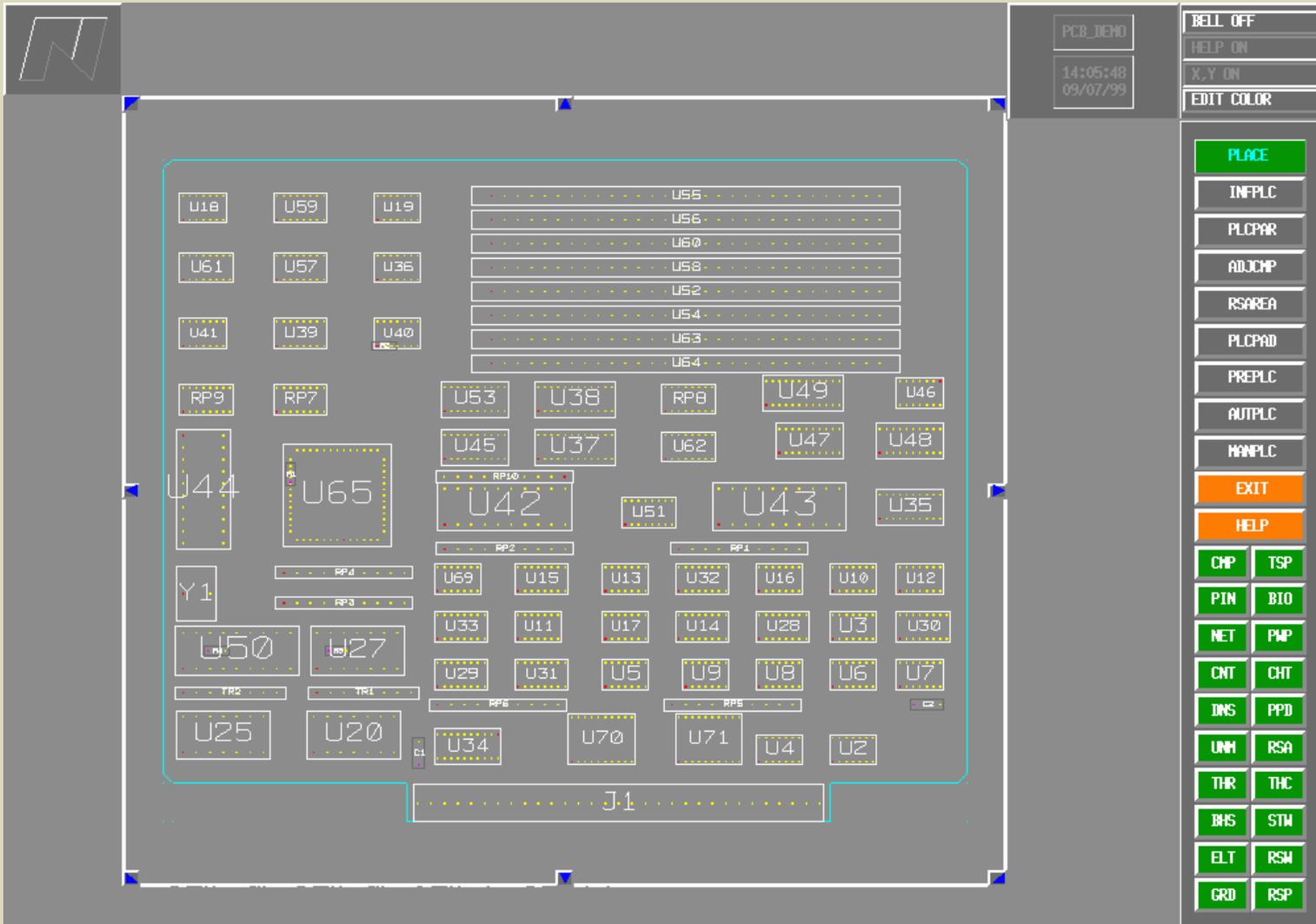
EXIT

X= 0.8300 Y= -0.0600 DX= -3.7700 DY= -2.6900 L= 4.6313 (in)
>>> LEFT BTN TO PUT, MIDDLE BTN TO ROTATE, <F3> KEY TO CHANGE BOARD SIDE, RIGHT BTN TO CANCEL



PCB Thermal

部品番号とピンを表示したPCBレイアウト図



PCB Thermal

PCB層構造: EDA CADからのインポートor会話的に設定

The screenshot displays the PCB Thermal software interface. At the top, there is a menu bar with options: ADD GRP, CPY GRP, ADD LVR, CPY LVR, CHG LVR, DEL LVR, PROPERTY, SAVE, and EXIT. The main window shows a table of layer properties and a list of materials on the right.

Table: THICKNESS GROUP

GRP	LVR	TYPE	DIELECTRIC	MATERIAL	CONDUCTING MATERIAL	THICKNESS (in)	MESHED PLANE (in)	WIDTH	HOLE
1	11	S	1	85% FR-4	15% COPPER-ETP	0,0014			
	10	DIEL	100%	FR-4	0%	0,0098			
	9	S	2	90% FR-4	10% COPPER-ETP	0,0014			
	8	DIEL	100%	FR-4	0%	0,0098			
	7	COND	0%		100% COPPER-ETP	0,0014			
	6	DIEL	100%	FR-4	0%	0,0098			
	5	COND	0%		100% COPPER-ETP	0,0014			
	4	DIEL	100%	FR-4	0%	0,0098			
	3	S	5	91% FR-4	9% COPPER-ETP	0,0014			
	2	DIEL	100%	FR-4	0%	0,0098			
	1	S	6	88% FR-4	12% COPPER-ETP	0,0014			
			Z BOTTOM =	0,0000	TOTAL =	0,0574			
2	12	COND	0%		100% ALUMINUM-6061T6	0,0500			
	11	S	2	85% FR-4	15% COPPER-ETP	0,0014			
	10	DIEL	100%	FR-4	0%	0,0098			
	9	S	3	90% FR-4	10% COPPER-ETP	0,0014			
	8	DIEL	100%	FR-4	0%	0,0098			
	7	COND	0%		100% COPPER-ETP	0,0014			
	6	DIEL	100%	FR-4	0%	0,0098			
	5	COND	0%		100% COPPER-ETP	0,0014			
	4	DIEL	100%	FR-4	0%	0,0098			
	3	S	6	91% FR-4	9% COPPER-ETP	0,0014			
	2	DIEL	100%	FR-4	0%	0,0098			
	1	S	7	88% FR-4	12% COPPER-ETP	0,0014			
			Z BOTTOM =	0,0000	TOTAL =	0,1074			

Material List:

- AIR
- ALLOY42
- ALUMINA94Z
- ALUMINA96Z
- ALUMINUM-0TMPR
- ALUMINUM-6061T6
- BERYLLIA
- COPPER-ETP
- FR-4
- G-10
- GALLIUM-ARSENIDE
- GOLD
- KOVAR
- MOLYBDENUM
- NICKEL
- PLASTIC-NOMOLAC
- POLYIMIDE
- SILICON
- SILICONE-GREASE
- SOLDER-63%SN
- STEEL-SAE-1020

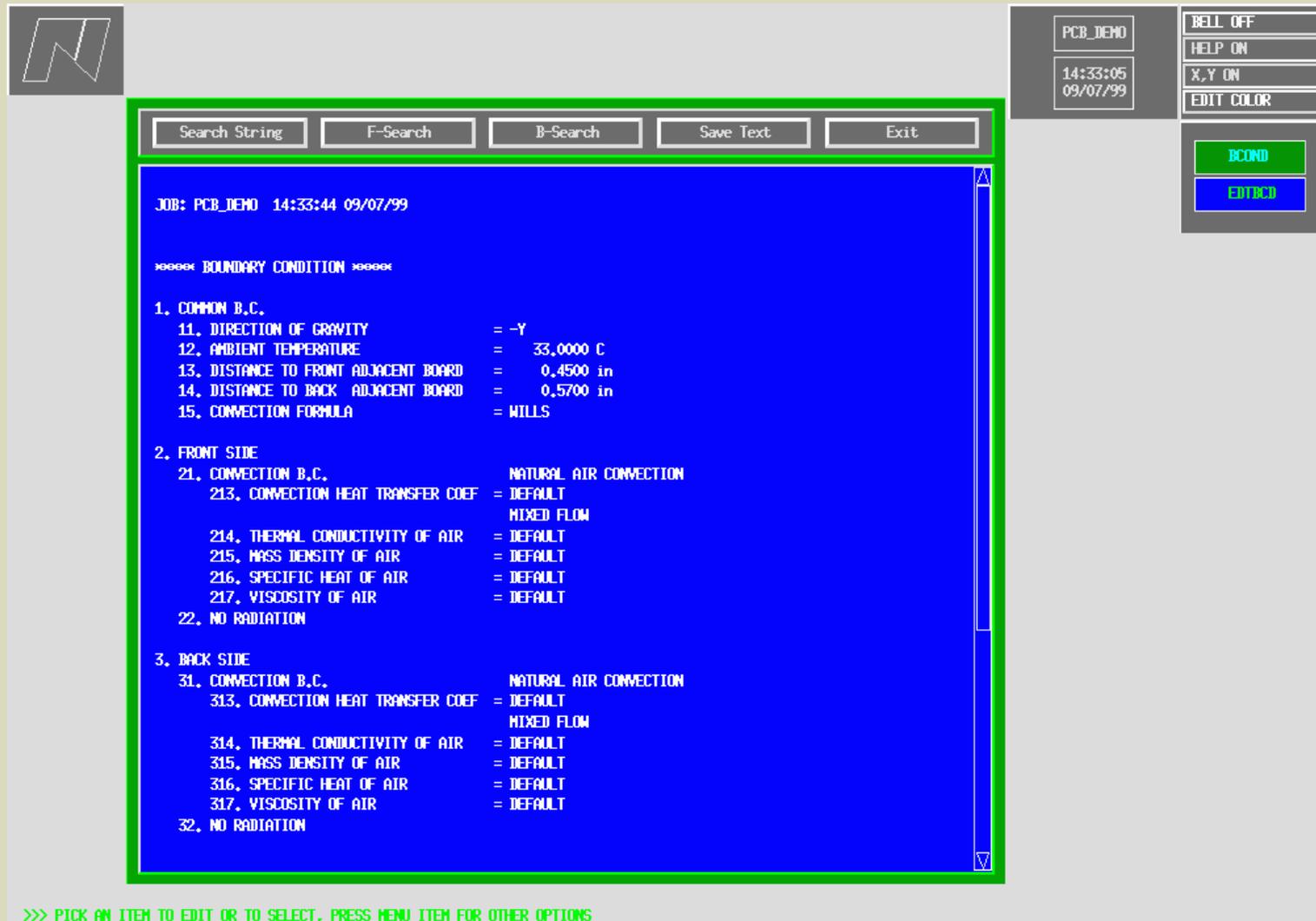
PCB Thermal

PCB ヒートシンク:熱伝導, 対流, 放射, 熱流束 ;
サイズ、場所は自由



PCB Thermal

PCB 境界条件: 熱伝導, 放射, 対流



The screenshot displays the ANSYS PCB Thermal software interface. At the top left is the ANSYS logo. The main window shows a blue background with white text for boundary conditions. At the top right, there are control buttons for 'PCB_DEMO', 'BELL OFF', 'HELP ON', 'X,Y ON', 'EDIT COLOR', 'BCMD', and 'EDITCB'. Below the main window, a green prompt reads '>>> PICK AN ITEM TO EDIT OR TO SELECT, PRESS MENU ITEM FOR OTHER OPTIONS'.

Search String F-Search B-Search Save Text Exit

JOB: PCB_DEMO 14:33:44 09/07/99

***** BOUNDARY CONDITION *****

1. COMMON B.C.

11. DIRECTION OF GRAVITY	= -Y
12. AMBIENT TEMPERATURE	= 33,0000 C
13. DISTANCE TO FRONT ADJACENT BOARD	= 0,4500 in
14. DISTANCE TO BACK ADJACENT BOARD	= 0,5700 in
15. CONVECTION FORMULA	= WILLS

2. FRONT SIDE

21. CONVECTION B.C.	NATURAL AIR CONVECTION
213. CONVECTION HEAT TRANSFER COEF	= DEFAULT
	MIXED FLOW
214. THERMAL CONDUCTIVITY OF AIR	= DEFAULT
215. MASS DENSITY OF AIR	= DEFAULT
216. SPECIFIC HEAT OF AIR	= DEFAULT
217. VISCOSITY OF AIR	= DEFAULT

22. NO RADIATION

3. BACK SIDE

31. CONVECTION B.C.	NATURAL AIR CONVECTION
313. CONVECTION HEAT TRANSFER COEF	= DEFAULT
	MIXED FLOW
314. THERMAL CONDUCTIVITY OF AIR	= DEFAULT
315. MASS DENSITY OF AIR	= DEFAULT
316. SPECIFIC HEAT OF AIR	= DEFAULT
317. VISCOSITY OF AIR	= DEFAULT

32. NO RADIATION

>>> PICK AN ITEM TO EDIT OR TO SELECT, PRESS MENU ITEM FOR OTHER OPTIONS

PCB Thermal

Component thermal models

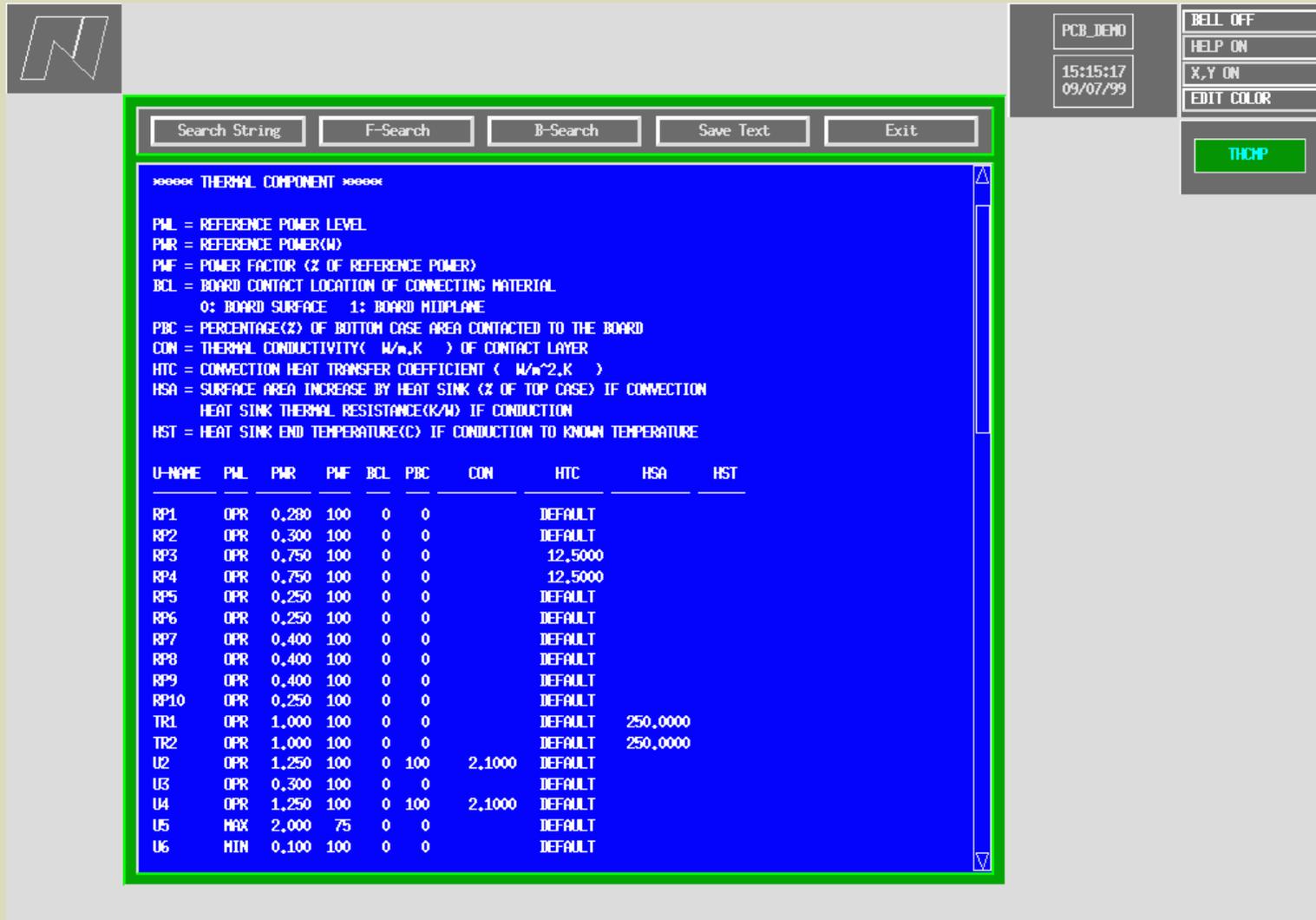
The screenshot displays the ANSYS PCB thermal modeling software interface. A configuration window for a thermal component is open, showing the following parameters:

- 1. COMPONENT TYPE = CC (CHIP CARRIER)
- 2. IDENTIFIERS
 - 21. PART NAME = Z8001_52-1
 - 22. FUNCTIONAL NAME = Z8001_52-1
 - 23. PACKAGE TYPE NAME = PLCC52
 - 24. MANUFACTURER =
 - 25. MILITARY I.D. =
- 3. GEOMETRIC DATA
 - BODY SIZE = 0,8500 0,8000 0,2000 in
 - MOUNTING CLEARANCE = 0,0100 in
- 4. POWER DISSIPATIONS
 - MAX. & MIN. DISSIPATIONS = 1,0000 0,1000 W
- 5. J-CASE THERMAL RESISTANCES
 - REFERENCE J-CASE = 5,0000 K/W
 - RELATIVE J-TOP CASE = 0,7968
 - RELATIVE J-BOTTOM CASE = 0,7924
- 6. J-BOARD THERMAL RESISTANCE = 15,2942 K/W
- 7. EFFECTIVE BODY THERMAL CONDUCTIVITIES
 - PLANAR (X,Y) DIRECTION = 14,4030 W/m.K
 - Z-DIRECTION OF TOP HALF = 0,3787 W/m.K
 - Z-DIRECTION OF BOTTOM HALF = 3,4966 W/m.K
- 8. INTERCONNECT THERMAL RESISTANCE
 - CASE TO BOARD = 15,0000 K/W
- 9. ALLOWABLE MAX. JUNCTION TEMPERATURES
 - LOW & HIGH LEVEL = 110,0000 125,0000 C
- 10. OTHER PROPERTIES
 - 101. RADIATION EMISSIVITY = 0,8500
 - 102. MASS = 0,0080 Kg
 - 103. SPECIFIC HEAT = 1800,0000 J/Kg.K

The background shows a 3D model of a component on a PCB. The component is a blue rectangular block with a grid of pins on its bottom surface. The PCB is a black grid with white squares. The component is mounted on the PCB. The software interface includes a search string field, search buttons (F-Search, B-Search), and save/exit buttons. A right-hand panel contains buttons for editing and reviewing global thermal parameters, copying global thermal parameters, reviewing thermal parameters for each component, editing or reviewing applied powers, and editing or reviewing other parameters. A top-right panel shows the PCB name (PCB_DEMO), the current time (15:19:03), the date (09/07/99), and a bell icon.

PCB Thermal

部品パラメータ: 電力, マウントテクノロジー,
ヒートシンク, 境界条件



The screenshot displays the ANSYS PCB Thermal software interface. At the top left is the ANSYS logo. The main window shows a text editor with a table of thermal component parameters. The table has columns for U-NAME, PML, PMR, PMF, BCL, PBC, CON, HTC, HSA, and HST. The components listed include resistors (RP1-RP10), a transformer (TR1, TR2), and various ICs (U2, U3, U4, U5, U6). The parameters are set to either 'DEFAULT', 'MAX', or 'MIN' values.

***** THERMAL COMPONENT *****

PML = REFERENCE POWER LEVEL
PMR = REFERENCE POWER(W)
PMF = POWER FACTOR (% OF REFERENCE POWER)
BCL = BOARD CONTACT LOCATION OF CONNECTING MATERIAL
0: BOARD SURFACE 1: BOARD MIDPLANE
PBC = PERCENTAGE(%) OF BOTTOM CASE AREA CONTACTED TO THE BOARD
CON = THERMAL CONDUCTIVITY(W/m.K) OF CONTACT LAYER
HTC = CONVECTION HEAT TRANSFER COEFFICIENT (W/m^2.K)
HSA = SURFACE AREA INCREASE BY HEAT SINK (% OF TOP CASE) IF CONVECTION
HEAT SINK THERMAL RESISTANCE(K/W) IF CONDUCTION
HST = HEAT SINK END TEMPERATURE(C) IF CONDUCTION TO KNOWN TEMPERATURE

U-NAME	PML	PMR	PMF	BCL	PBC	CON	HTC	HSA	HST
RP1	OPR	0,280	100	0	0		DEFAULT		
RP2	OPR	0,300	100	0	0		DEFAULT		
RP3	OPR	0,750	100	0	0		12,5000		
RP4	OPR	0,750	100	0	0		12,5000		
RP5	OPR	0,250	100	0	0		DEFAULT		
RP6	OPR	0,250	100	0	0		DEFAULT		
RP7	OPR	0,400	100	0	0		DEFAULT		
RP8	OPR	0,400	100	0	0		DEFAULT		
RP9	OPR	0,400	100	0	0		DEFAULT		
RP10	OPR	0,250	100	0	0		DEFAULT		
TR1	OPR	1,000	100	0	0		DEFAULT	250,0000	
TR2	OPR	1,000	100	0	0		DEFAULT	250,0000	
U2	OPR	1,250	100	0	100	2,1000	DEFAULT		
U3	OPR	0,300	100	0	0		DEFAULT		
U4	OPR	1,250	100	0	100	2,1000	DEFAULT		
U5	MAX	2,000	75	0	0		DEFAULT		
U6	MIN	0,100	100	0	0		DEFAULT		

PCB_DEMO
15:15:17
09/07/99

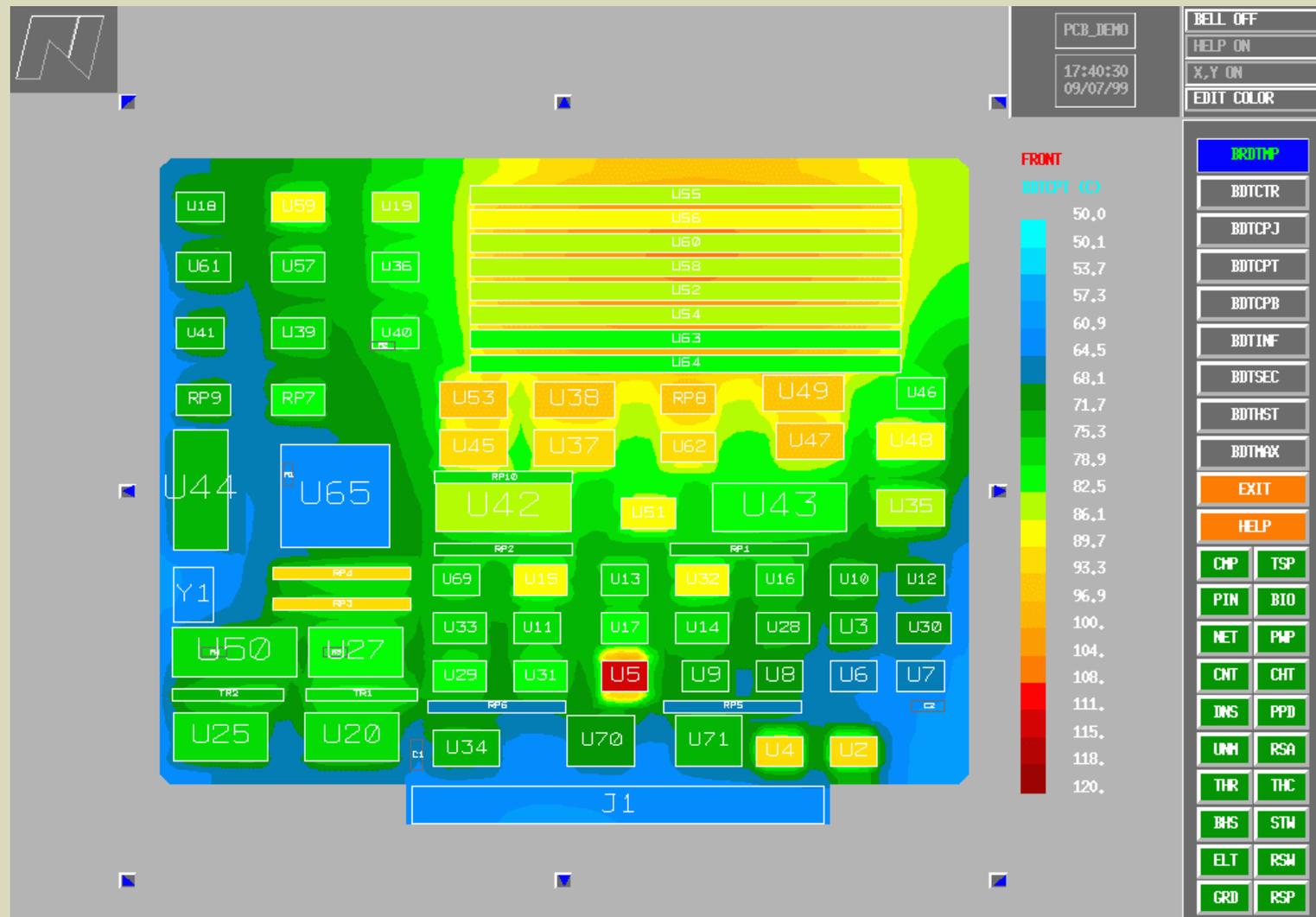
BELL OFF
HELP ON
X,Y ON
EDIT COLOR

THCMP

ANSOFT

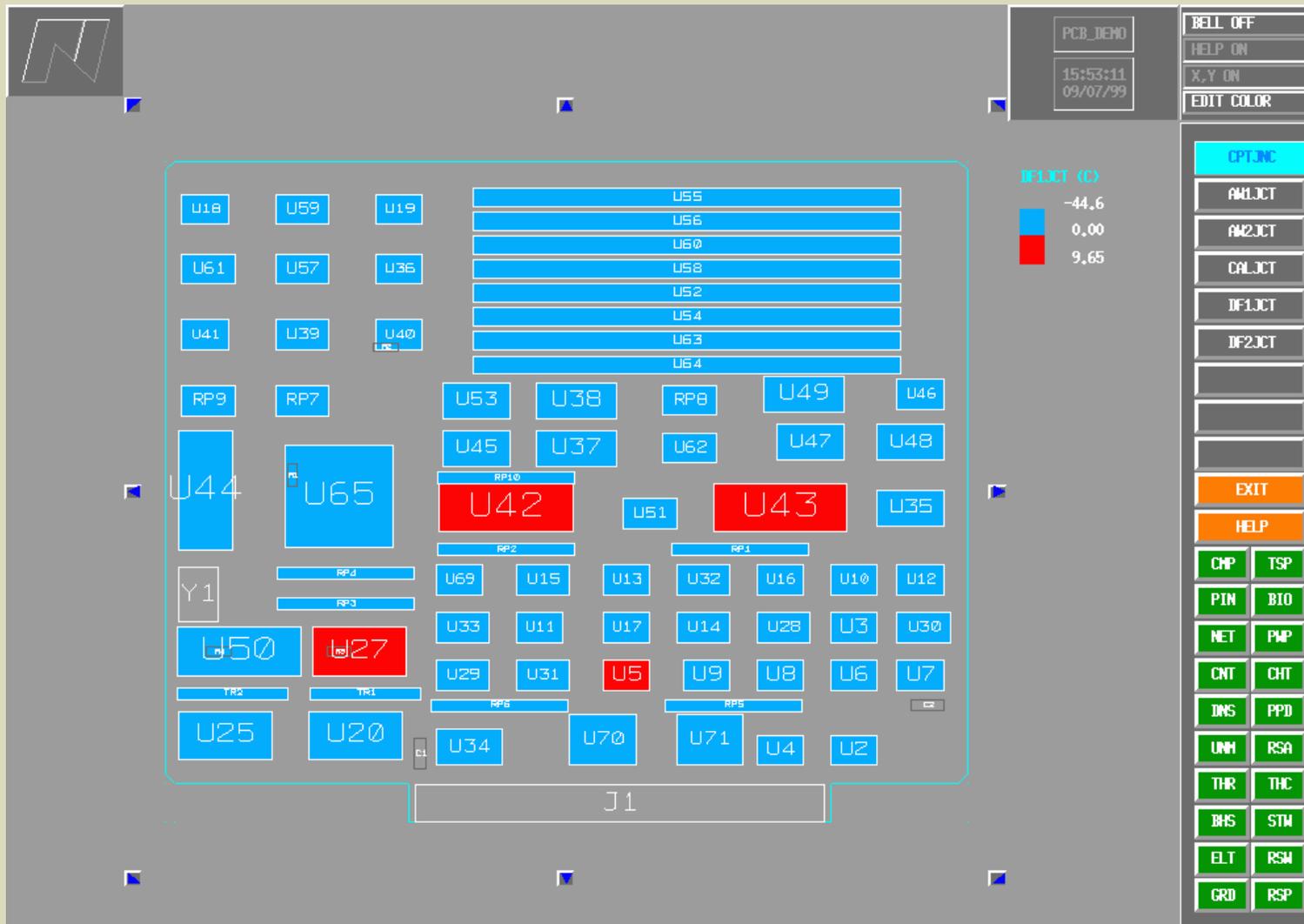
PCB Thermal

熱コンター図: PCBの部品面



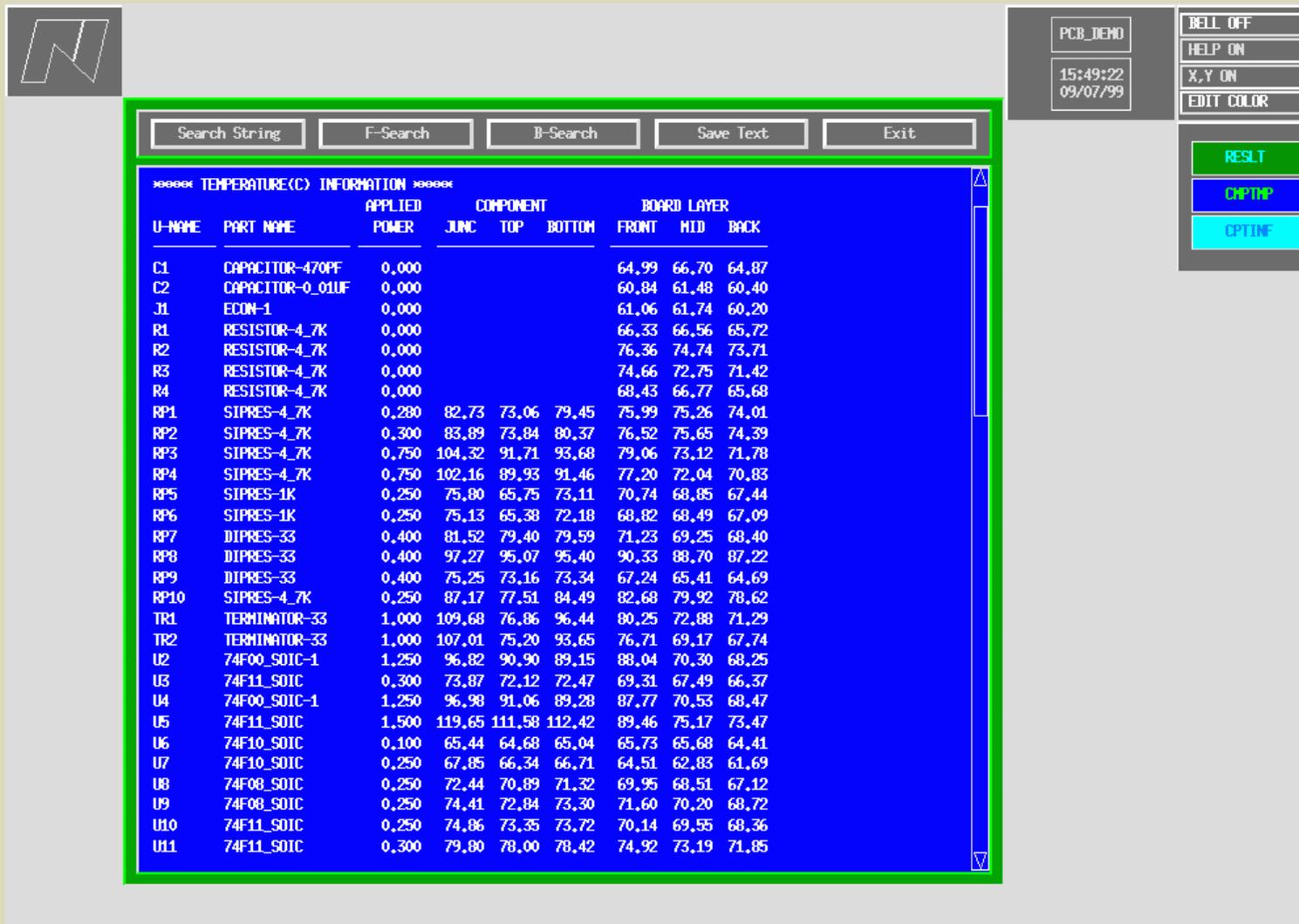
PCB Thermal

設計ルールのチェック: 青 - OK;
赤 - 設定製造条件をオーバー



PCB Thermal

温度情報: PCBと部品のジャンクション温度

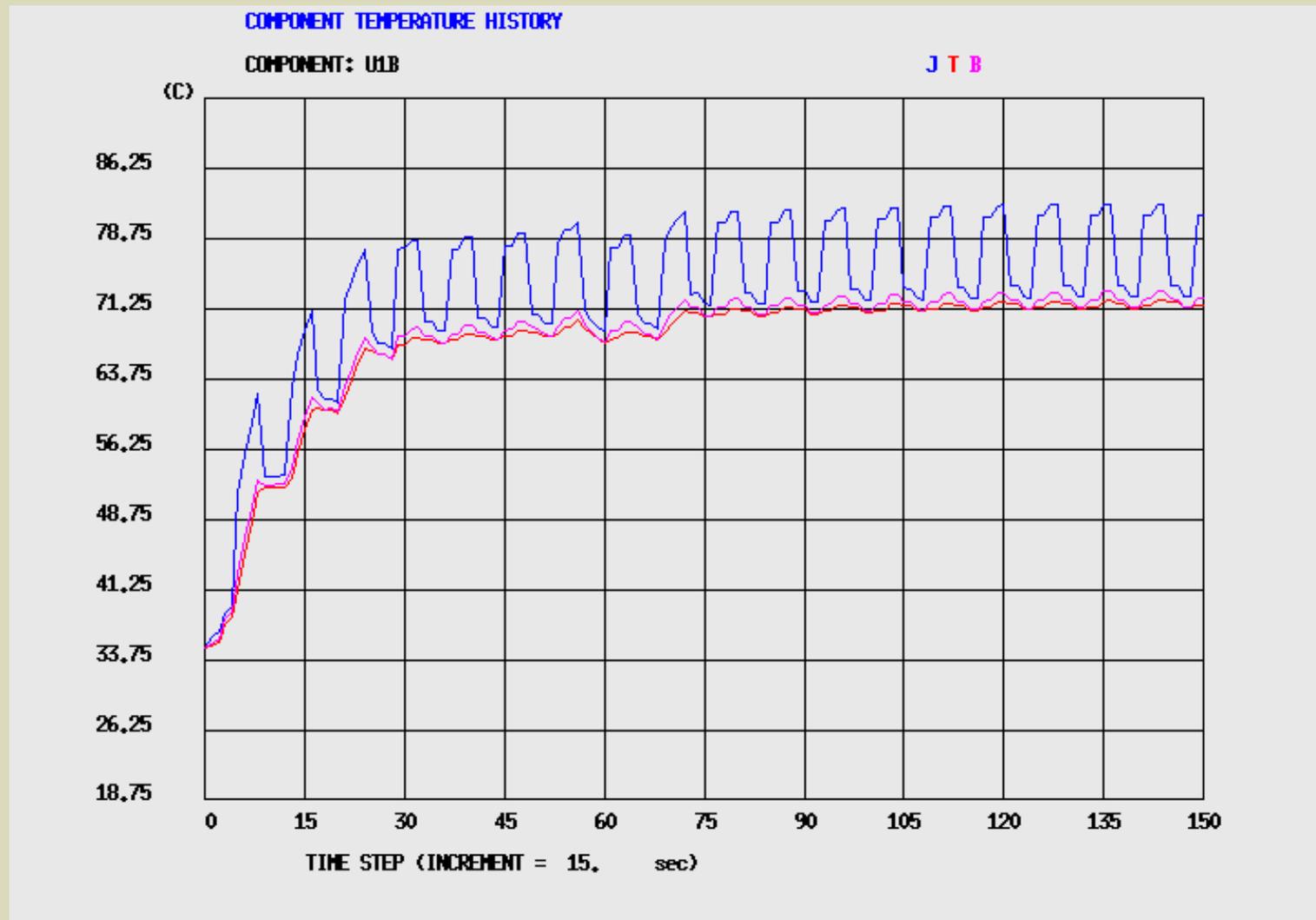


The screenshot displays the ANSYS PCB Thermal software interface. At the top left is the ANSYS logo. The main window shows a table titled "TEMPERATURE(C) INFORMATION" with columns for U-NAME, PART NAME, APPLIED POWER, COMPONENT (JUNC, TOP, BOTTOM), and BOARD LAYER (FRONT, MID, BACK). The table lists 21 components with their respective power and junction temperatures. On the right side, there are control buttons for "BELL OFF", "HELP ON", "X,Y ON", "EDIT COLOR", "RESULT", "CPTINF", and "CPTINF". At the bottom left, the ANSOFT logo is visible.

U-NAME	PART NAME	APPLIED POWER	COMPONENT	BOARD LAYER
			JUNC TOP BOTTOM	FRONT MID BACK
C1	CAPACITOR-470PF	0.000		64.99 66.70 64.87
C2	CAPACITOR-0.01UF	0.000		60.84 61.48 60.40
J1	ECON-1	0.000		61.06 61.74 60.20
R1	RESISTOR-4.7K	0.000		66.33 66.56 65.72
R2	RESISTOR-4.7K	0.000		76.36 74.74 73.71
R3	RESISTOR-4.7K	0.000		74.66 72.75 71.42
R4	RESISTOR-4.7K	0.000		68.43 66.77 65.68
RP1	SIPRES-4.7K	0.280	82.73 73.06 79.45	75.99 75.26 74.01
RP2	SIPRES-4.7K	0.300	83.89 73.84 80.37	76.52 75.65 74.39
RP3	SIPRES-4.7K	0.750	104.32 91.71 93.68	79.06 73.12 71.78
RP4	SIPRES-4.7K	0.750	102.16 89.93 91.46	77.20 72.04 70.83
RP5	SIPRES-1K	0.250	75.80 65.75 73.11	70.74 68.85 67.44
RP6	SIPRES-1K	0.250	75.13 65.38 72.18	68.82 68.49 67.09
RP7	DIPRES-33	0.400	81.52 79.40 79.59	71.23 69.25 68.40
RP8	DIPRES-33	0.400	97.27 95.07 95.40	90.33 88.70 87.22
RP9	DIPRES-33	0.400	75.25 73.16 73.34	67.24 65.41 64.69
RP10	SIPRES-4.7K	0.250	87.17 77.51 84.49	82.68 79.92 78.62
TR1	TERMINATOR-33	1.000	109.68 76.86 96.44	80.25 72.88 71.29
TR2	TERMINATOR-33	1.000	107.01 75.20 93.65	76.71 69.17 67.74
U2	74F00_SOIC-1	1.250	96.82 90.90 89.15	88.04 70.30 68.25
U3	74F11_SOIC	0.300	73.87 72.12 72.47	69.31 67.49 66.37
U4	74F00_SOIC-1	1.250	96.98 91.06 89.28	87.77 70.53 68.47
U5	74F11_SOIC	1.500	119.65 111.58 112.42	89.46 75.17 73.47
U6	74F10_SOIC	0.100	65.44 64.68 65.04	65.73 65.68 64.41
U7	74F10_SOIC	0.250	67.85 66.34 66.71	64.51 62.83 61.69
U8	74F08_SOIC	0.250	72.44 70.89 71.32	69.95 68.51 67.12
U9	74F08_SOIC	0.250	74.41 72.84 73.30	71.60 70.20 68.72
U10	74F11_SOIC	0.250	74.86 73.35 73.72	70.14 69.55 68.36
U11	74F11_SOIC	0.300	79.80 78.00 78.42	74.92 73.19 71.85

PCB Thermal

トランジェント解析: 時間に応じたパワーオンオフ,
境界条件, ヒートシンク, 周囲環境の大気温度



PCB Thermalの優位性

- 定常・過渡解析環境下のPCBと部品温度を予測
- 伝導、対流、放射による熱の変化によるPCB,部品の温度を予測する
- ワット損と境界条件に基づく最適な部品配置とパッケージタイプを検証する
- 部品のヒートシンクとマウンティング要求を検証する